Slide Session
Student Competition
Monday, June 17, 2013, 9:00 am - 10:30 am
Campus Center Room 162

Moderator: Kate Lyden

9:00 – 9:15

Calibration And Cross-validation Of Wrist Worn Actigraph Gt3x+ In Young Preschoolers

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INTRODUCTION: In order to obtain accurate estimates of sedentary time and physical activity in young children objective methods are needed. Wrist worn accelerometers have shown good feasibility among participants in previous studies. The acceleration signal collected by many commercially available activity monitors is usually summarized in an arbitrary unit (counts). Calibration studies are needed to translate activity counts into intensity categories. The placement of the activity monitor may affect the output, thus affecting the validity of the measurement. **PURPOSE:** The aim was to calibrate the Actigraph GT3X+ accelerometer for wrist worn placement in ambulatory young preschoolers by developing intensity thresholds for sedentary, low and high physical activity. Furthermore, to cross-validate the developed thresholds in a sample of young preschoolers and apply the developed thresholds on a sample of free living two year old children. **METHODS:** Wrist worn Actigraph GT3X+ was used to measure physical activity during 30 minutes of structured activities and free play in 38 children (15-36 months). Activity was video recorded and scored based on Children´s Activity Rating Scale (CARS) and combined with accelerometer data on a five second level. To develop intensity thresholds for sedentary, low and high physical activity ROC analysis was performed on data from 26 randomly selected children. The remaining 12 children were used for cross-validation. We applied the developed thresholds on data from 20 free-living children who wore an Actigraph on the wrist for 7 consecutive days.**RESULTS:** Optimal thresholds for sedentary were ≤89 Y-counts and ≤221 VM-counts/5 sec. Optimal thresholds for high physical activity were ≥440 Y-counts and ≥730 VM-counts/5 sec. Sensitivity and specificity was the same for the Y-axis and VM. Sensitivity for the sedentary threshold was 100% and specificity 60%. For the high physical activity threshold sensitivity was 60% and specificity 92,3%. Strong correlations were found between the developed thresholds for the accelerometer and CARS scoring time in sedentary, low and high intensity physical activity. Free-living children were categorized as sedentary for 384 (SD 70,3); low physical activity for 307 (SD 45,7) and engaged in high physical activity for 89 (SD 33,7) minutes per day.**CONCLUSION:**A wrist mounted Actigraph GT3X+ activity monitor can accurately assess sedentary behavior and different levels of physical activity in young preschoolers.

9:15 – 9:30

Day-to-day Differences In Sedentary Behavior In Adults And Adolescents

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INTRODUCTION: Day-to-day patterns of habitual physical activity (PA) have been widely examined. Unlike PA, there is less evidence describing day-to-day variability in sedentary behavior (SB). **PURPOSE:** To determine if there are day-to-day differences in SB in adults and adolescents. **METHODS:** Forty-six adults (age=45.1±16.1 years) and 35 adolescents (age=14.3±1.4 years) wore an activPAL for 7-days. SB was computed from activPAL as percent of monitor wear time spent sedentary (%SED). Linear mixed effect models were used to test for differences in %SED across the seven days and between weekdays and weekend days. Independent t-tests were used to test for differences in the coefficient of variation (CV) between individuals with higher sedentary time ($\geq 50^{th}$ percentile of group) and individuals with lower sedentary time ($<50^{th}$ percentile of group). Separate analyses were conducted for adults and adolescents. Statistical significance was set at $p<0.05$.**RESULTS:** There were no significant differences in %SED between any of the seven days in adults and adolescents. %SED was similar between weekday and weekend days for both adults and adolescents. A significant difference in mean CV was observed between the group with higher sedentary time (adults=11.4±5.07%; adolescents=11.3±3.87%) and the group with lower sedentary time (adults=18.2±9.03%; adolescents=18.0±6.92%)

Table 1. Mean (SD) %SED by day of the week

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
%SED Adult	65.1 (13.49)	65.6 (13.01)	65.4 (13.79)	64.4 (15.52)	61.5 (15.97)	63.1 (16.25)	62.7 (16.66)
%SED Adolescent	68.4 (11.41)	66.0 (12.82)	66.5 (12.10)	68.0 (11.44)	66.7 (14.41)	66.2 (10.58)	65.3 (13.81)

CONCLUSION: These data demonstrate SB is stable day-to-day in adults and adolescents. One important finding was that type of day (weekday *vs.* weekend) did not influence SB. A second finding was that individuals who were more sedentary had lower day-to-day variability in SB. Both of these findings were in contrast to previous data on PA where weekday PA was significantly higher than weekend PA and day-to-day variability in PA was higher with increasing levels of PA. Our data suggest that SB and PA each have their own unique measurement characteristics. Further analyses are required to determine the minimum number of days to reliably estimate habitual SB.

Supported by NIH R01 NR011477

9:30 – 9:45

Predicting Activity Type from Accelerometer Data in Older Adults

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INTRODUCTION: Assessing time spent in different activity types may be important for early detection of mobility limitations in older adults. To date, accelerometer-based activity type prediction using machine learning algorithms have not been validated for this segment of the population. Therefore, the aim of this study was to use Random Forest (RF) models to predict activity type from accelerometer data in older adults.**METHODS:** Thirty-five healthy older adults (mean ± SD age = 70.8 ± 4.9 years) wore 3 ActiGraph GT3X + accelerometers. The monitors were initialized to collect data at 80hz and were positioned on the dominant wrist, hip and ankle. Participants performed one of two activity routines (7 activities each, 5 min/activity) including sedentary (SED), locomotion (LOC), household (HOU), and recreational (REC) activities. Accelerometer data were downloaded and transformed to 1-second epoch data using the Actilife 5 software. For each monitor, the 10th, 25th, 50th, 75th, and 90th percentiles of the vector magnitude counts corresponding to each minute of activity were calculated. These features along with the corresponding activity type label were used to train seven RF models (hip, wrist, ankle, hip + wrist, hip + ankle, wrist + ankle, and hip + wrist + ankle) for prediction of SED, LOC, HOU, and REC activity type. A leave-one-out method was used to test the accuracy of each model.**RESULTS:** Overall accuracy of the RF models in detecting activity type ranged from 82% to 88% using single monitor data, and from 92% to 95% when combining data from two or three monitors. The RF model with the greatest accuracy (hip + wrist + ankle) correctly classified SED, LOC, HOU and REC activities 94%, 99%, 94%, and 91% of the time, respectively.

The confusion matrix for this RF model is shown in the table below.

		Predicted			
		Locomotion	Sedentary	Household	Recreational
Actual	Locomotion	283	0	3	0
	Sedentary	0	137	7	1
	Household	1	13	412	11
	Recreational	1	1	11	133

CONCLUSION: The RF models in this study accurately predicted activity type from a single or multiple accelerometers. Using machine learning models such as the RF method to detect activity type in free-living older adults may be useful for identifying mobility limitations.

Funded in part by NIH R01 CA121005

9:45 – 10:00

Normalization And Extraction Of Interpretable Metrics From Raw Accelerometry Data

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INTRODUCTION: Accelerometers provide objective measurements of human activity and have been used extensively in health studies. In many of these studies, analysis was done not based on the raw data, but on summarized metrics like "activity counts", which are the result of proprietary pre-processing software. Such metrics do not have a clear interpretation and are not comparable between devices or even batches of the same de-vice. Thus, there is a clear and urgent need to introduce data normalization and signal extraction approaches that are transparent and meaningful.**PURPOSE:** The goal of this study was to introduce a transparent and explicit normalization procedure of raw accelerometry data and associated visualization tools. We also propose a series of novel metrics for transforming the large amount of information gathered by accelerometers into simple, meaningful, consistent and reproducible measurements.**METHODS:** The tri-axial raw accelerometry data were first processed and each interval of one second was assigned a label, either "active" or "sedentary". Based on the raw data and the label, 7 metrics were proposed: Wake Time, Time Active, Time Active Mean, Time Active Variability, Cumulative Relative Time Active, Activity Intensity, Activity Intensity Mean, Activity Intensity Variability and Cumulated Relative Activity Intensity. The as-sociation between some of these metrics and the subjects' demographic predictors were studied, using the data from the Baltimore Memory Study (34 subjects, each with 3-5 days of observation).**RESULTS:** Self Reviewed Health, Quality of Life, Age, and Divorced were found to be sig-nificant predictors of both the mean and variability of Time Active and Activity Intensity. Gender was also a statistically significant predictor of those metrics except Activity In-tensity Mean.**CONCLUSION:** The metrics proposed are valid, transparent and reproducible. They are generated following a clear and interpretable approach. The regression analysis demonstrates the validity of the metrics.
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10:00 – 10:15

Inferred Time In Bed Independently Predicts Levels Of Daytime Activity And Sedentary Behavior

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PURPOSE: Increased all-cause mortality has been consistently associated with longer (8-10 hours+) self-reported sleep duration. The possibility that longer sleep may impact survival through inactive lifestyles was proposed by Morgan (2007), and subsequently tested by Hartescu et al (2012) who concluded that, independent of health status, longer sleep duration, and the inevitably longer periods of time spent in bed, could represent inactivity and/or sedentary behavior. It may be possible to infer Time in Bed (TIB: i.e. the time spent in bed irrespective of time spent asleep) from the periods excluded from daytime data collection in instrumental surveys of physical activity. The present analyses explore this possibility and address the question: is inferred TIB predictive of daytime activity/sedentary behavior levels?
METHODS: Profiles of health and physical activity were obtained from a random community sample of 1917 adults aged 25+ assessed for the 2008 Health Survey for England. Sedentary time and medium-vigorous physical activity (both in minutes/day) were calculated from accelerometer data over a 7-day period. The 1 minute epoch Actigraph GT1M accelerometer data was analysed using KineSoft version 3.3.75. Only those who had valid accelerometry data for at least 1 day (i.e., at least 10 hours of wear) were included. Time in Bed (TIB) was inferred from accelerometer "non-wear" periods (devices were removed at bedtime, and replaced at waking time). To assess the strength of associations between sleep and daytime variables separate regression models were fitted with sedentary time (Model 1) and moderate-vigorous activity (Model 2) as dependent variables. In both models, TIB, age, sex, BMI, health status, and mental health were entered as covariates.**RESULTS**: The modal inferred TIB duration was 600 minutes. In the adjusted regression models, longer inferred TIB duration was significantly associated with lower levels of medium-vigorous physical activity ($r^2 = 0.17$, $F(6, 1910) = 66.66$, $p<0.01$), but also with significantly lower levels of daytime sedentary behavior ($r^2 = 0.13$, $F(6, 1910) = 49.08$, $p<0.01$).**CONCLUSION:** While the explained variance is modest, longer TIB emerged as a significant predictor of both physical activity and sedentary behavior. The directionality of these relationships, however, indicates that lower PA, rather than higher levels of sedentary behavior may be contributing to TIB-mortality relationships, supporting the use of this proxy measure as an analogue of TIB. Confirmation of these findings will be required, but the consistency of the present findings supports the use of non-wear or "non-recording" time as a proxy for time spent in bed.

10:15 – 10:30

Machine Learning To Predict Energy Expenditure And Type Of Physical Activity From Accelerometer And Heart Rate Data

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PURPOSE: Wrist accelerometers are being used in population level surveillance (i.e. NHANES) of physical activity (PA) but more research is needed to evaluate the validity of a wrist-worn device for predicting PA. In this study we compare accelerometers worn on the wrist and each hip for predicting PA type and energy expenditure (EE) using machine learning algorithms. We also investigate the added value of including heart rate (HR) data in making predictions.**METHODS:**Forty adults (21 women, 19 men; mean age = 35.8 ±12.1 yrs; BMI = 24.8 ± 2.9) performed 8 locomotion and household activities for 6 minutes in a lab setting. Participants wore three ActiGraph GT3X+ accelerometers (left hip, right hip, non-dominant wrist), a HR monitor (Polar RS400), and a portable indirect calorimeter (COSMED K4b2). METs were computed for each minute of ventilatory data and 154 features were extracted from each minute of accelerometer data. HR (beats per minute) was used as an additional feature. We developed two different predictive models: a random forest classifier to predict activity type from these features and a random forest of regression trees to estimate EE. Predictions were evaluated using leave-one-user-out cross-validation.**RESULTS:**For predicting four activity types (household, stairs, walking, running), the hip accelerometer obtained 88.9% accuracy while the wrist accelerometer obtained 82.0% accuracy. Combining data from multiple accelerometers or including HR did not significantly improve these results. In predicting all 8 activities (laundry, window washing, dusting, dishes, sweeping, stairs, walking, running), the (left) hip and wrist accelerometers alone obtained 69.0% and 74.2% accuracy, respectively. Combining hip and wrist data led to 80.0% accuracy, but adding HR did not significantly improve results. Predicting METs using the (left) hip or wrist devices alone obtained root mean square errors (rMSE) of 1.138 and 1.249, respectively. Including HR data and multiple accelerometers improved MET estimation (rMSE = 1.061 with combined wrist, left hip and HR). There was no significant bias. **CONCLUSION:**Results demonstrate the validity of random classification and regression forests for activity type and MET prediction using accelerometers. The wrist accelerometer was more useful in predicting activities with significant arm movement (e.g., household activities), while the hip accelerometer was superior for predicting locomotion and estimating EE. Results also demonstrate that HR data does not significantly improve activity classification but does improve MET estimation.

Slide Session
Sedentary Behavior
Monday, June 17, 2013, 9:00 am - 10:30 am
Campus Center Room 163

Moderator: Phillipa Dall

9:00 – 9:15

Time Spent in Different Domains of Sitting and their Associations with Cardio-Metabolic Health

Charlotte Edwardson[1], Trish Gorely[2], Thomas Yates[3], Emma Wilmot[4], Kamlesh Khunti[4], Melanie Davies[4], Myra Nimmo[1], Stuart Biddle[1]. *[1]Loughborough University, Loughborough, United Kingdom.[2]Stirling University, Stirling, United Kingdom.[3]University of Leicester, Leicester, United Kingdom.[4]Leicester Diabetes Centre, University of Leicester, Leicester, United Kingdom.*

INTRODUCTION: Evidence suggests that sedentary behaviour (sitting) is detrimental for health and this association may be independent of physical activity levels. Most studies however, have focused on TV viewing with little consideration for the other ways in which sitting is accumulated such as during leisure, work or transportation.**PURPOSE:** The purpose of this study was to explore time spent sitting in different domains and their association with cardio-metabolic health.**METHODS:** Baseline data from the Sedentary Time and Diabetes (STAND) randomised controlled trial were analysed. Overweight and obese adults (N = 149, 67% female, mean age 32.8 ± 5.7 years, mean BMI 34.6 ± 5.0kg/m2) completed a questionnaire assessing time spent sitting during five domains (travel, work, TV, computer and leisure). Fasting plasma glucose, 2-h plasma glucose (measured using an oral glucose tolerance test), waist circumference, body fat percentage, blood pressure, triglycerides, total cholesterol and high-density-lipoprotein (HDL) cholesterol were measured. Forced entry linear regression models examined the associations of sitting time (in five different domains) and metabolic risk variables. **RESULTS:** Participants spent 81.7 (± 91.6) minutes sitting during travel, 203.4 (± 149.4) minutes sitting at work, 183.5 (± 96.4) minutes sitting watching TV, 101.1 (±86.7) minutes sitting using a computer at home and 110.6 (± 88.1) minutes sitting for leisure (not including TV). After adjustment for confounders (age, gender, ethnicity, index of multiple deprivation and moderate-to-vigorous physical activity) time spent sitting watching TV was positively associated with measures of adiposity (body fat percentage (β =0.15, p = 0.024) and BMI (β = 0.24, p = 0.007)), time spent sitting during work and leisure were positively associated with waist circumference (β = 0.26, p = 0.036; β = 0.24, p = 0.006).**CONCLUSION:** Using a domain specific sitting questionnaire reveals relationships between certain domains of sitting and measures of adiposity (body fat percentage, BMI and waist circumference) but no associations with other measures of cardio-metabolic health. These results support the potential benefit of assessing multiple domains of sedentary time.

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9:15 – 9:30

Congruency of Motion Sensors to Detect Change following a Sedentary Behavior Intervention

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INTRODUCTION: Time spent in sedentary behavior (SB) has deleterious effects on health. As a result, there is a strong scientific need to evaluate methods to assess SB. PURPOSE. To determine responsiveness of two motion sensors to detect change in free-living, occupational SB during an intervention to decrease sitting activity. **METHODS:** Adults who spent > 60% of their working day sitting were recruited to participate in an intervention to reduce SB at work. SB was assessed using two accelerometers, an Actigraph GTX3 (AG) worn on a belt, at the midline of the right thigh, and an activPAL (AP) affixed to the middle of the right thigh. SB was assessed during working hours for three consecutive days (baseline) and during the same three days the week following while undergoing the intervention (post). Data from both motion sensors were time-matched to allow direct comparison. SB was determined from time spent sitting/lying by AP and time below 100 cts/min, using 60-s epochs by AG. Pearson correlation coefficients were calculated to determine strength of association between the measures. Difference between AP and AG measures of SB at baseline and post were compared with paired samples t-test. Baseline-post intervention difference scores were compared using paired samples t-tests. **RESULTS:** Sixty-seven adults (45.3 ± 11.2y; 29.2 ± 7.7 kg/m2) completed the intervention. At baseline, participants spent approximately six of their eight working hours in sedentary activities. Time spent in SB as assessed by AG and AP were correlated (baseline: $r=0.64$, $p<0.001$; post: $r=0.5$, $p<0.001$). Measures of SB differed between AP and AG at baseline (AP 355.6 ± 11.0 min; AG 386.8 ± 8.2 min; $p<0.001$) and post assessment (AP 337.3 ± 10.8 min; AG 368.8 ± 7.7 min; $p=0.002$). Baseline-post AP difference scores (16.5 ± 6.8 min) were not significantly different than baseline-post AG difference scores (16.2 ± 5.6 min, $p=0.56$). **CONCLUSION:**Results reveal that both the AP and AG were able to assess responsiveness to change following a SB intervention to a similar degree. However, the AP and the AG significantly differed in their baseline and post assessment of time spent in SB.

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9:30 – 9:45

Objectively Determined Light Intensity Physical Activity Is Negatively Associated With Adiposity In Adolescent Females

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INTRODUCTION: International guidelines have focused on the promotion of daily Moderate to Vigorous Physical Activity Time (MVPA) to reduce the incidence of inactivity related disease. No precise guidelines are provided for Light Intensity Physical Activity Time (LIPA). Previously, LIPA has been estimated using a sedentary count threshold. Simultaneous measurement of posture and ambulation enables the accurate categorisation of LIPA, allowing resultant relationship to adiposity measures to be explored.**PURPOSE:** To examine the relationship between Sitting/Lying Time (SLT), Standing Time (ST), LIPA (excluding ST), and MVPA with adiposity measures in a cohort of adolescent females.**METHODS:** A sample of 192 adolescent females (mean age: 15.7 yrs. (range: 13.1-18.7), mean BMI percentile: 62nd (1st-98th) were included in this analysis. Body Mass Index (BMI) was calculated from height and weight. Skinfold measurement from bicep, triceps, subscapular and iliac crest sites were summed (Σ Skinfolds (cm)). The activPAL^{TM} (an inclinometer-based activity monitor) was worn for 7 days and minutes spent in SLT and ST were estimated from activPAL output based on upper thigh inclination. A validated threshold of 2997 activPAL counts/15s^{-1} epoch was used to determine minutes of MVPA (Dowd et al., 2012; PLoS One, Vol. 7 (10), e47633). All remaining time was quantified as LIPA. Mean daily LIPA was divided into quartiles, with <4.5% and >6.4% of waking hours defining the lower and upper quartiles respectively. Linear Regression Analyses (LRA) examined associations between activity variables and adiposity, adjusting for age and MVPA. Odds ratios of being overweight/obese (BMI ≥85th percentile) or in the upper quartile of Σ Skinfolds (>81.5 cm) were calculated using logistic regression, adjusting for age and MVPA.**RESULTS:** Participants spent 9.7 (± 1.1) hrs. in SLT (66.2%), 3.3 (± 0.8) hrs. in ST (22.8%), 0.8 (± 0.2) hrs. in LIPA (5.6%) and 0.9 (± 0.3) hrs. in MVPA (6.1%). Partial correlations were found between LIPA and both BMI (r=-0.25: p<0.01) and Σ Skinfolds (r=-0.25: p<0.01), while LRA indicated that LIPA significantly predicted BMI (Beta = -0.25, p<0.01) and Σ skinfolds (Beta = -0.25, p<0.01). Compared to participants in the highest LIPA quartile, participants in the lowest quartile had greater odds of being overweight/obese (odds ratio [OR] 5.13, 95% CI 1.53-17.44) and of having higher Σ Skinfolds (OR 3.75, 95% CI 1.22-11.53).**CONCLUSION:** A relationship exists between LIPA and measures of adiposity in this sample, even after controlling for age and MVPA. Increasing LIPA by reducing SLT may represent a useful target for interventions to improve adiposity markers.

9:45 – 10:00

Comparison Of International Physical Activity Questionnaire (ipaq) With Inclinometry (activpal) For Measuring Sitting Time

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INTRODUCTION: Too much time spent sitting has been identified as a public health risk, independent of a lack of physical activity. While objective measures of sitting time and sedentary behaviour are becoming more widely used, self reported measures of sitting time are still the most pragmatic and frequently used solution for population surveillance. The International Physical Activity Questionnaire (IPAQ) is a widely used self reported measure, and includes items assessing sitting time. These items were deemed approximately as valid and reliable as sitting time measured objectively with an Actigraph. However, it is accepted that using the Actigraph as a criterion measure does not provide a true measure of sitting, and it has recently been recognised that inclinometers such as activPAL offer a more valid and accurate objective measure of sitting time.**PURPOSE:** To compare the accuracy of the IPAQ sitting time item against a robust objective measure of sitting time (activPAL).**METHODS:**A convenience sample of volunteers (N=80; 25 to 62 years old) were recruited from the general population of Glasgow. They wore an activPAL activity monitor continuously for 7 days. At the end of this period the participants completed the IPAQ sitting items detailing the time spent in sitting during week and weekend days. The activPAL data were processed to identify sitting periods and total sitting time over the same periods for each individual. IPAQ and activPAL data were compared using intraclass correlation coefficients (ICC), Pearson correlation and Bland Altman analysis for sitting time over the total week, week days and weekend periods.**RESULTS:** Correlation between IPAQ and the criterion objective measure is very low (total week ICC=0.11, week days ICC=0.16, weekend ICC=0.28) and no statistically significant linear correlations were found. The Bland Altman revealed that sitting time was consistently underestimated by IPAQ. This error was systematic across the range of objectively measured sitting time for the total week (mean = 3.39 h/day, CI [0.56 6.21]) and for the weekend (mean = 4.64 h/day, CI[1.24 8.03]). For week days the mean difference was 3.43 h/day (CI [0.62 6.25]), but showed a trend, inversely proportional to the amount of sitting suggesting that the error is relative to the total amount of time spent sitting.**CONCLUSION:** The sitting items of IPAQ are a poor measure of sitting time in terms of accuracy. They underestimated true sitting time, which suggests that population surveys based on IPAQ might also be underestimating the prevalence of sitting time. However due to the systematic nature of the error it might be possible to develop corrections for the IPAQ items.

10:00 – 10:15

Validity of Automated Estimation of Worn Waking Time for ActivPAL Data

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INTRODUCTION: Automated estimation is a low-burden method to estimate accelerometer non-wear that is essential for large-scale studies. However, no published research to date demonstrates the validity of automated estimation algorithms for activPAL data. Removing non-wear and sleep from activPAL data has required the use of self-report data or untested approaches, such as assuming the longest bout of sitting/lying each day is sleep and assuming periods of at least 60 minutes of zero acceleration are non-wear.**PURPOSE:** Using baseline data from a workplace sitting intervention, we compared several automated estimation algorithms with self-reported worn waking time.**METHODS:**Office workers (n=43) were asked to wear activPALs continuously for seven days and report their sleeping and removal times in a diary. For the referent assessment method, each bout from the activPAL events files was classified as awake (or asleep) and removed (or worn) depending on whether or not most (i.e., >=50%) of the bout fell into those classifications according to self-report. Six different automated estimations were implemented and compared with the referent assessment method: at least 60, 90, 120, 240 and 360 minutes of continuous sitting/lying and at least 60 minutes of continuous zero acceleration. Bland-Altman analysis assessed agreement in daily worn waking time and Kappa assessed agreement of the wear classification of each bout. As misclassification is most problematic for the longest bouts, Kappa was assessed with weighting for bout duration (in minutes).**RESULTS:**Prolonged zero acceleration classified all time as worn waking time. The smallest mean differences [95% Limits of Agreement] in daily worn waking time against the referent method were provided by 60 and 90 minutes of continuous sitting/lying (-31 [441, 379] and 41 [-350, 433] minutes, respectively). The best agreement in wear classification was provided by 90 and 120 minutes of continuous sitting/lying (Kappa [Standard Error] = 0.75 [0.03] and 0.75 [0.04], respectively).**CONCLUSION:** Automated estimation of worn waking time based on prolonged sitting/lying may be useful for large-scale studies employing activPALs, with 90 minutes being the most supported minimum non-wear period. The level of accuracy is acceptable and comparable to automated estimation with other accelerometer data. Wider validation in more general populations is needed.

Grant funding: This study was funded by an NHMRC project grant [#1002706], with additional financial support from the Victorian Health Promotion Foundation.

10:15 – 10:30

Assessment Of Sedentary Behaviours, Activity And Sleep With A Wrist-worn Accelerometer; Introducing The Sedentary Sphere

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BACKGROUND: There is a need for an unobtrusive, objective method that enables the assessment of sedentary behaviour, physical activity and sleep concurrently in free-living individuals.**PURPOSE:** The aims of the present study were: a) to determine whether a wrist worn accelerometer can provide valid measures of sedentary time, activity and sleep and b) to explore a novel method for the analysis, identification and visual presentation of sedentary behaviours, the Sedentary Sphere.**METHODS:** Thirteen adults (age (mean±SD) 34.5±13.2 y) wore a GENEActiv on their wrist and an ActivPAL on their thigh for 24 h. The next day they completed the Multimedia Activity Recall for Children & Adults (MARCA), a computerised use of time instrument. Posture was determined from the GENEActiv and ActivPAL data. Time classified as sleep, sedentary, and moderate-to-vigorous activity (MVPA) was determined from the GENEActiv and the MARCA. GENEActiv data were plotted on the Sedentary Sphere. **RESULTS:** Sitting time, determined by the GENEActiv (995±128 min), correlated positively with and did not differ significantly from ActivPAL sitting time (1015±99 min), ($r = 0.85$, $p < 0.001$). Intra-individual classification agreement across 15 s epochs was 83.9±7.6% (mean kappa = 0.63 ± 0.29). Time classified as sleep and MVPA by the GENEActiv correlated with the corresponding time reported in the MARCA ($r=0.71$, $r=0.70$, $p < 0.05$, respectively). Intra-individual sleep classification agreement between the GENEActiv and MARCA for 5 min periods was 89.8±5.5% (mean kappa = 0.77±0.42). GENEActiv acceleration data were plotted in 3 dimensional space. When sedentary, gravity provided the primary signal allowing wrist elevation (latitude) and rotation (longitude) to be determined. Periods of consecutive points formed distinct clusters which could be differentiated by their position and distribution. These clusters corresponded to specific behaviours with the sedentary behaviours distributed on the surface of a sphere of radius 1g determined by gravity within the signal. Where behaviours included significant levels of acceleration (i.e. they were active and non-sedentary) the clusters were differentiated by points that departed substantially from the surface of the sphere. **CONCLUSION:** The wrist-worn GENEActiv is an unobtrusive device that can simultaneously assess physical activity, sedentary behaviour and sleep. Concurrent validity with accepted measures of each outcome is good. The Sedentary Sphere can be used to classify sedentary behaviours; location on the surface of the sphere is indicative of posture and movement away from the surface represents the amount of energy of a movement.

Slide Session

Behavior and Health Outcomes

Monday, June 17, 2013, 2:00 pm - 3:00 pm

Campus Center Room 163

Moderator: Stuart Biddle

2:00 – 2:15

Contemporaneous Assessment Of Physical Activity, Sedentary Behavior And Sleep Using An Actigraph GT3X+ Accelerometer

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INTRODUCTION: Physical activity (PA), sedentary behavior (SB) and sleep form the behavioral tripartite of energy expenditure and appear inter- and independently related to cardiometabolic disease and cancer. The ability to collect valid data on all three behaviors contemporaneously using one type of accelerometer is important because it may improve our understanding of behavioral inter-relationships while lowering research costs and participant burden. **PURPOSE:** (i) Examine the feasibility of using an ActiGraph GT3X+ accelerometer to measure PA, SB and sleep during 7 days and 7 nights of continuous monitoring; (ii) measure the day-to-day variability in PA, SB, and sleep habits, and (iii) examine associations between PA, SB and sleep. **METHODS:**Twenty three women (mean age = 54.7 ±15.5 yrs; BMI = 31.8 ±3.4) wore an ActiGraph GT3X+ accelerometer on their hip for 7 consecutive days during waking hours, and the same device on their non-dominant wrist 24 hr/day for 7 days. PA and SB data were scored using validated cut-points (SB = <100 counts per min [CPM]; moderate intensity PA = 1952-5724 CPM; vigorous PA = >5724 CPM. Non wear time was defined as 90 consecutive minutes of zero count data. Sleep data were scored using the Cole-Kripke algorithm in ActiLife v6.5.1. Self-reports of bedtime and out-of-bed time were used to establish the sleep analysis window for each actigraphy file. **RESULTS:** Compliance to wearing the hip-mounted device for the full monitoring period was 83% (mean wear time = 5.8±1.3 days, 13.4±1.8 hr/day). Compliance to wearing the wrist-device was 102% (7.13 ±0.87 nights). Across all participants, 133 days of matched PA, SB and sleep data were collected. The within-person daily stability (intraclass correlation, R) of SB and moderate-to-vigorous PA was 0.78 and 0.86, respectively. The nightly stability of sleep parameters were R = 0.93 (Total Sleep Time), 0.89 (Sleep Efficiency), 0.13 (Sleep Latency), and 0.84 (Wakefulness After Sleep Onset). Daily PA and SB were not significantly associated with subsequent nightly sleep parameters (range, r = -0.2 to 0.1), although associations were stronger (range , r = -0.45 to 0.33) when weekly averages were used. **CONCLUSION:** It is feasible to collect PA, SB and sleep data contemporaneously using an ActiGraph GT3X+ accelerometer. A 5-7 day monitoring period was sufficient to yield stable estimates of all measured variables, except sleep latency. Future research should attempt to examine associations between PA, SB and sleep in a larger sample and validate the use of the GT3X+ for sleep assessment using polysomnography.

This study was supported by funding from the NIH/National Cancer Institute (TREC 1U54 CA155435-01)

2:15 – 2:30

MvpaAnd Sedentary Behavior In Community Dwelling Older Men Measured By Accelerometer

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PURPOSE: The 2010 physical activity (PA) guidelines for older adults in the UK include a target of 150 minutes of moderate or vigorous PA (MVPA)/week and recommend minimizing time spent being sedentary in extended periods. There are few large studies of objectively measured PA in the elderly which can estimate the prevalence and predictors of adherence to PA guidelines which are likely to provide health benefits. We therefore investigate prevalence of adherence to MVPA guidelines using two thresholds for PA bouts and describe levels of SB, among older men.**METHODS:** In 2010-2012, 3292 British men aged 70-93 years participating in an on-going population-based cohort study recruited from primary care centres in 24 British towns were invited (by post) to wear an Actigraph GT3X accelerometer over the hip for 7 days and complete questionnaires. Uniaxial data were analysed in 60s epochs. Bouts of >120 minutes of continuous zeros with no interruptions were excluded. >=3 valid days (of >=600 minutes wear time) were required for inclusion in analyses. Cut point thresholds were <100 (sedentary behavior), 100-1951 (light) and >=1952cpm (MVPA), in bouts of 1 minute (MVPA-1) or bouts of >=10 minutes (MVPA-10+). Logistic regression models were used to model MVPA and adjusted for age, region, day order, month and accelerometer wear time.**RESULTS:** 1674 (51%) men participated, mean age 78 years. 7% men did MVPA-10+, and 27% did MVPA-1. Achieving MVPA-10+ was associated with younger age, having no mobility limitations (OR 8.4, 95%CI 2.05, 34.37) and no chronic diseases (OR 2.06, 95%CI 1.38, 3.06), not being depressed (OR 4.87, 95%CI 2.10,11.25) or fearful of falling (OR 3.45, 95%CI 1.48, 8.63), having higher exercise self-efficacy (OR 2.72 95%CI 2.07, 3.56) and outcomes expectations (OR 1.88 95%CI 1.53, 2.32), leaving the house >=5 days/week (OR 3.62 95%CI 1.45,9.05), living near green spaces (OR 1.67 95%CI 1.13,2.47) and walking a dog (OR 2.28 (95%CI 1.39, 3.73). In models adjusted for all covariates, exercise self-efficacy and dog walking remained significant and little changed. The same variables were associated with achieving MVPA-1. Total daily minutes of MVPA and SB were weakly inversely correlated (r=-0.20). Mean total SB was 658 (SD 112) mins/day, of which 156 (SD 125) were spent in bouts of 60 minutes or more.**CONCLUSION:** Adherence to MVPA guidelines is low in older men (varying 7-27% depending on assumptions) and burden of SB is high, leaving room for substantial potential health gain. Poor mental and physical health were important barriers and important modifiable facilitators were dog walking and high levels of exercise self-efficacy.

Funding: NIHR Post Doctoral Fellowship

2:30 – 2:45

Sustained vs. Shorter Bouts of Physical Activity and Cardiovascular Health

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INTRODUCTION: Physical activity is known to prevent cardiovascular disease (CVD). However, the relative importance of accumulating physical activity in sustained bouts versus shorter bouts in terms of CVD risk is yet to be determined.**PURPOSE**: The aim of this study was to investigate the relationship between moderate-to-vigorous physical activity (MVPA), measured in bouts ≥10 minutes and <10 minutes, and CVD risk factors in a nationally representative sample of adults.**METHODS:** A sub-sample of adults (aged ≥ 16 years) from the 2008 Health Survey for England with valid accelerometry data for at least 1 day (i.e. ≥ 10 hours of wear time) were included in the study (N = 2353). The one minute epoch ActiGraph GT1M accelerometer data was analysed using KineSoft version 3.3.75. Total MVPA, MVPA accumulated in bouts ≥10 minutes (MVPA10+), and MVPA accumulated in bouts <10 minutes (MVPA<10) were calculated (Troiano et al. 2008). MVPA exposures were related to individual CVD risk factors, including measures of adiposity (BMI & waist circumference), blood cholesterol (Total and HDL), systolic and diastolic blood pressure, and HbA1c, using linear regression (controlling for age, sex, and accelerometer wear time). All statistical analyses were conducted using SPSS version 20. **RESULTS:**The mean age of the participants was 51.6 years, 55% female, with a mean BMI of 27.5 kg/m2. Total MVPA was significantly associated with lower waist circumference and higher high-density lipoprotein (HDL) levels, (P<0.0001). None of the other CVD risk factors were significant. MVPA10+ also showed statistically significant associations with these two CVD risk factors (P <0.001). However, MVPA<10 was not significant for HDL and the significance level for waist circumference dropped to (P<0.003).**CONCLUSION:**Our cross-sectional observations on a large nationally representative sampleconfirm a positive association of MVPA with a healthier CVD risk factor profile. However, these data suggest that health benefits of MVPA in terms of HDL cholesterol, are only realized when sustained bouts are accumulated. That said, for waist circumference these data indicate that accruing MVPA in bouts <10 minutes may favourably influence CVD risk. Additional investigations are warranted to confirm these findings.

2:45 – 3:00

Intra-Day Physical Activity Patterns in Young and Older Adults

Stephen A. Foulis, Teresa O'Brien, Anita Christie, Jane A. Kent-Braun. *University of Massachusetts, Amherst, MA.*
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INTRODUCTION: While many studies report lower daily physical activity (PA) in older compared with young adults, few have focused on how PA patterns may vary over the course of a day. Our working hypothesis is that older adults who report fatigue may adjust their behavior such that they accumulate relatively more of their PA early in the day. **PURPOSE:** Our purpose was to develop and test a method to quantify intra-day PA behavior, based on accelerometer data, in young and older adults. We also explored the association between PA and symptomatic fatigue. **METHODS:** Accelerometer data were collected from 22 Young (22.9 ± 0.5 yr, mean ± SE; 12 Male, 10 Female) and 21 healthy Older (73.0 ± 1.3; 9M, 12F) adults. Young and older groups were matched for total daily PA. An accelerometer (Actigraph GT1M, Pensacola, FL) was worn at the hip during waking hours for 10 days; activity was recorded in 60s epochs. A survival curve analysis (Mathworks, Natick, MA) was used to quantify the timing (relative to wear time) of PA use (relative to total daily counts) over the course of each day. The relative time remaining in the day when PA had accumulated to 25%, 50%, and 75% of daily total (*Time*$_{PA25}$, *Time*$_{PA50}$, and *Time*$_{PA75}$, respectively) was calculated. In a subset of 12 Older adults, symptomatic fatigue was evaluated using the Multidimensional Fatigue Inventory (MFI; Smets et al, 1995). **RESULTS:** Total PA did not differ between groups, nor did *Time*$_{PA25}$. However, *Time*$_{PA50}$ and *Time*$_{PA75}$ were higher in Older, indicating that they completed a greater percentage of their daily PA earlier in the day than Young. In the older subset, MFI was correlated with PA_{50} and PA_{75} ($r \geq 0.78$, $p < 0.01$), such that those with greater fatigue completed a higher percentage of their PA earlier in the day.

	Total Counts *(cts·day·1000^{-1})*	*Time*$_{PA25}$ *(% day remaining)*	*Time*$_{PA50}$ *(% day remaining)*	*Time*$_{PA75}$ *(% day remaining)*
Young	*213 ± 14*	*74.7 ± 1.3*	*55.4 ± 1.3*	*35.3 ± 1.3*
Older	*227 ± 22*	*76.9 ± 1.5*	*61.0 ± 1.9*	*42.3 ± 1.9*
p-value	*0.61*	*0.27*	*0.02*	*<0.01*

CONCLUSION: These results illustrate the utility of this new approach, and suggest that older adults of comparable total PA accumulate their PA earlier in the day than do young adults. We also provide preliminary evidence that this shift may be associated with fatigue in older adults, supporting the possibility that these individuals may tire early and become sedentary during the latter part of their day.

Support: NIH R01 AG21094

Slide Session

Gait and Fall Detection

Monday, June 17, 2013, 2:00 pm - 3:00 pm

Campus Center Room 162

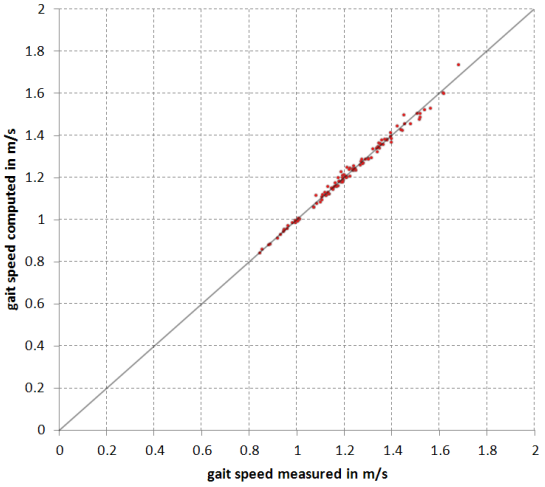
Moderator: Malcom Granat

2:00 – 2:15

Assessing the Accuracy of Accelerometry to Measure Gait Speed

Klaus-Hendrik Wolf[1], Michael Marschollek[2], Andreas Hornberger[1], Matthias Gietzelt[1]. *[1]TU Braunschweig, Braunschweig, Germany.[2]Hannover Medical School, Hannover, Germany.*

PURPOSE: Gait speed is a predictor of several health-related conditions, e.g. dementia and it is even a measurement of rehabilitation processes [1]. In theory, it is possible to measure gait speed using accelerometry.**METHODS:** We conducted a study to measure gait speed with a single waist-mounted accelerometer. The study took place during a public science presentation show in order to reach a broad spectrum of participants [2]. The participants were asked to walk 20 m at self-selected speed. They wore an accelerometer, which was cased in a belt bucket. Simple statistical parameters were computed on the Euclidian norm of the tri-axial accelerometer signal. The Euclidian norm was chosen, because this parameter is orientation-invariant. A quadratic regression analysis was used to compute gait speed from the data.**RESULTS:** A heterogeneous sample of 111 healthy subjects was analyzed (50 female). The subjects were 49.1 ± 23.9 years old (range 7 to 86), their body weight was 68.1 ± 17.6 kg (range 20 to 104), and their height was 168.1 ± 14.2 cm (range 115 to 190). Age did not correlate with walking duration, dur, (r=0.23) or the measured gait speed (r=-0.24). The regression analysis eliminated all parameters except for dur and variance var:speed = 0.00253•dur² - 0.14866•dur - 0.02901•dur•var + 0.08308•var² + 0.85146•var + 2.94126A 10 fold cross-validation showed a coefficient of correlation of 0.9887 and a mean absolute error of 0.024. Figure 1 shows the result of applying the formula to the sample.**CONCLUSION:** We showed that gait speed can be computed from orientation-independent accelerometric parameters with high accuracy. It remains to be shown that the formula is also able to reliably estimate gait speed in other settings.



[1]Kubota S, Nakata Y, Eguchi K, Kawamoto H, Kamibayashi K, Sakane M, Sankai Y, Ochiai N. Feasibility of rehabilitation training with a newly developed wearable robot for patients with limited mobility. Arch Phys Med Rehabil. 2013. doi: 10.1016/j.apmr.2012.12.020.

[2] Marschollek M, Gövercin M, Wolf KH, Song B, Gietzelt M, Haux R, Steinhagen-Thiessen E. A performance comparison of accelerometry-based step detection algorithms on a large, non-laboratory sample of healthy and mobility-impaired persons.ConfProc IEEE Eng Med BiolSoc 2008; 2008:

2:15 – 2:30

Fall Detection Sensitivity and False Alarm Rate During a Long Term Test Among Elderly

Maarit Kangas[1], Raija Korpelainen[2], Irene Vikman[3], Lars Nyberg[3], Timo Jämsä[1]. *[1]University of Oulu, Oulu, Finland.[2]Oulu Deaconess Institute, University of Oulu and Oulu University Hospital, Oulu, Finland.[3]Luleå University of Technology, Luleå, Sweden.*
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INTRODUCTION: About one third of home-dwelling elderly fall each year. Falling results in deaths, physical injuries and affects the quality of life and the ability to live independently. Automatic fall detectors are one method of improving the security of elderly. However, in most cases, fall detectors are designed and tested with data collected from experimental falls in younger people.**PURPOSE:**The aim of this study was to evaluate long-term sensitivity and false alarm rate of a fall detector in real-life use among older people.**METHODS:**Sixteen older people (mean age 88±5 years) living in elderly care units were recruited to wear a prototype of an automatic fall detector [1]. The device was designed to collect acceleration data. The implemented fall detection algorithm detected impact from an acceleration sum vector and end posture based on the vertical axis acceleration. In addition, the sensor continuously collected activity data in order to evaluate the usage of the sensor. The sensor was attached on the waist with an elastic belt. Real-life falls were identified based on the reporting by the care personnel. The number of fall alarms was collected from the database based on the fall label generated by the system.**RESULTS:**Altogether 12 382 hours from 975 days of real life were monitored with the sensor. Most of the test subjects wore the sensor during waking hours (average 13.1±1 hours per day). The false alarm rate varied from 0.000 to 0.178 alarms per hour, with an average value of 0.049±0.004 alarms per hour, corresponding to 1.2 false alarms over a 24-hour time period. During the test period the sensor system was reported to be used during 15 fall events. The acceleration data of real-life falls were collected from 13 of those and 12 of them were detected as falls by the fall detection algorithm. This results in a fall detection sensitivity of 80%. In two fall cases the criterion for data collection triggering was not fulfilled and in one case the acceleration data was collected but not detected as a fall because of the non horizontal end posture.**CONCLUSION:**In this study, real-life sensitivity and false alarm rate of an accelerometer based fall detector among old persons living in elderly care units were analyzed. These data suggest that automatic accelerometric fall detection systems might offer a tool for improving home safety among older people. In future, more advanced algorithms to further reduce the false alarm rate would increase the applicability of the system.

Supported by: the European Regional Development Fund of the European Union, Finnish Funding Agency for Technology and Innovations, and the Academy of Finland.

[1] Kangas et al. Gait Posture 2012;35(3):500-5

2:30 – 2:45

Assessing Feasibility of Using Wearable Foot Pressure Sensor After Injury

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INTRODUCTION: The smart house with many sensors and broadband-ubiquitous home network will support new services, especially for the elderly. Simple sensors will be the key to capturing the data needed, including vital medical information. This will stimulate new infrastructures or services in Home Healthcare, or e-Health.**PURPOSE:** In order to clarify how sensor-based systems can assess the rehabilitation status of people with leg injuries, we conducted experiments on using a wearable foot pressure sensor to capture foot pressure while walking. This paper details the results of an extended experimental period, about 1.5 year, that differ from the initial results presented [1].**METHODS:** A healthy female (45 y) injured her left leg and fell down while playing tennis about 2 years before. She had pain on the left side of the left knee; X-rays indicated no bone was broken. An MRI diagnosis indicated ACL damage, bone bruise just under the left knee, no damage of collateral ligament, and stretched status of PCL. An MD determined that recovery would take 6 months (mo.).The 16 mo. period after the injury included; i) Clinical ordinary treatment by the MD, ii) Rehabilitation (stretching and muscle exercises) as per the MD's instruction, iii) Daily physical status report, and iv) Weekly foot pressure measurements while walking on a wooden flat floor using a wearable sensor (Pedar system [2]).The subject walked at a speed comfortable to her, i.e. no pain, about 2 km/h. After the warm-up for about 2 min, she first walked 5.5 m in a straight line, stopped for 10 sec, and then walked back. This cycle was repeated 4 times in total.Peak pressure at the terminal stance in a cycle, average time period and the COP were measured and analyzed. Scores for pain, fatigue intensity, and walking ability taken from the subject daily report were also analyzed.
RESULTS: Peak pressure and average time period for 3 cycles indicated significant improvement in walking ability over the initial 2 mo., and a slight further improvement in the next 2 mo. They remained unchanged values thereafter. Fatigue intensity and walking ability mirrored these trends. However, pain intensity was different in that the pain steadily reduced in the first 4 mo., reduced little by little until the virtually normal condition was reached after 12 mo. The MD declared her recovered at 16 mo. after the injury.**CONCLUSION:** Our experiment clarified that rehabilitation status can be partially discerned from sensor data. Such information will help to motivate the subject to continue with rehabilitation even at home. Further COP analysis in detail will help detailed assessment.

REF.:

[1]K. Oguchi, et al., Proc. ICBPE2011
[2]Pedar, http://novel.de/

2:45 – 3:00

Normal Ranges for Novel Measures for Balance Quality in Healthy Individuals and Patients based on Mobile Accelerometry

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INTRODUCTION: Poor balance control is an important factor to predict risk of falling. The clinical screening methods to assess balance (e.g. the recorded time) are affected by floor and ceiling effects. Recently, accelerometers have been presented as a portable and feasible alternative with strong correlations to force plate signals. However, standards and information about reference values are still missing.**PURPOSE:**The purpose was to generate standardized balance acceleration data, compare normal ranges and gain knowledge about human postural control behaviour in patients with Multiple Sclerosis (MS), osteoporosis and healthy individuals. **METHODS:** 98 females with osteoporosis (68.8 ± 4.9 yrs), 50 healthy individuals (29.3 ± 9.7 yrs) and 28 MS patients (49.1 ± 8.5 yrs, EDSS 4-6.5) were recorded with a triaxial accelerometer when performing the following tests: Romberg (T1), Semi-tandem (T2), Tandem (T3) and One Leg Stand Test (T4). With eyes open/closed (EO/EC). Data was preprocessed and parameters extracted. The key outcome is the area covered by the best matching ellipse that includes 95% of the acceleration points in the horizontal plane.**RESULTS:**Formally significant differences were found for the 3 groups for the T1EO and T3EO tests ($p<0.0001$; Kruskal-Wall test). Differences were not statistically significant for healthy vs. osteoporotic patients ($p=0.08805$ for T1EO and $p=0.1057$ for T3EO; Wilcoxon rank sum test)

	Area of ellipse [BU] (1BU=0.096 m^2/s^4)			
	T1EO	T2EO	T3EO	T4EO
Healthy	0.54+/- 0.33	0.70+/- 0.43	0.98+/- 0.55	1.44+/- 0.87
Osteoporosis	0.42+/- 0.25	1.00+/- 0.58	1.51+/- 0.90	4.68+/- 4.07
	T1EO	T1EC	T3EO	T3EC
MS	2.15+/- 1.36	5.53+/- 4.20	16.00+/- 13.14	26.41+/- 27.60

CONCLUSIONS: The results show a clear difference between the balance ability of healthy individuals and MS patients with moderate/high levels of disability, that can at best be partially explained by the difference in age. Test difficulty is much higher when eyes are closed (about a factor of 2). There are also differences between healthy individuals and patients with osteoporosis, in the range of 1.5-3, but not for the easiest test (T1E0) that has no distinctive power here. Overall the results are plausible and promising and will need to be further enhanced by more data from a wider range of patients with balance disorders and different age.

Poster Session
Statistical, Computational, and Data Processing Methods
Monday, June 17, 2013, 4:30 pm - 6:00 pm
Campus Center Auditorium

Board #1

A Preliminary Study for Development of A New Identification Algorithm for Objectively Measured Sedentary Behavior

Youngdeok Kim, James L. Farnsworth, Saori Ishikawa, Minsoo Kang. *Middle Tennessee State University, Murfreesboro, TN.*
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INTRODUCTION: Sedentary behavior (SB) has been defined as any purposefully engaged activity that is mainly dominated by prolonged sitting with low energy expenditure (METs<1.5). Objective measures (e.g., accelerometer) has widely been used for monitoring SB in free-living settings; however, relatively little effort has been made to develop an appropriate algorithm to identify true SB bout in accelerometry data.**PURPOSE:** The primary aim of this pilot study is to develop SB identification algorithm for accelerometry data collected in free-living settings.**METHODS:** Two of the primary investigators wore an accelerometer (ActiGraph GT1M) on the waist and engaged in 6 consecutive activities for 30 to 60 minute durations in a free-living setting that include 3 SBs (i.e., watching TV, reading, and computer use) with typical sedentary break (SBK) activities (i.e., standing) and 3 light to moderate intensity physical activities (i.e., house work and slow walking). The starting and ending times for each activity including the times for SBK were also recorded. SB patterns in accelerometry data were visually scrutinized and SAS v9.3 was used to create an automated macro algorithm to identify true SB bouts using a threshold of <100 counts per minute (cpm) as a potential sedentary minute. **RESULTS:** A new algorithm developed to identify a true SB bout was featured by the following conditions; 1) start the first screening window at the minute when activity counts <100 cpm; 2) within the first screening window allow up to 2 consecutive minutes with >99 cpm (*condition 1*); 3) start a second screening window up to 10 minutes after the last minute of allowed consecutive minutes with >99 cpm (*condition 2*) [50% of the second screening window has to be sedentary in order to continue the first screening window]; and 4) start a third screening window across entire bouts observed from first screening window to check the existence of 5 consecutive sedentary minutes (*condition 3*), when the first screening window is closed (i.e., failed to meet *condition1* and *2*). A duration that meets all of conditions was considered a SB bout. Using the new algorithm, an average of 97.8% of true SB times across 3 SBs for two accelerometry data were correctly identified (1.1% of misidentification of non-SB as SB). **CONCLUSION**: The present study is a preliminary study to develop the new SB algorithm for accelerometry data. A relatively high accuracy for identification of true SB bouts could be achieved by applying sequential screening processes in the algorithm. A future study is warranted to investigate the patterns of SB and to develop more elaborate screening processes based on a large sample size.

Board #2

The Influence Of Minimum Sitting Period Of The Activpal On The Measurement Of Breaks In Sitting In Young Children

Zubaida Alghaeed[1], John Reilly[2], Sebastien Chastin[3], Anne Martin[4], Gwyneth Davies[5], James Paton[1]. *[1]School of Medicine, College of Medical, Veterinary, and Life Sciences, Glasgow, United Kingdom.[2]Physical Activity for Health Group, University of Strathclyde, Glasgow, United Kingdom.[3]School of Health and Social Care, Glasgow Caledonian University, Glasgow, United Kingdom.[4]Institute of Sport, PE and Health Science, University of Edinburgh, Edinburgh, United Kingdom. [5]National Heart and Lung Institute, Imperial College London, London, United Kingdom.*

PURPOSE: Sitting time and breaks in sitting influence cardio-metabolic health. New monitors (e.g. activPAL™) may be more accurate for measurement of sitting time and breaks in sitting although how to optimise measurement accuracy is not yet clear. One important issue is the minimum sitting/upright period (MSUP) to define a new posture. Using the activPAL™, we investigated the effect of variations in MSUP on total sitting time and breaks in sitting, and also determined the criterion validity of different activPAL™ settings for both constructs.**METHODS:** To examine the impact of differences in activPAL™ setting of MSUP, 23 children (mean (SD) age 4.5y (0.7)) wore activPAL™ (24h/d) for 5-7d. We first studied activPAL™ using a setting of 10s MSUP and then reduced this to 5s, 2s and 1s. In a second study, in a convenience sample of 30 pre-school children (mean age 4.1y (SD 0.5)) we validated the activPAL™ measures of sitting time and breaks in sitting at different MSUP settings against direct observation. **RESULTS:** Comparing settings of 10, 5, 2 and 1s, there were no significant differences in sitting time (6.2h (1.0), 6.3h (1.0), 6.4h (1.0) and 6.3 (1.6), respectively) between settings but there were significant increases in: the apparent number of breaks - (8(3), 14(2), 21(4) and28 (6)/h) at 10, 5, 2 and 1s settings, respectively.In comparison with direct observation, a 2s setting had the smallest error relative to direct observation (95% limits of agreement: -13.6 to 17.2, mean difference 1.83, p = 0.2). **CONCLUSION:** With activPAL™, breaks in sitting, but not total sitting time, are highly sensitive to the setting of MSUP with 2s optimal for young children. The MSUP to define a new posture will need to be empirically determined depending on age range and setting under studied if accurate measurements of number of breaks in sitting are to be obtained.

Board #3

Accounting For Physical Activity In Sedentary Behaviour Research: A Theoretical Framework

Geeske Peeters[1], Andrew Page[1], Annemarie Koster[2], Charles E. Matthews[3], Annette J. Dobson[1], Wendy J. Brown[1]. *[1]The University of Queensland, Brisbane, Australia.[2]Maastricht University, Maastricht, Netherlands.[3]National Cancer Institute, Rockville, MD.*
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INTRODUCTION: Given its associations with morbidity and mortality, sedentary behaviour (SB) has emerged as a potentially significant public health issue. Although most studies of relationships between SB and health outcomes acknowledge that some sort of adjustment should be made for physical activity, there is no consensus on the approach for doing this.**PURPOSE:** The aim was to clarify the role of moderate to vigorous physical activity (MVPA) in the relationship between SB and mortality, by illustrating models with PA considered as a confounder, mediator and effect modifier and with SB and PA measured both with questionnaires and accelerometry. **METHODS:** Data were from 1906 participants (aged 50+) in the National Health and Nutrition Examination Survey (NHANES) who wore an accelerometer (ActiGraph AM-7164) for 7 days in 2003/04. Mortality data were available until December 31, 2006. The association between SB and mortality was analysed with Cox proportional hazards models. Assumptions for confounding, mediation and effect modification were tested. Analyses were done with separate models for SB and MVPA measured with accelerometry (SB=% time counts<100, MVPA=%time counts<2020) and self-report (SB=h/day tv/computer; MVPA=MET.min/week leisure MVPA).**RESULTS:** For both accelerometry and self-report, associations between (1) MVPA and SB ($p<0.001$), (2) MVPA and mortality ($p<0.001$), and (3) SB and mortality ($p\leq0.001$) were statistically significant, suggesting MVPA was a potential confounder. Additional adjustment for MVPA in the association between SB and mortality resulted in a small attenuation of the hazard ratios, but confidence intervals were wide and the direction of the effect was unclear, so there was insufficient evidence for mediation. The variance inflation factor was low ($VIF\leq1.2$) suggesting no collinearity. The p-value for interaction was 0.26 for accelerometry and 0.48 for self-report. For both measurement methods, stratified analyses showed similar hazard ratios for participants in the low and high MVPA categories, suggesting no effect modification, but confidence intervals were wide.
CONCLUSION: Assumptions for confounding were met and there was no evidence for collinearity. Mediation and effect modification could not be adequately assessed.

Board #4

Automatic Snoring Detection Using Piezo Sensor Data Based On Continuous Hidden Markov Models

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INTRODUCTION: Snoring detection is considered to be an important subject in multiple clinical domains for evaluation of sleep-disordered breathing. Most methods using one or more microphones, which require acquisition of high-quality and high-capacity snoring sound data, were used to automatically detect snoring during sleep. Recently, a piezo sensor was often used instead of a microphone in polysomnogram (PSG) study. However, an automatic snoring detection using a piezo sensor has not been reported in the literature. **PURPOSE:** This study proposes an automatic snoring detection using a piezo sensor data. The method is based on continuous hidden Markov models (CHMMs) which have excellent modeling power for various and even distorted data. **METHODS:** Eight patients with obstructive sleep apnea gave written consent to participate. For training set, thirty minutes of data containing frequent snoring was selected from four patients (56.5±12.0 years, BMI: 26.6±3.9, AHI: 23.7±5.1). For test set, sixty minutes of data was selected from 4 other patients (50.8±20.9 years, BMI: 27.9±3.3, AHI: 31.3±23.3). The data were acquired from a small piezo sensor with 1.5 mm connectors (REF 1420610, Embla System Inc., USA) attached to the neck. The short-time Fourier transform and short-time energy of lowpass filtered data (cutoff frequency: 15 Hz) were computed so that they could be applied to CHMMs. The two transformed data were classified as snoring, noise and silence according to their CHMMs. The CHMMs have a simple left-to-right topology. The number of states of each CHMM for snoring, noise and silence were 4, 6 and 5, respectively. This study assumed the observations were to be Gaussian probability densities. **RESULTS:** The performance of the method was evaluated by examining the sensitivity and positive predictive value (PPV). The sensitivity and PPV were 90.8% and 99.7% for snoring and 82.8% and 55.2% for noise, respectively. No evaluation for silence was implemented since silence was not defined as an episode. **CONCLUSION:** The CHMM-based results using a piezo sensor data are equivalent to those in previous studies using a microphone. These results showed that the proposed method can possibly be used as a sleep analysis system for snoring detection. The piezo sensor will be useful for evaluating sleep quality in a home environment since the cardiopulmonary information can be obtained from the sensor. Further studies with a wireless smart snoring detection system are needed to acquire cardiopulmonary information.

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Board #5

Seasonal Variation In Objectively Measured Physical Activity, Sedentary Time, And Sleep Duration Among Children

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PURPOSE: Understanding fluctuations in lifestyle indicators is important to identify relevant time periods to intervene in order to promote a healthy lifestyle; however, objective assessment of multiple lifestyle indicators has never been done using a repeated-measures design. The primary aim was, therefore, to examine between-season and within-week variation in physical activity, sedentary behaviour and sleep duration among 8-11 year-old children. **METHODS:** A total of 1021 children from nine Danish schools were invited to participate and 834 accepted. An ActiGraphTM accelerometer (GT3X+ or GT3X) was worn for 7 days and 8 nights on the waist during autumn, winter and spring, from which physical activity, sedentary time and sleep duration were measured. Physical activity and sedentary time were obtained between 6 am and midnight. To remove non-wear time and nocturnal activity during early morning and late evening, ≥15 minutes of consecutive zeros and consecutive wear time of less than 60 minutes was disregarded before analysis. ≥10 hours of measured monitor wear time was considered a valid day. Vertical axis and epoch length of 1 min was used. Sedentary time was defined as ≤100 cpm and moderate-to-vigorous physical activity (MVPA) as ≥2296 cpm. To estimate sleep duration from the accelerometer, self-reported bedtimes and waking times were used as the possible window of sleep and scored in ActiLife6. A minimum of 3 weekdays and 1 weekday was considered necessary; hence 730 children were included in the current analytical sample. The study is part of the OPUS (Optimal well-being, development and health for Danish children through a healthy New Nordic Diet) School Meal Study*. **RESULTS:** Mean MVPA, sedentary time and sleep duration were 0:50, 7:55 and 9:10 h:mm/day, respectively. The children spent 30% more time in MVPA during spring compared to winter and 49% more time during weekdays compared to weekends ($P<0.001$). Sedentary time was 5% higher during winter compared to spring and during weekends compared to weekdays ($P<0.001$). Sleep duration was 15 min shorter during spring compared to autumn, with 7 min less sleep during weekends ($P<0.001$). Interclass correlation coefficients between seasons ranged from 0.47-0.64, leaving 59-78% to seasonal variation. **CONCLUSION:** Collectively, the lifestyle of children in this cohort was relatively healthier during spring and weekdays. The considerable intra-individual variation when measured across three different seasons suggests that a single measurement taken at one point in time may not adequately characterise children's habitual sleep and activity.
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Board #6

The Influence Of Applying Different Non-wear Criteria On Wear-time Distributions Across Childhood And Youth

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INTRODUCTION: The field of physical activity monitoring has developed rapidly over the last decade. It is becoming more common to apply accelerometer-based physical activity monitors in large population based samples. The researchers are faced with large variety of choices regarding settings including wear and non-wear criteria. As no consensus has been reached regarding non-wear criteria researchers have little information to qualify their choices.**PURPOSE:**The purpose of the study is to describe the influence of different non-wear criteria on daily wear-time across a large age heterogeneous sample of Danish children, adolescents and adults. **METHODS:** The analysis will be based on population-based samples with 4500 individuals and 8600 observations from the Danish arm of the European Youth Heart Study (EYHS) (N=1600, age 9 to 27 years) with 2-3 waves (1997-2009) of follow-up, The Copenhagen School Child Intervention Study (COSCIS) (N=700, age 6 to 14 years) with 3 waves of follow-up (2001-2010), The Childhood Health, Activity, and Motor Performance School Study Denmark (The CHAMPS-study DK) (N=1200, age 6-12 years) with two waves of follow-up (2009 and 2010), The Odense Preschool Study (TOPS) (N=450, age 5 years), and The Public After-School Care study (N=550, age 6-8 years). All physical activity measurements were measured using the Actigraph AM7164, GTM1, GT3X or GT3X+. **ANALYSIS PLAN:**In step one, all data files will be screened for compliance to the night-time removal criteria using the customized software Propero. Data files containing activity between 11 pm through 5 am will be screened manually (independently by two researchers) and the night-time duration estimated. If consensus cannot be reached on the night-time duration, the file is excluded from the analysis. In cases were consensus has been reached, strings of zeros will be imputed. Secondly, wear-time (without non-wear criteria applied) by gender and age are described and used as a reference for further analysis. Third, we will remove 10, 30, 60 and 90 minutes of consecutive zeros and describe the absolute number of minutes removed and describe the influence on the age- and gender specific distributions of wear-time. Finally, we will describe the probability of exclusion by different minimum wear-time criteria (60, 80 and 100% of a predefined minimum day) and non-wear criteria (10, 30, 60 and 90 minutes of consecutive zeros) across gender and age. **SIGNIFICANCE OF WORK:**The study will provide researchers using Actigraph activity monitors with observations that will enable them to make informed decisions when applying non-wear criteria.

Board #7

Commonly Used Single Regression Model Compared To Activity Based Method To Predict Energy Expenditure

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INTRODUCTION: The calculation of energy expenditure (EE) is an accepted method to assess human physical activity. To express the energy cost of activities, the calculation of the Metabolic Equivalent (MET) is commonly used. Device-dependent counts are calculated from the acceleration signal and MET values are calculated based on a single regression model. However, one single regression model is not applicable across all types of activities because one cannot assume a linear association between acceleration and EE. There are activities such as walking up the stairs having a similar acceleration signal to other activities (e.g. walking) but a considerably higher EE. Activity based data processing via decision trees can use more information from the acceleration signal and apply different activity-dependent models for the calculation of EE. **PURPOSE:** The purpose of this study was to examine whether the activity based prediction of EE was more accurate compared to the commonly used single regression model.**METHODS:** 19 adults (m=11; f= 8; 30.4 ± 9.0 yrs) wore the Move II (movisens GmbH, Karlsruhe, Germany) attached to the waist and the portable indirect calorimeter Meta Max 3B (Cortex Biophysics GmbH, Leipzig, Germany) as reference. Subjects performed 5 different walking activities. To calculate the MET values using the single regression method a common formula was used. For the activity dependent MET estimation, the activity was first classified. Based on the detected activity class, the appropriate activity-dependent model was selected to estimate EE. MET was calculated as the ratio of the activity-specific associated metabolic rate divided by the resting metabolic rate (RMR). To analyze the agreement between each method and the reference, Bland Altman plots were conducted for each activity.**RESULTS:** For jogging Bland Altman revealed a bias of 2.86 (0.03 to 5.69) for the single regression based method and a bias of 0 (-2.35 to 2.35) for the activity based prediction model. For walking up the stairs, the bias was 1.8 (0.61-2.99) for the first and 1.7 (-3.21 to -0.2) for the second method respectively. While the activity based method overestimated MET for walking up the stairs, the single regression based method underestimated. The biases for walking, walking down the stairs and crossing a bridge were similar for both methods. **CONCLUSION:** The MET prediction for jogging was considerably more accurate with the activity based compared to the single regression based method. The MET overestimation may be due to the duration of the activity and since the steady state was not achieved. In contrast, the error due to underestimation may increase over a longer time frame.

Board #8

Integrated Movelets Approaches For Predicting Human Movement Type Based On Multiple Accelerometers

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INTRODUCTION: Tri-axial accelerometers record the acceleration of people's daily activity on three orthogonal directions. One fundamental question is how to decipher and interpret the acceleration signals into meaningful information such as types of human movement. **PURPOSE:** We provide statistical methods for predicting activity type and answer the following questions: 1) how well do accelerometry data reflect a given program of activities; and 2) given simultaneous accelerometry data from multiple sites of the human body, how could we effectively integrate the combined information? **METHODS:**We propose the integrative movelet methods for predicting activity types. A movelet is a time series collected in a window of given length. The sets of movelets constructed from the accelerometry data with annotated labels are organized by activity types, i.e., "chapters", which play the role of the accelerometry dictionaries for different activities. Predictions of accelerometry data without labels are provided through identifying the chapter that is most similar to the data in terms of mean squared error. Information from multiple accelerometers is integrated in three ways: 1) by building separate movelet dictionaries and combining predictions using voting (movelets voting); 2) by designing a joint dictionary (expanded movelets); and 3) by establishing a decision tree (movelets tree). **RESULTS:**We tested our methods with the Aging Research Evaluating Accelerometry (AREA) study. 20 older subjects were instructed to perform 15 types of activities while wearing Actigraph GT3X at the hip, right and left wrist in lab sessions. The prediction precision of the proposed methods is shown in Figure 1. **CONCLUSIONS:**Based on our results, we propose that observational studies involving accelerometers could dramatically improve data quality by incorporation of a set of standardized "life" activities that could be performed at the time the devices were initially placed. While the home setting is preferable, if not feasible, then even a clinic setting would still result in enhanced data quality.**ACKNOWLEDGEMENT:** This research was supported, in part, by the Intramural Research Program of the National Institute on Aging. He, Bai, and Crainiceanu were supported by Grant R01NS060910 from the National Institute of Neurological Disorders and Stroke. This work represents the opinions of the researchers and not necessarily that of the granting organizations.

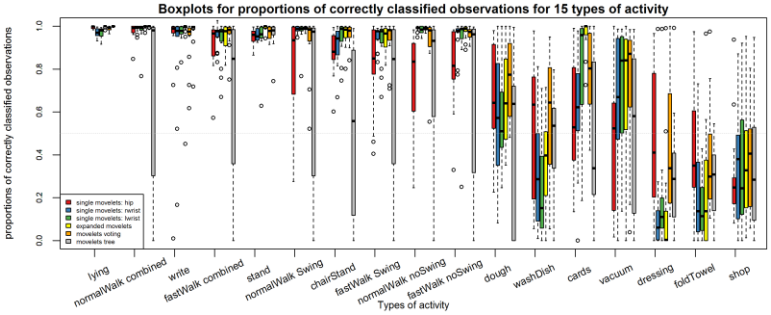

Figure 1: Boxplot for prediction accuracy for 15 types of activity using hip-worn accelerometer (red), right wrist-worn accelerometers (blue), and left wrist-worn accelerometers (green), and using integrative approaches expanded movelets (yellow), movelets voting (orange), and movelets tree (grey). The activity labels on the X axis are ordered decreasingly by the median prediction accuracy of hip-worn accelerometers.

Board #9

Feature Selection for Actigraphy Signal Processing and Recognition

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INTRODUCTION: In classifying actigraphy signals, features are usually extracted from raw data and then fed to some sort of a classifier that determines the type and level of activity. A huge variety of features have been tried by many researchers in this field. Some features are statistical in nature, some are based on the frequency content of the signals, others are based on the time domain content, etc. In much of the literature we reviewed for this work, there usually was no justification of why a particular feature or set of features were used with a particular classifier. **PURPOSE:** The purpose of this research was to create algorithm(s) to automatically evaluate and select the top-performing feature or set of features to maximize the correct classification rate of actigraphy signals. **METHODS:** Two selection algorithms are developed to evaluate and select the top performing features among 63 commonly-used ones in actigraphy signal processing. The first selection algorithm is based on entropy minimization. It tries to minimize the uncertainty and disorder (i.e. entropy) in a classifier decision. The second algorithm (a.k.a. Add-One) first classifies the data using each of the features individually and then picks the top performing feature. Next, that feature is paired with each of the other features. The top performing pair is chosen. Triplets are formed by combining that pair with each of the other features. The top performing triplet is chosen, and so on, until the specified number of features is reached. Once the top features are selected, they were used to classify signals from five activity types (standing, laying down, working at a desk, and jogging at 2mph and 3mph). The actigraphy data was sampled at 30 Hz and divided into 5 second intervals. Data was divided into training and testing subsets using the Jackknife method. Minimum distance and artificial neural networks classifiers were used to classify the testing data. **RESULTS:** Features selected using the entropy minimization algorithm yielded correct classification rates of 85-90% using only the top 5-10 features. Correct classification rates of 95-100% were achieved using only 1-5 features selected using the Add-One method. A closer look at the top performing features shows that some were highly ranked across many experiments we conducted. Overall, the features based on statistics and *n*th percentile seemed to outperform all the other features.
C**ONCLUSION:** The Add-One feature selection algorithm yielded better results than the entropy minimization algorithm. Correct classification rates greater than 95% were achieved with only 1-5 features. There were some consistently top performing features; most of them were statistical in nature.

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Board #10

A Statistical Model For Estimating Within-subject Variability Of Objectively Measured Physical Activity

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INTRODUCTION: In physical activity interventions, most statistical models of accelerometer-measured physical activity focus on changes in mean levels of activity over time. However, it is often of scientific interest to measure the effect of an intervention on within-subject variability as this source of variability may be important in predicting future health outcomes of interest. **PURPOSE:** To develop a statistical method for measuring the effect of a lifestyle intervention on within-subject variability. **METHODS:** Our sample consists of five weeks of daily accelerometer data from the Make Better Choices study, a lifestyle intervention trial in which 204 participants were randomized to either increase physical activity or decrease sedentary behavior. We used a mixed-effects location scale model to model both the mean and variance of daily moderate-to-vigorous activity (MVPA) as a function of subject-specific random effects and time varying covariates.**RESULTS:** Post baseline and controlling for accelerometer wear time, those participants randomized to the increase physical activity condition engaged in significantly more MVPA than those participants randomized to the decrease sedentary behavior condition. MVPA was significantly lower for women and on weekends. In addition, within-subject variability was significantly greater in the increase physical activity condition and was greater on weekends. Women had significantly less within-subject variability. **CONCLUSION:** Our model suggests that within-subject MVPA variability can be estimated as a function of covariates in the context of an intervention study and may provide inferences of scientific interest.

Board #11

Estimation Of Physical Activity Level With An Accelerometer Using An Intensity-based Classification Of Counts

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INTRODUCTION: Physical activity level can be estimated from accelerometers using total daily counts, but classic linear regression modeling techniques tend to oversimplify the relation between accelerometer output and physical activity level.**PURPOSE:** The aim of this study was to classify daily movement as part of sedentary or active periods and deploy the measured counts from an accelerometer to estimate physical activity.**METHODS:** Subjects were 11 men and 25 women (age: 41±7 y, BMI: 31.0±2.5 kg/m2). Physical activity was monitored with TracmorD (DirectLife, Philips Consumer Lifestyle, Netherlands) under free-living conditions while total energy expenditure was measured simultaneously with doubly-labeled water. The physical activity level (PAL) was calculated dividing total energy expenditure by sleeping metabolic rate. TracmorD output was expressed as counts/min and classified as 'active time counts' (TracmorD output >700counts/min) or 'sedentary time counts' (TracmorD output <700 counts/min). A simple linear model was developed to predict PAL from total daily counts (Model 1, M1), while a multiple linear model included daily active time counts and daily sedentary time counts as independent variables (Model 2, M2). **RESULTS**: The M2 explained 61% ($p<0.001$) of the variance of the measured PAL, which was 20% higher than the M1 (51%, $p<0.001$) and higher than any model previously developed from TracmorD output. Physical activity level was estimated from the M2 with a standard estimation error of 0.12 (6.7% of the average PAL), which increased with the M1 up to 0.14 (7.9% of the average PAL). The correlation between the residuals and PAL was lower in the M2 than in the M1 (-0.63 vs. -0.70). **CONCLUSION**: In conclusion, prediction models based on distinct measures of counts during sedentary or active time are a more promising technique than models based on total daily counts to develop estimation equations of physical activity level from accelerometers.

Board #12

Objectively Measured Total Accelerometer Counts and MVPA: The Relationship with Biomarkers Using 2003 - 2006 NHANES

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PURPOSE: To contrast the associations of objectively measured moderate-to-vigorous physical activity (MVPA) and total accelerometer counts with biomarkers in a representative sample of U.S. adults. **METHODS:** Data from the 2003 - 2006 NHANES were used for this analysis. The sample included adults ≥ 20 y, not pregnant or lactating, who had self-reported PA and ≥ 4 d of accelerometer data with ≥ 10 h wear time (N = 5668). MVPA was defined as the mean minutes with counts ≥ 2020 using a 10-min bout criterion on valid days. Total accelerometer counts represented the mean total counts acquired on valid days. Biomarkers included: blood pressure, body mass index (BMI), waist circumference, triceps and subscapular skinfolds, cholesterol, triglyceride, glycohemoglobin, plasma glucose, C-peptide, insulin, C-reactive protein, and homocysteine. Simultaneous regressions were conducted in which each biomarker was regressed on MVPA and total accelerometer counts per day independently while adjusting for relevant covariates. **RESULTS:** When compared to MVPA, total accelerometer counts per day displayed stronger associations with the following biomarkers: BMI, waist circumference, triceps skinfolds, subscapular skinfolds, HDL, triglycerides, plasma glucose, C-peptide, insulin, C-reactive protein, and homocysteine (adj. Wald $F = 9.04 - 97.41$, $P < 0.05 - 0.0001$). Only one biomarker, glycohemoglobin, had stronger associations with MVPA ($F = 6.67$, $P \leq 0.05$) than total accelerometer counts ($F = 0.87$, $P > 0.05$). After adjusting for BMI and other relevant covariates, total accelerometer counts remained more strongly associated with cardiometabolic biomarkers than MVPA, with glycohemoglobin found to have no relationship with either PA variable. **CONCLUSION:** Total accelerometer counts per day were more robustly associated with various cardiobiomarkers than MVPA. Thus, using total accelerometer counts per day may provide a better estimate of the strength of the relationship between PA and biomarkers.

Board #13

Feature Extraction from Biological Motion with PARTwear An Application for Sprint Running

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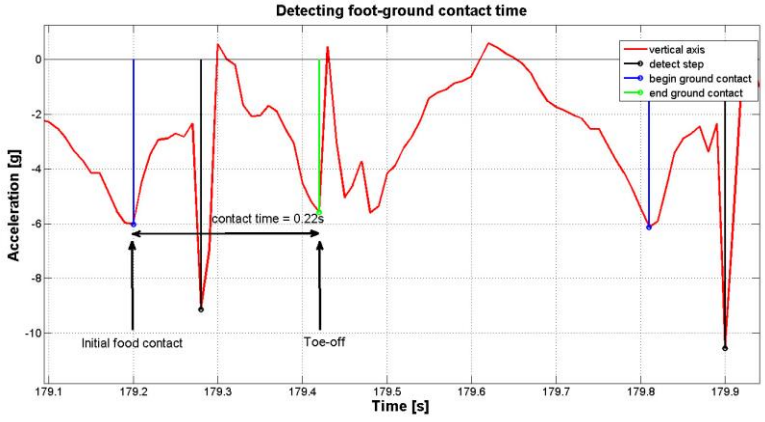
INTRODUCTION: Traditionally the measurement of elite athlete performance is commonly done in a laboratory environment. Laboratory testing however places limits on how the athlete performs, as the feeling is different to the training environment. Through technological innovation and development, new sensors, devices and systems become available, which enable the testing and monitoring of athletes in their natural training and competition environment.
PURPOSE: Foot-ground contact time is an important variable that influences top running speed, with athletes that have shorter contact times typically being faster sprinters. The aim of this study was to investigate if it is possible to measure the foot-ground contact time using PARTwear, an accelerometer based system to monitor the activity of human beings. **METHODS:** For each sprint run measured, the PARTwear sensor is worn at the right foot link of the subject. 3D acceleration data of the MEMS based sensor ADXL345 from Analog Devices were sampled by a MSP430 micro-processor at 100 Hz per channel and recorded to the internal flash memory. The subjects were required to run first on a treadmill and second along a runway. Each test run has been filmed with a GoPro HERO3 camera in 30 fps for being able to compare the measured accelerations to the real movement of the subjects right food. According to this video analysis two events appeared to be appropriate for determining the initial foot contact and the toe-off moment. These two events were used to calculate the contact time. The first event was the minimum in the vertical acceleration axis which occurred near the beginning of ground contact. For detecting its ending, a second event was observed using again the vertical accelerations, which experience a second local minimum near toe-off.**RESULTS:** Foot-ground contact times were measured in a range of 0.2s and 0.32s. The mean error difference of the estimated contact time between the video and the accelerometer-based estimates is 0.019 seconds.
CONCLUSION: We conclude from the visualization that close estimates of foot-ground contact time during running can be obtained using body mounted accelerometers, with the best estimates obtained in conditions associated with the highestaccelerations. Further validation should be made with a larger number of subjects to enhance the algorithm for detecting every conceivable running style.



Board #14

Estimating Accelerometer Wear And Non-wear Events: Comparative Study Of Physical Activity Between Children And Adults

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INTRODUCTION: Accelerometer captures data in wear and non-wear time intervals. There is critical need to correctly classify accelerometer wear and nonwear time intervals. Different from adult physical activity(PA), child PA is characterized by frequent spasmodic bursts of short duration. The objective of this study is to establish and compare the wear and non-wear time events of physical activity between children and adults using a novel method which considers both movements and surface skin temperatures. **METHODS:** This study recruited 50 participants aged 5-16 yrs (n=23) and over 16 yrs (n= 27) in two phases - Phase 1: Development of wear/non-wear algorithm (n=20) and Phase 2: Sensitivity/specificity analysis of the algorithm (n=30). Participants wore wrist mounted tri-axial accelerometers (GeneActiv ©) against the skin surface. They were asked to record time on and time off in which events of wear or non-wear time last for at least 15 minutes. A bi-moving-window based technique was proposed that combined temperatures and movements to classify the two events. The classifiers that consider movements or temperatures alone are used to compare with the proposed method.
RESULTS: The proposed method outperforms the classifiers that consider movements or temperatures alone. The proposed method led to sensitivity of child PA as 0.96 (95% CI = (0.94, 0.99)) and specificity 0.93 (95 % CI = (0.90, 0.96)). As a comparison, the movement classifier achieved sensitivity 0.76 (95% CI = (0.6, 0.93)) and specificity 0.89 (95 % CI = (0.84, 0.94)), and the temperature classifier generated sensitivity 0.96 (95% CI = (0.93, 0.99)) and specificity 0.64 (95 % CI = (0.59, 0.69)). To compare with child PA, the proposed method led to sensitivity of adult PA as 0.93 (95 % CI = (0.88, 0.98)) and specificity 0.88 (95 % CI = (0.82, 0.94)). No significant difference is found between wear and non-wear time events of child and adult PAs.

Table: The performance of classifying WEAR and NON-WEAR events in terms of classification rate (CR), sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV)

Participant category	***Classifiers***	***CR (95% C.I.)***	***Sensitivity (95%C.I.)***	***Specificity (95%C.I.)***	***PPV (95%C.I.)***	***NPV (95%C.I.)***
Children (5 -16 years)	The proposed method	0.95 (0.93, 0.98)	0.96 (0.94, 0.99)	0.93 (0.90, 0.96)	0.79 (0.69, 0.89)	0. 97 (0.93, 1.00)
	The Temperature alone	0.73 (0.64, 0.82)	0.96 (0.93, 0.99)	0.64 (0.59, 0.69)	0.45 (0.24, 0.67)	0.97 (0.93, 1.00)
	The Movement alone	0.80 (0.68, 0.92)	0.76 (0.6, 0.93)	0.89 (0.84, 0.94)	0. 69 (0.59, 0.79)	0. 78 (0.56, 0.95)
Adults (≥17 years)	The proposed method	0.93 (0.88, 0.98)	0.91 (0.82, 0.99)	0.88 (0.82, 0.94)	0.85 (0.78, 0.93)	0.92 (0.79, 1.00)
	The Temperature alone	0.77 (0.64, 0.9)	0.90 (0.82, 0.99)	0.65 (0.55, 0.75)	0.63 (0.37, 0.9)	0.92 (0.79, 1.00)
	The Movement alone	0.85 (0.73, 0.97)	0.84 (0.7, 0.99)	0.88 (0.77, 0.99)	0.82 (0.69, 0.95)	0.76 (0.53, 0. 99)

CONCLUSION: There is no significant difference between classifications of wear/non-wear time events of child and adult PAs. Comparing with the classifications by accelerometer temperatures or movements alone, the proposed algorithm significantly improves the classification of wear/non-wear time and activity prediction for both children and adults.

Board #15

Influence of Children's Age and Gender in Establishing Reliable Physical Activity Estimates

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INTRODUCTION: Children's physical activity (PA) behavior can be challenging to reliably measure due to the influence of age and gender on within-subject PA variability. Because of this variability PA is measured over many days. **PURPOSE:** The purpose of this study was to determine the minimum number of days to assess reliable estimates of step-count data for children based on age and gender. **METHODS:** A total of 428 developing children (at least 30 boys and 30 girls in seven two-year intervals from 2-3 yrs to 14-15 yrs of age) wore a StepWatch accelerometer for 7 consecutive days. Following data screening, 422 children's data were finally analyzed by gender and age groups using the Generalizability Theory. Single-facet crossed designs [i.e., Participant (P) x Days (D)] were applied for each of 14 datasets. G-studies were performed to quantify the percentage of variance associated with the facet and interaction in the model. Follow-up D-studies were performed to determine the minimum number of days of step-count data collection needed to achieve a desirable reliability coefficient ($G \geq .80$). **RESULTS:** The results from the G-studies show P accounted for 26%-71% of the variance, while D had little effect on the total variance (0%-5%). A relatively large portion of variance was unidentified (i.e., the P x D interaction). The minimum number of days to achieve $G \geq .80$ for boys, girls, and the both groups combined for each age group can be found in Table below.

	Age						
Gender	2-3 yrs	4-5 yrs	6-7 yrs	8-9 yrs	10-11 yrs	12-13 yrs	14-15 yrs
Girls	5	6	4	7	12	7	3
Boys	3	2	3	4	3	7	4
Both	4	3	3	5	4	6	4

CONCLUSION: The minimum number of days necessary to achieve a reliability coefficient ($G \geq .80$) ranged from 2 to 12. On average, boys required less days of monitoring. The more the between-subject variability and the less the between-day variability result in fewer days needed. These results suggest that if PA data are not collected for enough days the validity of the study results is jeopardized.

Board #16

Real-Time Activity Recognition using Changepoint Detection and Machine Learning on Free-Living Accelerometer Data

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INTRODUCTION: Physical activity recognition in real-time requires algorithms that can classify activities from free-living accelerometer data as the data is being recorded. These algorithms need to quickly detect when an individual switches to a new activity and then accurately classify the new activity. Much of the past work in activity recognition algorithms have focused on algorithms that can achieve high accuracy. The real-time setting adds the criterion of a quick detection time and thus requires activity recognition algorithms that can effectively balance these two criteria. **PURPOSE:** The purpose of this paper is to investigate the effectiveness of a novel real-time activity recognition approach which uses techniques from changepoint detection and machine learning. Changepoint detection methods are used to detect when changes in activity occur and thus segment the free living data into shorter subsequences, which are then classified by a machine learning algorithm.**METHODS:** We investigated using two changepoint detection algorithms, namely the Control Chart (CC) and the Kullback-Leibler Importance Estimation Procedure (KLIEP). For machine learning algorithms, we used decision trees (DT) and support vector machines (SVM). We measured the accuracy and detection time of the four possible combinations on synthetically generated free-living data by concatenating triaxial hip accelerometer data from actual lab activity trials.**RESULTS:** For our four configurations, we report the best accuracy and its corresponding detection time: DT-CC (Accuracy: 41.4%, Detection time: 85.4 secs), DT-KLIEP (Accuracy: 49.2%, Detection time: 69.7 secs), SVM-CC (Accuracy: 68.7%, Detection time: 43.9 secs) and SVM-KLIEP (Accuracy: 58.0%, Detection time: 63.3 secs). We can improve the detection time by lowering the threshold used by the changepoint detection algorithm. For instance, the detection time of SVM-CC can improve to 35.2 seconds but we lower its accuracy to 47.1%.**CONCLUSION**: The best performing configuration overall was the control chart for change detection and a support vector machine for classification. However, choosing an appropriate threshold for the changepoint detection algorithm is critical to balancing the accuracy and detection time.

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Board #17

Comparison Of Four "Time In Intensity" Physical Activity Indices As Predictors Of Cardiometabolic Health

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INTRODUCTION: Recent physical activity (PA) guidelines incorporate recognition of the greater health benefits from higher intensity PA, but still dichotomize intensity into moderate or vigorous categories. New ubiquitous wearable accelerometry enables the estimation of intensity along the continuum from moderate intensity upwards. **PURPOSE:** To compare two versions of a MET-min points system to two interpretations of recent guidelines, in relation to several cardiometabolic health indices. **METHODS:** NHANES 2003-2004 accelerometry data were screened according to previous NHANES protocols, and converted into four PA indices: a) minutes in moderate intensity or above (3+ METs; minsMPA); b) weighted minutes, where vigorous (6+ METs) minutes were scored double (minsMVPA); c) a MET-min points system (3+ METs) based on gross MET-min (MET-minsGross); and d) a similar points system based on net MET-min (MET-minsNet). Participants with 1+ days, 13+ hours and who engaged in at least one 10+ min bout of MVPA were included. These data processing criteria produced a final sample of $N = 440$. All four indices required PA to occur in at least 10 min bouts in order to be counted. These indices were regressed on six measures of cardiometabolic health: BMI; HDL-C; triglycerides; fasting glucose; mean arterial pressure; and waist circumference. Logistic regression was also used to compare the associations between the four PA indices and metabolic syndrome. **RESULTS:** All PA indices were highly interrelated ($r = .97$ -.99). Correlations with health measures were systematically higher for the MET-mins points systems, especially MET-minsNet, in comparison to minsMPA. This pattern was consistent for RMSE, AIC, BIC, and associated F-values. However, explained variances were low, ranging from $r^2 = .003$ for HDL-C to $r^2 = .015$ for fasting glucose. Similar patterns were evident from logistic regression, with several indices showing improvement for MET-minsNet compared to minsMPA and minsMVPA. However, diagnostic accuracy was unimpressive, with area under the curve being only 0.60. **CONCLUSION:** It appears that minsMVPA measures incorporating the new PA guidelines (giving double-credit for time in VPA) are more strongly related to cardiometabolic health than measures based on the previous 150 mins MPA guidelines. Two MET-mins outcomes were even more strongly related to cardiometabolic health. Although all four measures were weakly related to cardiometabolic health, the MET-mins index could easily be converted to an activity points system and may hold promise for converting PA guidelines into a simple metric for popular use, incorporating ubiquitous technology such as mobile phones.

Board #18

Physical Activity Intensity Signature (pais) Of Pain: Large-scale Study Reveals Novel Cut-points For Accelerometry Analysis In Regional Body Pain

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PURPOSE: Current scientific foundation for accelerometer-based tracking of physical activity developed in the cardiovascular and nutrition literature. Here, acceleration data is analyzed using cut-points optimized for energy expenditure estimation. We describe the construction of novel analytic approaches optimized for the study of pain. In this work we aim to discover signature patterns of physical activity alterations due to pain, and to empirically derive physical activity intensity signatures cut-points (PAIS cut-points) for studies in pain. **METHODS:** 6,796 subjects from NHANES (2003-2004) underwent accelerometry-based measurement. Python 2.7, R 2.11, and SAS 9.2 macros were employed for data processing, complex survey regression analyses, model selection, and clustering. Physical activity intensity profiles are adjusted for demographic, social, and medical variables. Self-reported pain is summarized. Two-way hierarchical clustering was performed. Across body regions, axial pain and appendageal pain clustered distinctly. Across intensity intervals, continuous ranges of intensities clustered tightly, which are adopted to define PAIS cut-points. Extreme intensities (zero and >30,000) ignored given high coefficients of variation. **RESULTS:** "PAIS cut-points" are empirically derived that define novel "PAIS intervals" that can be seen as an elaboration of existing intervals for sedentary activity: 1-190 ("PSE"); light activity: 191-350 ("PL1"), 351-800 ("PL2"), and 801-2,500 ("PL3"); and moderate/intense activities: 2,000-30,000 ("PMI"). Across these five intervals, distinct signatures of activity alterations are seen for axial pain and appendageal pain. **CONCLUSIONS:** Applying statistical and machine learning techniques to a population-based biomechanical assessment of free-living physical activity, we derived PAIS intervals for accelerometry analysis, specially tuned to detect signature patterns of alterations in physical activity due to pain. Compared to existing cut-points based on energy expenditure, PAIS intervals are distinct in motivation, empiric in origin, and provide finer resolution in the light activity ranges.

Board #19

Two-Tiered Machine Learning Model for Estimating Energy Expenditure in Children

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INTRODUCTION: Most current methods to estimate energy expenditure (EE) in children using accelerometer data involves the use of linear regression models; however they have limited accuracy. Currently there is increased interest in the use of machine learning models, which utilize additional input information compared to traditional regression approaches and have potential to improve the estimates of EE. **PURPOSE:** The purpose of this study was to examine the use of machine learning method that first classified activity type using tri-axial accelerometer data and then estimates EE using an activity-specific regression. **METHODS:** One-hundred and twelve children (age range: 9-15 yrs) had their resting metabolic rate measured and performed various activities ranging from sedentary behaviors to vigorous activities. Eighteen activities were split into three routines with each routine performed by 33-36 children. During all testing, activity data was collected using an ActiGraph GT3X accelerometer on the right hip, and oxygen consumption was simultaneously measured with a portable indirect calorimeter. Accelerometer data was aggregated for each axis into feature vectors which included percentile and autocorrelation information per minute and used to train a subset of data using an artificial neural network. Linear regression models were constructed for each activity in the training set to estimate EE (METs). The models were validated using leave on person out for each activity on its own (uncategorized) and grouped into categories of sedentary, locomotion, chores, sports and games, and exercise and sports. **RESULTS:** Average classification accuracy for all feature vectors using the uncategorized activities was 56.0% with a range of 0% (e.g. reading and internet) to 100% (lying rest and Trazer). Average classification accuracy for the categorized activities was 83.2%, with sedentary activities classified 100% accurately and exercise and sport performing the worst at 42.1%. The root-mean squared errors (RMSE) for the uncategorizedactivities ranged from 0.6 METs (Dance Dance Revolution) to 2.2 METs (track running) with an average RMSE of 1.3 METs. For the categorized activities the RMSEs ranged from 0.8 METs (sedentary activities) to 2.1 METs (exercise and sports) with an average RMSE of 1.3 METs. **CONCLUSION:** The results demonstrate that using a two-step classification and regression model can provide reasonable estimates of EE in children. In addition, when using the categorized activities, the estimation of EE is improved. Further work is needed to examine how to improve the prediction of individual uncategorized activities.

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Board #20

A Novel Method To Assess The Intensity And Duration Of Walking Bouts In Youth

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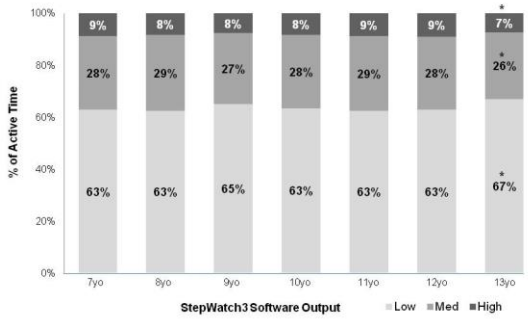
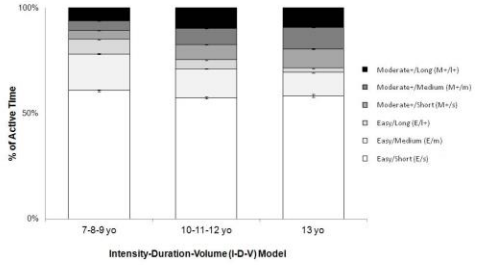
INTRODUCTION: Daily step counts have been widely studied resulting in reference values across age groups [1]. The StepWatch3 Activity Monitor (SAM) is a bi-axial accelerometer which has been used to assess the daily activity levels of children [2-4]. Orendurff et. al developed an algorithm to ensemble steps from outputted SAM data into individually quantified walking bouts [5]. This method has now been further developed to combine intensity, duration and volume (I-D-V model).**PURPOSE:**To compare the activity levels of typically developing 7-13 year olds using two analyses, SAM analysis software and the I-D-V model.**METHODS:**105 children wore a SAM which recorded steps in 10sec intervals for two weeks. Data were processed in the StepWatch3 software using the default activity levels[2] and raw data were processed through a custom built MATLAB program (I-D-V model). Intensity levels were defined based on age normalized overground walking cadence as measured in a gait lab. The volume of walking bouts [5] were analyzed based on intensity level: easy (E, 0-60%), moderate+ (M+, 60+%), and duration period: short (s, <2 min), medium (m, 2-5 min), long (l+, 5+ min). All data were reported as a percent of active time (PAT). Mann-Whitney tests were used to determine differences across age groups for SAM software and I-D-V model outputs independently. **RESULTS:**13yo were consistently different than younger children for all activity levels using the SAM software with no significant differences observed among 7-12 yo. Similar results were seen using the I-D-V model, as 13yo demonstrated significantly lower E/m, E/l+ activity and higher M+/s and M+/m activity. The I-D-V model also detected significant differences between 7-8-9 yo compared to 10-11-12 yo for all activity levels.





CONCLUSION: The I-D-V model was able to detect differences in activity patterns not seen using the standard SAM software.

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Board #21

Discriminative Accelerometer Patterns in Children Physical Activities

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INTRODUCTION: Physical activity (PA) plays an important role for maintaining healthy weight in children. Accelerometers are commonly used for estimating PA energy expenditure in free living settings. Many existing classification approaches (i.e. artificial neural networks) using accelerometer data identify PAs using feature representations of accelerometer counts such as major percentiles and correlation between counts to summarize a minute of data. Though these feature representations can summarize the data, they often overlook aspects of the inter-relationship between the individual count values. **PURPOSE**: The purpose of this study is to detect patterns between neighboring 1-sec count values which are common in one particular PA but are rare in other PAs and propose a method which can detect discriminative patterns for different PAs. **METHODS**: Seventy one children (age range: 8-12 yrs) participated in the experiment. PA was recorded using an ActiGraph GT3X+ 3-axis accelerometer and the vector magnitude was used in the experiments. Data were examined for two similar activities "Dance Dance Revolution" and "Workout video" with a duration ranging from 5-11 mins. For each possible time interval extracted from one activity instance, two kinds of supports were calculated: 1) positive support, the percentage that the subsequence existed in other instances of the same PA, and 2) negative support, the percentage that the subsequence existed in a different PA. When a subsequence has high positive support but low negative support, it is marked as a discriminative pattern for this PA, which has the ability of telling the difference between activities. **RESULTS**: The best discriminative pattern found in "Dance Dance Revolution" lasts 50 seconds and has 69.4% positive support and no negative support. In "Workout video", the best discriminative pattern lasts 70 seconds and has 54.3% positive support and no negative support. This indicated 69.4% and 54.3% true positive activities can be accurately classified by examining the possession of these two patterns. **CONCLUSION**: While this study only explored the most discriminative pattern per PA, other work in machine learning has shown that using multiple discriminative patterns for each PA may improve classification performance. The results indicate that when children perform the same activity, there are common patterns appearing in most of the cases and among these common patterns, there are some discriminative patterns which are rare or even non-existent in other activities. Further work in detecting these discriminative patterns can further assist in correctly classifying PAs.

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Board #22

Comparison of Two Filter Settings in Accelerometer-assessed Physical Activity in Individuals with Impaired Gait

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INTRODUCTION: Accelerometer data output is commonly processed through a band-pass filter adjusted to eliminate artifacts and to include only normal human motion. This particular bandwidth poses a potential limitation when assessing physical activity in individuals with impaired gait, e.g. in Parkinson´s disease (PD). To account for this, the Actigraph GT3X+ accelerometer offers a low frequency extension filter that widens the bandwidth of accumulated data. However, it´s not known how the low frequency extension filter affects physical activity parameters, when compared to the normal filter setting in individuals with impaired gait. **PURPOSE:** To compare common free-living physical activity parameters assessed with the Actigraph GT3X+ accelerometer and processed with two different filter settings, in a sample of elderly individuals with PD.**METHODS:** Thirty-eight men and 28 women, mean (SD) age 73 (6) years, with mild to moderate idiopathic PD carried an Actigraph GTX3+ accelerometer on the hip for seven consecutive days. Mean number of steps and mean minutes per day in sedentary behavior, low intensity-, lifestyle-, and moderate-to vigorous activities were obtained in the manufacturer´s software (Actilife 6) with the normal filter setting and a low frequency extension filter, respectively.**RESULTS:** The results demonstrated that the low frequency filter consistently generated significantly ($p<0.001$) larger values compared to the normal filter on all outcome variables, with the exception of MVPA and total wear time. The largest difference was observed for mean (SD) steps per day (normal filter setting, 4730 (3210) steps; low frequency extension filter setting, 11117 (4553) steps). Pearson´s correlations were consistently high, ranging from 0.901 to 0.997, indicating a linear relationship between data processed with the two filter settings. However, intraclass correlation confidence intervals and limits of agreement (95 %) were generally wide but improved with higher physical activity levels. Bland-Altman plots demonstrated marked heteroscedasticity for steps per day.**CONCLUSION:** The discrepancies found between the two filter settings in this study can most likely be explained by an overestimation of the results obtained with the low frequency extension filter. These errors could lead to misclassifications of important physical activity parameters, a problem particularly relevant for individuals who do not meet the daily recommendations of physical activity. In order to characterize physical activity in elderly individuals with PD, the appropriate lower-band cutoff for this patient group should be determined.

Board #23

A Novel Method for Summarizing Activity Intensity Levels and Bout Durations During Everyday Living

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INTRODUCTION: Our wearable triaxial accelerometer based activity/fall monitor records activity and fall events for two weeks of everyday living [1-2]. A method is needed to analyze the resulting patterns of activity intensity and bout durations. **PURPOSE:** To introduce and illustrate a novel method for analyzing everyday living activity patterns.**METHODS:** The amplitude probability distribution function (APDF) provides an overview of activity level and useful summary statistics, such as integrated activity and P10, P50, and P90 percentiles, representing, respectively, "static," "median," and "peak" intensities. However, the APDF provides no bout duration information. Exposure variation analysis (EVA) summarizes both intensity and bout information but in an inconvenient form. Our novel joint cumulative amplitude-duration (JCAD) analysis [3] gives a meaningful summary of activity intensities and bout durations. **RESULTS:** Figure 1 shows (a) a 10-hour recording from a five-year-old girl of root mean square activity (%g, 1-min. epochs) versus time (min.) and (b) the corresponding JCAD plot. The JCAD plot, an extension of the APDF, shows amplitude threshold (y-axis, %g) versus accumulated activity time (x-axis, min.). The plot's z-axis uses color to show bout duration threshold (min.). The upper edge curve for each duration threshold shows the accumulated time of activity having intensity above each amplitude threshold value for bouts lasting at least the duration threshold value. Each curve provides APDF-like statistics. For example, Figure 1b shows that for 10% (60 min.) of the 10-hour recording, activity level exceeded 30 %g for bouts at least 10-min. long. **CONCLUSION:** JCAD analysis provides summaries of intensities and bout durations of activity during everyday living useful for determining fitness, identifying abnormalities, and assessing therapy.

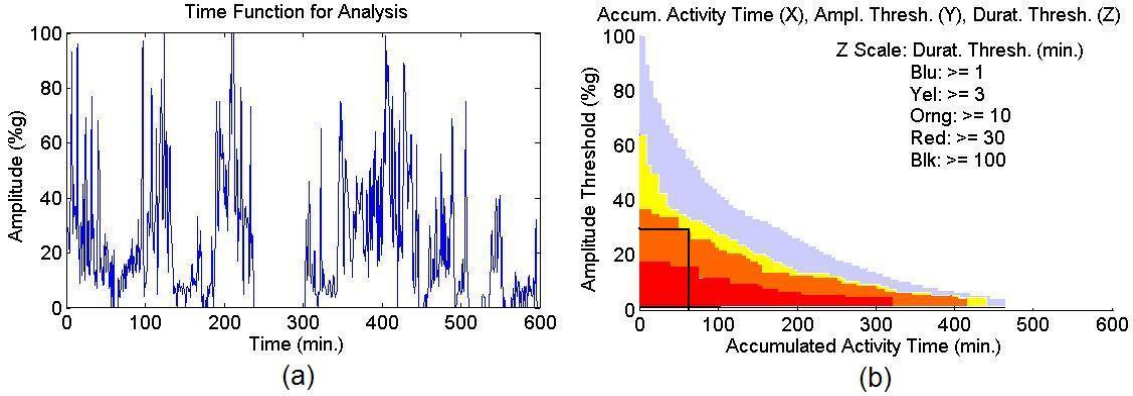

Figure 1. Ten-hour activity recording (a) and JCAD plot (b) for a five-year-old girl during everyday living

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Board #24

Evaluation Of A Method For Minimizing Diurnal Information Bias In Objective Sensor Data

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INTRODUCTION: Body-worn sensors are increasingly used to describe aspects of human behaviour. It is not uncommon that such records contain segments of missing data, for example due to sensors not being worn. Since most biological signals display a degree of periodicity according to the circadian rhythm, the pattern of missingness may give rise to bias when summarising the information. **PURPOSE:** To evaluate summation methods with respect to bias caused by imbalance of information across different times of the day.**METHODS:** 499 adults (mean (sd) age of 46 (7) yrs) wore a combined acceleration and heart rate monitor on the chest continuously for 4-6 complete days. Incomplete days were removed and within-individual mean acceleration (ACC), activity energy expenditure (AEE), and time spent sedentary (SED) and at moderate-to-vigorous physical activity intensity (MVPA) were calculated as reference values. We simulated missingness with different diurnal patterning by removing time quadrants (night 0:00-06:00, morning 06:00-12:00, afternoon 12:00-18:00, evening 18:00-0:00) on two, three, or four days yielding a total of 24 test scenarios. Within-individual mean values were calculated for each scenario in two ways, 1) naïve mean of non-missing data, or 2) by regression against two phase-shifted sine functions (perpendicular to each other) with periods of 24 hrs. For both methods, bias was calculated as difference from the reference values, and error as the square of those differences.**RESULTS:** Mean (sd) reference values were ACC 0.126 (0.06) m/s2, AEE 53.4 (22) kJ/d/kg, SED 16.6 (2.4) hrs/d, and MVPA 95 (75) min/d. Most simulated missingness scenarios introduced bias in the activity outcomes. The sine regression method had significantly lower magnitude of bias (max 5.5%) compared to the naïve method (max 20%), e.g. +10% vs +2% and +19% vs +4% in AEE for two and four missing nights, respectively. Sedentary time was the least prone to diurnal information bias (max +8.4% for naïve and max +2.4% for sine regression method). Bias and error were largest for missing information at night and in the afternoon for the naïve method, whereas missing morning and afternoon data caused greater bias and error for the sine regression method. **CONCLUSION:** The double-sine regression method reduces bias caused by diurnal imbalance of available body sensor information, compared to the naïve mean method. The sine regression method is particularly powerful with individual-level information in all time quadrants which is usually available in abundance and the method allows inclusion of all acquired information, including incomplete monitored days.

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Board #25

Accelerometer Cutpoints: What to do During the Transition from Adolescence to Adulthood in Longitudinal Studies?

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INTRODUCTION: Accelerometer cutpoints have been established separately for children, adolescents and adults. As a result, cutpoints do not always align across age categories. This poses a challenge for longitudinal studies where individuals transition from adolescence to adulthood.**PURPOSE:** To describe the impact of changing accelerometer cutpoints during the transition from adolescence (<19 yr) to adulthood (≥19 yr) on estimates of moderate to vigorous physical activity (MVPA) and achievement of PA guidelines. **METHODS:** We used accelerometer data (ActiGraph GT1M, 15s epoch) from participants who were part of the UBC Healthy Bones III study between 2008-2012. We excluded non-wear time (≥60 min of zeros; 2 min of non-zero counts permitted) and applied three MVPA cutpoints to those aged 9-18 yr (Evenson, EV; Freedson/Trost 3 MET, FT3; Freedson/Trost 4 MET, FT4) and one MVPA cutpoint for those ≥19 yr (Freedson adult). We processed data using KineSoft (v3.3.62). We determined the proportion of individuals meeting PA guidelines (60 min/d for those 9-18 yr; 30 min/d for those ≥19 yr) with each cutpoint and quantified the impact of the age-related change in cutpoints on MVPA (min/d) and guideline adherence on those measured at both age 18 and 19. **RESULTS:** We obtained valid data (≥10h/day on ≥3 days) for at least one measurement period for 312 participants (9-23 yr). In those aged 9-18 yr, 30%, 66% and 24% of participants met PA guidelines using the EV, FT3 and FT4 cutpoints, respectively. There were clear age-dependent trends in guideline compliance for both FT3 and FT4 (younger>older). In those ≥19 yr, 67% met PA guidelines (30 min/d). Data were available for 35 participants measured at age 18 and 19. Decreases in wear time (20 min/d, 95% CI -2.5, 43) and average PA (26 counts/min; 95%CI -20, 71) were not statistically significant. MVPA increased slightly from age 18 to 19 when MVPA at age 18 was established using EV (1.6 min/d; -5.5, 8.7) or FT3 (1.2 min/d; -5.9, 8.3) cutpoints, but MVPA increased 23.1 min/d (95% CI 17.3, 28.9) from age 18 to 19 when MVPA at age 18 was established with the FT4 cutpoint. At age 18, 19%, 19% and 3% met PA guidelines using the EV, FT3 and FT4 cutpoints, respectively, compared with 74% (30 min/d) or 26% (60 min/d) at age 19.**CONCLUSION:**The dual challenge of changing cutpoints and PA guidelines makes it difficult to understand PA patterns during the transition from adolescence to adulthood. The impact of changing cutpoints was lower when the EV or FT3 cutpoints were applied at age 18 compared with the FT4 cutpoint. A consensus on how to address changing cutpoints and PA guidelines during the adolescence to adulthood transition is required.

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Board #26

How Many Hours And Days Of Data Provide Reliable Estimates Of Habitual Physical Activity In Preschool Children?

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INTRODUCTION: Accelerometers are widely used in physical activity research; however several questions remain on how accelerometry data are processed. For population based studies it is important to determine how many hours of data constitute a 'valid day' and how many days are needed to provide a reliable estimate of 'habitual activity' and these parameters may be population specific.**PURPOSE:**The purpose of this study was to determine the number of hours and days of accelerometry data necessary to reliably estimate habitual physical activity in preschool children. The impact of including or excluding a weekend day on reliability estimates was determined.**METHODS:**Accelerometry data was collected from 112 children (60 males, 52 females, 3.70 ± 0.16 yrs) over 7 days. Validated accelerometry cut-points (Puyau et al, 2002) were applied to categorise data into different intensities. As Kolmogorov-Smirnov statistic revealed that data were not normally distributed ($p<0.05$), the median percentage time spent total physical activity (combining light, and moderate to vigorous activity) was calculated. Median counts per minute (cpm) for weekend and weekdays were also determined and differences assessed using Wilcoxon rank-sum test. Reliability was calculated using Intraclass Correlation Coefficient (ICC) (2,1) and the Spearman-Brown Prophecy formula (S-B prophecy formula) was used to predict the number of days and hours of data required to achieve an arbitrarily determined desired reliability of 0.7. The impact of including a weekend day on reliability estimates was evaluated by comparing the reliability coefficient(r) and 95% Confidence interval (CI) for data with 4 weekdays with data for 4 days including 1 weekend day. **RESULTS:**There was no significant difference between cpm for weekend days (*Mdn*=653) and weekdays (*Mdn*=607) (z= 1.66, p=0.097 r= 0.11). However, there was a significant difference between percentage time spent in total physical activity (z=-3.59, p=0.00, r=-0.21) between weekend days (*Mdn*=26.32%) and weekdays (*Mdn*=25.11%). Results of the S-B prophecy formula suggest that 7 hours of data collection per day for 3 days is necessary to achieve an ICC value of 0.7. Including a weekend day had minimal impact on reliability estimates between 4 days including 1 weekend day r=0.74 (0.63-0.83) and 4 weekdays r=0.74 (0.62-0.82). **CONCLUSION:**Results of the S-B prophecy suggests that 3 days of data collection for 7 hours a day had sufficient reliably and inclusion of a weekend day had minimal impact on reliability estimates. There were differences between weekday and weekend day estimates of total physical activity however the effect size was small (r=0.21).

Board #27

The Use of Triaxial Accelerometry Data to Define Nonwear Time

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INTRODUCTION: One of the fundamental challenges in use of free-living accelerometry data is to distinguish between time when the accelerometer is worn (wear time) from time when it is not worn (nonwear time). Distinguishing between the two wear states is essential for two main issues: 1) minimally acceptable wear time; 2) correct estimation of time spent in different intensity levels of physical activity.**PURPOSE:** The purpose of this study was to compare a commonly used definition of nonwear time to a newly developed method based on triaxial accelerometry data.**METHODS:** Data from 653 older adults from the Age, Gene/Environment Susceptibility (AGES)-Reykjavik Study were analyzed. The new algorithm defined nonwear time as a 60-minute window of zero counts in all three axes (compared to the vertical axis only), allowing for up to two minutes of nonzero counts under 100 in the vertical axis (compared to any number of up to two consecutive nonzero counts under 100).**RESULTS:** 245 participants (38%) gained one or more valid days (≥10 hours) of wear time using the new tri-axial nonwear algorithm. On average 0.6 days and 48 minutes of wear time per day was gained using the new definition ($p<0.001$). Average counts/minute during wear time decreased ($p<0.001$) with the new method due to an increase in sedentary time of 52 min/day ($p<0.001$).**CONCLUSION:** The new method to define nonwear time using triaxial accelerometry data provides a more plausible estimate of nonwear time in free-living accelerometry data. The new algorithm increases the number of days that are considered valid for analysis and may more accurately reflect sedentary levels of free-living populations.

Supported by NIH contract N01-AG-12100, the NIA Intramural Research Program, Hjartavernd (the Icelandic Heart Association), and the Althingi (the Icelandic Parliament).

Board #28

Decision Rules In Analyzing Acceleration Data And Their Impact On Meeting ACSM Physical Activity Recommendations

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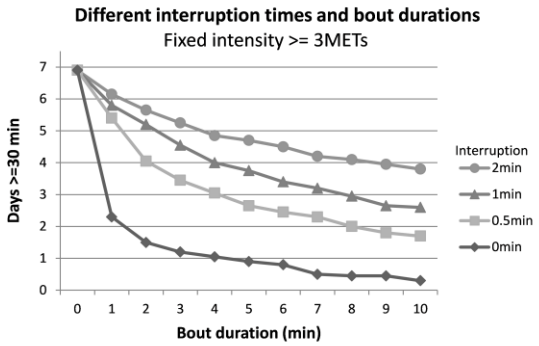
PURPOSE: Sufficient physical activity (PA) is increasingly recognized as an important factor in the prevention and treatment of a number of health conditions. Recent studies have shown that Chronic Obstructive Pulmonary Disease (COPD) is associated with reduced PA, already in the early stages of the disease. Subjects with a chronic disease may find it impossible to generate physical activities with moderate intensity, or to sustain such intensities in bouts of at least 10 minutes. It has been shown that different methods to process accelerometer signals affect the summary reports of accelerometer data. The aim of this study is to investigate if different decision rules with different thresholds of intensity, bout duration and interruption time, have impact on the compliance of COPD patients with physical activity recommendations.
METHODS: Twenty patients with COPD with a broad range of PA levels were included in the study, and asked to wear an activity monitor (DynaPort© MoveMonitor©, McRoberts, The Netherlands) continuously for one week. We analyzed whether subjects meet the recommendations of the American College of Sports Medicine (ACSM), using decision rules with different tresholds. **RESULTS:** None of the COPD patients complied with the recommendation of the ACSM that all healthy adults need to engage in moderate-intensity aerobic physical activity (>3 MET) for a minimum of 30 min per day on at least 5 days per week in bouts of at least 10 minutes continuously. Compliance with the ACSM recommendations increased importantly when using shorter bout duration and introducing interruption times between periods of PA. The mean number of days subjects complied with the recommendation increased from 0.3 to 0.9 if bouts of 5 instead of 10 min were used (Figure 1). If an interruption duration of 1 minute was accepted, the mean number of days subjects complied with the recommendation increased from 0.3 to 2.6 (Figure 1).**CONCLUSION:** Our data shows clearly that even small differences in thresholds for intensity, bout duration and interruption time between bouts have a major impact on the compliance with PA recommendations in COPD patients. The introduction of interruption time has the greatest effect. Data reporting should include explicitly the decision rules used.



Board #29

Relationships between Physical Activity and Adiposity: Does Accelerometer Non-Wear Criteria Matter?

Leigh Gabel, Lindsay A. Nettlefold, Louise C. Mâsse, Douglas Race, Heather A. McKay, Heather M. Macdonald. *The University of British Columbia, Vancouver, BC, Canada.*
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INTRODUCTION: Decisions regarding non-wear criteria are necessary for accelerometer data processing; however, no consensus exists. **PURPOSE:** We investigated the implication of different non-wear criteria on the relationship between physical activity (PA), sedentary time (SED) and adiposity.**METHODS:** We used ActiGraph GT1M accelerometers to assess PA and SED in 340 participants (181 girls) aged 9-20 yrs who were part of the UBC Healthy Bones III Study. We used 15-sec epochs and included participants with ≥10h/day on ≥3 days/week. We applied the Freedson age- and sex-specific cutpoints and 5 non-wear criteria: 10-, 20-, 30-, and 60- min (with and without 2-min of interruption) of consecutive zeros. We report the number of participants, valid days, wear bouts, and estimated wear time, counts per minute (CPM), moderate to vigorous PA (MVPA; min/day), and SED (as a proportion of SED + light PA). We measured percent body fat (%BF) using dual-energy X-ray absorptiometry. We assessed differences between non-wear criteria using repeated measures ANOVA and relative rank with spearman correlations. We fit sex-specific multivariable regression models for CPM, MVPA, and SED to investigate the influence of non-wear criteria on %BF (adjusting for age, height, and maturity). Comparisons included only those participants who had valid files for all 5 non-wear criteria.**RESULTS:** The 60-min with no interruption criteria resulted in 209 participants (113 girls; 14.5 ± 3.7 yrs) and 1038 valid days. These values decreased with shorter non-wear time criteria to 185 participants and 841 valid days for the 10-min criteria. Participants excluded with the 10-min criteria were significantly older, engaged in more SED and less MVPA. Number of wear bouts was highest with the 10-min criteria and lowest with the 60-min criteria (7.3-1.5 times/day). Estimated wear time and SED significantly increased with longer non-wear criteria while CPM and MVPA significantly decreased with longer non-wear criteria. We observed strong rank order agreement between all 5 criteria and CPM, MVPA and SED (range r=0.92-0.99; $p<0.001$ for all). CPM was negatively associated with %BF in girls using the 20-, 30- and 60- min criteria, but not using the 10-min. **CONCLUSION:** The 10-min non-wear criterion moderates the relationship between PA and adiposity and preferentially excludes less active, older participants compared with longer criteria. In lieu of a consensus regarding the most appropriate non-wear criteria in this population, our data indicates values between 20-60 min are comparable when relating PA and SED to adiposity.

Supported by Canadian Institutes of Health Research (MOP-84575)

Board #30

Geneactiv And Actigraph Gt3x+ Raw Acceleration Outputs: Are They Similar In Children?

Christine A. Schaefer, Valerie Ward, Raymond C. Browning. *Colorado State University, Fort Collins, CO.*
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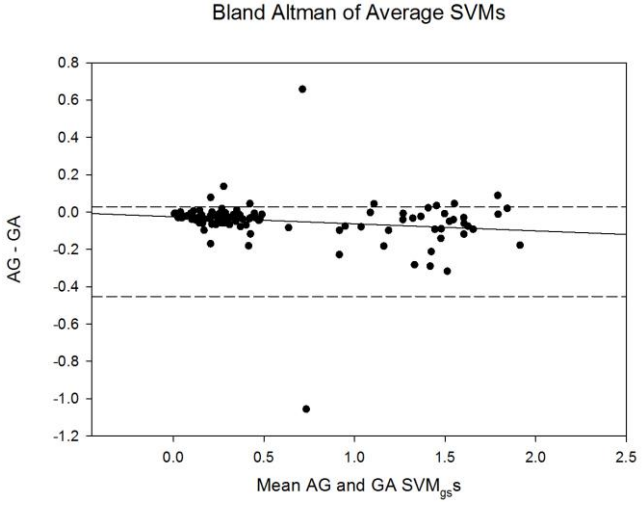
INTRODUCTION: Accelerometry (ACC) has become the most popular method for objectively quantifying physical activity (PA). The PA monitoring community is currently moving toward collecting raw acceleration data, partly in an effort to allow comparisons of PA between studies. However, no studies have compared raw acceleration output between two monitors. **PURPOSE:** To compare the outputs of the GENEActiv (GA) and Actigraph GT3x+ (AG) accelerometers during typical activities performed by elementary school-aged children. **METHODS:** ACC data were collected during 9 activities, including rest, coloring, building with Legos, Wii ® Tennis and Boxing, and treadmill walking (0.75 and 1.25 m/s) and running (1.75 and 2.25 m/s) in 13 children ages 6-11. Each activity was performed for 6 minutes. Raw acceleration data were recorded simultaneously on the non-dominant wrist at 75 (GA) and 80 (AG) Hz, respectively. We filtered the raw GA data using a band-pass filter (.2-15 Hz). AG data were downloaded using ActiLife software (V 5.0) and was not post-processed. Acceleration values were averaged into one-second, gravity-subtracted, signal vector magnitudes (SVM_{gs}, g·s). The one-second SVM_{gs} were then averaged over the last two minutes of each activity. We used linear regression to determine the correlation between SVM_{gs} values for each device and generated a Bland-Altman plot to examine the presence of fixes or proportional bias. **RESULTS:** The SVM_{gs} of the GA and AG devices were strongly correlated (r^2=0.95). The Bland-Altman plot showed a non-significant negative proportional bias (p=.08), particularly during vigorous activities, suggesting that AG ACC output tends to not increase to the same degree as the GA output (Figure 1). **CONCLUSION:** The strong correlation between the AG and GA SVM_{gs} is encouraging, suggesting that the outputs from these devices can be compared, particularly during sedentary-moderate intensity activities. Future studies should further examine the influence of the signal post-processing on acceleration output, particularly during higher-intensity activities.



Board #31

Activity Classification Using the Wrist-Mounted GENEActiv Accelerometer in Children

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INTRODUCTION: Accelerometry (ACC) is one of the most widely used methods for quantifying individuals' levels of physical activity (PA). Recently, ACC outputs have been used to classify the types of activities taking place. Devices that record raw acceleration may allow improved activity classification due to the quantity of data available to train the classifier. **PURPOSE:** The purpose of this study was to evaluate the ability of a neural network classifier to correctly identify a variety of typical children's activities using data from a wrist-mounted accelerometer. **METHODS:** Twenty-four children ages 6-11 years performed 9 activities (6 minutes/activity) while wearing a GeneActiv ACC on the non-dominant wrist. Activities are listed in Table 1. ACC data were recorded at 75 Hz and filtered (0.2-15 Hz). We used five minutes of acceleration data per activity and calculated the mean and variance of each ACC axis in 30 s windows that overlapped by 25 s. Means and variances were used as inputs into a neural network (NN) with one hidden layer of 50 units. The scaled conjugate algorithm was used to train the NN for 5,000 iterations though the training set (all but one participant) and validated using leave-one-out (LOO) methodology on the remaining participant. **RESULTS:** Overall classification accuracy was 54.5%. Individual classification accuracies (per activity) are listed in the confusion matrix (Table 1). When activities were grouped (e.g. rest, color and Legos as sedentary), classification accuracy improved to 74.7%. Conclusion: Although overall classification accuracy was not as good as expected, classification accuracy when similar activities were grouped improved substantially. Active gaming activities were the most difficult to classify correctly. To improve the overall classification accuracy, additional features may need to be included. Table 1. Confusion Matrix of predicted (labels on columns) versus actual (labels on rows) activity classification accuracy during (1) Rest (2) Coloring (3) building Legos (4) Wii ® Tennis (5) Wii ® Boxing (6) 0.75 m/s (7) 1.25 m/s (8) 1.75 m/s and (9) 2.25 m/s.

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
1	70.3	18.5	7.6	2.5	0.1	0.8	0.0	0.0	0.0	0.2
2	23.9	46.3	19.8	4.0	0.2	5.5	0.0	0.0	0.0	0.2
3	6.8	12.5	67.6	5.8	0.1	4.5	0.7	0.1	0.0	2.2
4	2.9	11.9	9.4	42.3	3.1	6.9	8.2	1.7	0.2	13.9
5	1.7	3.3	3.0	4.3	57.0	5.1	0.6	6.6	14.4	5.0
6	1.1	3.5	6.0	8.4	1.1	54.7	19.6	1.6	0.3	4.6
7	0.1	0.0	0.1	9.1	0.0	13.5	70.5	1.0	0.3	6.2
8	0.0	0.0	0.6	3.2	9.6	1.1	2.5	55.2	20.7	8.2
9	0.0	0.0	0.0	1.3	19.6	0.4	0.5	20.4	54.4	4.2
10	0.8	2.3	7.3	33.4	6.1	8.4	14.6	8.2	4.8	13.9

Board #32

Moveecloud: An Analytical And Study Management Platform For Raw Sensor Data

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INTRODUCTION: Raw accelerometry has gained popularity as a tool for ambulatory monitoring. The analytical freedom coming from the access to raw data is likely to facilitate future research. The downside, however, is that analytical reproducibility is challenged and computational demands are higher for raw accelerometry compared with traditional methods. **PURPOSE:** Our objective is to address the downsides of raw accelerometry by developing a platform for the storage and analyses of raw sensor data utilizing cloud technology and state of the art signal processing techniques. **METHODS:** The MOVEeCloud (moveecloud.com) is based on e-science central, a cloud computing facility developed by Newcastle University and comes with data provenance, private working areas, study team moderated public release of data and algorithms. The MOVEeCloud web-interface allows for data upload to the cloud, study data management, and rapid data processing. Users will be able to contribute algorithms, but for the moment the main available algorithm comes with the following automated functionalities: (i) Basic data quality check for monitor non-wear time, signal clipping and calibration error; (ii) Signal feature extraction, e.g. the vertical arm angle and body acceleration based on optimised removal of the gravitational component. These features are stored per user defined epoch; (iii) Imputation of invalid data informed by the data quality check and the study protocol; (v) Extraction of meta features, e.g.: time spent in activity levels, the Gini-index to characterise the distribution in the duration of inactivity bouts, and sleep indicators; (iv) Summary report generation per data file. The algorithm is currently compatible with the following accelerometer devices: Genea (Unilever Discover, UK), GENEActive (Activinsights Ltd, UK) and Actigraph raw (Actigraph Inc, USA).**RESULTS:** The algorithm was successfully tested outside the cloud for raw accelerometer data from various cohorts, including: GENEActive data from the Whitehall cohort (N = 6000) and Genea data from the MRC Newcastle 85+ cohort (N = 600). Next, we successfully tested the algorithm on the cloud. **CONCLUSION:** At the moment MOVEeCloud is mainly an environment for algorithm application. Our intention is to complement MOVEeCloud with functionality for algorithm development based on uploaded ground truth datasets. In conclusion, MOVEeCloud is a new platform that will improve computational possibilities, analytical reproducibility and analytical transparency in the fields of daily physical activity, sedentary behaviour, sleep and functional measures.

Board #33

Loaded and Unloaded Foot Movement Differentiation Using Chest Mounted Accelerometer Signatures

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INTRODUCTION: Accelerometry data is easy to collect and useful in many applications such as pedometry, fall detection, and activity/sleep monitoring. This paper aims to use accelerometry data to identify when heavy loads are being carried. Load carriage increases the metabolic work intensity leading to increased heat production which impacts thermal strain. Additionally, load carriage increases the risk of muscular-skeletal injuries. Differentiating between load versus no-load can: (1) improve energy expenditure estimations in heat illness risk assessments, and (2) lead to better understanding the role of load in injuries. In our prior work (Clements et al. 2011) we utilized a method to represent accelerometry in terms of 4s movement signatures.
PURPOSE: To identify a simple feature from our accelerometry movement signatures that can be used for real-time discrimination of walking with and without a heavy load.**METHODS:** Twenty-nine male (20 ± 3.1 yrs; ht: 177cm ± 9 cm; wt: 83 ± 13 kg; mean ± SD) soldiers wore an Equivital EQ-02 (Hidalgo, Cambridge, UK) physiological monitoring device containing a tri-axial accelerometer. Each volunteer completed a baseline walk for a 10 minute period wearing just a t-shirt, shorts, and boots on a treadmill at 3.0mph with a 0% grade. After a rest of at least 3 minutes additional 10 minute walks were conducted wearing randomly assigned load-bearing vest weighing 35, 45, and 55 kg. The data were categorized as unloaded (baseline walk) and loaded (35, 45, and 55 kg). Accelerometry data were segmented into 4s chunks (to capture at least a single gait cycle). Movement signatures (10x10 histograms) were generated from normalized lateral and vertical accelerations (Figure 1). Principle Component Analysis was applied to the movement signatures to identify a low dimensional representation that could discriminate between loads. Using only the first principal component, that explained the most variance, we trained and tested a Naïve Bayes classifier using 7-fold cross-validation.
RESULTS: The classifier correctly identified unloaded movement segments 92% of the time and loaded segments 94% of the time.**CONCLUSION:** We discovered a single feature that can be used in a Naïve Bayes classifier to discriminate between loaded and unloaded conditions > 92% of the time. This technique shows is a promising and useful addition to real-time models predicting thermal strain and risk of muscular-skeletal injury.

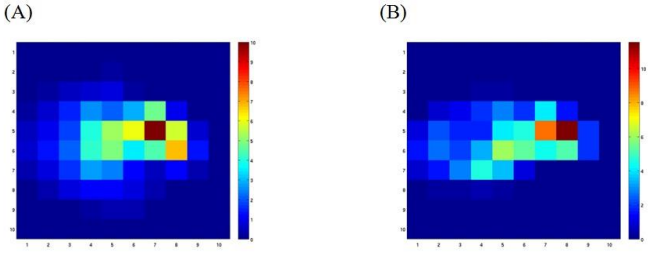

Figure 1: Mean unloaded movement signature (A), and loaded signature (B).

Board# 34

Post-trial Anatomical Frame Alignment Technique for Inertial Sensor System in Joint Kinematics Measurements

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INTRODUCTION: In recent years, combinations of inertial sensor and magnetic sensor have been introduced as an alternative to camera-based motion capture systems for joint kinematics measurement. Since inertial sensors do not measure position directly, functional calibration, anatomical calibration with a special apparatus or with a stationary motion capture system have been developed to find a transformation matrix between the local sensor frame and anatomical frame (AF) for each segment before data collection. With the transformation matrices, the 3D joint angular kinematics could be calculated in a similar manner as the camera-based system. As axes from the AFs are often used as the rotational axes of the joint involved, any difference in the AF determination will introduce discrepancies to the calculated joint angles, hindering the direct comparison of the joint kinematics obtained from different experimental systems or protocols. **PURPOSE:** The purpose of this study was to propose a new post-trial AF alignment method between inertial sensor-based system and camera-based system. **METHODS:** Joint angles are simultaneously measured using camera-based system and inertial sensor-based system. Each system has its own AF definition for individual limb, resulting joint angle differences. AF misalignments were determined from the joint angles measured from these two systems using a previously developed functional representation of joint angle errors due to two different AF definitions . Overground walking experiment has been performed on one subject and the joint angles were measured simultaneously using an inertial sensor system (Xsens MVN Biomech) and a camera-based system (NDI Optotrak 3020) at 100 Hz. The alignment algorithm and data analysis were performed using a custom MATLAB program. Only results from knee joint were presented here. **RESULTS:** The associated AFs misalignment between these two systems for the anatomical frame of the thigh, was estimated as , and the misalignment for the anatomical frame of the shank, was estimated as . After the post-trial AF alignment, the mean angle measurement errors between the inertial sensor-based system and the camera-based system were reduced from 3.0º to 1.3º for flexion/extension, from 1.6º to 0.4º for adduction/abduction, and 20.3º to 0.86º for knee internal/external rotation. **CONCLUSION:** By post-trial aligning the AFs, the inertial sensor-based system and camera-based system produced a similar waveform throughout a gait cycle. The proposed technique could serve as an effective tool for calibrating inertial sensor-based systems.

Poster Session
Engineering and Tool Development
Monday, June 17, 2013, 4:30 pm - 6:00 pm
Campus Center Auditorium

Board# 35

Detection of Respiration Rate During Sleep Using 3D Sensor

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In recent years there have been technical improvements in low cost 3D sensors capable of detecting movements unobtrusively. In addition to measuring body movement, these sensors have been used for measuring respiration. In most of these studies use of 3D sensors has a number of requirements (including fixed posture) that restrict their use in practice. In this pilot study we evaluated automatic detection of respiration rate using Kinect, low cost 3D sensor, in five subjects during daytime naps. Respiratory inductance plethysmograph (RIP) was used as a reference sensor. Simple algorithm averaging spectral power of 3D depth pixels values from Kinect during 30 s epochs was compared to the spectrum of the RIP signal. Only artifact free epochs demonstrating peak in spectrum were analyzed. When comparing respiratory rates between the two methods, correlation coefficient over subjects was high, 0.82. Thus, although the Kinect 3D sensor used in this study has limitations in measuring depth, the spectral averaging over pixels provided clear detection of respiration rate in the 30 s epochs. The same sensor also measures body movements and together with the detected respiration the combination of these signals could be used for unobtrusive automatic sleep staging.

Board #36

Evaluating Four Types Of Spinal Orthoses Using Inertia Sensor Based Motion Analysis

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PURPOSE: Various orthoses, varying in type, rigidity, mechanism, price, comfort and fit (prefabricated, custom), are used to treat different spinal conditions. The choice for a specific orthosis currently relies on the directives of the health care provider as a general guideline is lacking. This study evaluates the effect of 4 types of spinal orthoses on the performance of daily motion tasks using inertia sensor based motion analysis. **METHODS:** Ten healthy subjects (28±10yrs) performed 5 motion tasks (1. gait, 2. sit-stand-sit (STS), 3. block stepping up/down, 4. forward/backward-, 5. lateral bending test) representing daily activities while wearing a 3D inertia sensor at sacrum level. 5 conditions were compared (fixed order): normal and wearing 4 common spinal orthoses (Bandage, SecuTec Dorso, Jewett, Spinal cast). Self designed algorithms were used to derive motion parameters (e.g. speed in gait, bending angle in STS, block stepping and forward bending test, pelvic obliquity in block step and lateral bending test). Repeated measurement ANOVA using LSD correction was done to compare the different conditions ($p<0.05$). **RESULTS:** During gait, normal walk speed (5.3 ±0.6km/h), step length (0.95±0.2m) and cadence (101.7±17.5steps/min) were hardly influenced by wearing an orthosis. STS was sign. influenced by the orthoses, showing a lower bending angle during sit-stand (spinal cast 35.0 ±6.5° vs 42.0 ±6.3°) and stand-sit movements (Jewett 40.8 ±4.3° vs 48.0 ±8.9°) compared to normal. In block stepping, the pelvic obliquity was sign. reduced when wearing an orthosis (range: 2.4°-11.8°), showing the largest reduction with the SecuTec Dorso. Also the rotation angle was sign. reduced when stepping down (bandage 8.4 ±2.3°, SecuTec Dorso 8.5 ±2.6° vs normal 11.3 ±3.9°). In the forward bending test the angle was sign. limited by all orthoses, showing most restriction with the Jewett and Spinal cast (resp. 50.5 ±13.4°, 46.3 ±14.7° vs normal: 64.5 ±11.6°). During lateral bending, all orthoses caused an increase in pelvic obliquity with regards to normal (range 2.3° - 4.8°). **CONCLUSION:** Daily activities like transfers, managing steps or bending in any direction are influenced by wearing any type of orthosis. Differences between the designs were found which can lead to a preferred choice for certain clinical conditions, Jewett and Spinal cast are suited for conditions requiring mobilization and stabilization in bending angle, e.g. fractures. For patients requiring mobilization in pelvic obliquity the SecuTec Dorso is recommended. The bandage is only recommended for patients requiring low stability as it showed the lowest motion reduction questioning its objective usefulness.

Board #37

Towards Home Exercise Performance Measures: Classifying Walking Balance Exercises from Hip and Ankle Accelerometers

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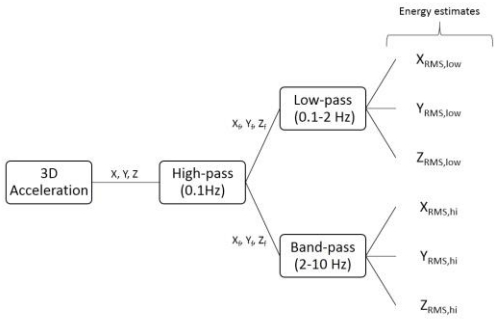
PURPOSE: Home-based balance exercises are recommended to reduce the risk of falling and fractures in older adults with low bone mass (LBM). However, adherence to exercise programs is difficult to measure at home. While body-worn accelerometers provide gross measures of physical activity, methods to distinguish exercise from other activities have yet to be established. The goal of the current study was to develop and evaluate a method to distinguish balance exercises and normal walking using hip- and ankle-worn accelerometers.**METHODS**: Eighteen (n=18) older females (≥50y) with self-reported LBM were recruited from osteoporosis support groups. Participants wore 3D accelerometers (X6-2 Mini, Gulf Coast Data Concepts Inc., 40Hz sampling, ±6g range, 16-bit resolution) at the left hip and on each ankle just above the lateral malleoli. Participants performed 5 tasks in their own home: 4 walking exercises aimed at improving dynamic balance (figure 8, heel-toe, side-step, and backwards) and straight-line walking. Each task was performed 4 times along a hallway or wall, with total task duration ranging from 25-70 secs per task. Fig 1 depicts the processing steps used to estimate energy from each accelerometer sensor. Sensor data from axes approximating sagittal, transverse, and coronal planes were filtered to remove gravity artifacts, then separated into low (0.5-2 Hz) and high (2-10 Hz) frequency bands. Energy was estimated as the root-mean-square (RMS) value. Computed for each sensor, axis, and band, a total of 18 energy estimates were used as inputs to a neural network classifier with 5 outputs corresponding to each task. The classifier was evaluated using a leave-one-out cross-validation protocol.**RESULTS:** The neural network classified tasks with an overall accuracy of 91.1%; 82 of 90 test instances were classified into the correct task category. Compared to a random selection accuracy of 20%, the results indicate excellent separation between tasks. Backwards walking was the most commonly confused classification (5 of 8 errors). **CONCLUSION**: We have developed and validated a method for distinguishing between five walking and balance exercise tasks using data from body-worn accelerometers, a key step in the development of a method to measure at-home exercise performance. Measures, such as type, frequency and intensity of exercise, can provide feedback of individual progress and indicate adherence.



Board #38

Assessing Physical Activity Intensity Using a Video Based Approach

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[1]CIAFEL, FADE-University of Porto, Porto, Portugal.[2]INESC TEC and Faculty of Engineering - University of Porto, Porto, Portugal.[3]School of Engineering - University of Minho and LIACC, Faculty of Engineering - University of Porto, Porto, Portugal.[4]Iowa State University, Ames, IA.
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INTRODUCTION: Assessing physical activity (PA) is a challenging task and many different approaches have been proposed. Accelerometry-based activity monitors have gained acceptance as a standard for field based research but they do not provide contextual information and can be invasive in some circumstances. Direct observation (DO) techniques can capture context but current methods require tedious manual coding and can't be used for large scale monitoring. In this study, we evaluate the utility of video analysis to record and discriminate levels of PA. This method may facilitate the capture of contextual information in a more cost-effective manner and at higher sampling frequencies.**PURPOSE:** The purpose of this study was to compare PA intensity, of a short basketball practice, between video analysis, accelerometry and DO. **METHODS:** Eight young players, three girls and five boys (10 years), wore the Actigraph GT3X+ during a 20 minute basketball session. While performing their regular routines, PA was analyzed by two observers using the SOPLAY instrument and by a video-based recording system (CAM). The GT3X+ and the video recording were setup to collect data in raw mode at 30Hz during the entire session. DO was performed every two minutes, with 10 seconds of observation for each gender. The percent of time spent in different intensities of PA from the GT3X were determined using cutpoints proposed by Evenson. Similar outcomes were computed from the SOPLAY and the video system using standard methods. A chi-square test was used to test differences in the percent times at three intensity zones (Light, Moderate and Very Active). The Yates' correction was used to prevent overestimation of statistical significance for small data. **RESULTS:** When compared with GT3X+ the CAM had better results than the SOPLAY. From the chi-square test yielded the following pairwise comparisons: CAM vs GT3x+ was $\chi 2$ (5)= 5.013, p<.414; SOPLAY2 vs GT3x+ was $\chi 2$ (5)= 45.751, p<.001; SOPLAY1 vs GT3x+ was $\chi 2$ (5)= 41.124, p<.001.**CONCLUSION:** These analyses suggest that the video tracking system has the potential to provide reasonable estimates of PA intensities, with the same sample rate as the accelerometer and without being intrusive to the player.

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Board #39

Comparing Energy Expenditure Prediction from a Wearable Wireless Network of Accelerometers to Indirect Calorimetry

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INTRODUCTION: Hip-mounted, commercially manufactured accelerometers can provide valid measurement of physical activity (PA) in most settings. However, their ability to estimate the energy cost of free-living activities is limited in terms of obtaining contextual information. Our research team created and validated a wearable wireless network of accelerometers to overcome limitations of traditional monitors. Previous examination involved laboratory-based activities; it is unknown if the system provides accurate measures of energy expenditure (EE) in a free-living setting.**PURPOSE:** To compare the ability of a wearable wireless network of accelerometers to predict EE versus indirect calorimetry during performance of various activities in a free-living setting. **METHODS:** Participants (n=25), 18-28 years old, engaged in 14 different activities (lying down, sitting reclined and straight, standing, biceps curls, sweeping, squats, jumping jacks, stair climbing, walking slow and fast, biking slow and fast, and jogging) over 60 minutes. While performing the activities, participants wore a portable metabolic analyzer (OM; Oxycon Mobile, Cardinal Health) and a wearable system of three wirelessly interconnected accelerometers worn on the right wrist, thigh, and ankle. Participants performed each activity at least once, but they chose the order and the duration (1-10 minutes) for performing activities. An artificial neural network (ANN) was created from the data using 10-fold validation method, in which the data set was randomly divided into 10 equal groups. The ANN was trained on features extracted from the wireless system and OM data from nine groups. Prediction of EE was conducted by testing the ANN on the tenth group. This approach was repeated for each of the ten groups. Root mean square error (RMSE) and Pearson correlations were calculated for predicted MET values from the wireless system compared to the OM. **RESULTS:** During the session, participants' MET values ranged from 0.82-12.46, and they spent 40 minutes in moderate-to-vigorous PA. Compared to OM, RMSE for the wireless network was 1.63 METs, and the correlation between predicted and measured MET values was $r=0.80$ ($p<0.001$).**CONCLUSION:** The wireless system provided similar RMSE values but lower correlations with OM than our previous laboratory-based study. RMSE values were higher than other laboratory-based studies, but the correlation in the current study is higher than those from other accelerometer-based ANNs for measuring PA. The wireless system can provide valid estimates of EE for adults participating in physical activities in a free-living setting.

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Board #40

Real-time Activity Classification With Android Smartphones

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PURPOSE: The advent of smartphones presents an opportunity to develop low-cost methods for performing real-time movement analysis which can quantify the relationship between activity and wellbeing. This tool would allow intervention and prevention strategies to be implemented, by offering suggestions about how to modify activity levels to improve wellbeing. The built-in cellular communications module allows for transmission of data and GPS position enabling clinicians and researchers to gather large amounts of data whilst monitoring patients from a remote location and provide immediate feedback. **METHODS:**Twenty young, healthy volunteers were recruited to wear the smartphone (Samsung Galaxy Nexus) on the anterior region of the upper thigh (in the front pocket of their pants or shorts) whilst data were collected and stored from its on-board sensors. Each participant was asked to perform seven activities of daily living (standing, sitting, lying down, walking, walking up and down stairs and travelling in an elevator) at least twice during the recording session. The participants were simultaneously recorded on video to annotate the start and end times of each activity. Once all the data were collated, 22 features were extracted from the multi-dimensional data. The information metric of maximum entropy was calculated for every possible combination until that which yielded the greatest entropy was identified. Leave-one-subject-out cross validation was used to evaluate the generalized classifier (WEKA's J48 decision tree algorithm) performance. Finally, a classifier was built using data from all 20 subjects. This was ported to the Android platform and implemented in Java to assess the viability of implementing such an algorithm in real-time. **RESULTS:**The cross validated algorithm identified the correct activity 86% of the time, demonstrating a mean Cohen's kappa coefficient of 0.8084 ± 0.0898. On average, the phone recorded 40 MB worth of data per hour for a period of fifteen hours. Under more demanding conditions in which the smartphone was used to continuously display video, and the Wi-Fi antenna was left on whilst the data collection application was running in the background the battery lasted only five hours. Data losses were negligible with each sensor exhibiting the following sampling rates $f_{accelerometer/gyroscope} = 100 \pm 0.8$ Hz (worst case sample interval of 0.11 seconds) and $f_{barometer} = 16.82 \pm 5.5$ Hz (worst case sample interval of 0.80 seconds). **CONCLUSION:** Smartphone technology may have reached a stage of advancement where it is viable to build unsupervised activity monitoring systems capable of providing unprecedented levels of feedback in real-time.

Board #41

PARTwear: A Modular System for a Flexible Development of Physical Activity Recognition and Tracking Applications

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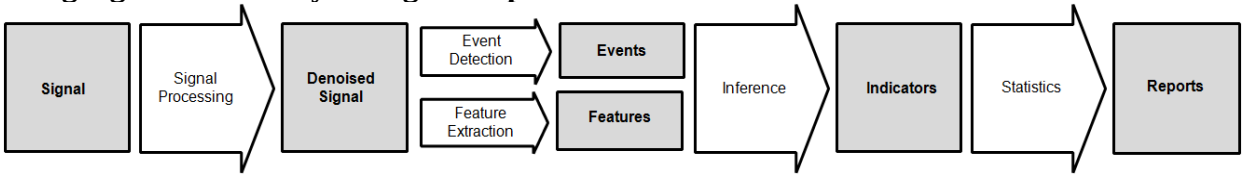
INTRODUCTION: Improvements in sensor and software technologies open up new opportunities for physical activity monitoring. Measurements of multiple dimensions of physical activity that will lead to more detailed descriptions of behavior need flexibly extensible body sensor networks in combination with adaptable algorithms.**PURPOSE:** The aim of this project is to develop a extensible and unobtrusive body sensor network that can be modified in short time to integrate additional monitoring tools and to establish a coordinated collaboration between a group of engineers and movement scientist that allow to develop and validate new monitoring tools using the proposed software framework. **METHODS:** The PARTwear system was developed with modularity and extensibility in mind. The hardware part consist of a wireless body sensor network to which several sensors can be interfaced. Two accelerometers, a heart rate monitor, Local Positioning Measurement System (LPMS) and a power measurement device for bicycles are the current components of the system. The firm- and software are build using a plugin-architecture to implement the general activity recognition process (see Figure 2). The firmware architecture allows to combine signal processing, event detection and feature extraction methods for specific tracking tasks to be computed directly on the sensor node. Indicators such as activity type, context and intensity can then be inferred using the PARTdesk Software executed on a desktop computer. **RESULTS:** The PARTwear system was used for monitoring studies in the Swiss and Austrian army over weeks. These measurements have resulted in objective data about activity pattern in recruit schools. In a coordinated collaboration between engineers and movement scientists several pilot studies have been conducted that resulted in promising results in the detection and tracking of sport specific indicators such as ground contact time in sprinting, tennis serve speed and cadence in rowing and biking.**CONCLUSION:** The PARTwear system can be deployed in monitoring studies for weeks as well for the detailed description of sport activities. The flexible re-use of software components and the coordinated cooperation between engineers and movement scientist guarantee short development cycles for new monitoring applications.

Figure 1: The modules of the PARTwear Firmware and Desktop Software are organized along a general Activity Recognition process.



Board #42

Classification Of Physical Activity Based On A Biomechanical Approach

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INTRODUCTION: Systems based on inertial sensors enable henceforth ambulatory movement analysis. This recent development offers new opportunities for rehabilitation purpose such as patients' physical activity (PA) monitoring. This typical application requires algorithms for the recognition of the PA recommended by the clinical staff. Currently, the algorithms proposed are based on decisional trees and neural networks built on data of young healthy subjects. The relevance of such algorithms is questionable for pathological subjects, whose physical abilities are expected to evolve with the rehabilitation process.**PURPOSE:** The aim of the present study is to propose a new algorithm based on the literal definition of postures and the characterization of the accelerations representing the specific body-segments coordination occurring during the physical activities (PAs) to classify. **METHODS:** An algorithm for PA classification was proposed based on the biomechanical definition of the postures to classify and on the hypothesis that to each PA corresponded a specific body-segments coordination. To determine how to characterise this specific body-segments coordination, a motion capture (Vicon system) was performed on 16 subjects of heterogeneous age and physical condition taking successively different posture (sitting/standing/lying) and performing different PAs (walking/running/cycling) at different pace (slow/normal/fast). Body-segments orientation and 16 vertical and horizontal accelerations were afterwards computed. All the combinations from 2 to 3 accelerations out of the 16 accelerations were tested to define which one was the most appropriate to distinguish the PAs by the mean of the Hausdorff Distance.**RESULTS:** The vertical acceleration of the knees had the HDs computed between two trials of a same PA the most different from the HDs computed between two trials of two different PAs, demonstrating thus the best ability for distinguishing the activities. This result was used in the algorithm for PA classification. With this algorithm, 94% of the trials were correctly classified for the 16 subjects. **CONCLUSION:** Conversely to previous studies, the present study proposed a biomechanical approach for the development of a methodology enabling PA classification. The promising results obtained with off-line implementation of the present algorithm on optoelectronic motion capture data open perspective to a real-time application based on inertial sensors.

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Board #43

Measurement Of Sit-stand And Stand-sit Transitions Using A Tri-axial Accelerometer On The Lower Back

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INTRODUCTION: The study of ambulatory human motion with accelerometer -based activity monitors has increased in many areas of biomedical research. These research areas include the monitoring of both older and younger adults. Reduction in sensor size coupled with more powerful data mining techniques have enabled the use of single sensor devices for longitudinal monitoring but sensor location and algorithm complexity play a key role in deriving a more complete activity summary.**PURPOSE:**The study aimed to investigate the feasibility of a discrete accelerometer-based sensor located on the lower back (L5) in determining sit-to-stand (SiSt) and stand-to-sit (StSi) postural transitions based upon a previous algorithm [1].
METHODS: Participants wore the AX3 (Axivity, York, UK) tri-axial accelerometer-based sensor on the lumbar vertebrae (L5). The device was attached by means of double sided tape and Hypafix. Sampling rate for the AX3 was set at 100 Hertz (Hz). Participants were initially told to stand still for 10 seconds to calibrate the accelerometers prior to testing. Participants were then asked to perform 3 SiSt and StSi transitions from 2 chairs (chair with/without arm rests, height = 43cm) at the notification of a researcher. Upon completion data were downloaded and analysed using MATLAB. **RESULTS:** Ten young (YHS, 33.1 ± 4.8 years) and 10 older (EHS, 64.7 ± 5.0 yrs) healthy adults were recruited (Table 1). In total 240 transitions were performed, divided evenly across both groups. Sensitivity and specificity values relating to SiSt and StSi for both YHS and EHS groups are shown in Table 1.

Group	**Height (cm)**	**Weight (kg)**	**Sensitivity (%)**		**Specificity (%)**	
			SiSt	**StSi**	**SiSt**	**StSi**
YHS	169.9 ± 8.6	67.7 ± 13.0	96.7	86.7	96.7	86.7
EHS	168.6 ± 9.4	69.3 ± 15.2	83.3	91.7	83.3	91.7

Table 1: group descriptives along with the sensitivity and specificity values for SiSt and StSi

CONCLUSION: Postural transitions can be accurately detected for older and younger adults with an accelerometer-based sensor located on L5. Previously the VESPA algorithm solely utilised vertical velocity estimates to differentiate between SiSt and StSi transitions. To improve the detection rates presented here, future work will incorporate vertical displacement values calculated from the vertical velocity. In addition, longitudinal (7 day) community based data will be assessed in comparison with a commercial activity monitor (activPAL™) to assess long term suitability and accuracy.

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Board #44

Dynamic Calibration Approach For A Multi-sensor Knee Brace Exploiting Inductive Coil Technology

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PURPOSE: Functional loading during activities of daily life (ADL) plays an important role in the pathomechanics of knee osteoarthritis. A multi-sensor knee brace has been developed to monitor knee kinematics and assess activity patterns during ADL in OA patients . The key technology is an inductive coil that circumvents the complexities of IMU based monitoring. This novel technology will enable to tailor treatment and rehabilitation strategies to the needs of the individual OA patient. However, initial trials showed that the kinematic output of the brace is sensitive to re-positioning, which likely to occur during ADL. The aim of the current study was to develop and test a dynamic calibration method that corrects for these positioning errors. **METHODS:**The multi-sensor knee brace comprises I) an inductive coil braided onto the fabric and II) two tri-axial accelerometers positioned just above and below the knee. The inductive coil provides an accurate reading of angular changes during dynamic activities, whereas the accelerometers provide angular data during sedentary activities. Initial calibration of the coil data is based on a series of postures assumed at known knee angles. Subsequently, the dynamic correction algorithm searches for sedentary periods in the acceleration data and then calculates the angle between the accelerometers. This data is used to update the coil calibration curve between sedentary periods. Two healthy adults participated in a pilot study to evaluate the correction algorithm. They wore the knee brace while going about their daily routines, for a series of periods varying between 30 minutes and 4 hours. During the sedentary periods the difference between angles derived from the coil and the accelerometers was calculated for 1) coil data based on initial calibration and 2) re-calibrated coil data. **RESULTS:**Coil data using the initial calibration showed considerable differences (>15°) with the angles calculated from the acceleration data. These differences fluctuated (10-40°) during the recording period. This indicates that the source of the error it is not sensor drift, instead re-positioning of the brace during ADL is the most likely cause. The re-calibration approach effectively cancelled the error (< 5° difference).**CONCLUSION:**The current study showed that a dynamic calibration approach is required to cancel re-positioning errors resulting from the interaction between sensor and user. The algorithm is fairly straightforward and can be easily incorporated in the onboard microprocessor of the knee brace. The most effective implementation will depend on the intended use of the brace.

Supported by MUMC-MOVE

Board #45

Absolute Performance of Physical Activity Monitors

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PURPOSE: Inexpensive, solid state accelerometer sensors can deliver flat response from 0 to 400 Hz and ±8 g at high resolution. Performance of physical activity (PA) monitors with these sensors often is much worse. Some reduce sensed signals to an arbitrary summary measure, such as "counts" or apply band-reducing filters to raw data. Others, such as mobile phones, may not read the sensors continuously to save battery or because they use a multi-tasking operating system. To date, no PA monitors come with calibration certificates or specifications on how to relate their output to international standards. The differences between devices make it hard for researchers to relate data collected with prior generations of monitors to current devices or to standard units.**METHODS:** We examined the characteristics of representative PA monitor and smartphones. Then we evaluated overall performance, along with means to correct errors, recover absolute signals, and perform calibration. **RESULTS:** Multi-tasking devices skipped or inaccurately time-stamped samples, especially when data were recorded at high rates. Many of these errors can be corrected with resampling processes such as the Lomb-Scargle algorithm. Intact monitors can be true calibrated across their complete force/frequency range with a "rate table" or a multiple degree of freedom positioner. With an absolute calibration translated to standard units it is possible to simulate the output of a legacy monitor from any signal of sufficient fidelity and known spectral performance.**CONCLUSION**: All modern PA monitors are capable of measurements across most of the range of human movement. However, often arbitrary differences in the design and operation of monitors make it difficult to compare data gathered with other monitors or make comparisons to international units. Until manufacturers provide monitors with standardized outputs researchers may be able to conduct their own calibrations and process signals for between-units comparisons.

Board #46

Assessing the Development and Application of an Overall Dynamic Body Accelerometer Technique for use in Elite Swimmers

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INTRODUCTION: The relative energetic costs of different swimming techniques are critical in determining the performance of an athlete. Assessing such energetic costs represents a unique challenge in a swimming environment. Technological advances offer a new method for determining the rate at which swimmers expend energy, based on measurements of overall dynamic body acceleration (ODBA) through the attachment of miniature acceleration data-loggers. This technique could resolve energy expenditure at a high (sub-second) temporal resolution, potentially enabling the relative cost of specific elements to be determined.
PURPOSE: This pilot study explores the application of ODBA to the analysis and differentiation of the relative energetic costs of stroke techniques between elite adult swimmers.
METHODS: Swimmers wore the ODBA miniature acceleration data-loggers while undertaking a series of race simulation swims on their preferred stroke. The 1 inch square sized device was located on the apex of the swimmer's head for symmetry, and comprised of a 3 axis accelerometer, 3 axis magnetometer, and a combined temperature and pressure sensor. The accelerometer had a logging range of +/- 16g with a resolution down to 4mg., the magnetometer had a resolution of 1-2°, whilst the combined temperature and pressure sensor had resolutions of 0.1°C and 0.01hPa respectively. The device was contained within a waterproof sealed bag allowing the pressure sensor to log water depth. Each sensor was queried for data at a rate of 40 Hz, all of which was stored sequentially via a buffer, along with individual time stamps from an on-board real time clock, onto a MicroSD card. Upon completion of the exercise, the MicroSD card was retrieved and the sensor data converted to a human readable format using MatLab. No filtering was carried out on the data as, at such low sampling frequencies, the sensors performed at their optimum levels.**RESULTS:**ODBA allowed the differentiation between swimming strokes and between swimming components (e.g. diving, swimming, turning). Furthermore, the rhythmic oscillations in the ODBA allowed inferences to be made a posteriori with regard to stroke rate and thus stroke length. **CONCLUSION:**This initial pilot study suggests that ODBA has the potential to inform the analysis of the relative energetic costs of different stroke techniques. This analysis has highlighted a number of questions that need to be addressed, such as the optimal location for the ODBA to be positioned, the relationship between ODBA and energy expenditure during swimming and its ability to predict overall swimming performance.

Board #47

Application of Nanotechnology and Computer Science to the Development of Physical Activity Sensors

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INTRODUCTION:A number of physical activity measurement techniques are available, yet typically have a number of inherent limitations associated with them; for example, laboratory-based protocols fail to replicate the sporadic nature of children's habitual activity patterns, techniques currently rely on the use of arbitrary classification thresholds and unrepresentative (i.e., healthy weight) sample populations have typically been used. Technological advances afford a novel method for ascertaining physical activity levels based on overall dynamic body acceleration (ODBA) through the attachment of miniature acceleration data-loggers. **PURPOSE:** The aim of the current study was to integrate nanotechnology and computer science to develop physical activity sensors and measurement systems. Subsequently, the application of the systems was piloted during an active video gaming (AVG) protocol representative of the natural sporadic movement patterns of children. **METHODS:**Twenty children aged 9-11 years varying in body weight and physical fitness participated in a maximal exercise test to determine peak O_2 and a 30 minute AVG protocol whilst wearing the ODBA miniature acceleration data-loggers, sampling at 40Hz. The data-logger was placed on ten different anatomical positions, and comprised of a tri-axial accelerometer (logging range = ± 16g), a tri-axial magnetometer, and a combined temperature and pressure sensor. Sampling resolutions were 4mg, 1-2°, 0.1°C and 0.01hPa, for the accelerometer, magnetometer, temperature and pressure, respectively. Sensor data was formatted using MATLAB R2012b. Sampling at such low frequencies enabled the sensors to perform at their optimal level, thereby requiring no filtering. **RESULTS:** Indirectly determined energy expenditure was related to ODBA derived from the miniature accelerometers. Furthermore, this relationship was modulated by anatomical position. Pattern recognition allowed specific movements to be elucidated from the ODBA data. **DISCUSSION:**These pilot data support the use of the developed sensors for the advancement of physical activity assessment in children which have the potential to thereby influence international physical activity guidelines and initiatives. Moreover, this initial pilot study alludes to resolving energy expenditure at a high (sub-second) temporal resolution potentially enabling the recognition of natural movement patterns in ecologically valid environments.

Board #48

Evaluating a Complete Streets Implementation using Web-Based Prompted Recall for MVPA Bouts

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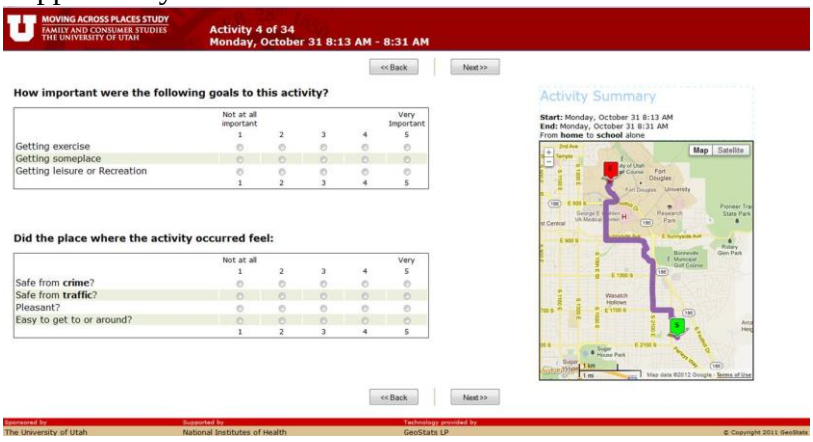
INTRODUCTION: The Moving Across Places Study-MAPS-is being conducted by the University of Utah to evaluate whether a natural community intervention in the form of a complete street construction relates to more moderate to vigorous physical activity (MVPA) bouts and healthier weight outcomes. **PURPOSE:**The goal is to assess adults now and again following the Complete Streets construction to detect changes in use of the complete street area in conjunction with MVPA and BMI. The intervention includes a new light rail line with five new stops, a bike path, and better pedestrian paths along North Temple Street.

METHODS: Research assistants, equipped with laptops and wireless communication cards which connect to the internet, conduct face to face recruitment and retrieval meetings with study participants (n=1,080 adults). Participants are given GPS data loggers and an accelerometer with instructions to wear both devices during waking hours for 7 days; BMI is also measured. At the follow up interview, survey team members download the data from the devices and upload the datasets to a website. The GPS and accelerometer datasets are merged and processed to identify Moderate to Vigorous Physical Activity (MVPA) bouts of activity using NHANES cut points and bout lengths of >=3 minutes. A web-based survey tool (Bouts Reviewer) allows for immediate review of MVPA bouts with participants (see figure below). The participant is then engaged in a face-to-face GIS/GPS enhanced prompted recall interview to probe for behavioral and attitudinal data related to the detected MVPA bouts.**RESULTS:**Phase 1 data collection was completed in December 2012 for 1,080 participants. 921 participants collected at least 4 days of 10 or more hours of worn physical activity data. 837 of those participants also collected GPS trips. From the data collected by the 1,080 participants, 10,439 MVPA bouts have been identified and reviewed.

CONCLUSION: Phase 1 has confirmed that the methodology is working. Implementing a computer-based survey system in the field that provides accurate spatial and temporal details of MVPA bouts (which were collected via passive, objective measurement) immediately after data collection concludes to be proving a very effective method for collecting precise information about MVPA bouts, and related details and perceptions from physical activity study participants.

Supported by National Cancer Institute Grant No. 1R01CA157509-01



Board #49

Accelerometer Technologies, Specifications, and Limitations

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INTRODUCTION: Technology advances and manufacturing efficiency improvements have drastically increased the options and flexibility available to users of accelerometer-based products. These advancements have led to confusion among activity monitor users, and many have been led to believe that device output normalization is an obvious and easy step. In truth, there are engineering obstacles that prevent this from becoming reality. **PURPOSE:** The purpose of this presentation is to educate users on the differences between integrated circuit accelerometer technology types and the tradeoffs and burdens that may be incurred by selecting one type over another, regardless of manufacturer. This paper will work to dispel the myth that accelerometers and/or activity monitors can be used interchangeably while furthering the understanding of accelerometers and their capabilities within the arena of human activity monitoring.**SUMMARY OF PRESENTATION:**Until recent years, researchers interested in monitoring and quantifying human activity only had one viable option. The technology of Microelectromechanical systems (MEMS) was not yet cost effective for everyday use, and as a result, accelerometer-based activity monitors relied primarily on piezoelectric bimorph beams. These beams, while functional, are typically expensive to manufacture, require periodic calibration, and are limited to measurement of time varying acceleration, which precludes positional information such as subject posture. Advances in silicon wafer and manufacturing processing have enabled MEMS based accelerometers to become prevalent in many applications, including nearly every smartphone manufactured today. This technology is extremely stable, exhibits negligible measurement drift due to temperature, and requires only a single calibration. Furthermore, because they are capable of measuring static acceleration, positional information can be harvested for various applications. These advances in the field of MEMS technology, coupled with the decreasing cost per bit for non-volatile memory, have led to a fundamental shift in the way activity data are collected. Researchers are no longer limited by the long standing filtered/epoch level data collection that dominated the arena for so many years. They are now free to collect raw acceleration data. This approach maximizes flexibility, allowing researchers to post process and reprocess data as new algorithms become available. With this additional flexibility has come a growing interest by the research community in normalizing outputs across devices, thereby removing the unique value provided by individual manufacturers. While this idea holds great promise among those tasked with harvesting useful information from the collected data, in reality there are numerous hurdles that prevent it from being feasible. Proper education can establish appropriate data collection expectations, reduce confusion about the data collected, and allow for realistic comparisons between different accelerometer based products.

Poster Session
Validation and Calibration
Monday, June 17, 2013, 4:30 pm - 6:00 pm
Campus Center Auditorium

Board #50

Discriminating Between Lying Down, Sitting, Standing, and Ambulating Using Two Tri-Axial Accelerometers

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INTRODUCTION: The activPAL™ is an accelerometer-based monitor that is typically worn on the thigh and classifies daily human behavior into sitting/lying, standing, or ambulation. The monitor detects orientation of the thigh and discriminates between sitting/lying and upright posture. However, a current limitation of the activPAL™ is that it does notiscriminate between sitting and lying postures. **PURPOSE:** To determine if four distinct behaviors (lying down, sitting, standing, and ambulation) can be correctly classified using two activPAL™ devices, one on the thigh and one on the chest. **METHODS:** Fifteen adults between 18 and 55 years participated in the study. Each participantwore an activPAL™ on the front of the right thigh, and on the right anterior axillary position on the chest using Tegaderm tape.Both monitors were synchronized and initialized to record data in 15-sec epochs. Participants performed a choreographed routine of activities for 3 minutes each. Activities included sitting, lying down in three different positions (stomach, back and on side of the right arm), sweeping, walking (3 and 4 mph) and running (6 mph). All activities were separated by a brief transition period. Start and stop times for each activity were directly observed and recorded by a trained observer. Output for each activPAL™ was exported to Excel, and merged in a new file where column 1 was the 15-sec time stamp, and columns 2 and 3 were sitting/lying time from the activPAL™ monitors on the thigh and chest, respectively. Those periods when both activPAL™ monitors recorded "sitting/lying" were classified as lying down. The periods when the activPAL™ on the chest recorded "standing" and the monitor on the thigh recorded "sitting/lying" were classified as sitting time. Percent accurate classifications and confusion matrices were used to determine the accuracy and identify misclassifications for the 2-activPAL™ method. **RESULTS:** The use of two activPAL™ devices enabled four behaviors to be accurately distinguished: lying down, sitting, standing, and ambulating. **CONCLUSION**: This method is advantageous over using a single activPAL™ because it allows researchers to distinguish between time spent lying down and time spent sitting. The distinction between sitting and lying down is not possible with a single thigh-worn activPAL™. This is a limitation when using the device over a 24-hour period. It is important to distinguish between sitting time and lying down because sitting (i.e. sedentary behavior) is deleterious to health and sleep is considered to be a healthy behavior due to its restorative powers on mental and physical function.

Board #51

A Comparison of Two Accelerometers For Measuring Physical Activity and Sedentary Behaviour

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INTRODUCTION: A central aspect of physical activity (PA) and sedentary behavior (SB) research is the accurate assessment of PA in the context of disease outcomes. By objectively measuring PA and SB, some of the measurement errors inherent in self-reported measures may be minimized and more accurate estimates of the association between PA and SB and health can be achieved.**PURPOSE:** To evaluate the convergent validity of the ActiGraph® GT3X+ (AG) and ActivPAL3™ (AP) accelerometers in a free-living sample of postmenopausal women. **METHODS:** Participants are from the Breast Cancer and Exercise Trial in Alberta (BETA Trial), a randomized controlled exercise intervention trial comparing the effects of a moderate (150 min/wk) versus high volume exercise (300 min/wk) intervention on biological mechanisms hypothesized to mediate the association between PA and postmenopausal breast cancer risk. Participants wore both monitors concurrently during waking hours for seven-days at the 6 month (n=208) time point, and completed a monitor wear log. AG summary measures (hrs/d) were: SB-inclinometer, SB-100cpm, and using vector magnitude counts per minute (cpm) time in moderate (2691-6166 cpm), vigorous (6167+ cpm) and light (0-2690 cpm - SB-inclinometer) activity was calculated. Total AG activity time was the sum of light, moderate, and vigorous time. AP summary measures (hrs/d) were: SB (sit/lie), upright (standing/stepping), moderate (3-5.9 METs), vigorous (6+ METs), and light activity (upright-mod-vig). Bland-Altman plots were used to measure mean differences and limits of agreement between monitors for time in SB, light, moderate and vigorous PA.**RESULTS:** For the AG measures of SB, SB-inclinometer values were significantly (p=0.0001) greater than SB-100cpm values. Compared to SB from the AP, SB-inclinometer values were no different (0.13 [-4.98 to 5.23] hrs/d, p=0.19) and the SB-100cpm values were lower (0.39 [-2.76 to 3.54] hrs/d, (p=<0.0001). Paired t-tests show no significant differences between AG and AP for time in light (-0.07 [-5.15 to 5.00] hrs/d; p=0.45) and moderate activity (-0.01 [-1.00 to 0.98] hrs/d; p=0.52) , but time recorded in vigorous activity by the AG was greater than AP (0.14 [-0.33 to 0.62] hrs/d, (p=<0.0001) and total activity for the AG was less than upright time for the AP (-1.32 [-6.16 to 3.52] hrs/d; p=<0.0001). **CONCLUSION:** The differences in reported estimates of time spent in various activity intensities from these two devices were small. For the majority of activities, the level of agreement suggests that the devices cannot be used interchangeably and if the study objectives include assessments of both PA and SB both devices may be useful.

Board #52

Validation Of The Activpal And Actigraph For Assessing Sitting In A School Classroom Setting

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INTRODUCTION: Emerging evidence associating sedentary behaviour with health and academic outcomes has drawn attention to the time children spend sitting. Activity monitors are commonly used to measure MVPA in children, yet there are few studies investigating their validity when measuring sitting time, in particular the ability to distinguish between sitting, standing and stepping. As children spend a large proportion of their days in classrooms, school is a setting of interest.**PURPOSE:** The purpose of this study was to validate the ActivPAL (APal) and ActiGraph 3GTX (AG) activity monitors for measurement of sitting against a criterion measure of direct observation (DO). **METHODS:** 40 children in grades 5, 6 & 7 wore APal inclinometers and AG accelerometers while being video recorded during 2 school lessons (80 total observations; mean duration of lesson = 36.3 min). Teachers nominated two classroom lessons for observation, one typically involving a high prevalence of sitting, and another where more movement around the classroom was permitted. Teachers undertook normal practice in both lessons with no intervention from researchers. Videos were subsequently reviewed and continuous DO data collected using Dartfish event tagging software. APal and AG data were collected in 15 second epochs. Individual participant DO and APal data were recorded as periods of lying, sitting, standing and stepping then summed for each observed lesson. AG data were converted into minutes spent sitting using a cut point of below 25 counts per 15 sec, chosen to correspond to the commonly cited sedentary cut point of 100 counts per min. **RESULTS:** All three measures of sitting were highly correlated (DO vs APal: $r = 0.90$, $p<0.001$; DO vs AG = $r = 0.76$, $p<0.001$; APal vs AG = $r = 0.72$, $p<0.001$). Bland-Altman analyses of agreement (accounting for two observations per individual) revealed the APal and AGraph underestimated sitting time by 5.1% (bias = -1.85 min, 95% LoA = -8.96 to 5.26 min) and 8.8% (bias = -3.19 min, 95% LoA = -13.08 to 6.70 min) respectively. **CONCLUSION**: These analyses suggest the APal is more accurate than the AG, when using a cut-point of 100, for assessing sitting time in children in classroom settings where the prevalence and duration of sitting is high. Further studies should seek to validate the APal and AG in settings with greater inter- and intra-individual variation in movement patterns and also evaluate different AG cut-points for assessing sitting.

Board #53

Reliability and Validity of a Domain-Specific, Last-7-Day Sedentary Behaviour Questionnaire in Adults

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INTRODUCTION: Reliable and valid questionnaires assessing domain-specific and overall sedentary behaviour in adults are needed to enable the impact of sedentary behaviours on health and the determinants of domain-specific sedentary behaviours to be studied in large samples. **PURPOSE:** To examine test-retest reliability, criterion validity and absolute agreement of a domain-specific, last-7-day sedentary behaviour questionnaire, for assessing total daily sedentary time (hrs/day) as an aggregate of sitting/lying down in 5 domains (meals, transportation, occupation, non-occupational screen time and other sedentary time). A Dutch (DQ) and English (EQ) version of the questionnaire were examined. **METHODS:** Fifty-five Flemish adults (aged 38.4 ± 11.1 [mean ± SD]) wore an activPAL3^{TM} monitor and simultaneously kept a domain log for 7 days. The Dutch questionnaire was subsequently completed twice with a 2-week interval between test and retest administration. The activPAL3^{TM} sedentary time data were annotated with the log data to create comparable domain-specific and total sedentary time variables between the combined criterion and the questionnaire. 440 English adults (aged 46.5 ± 7.4) wore an Actiheart for 6 days to objectively measure total sedentary time. The English questionnaire was subsequently completed twice with a ≥2-week interval. In both samples, the test questionnaire reference frame coincided with the administration period of the criterion measure (DQ: activPAL3^{TM} + log; EQ: Actiheart). All participants had ≥5 valid days of criterion data, including ≥1 weekend day.**RESULTS:** Test-retest reliability (ICC [95%CI]) was fair to good for *total sedentary time* (DQ: 0.68 [0.49-0.80]; EQ: 0.55 [0.47-0.62]) and *domain-specific sedentary time* (DQ: ranging from 0.37 [0.12-0.58] [meals] to 0.68 [0.49-0.81] [occupation]; EQ: ranging from 0.42 [0.33-0.50] [other sedentary time] to 0.77 [0.73-0.81] [meals]). In terms of criterion validity (Spearman`s rho), the questionnaire ranked individuals moderately to well for *total sedentary time* (DQ vs. activPAL3^{TM} + log: 0.52; EQ vs. Actiheart: 0.22; all P<0.001). Compared to the domain-specific criterion variables (Dutch sample), the questionnaire ranked individuals moderately to very well for *domain-specific sedentarytime* (ranging from 0.21 [meals] to 0.76 [P<0.001] [screen time]). Regarding absolute agreement, the questionnaire generally overestimated sedentary time compared to the objective criterion variables. **CONCLUSION:** This questionnaire shows fair to good reliability, comparable to questionnaires measuring physical activity, and acceptable to good validity for ranking individuals.

Board #54

Comparison Of Objectively Measured And Self-reported Time Spent Sitting For Administrative Workers

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INTRODUCTION: Until recently, methods for objective quantification of sitting time, although an important part of sedentary behaviour, have been lacking.**PURPOSE:** The aim of this study was to compare objectively measured and self-reported total and longest un-interrupted sitting time during working hours, workdays and leisure days. **METHODS:** Objective diurnal measurement of time spent sitting was obtained among 26 office workers with 2 accelerometers (ActiGraph GT3X+), mounted at the right hip and thigh for a 7-day period. Customized software was used to identify sitting time separated from other sedentary behaviours. Self-reported sitting time was obtained from a retrospective 7-day questionnaire. Difference between objectively measured and self-reported sitting time was tested with a generalized linear model.**RESULTS:** No significant correlations were found between objective and self-reported sitting time ($r<0.315$). Total sitting time was significantly underestimated on a leisure day ($p<0.001$) and un-interrupted sitting time was in all three time settings significantly overestimated ($p<0.045$). Poor agreement between objectively measured and self-reported sitting time was shown in Bland-Altman plots with wide limits of agreement.**CONCLUSION:**This study showed agreat individual variation and a general lack of agreementbetween self-reported vs. objectively measured total and un-interrupted sitting time. Objective measures are recommended for determining sitting time.

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Board #55

Reliability And Validity Of Subjective And Objective Instruments For Measuring Sedentary Behaviour In Older Adults

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INTRODUCTION: Objective measurement has strengths in terms of validity when compared with self-report, but self-report is more practical for measuring sedentary behaviour (SB) in large-scale studies. Self-report can also provide contextual information about SB and use of time, which are useful when trying to interpret behaviours. However, little is known about the validity and reliability of objective and subjective measurement of sedentary behaviour in older adults. **PURPOSE:** To assess the reliability and validity of three instruments for measuring SB in older adults.**METHODS:** 41 community-dwelling older adults (14/27 male/female, 74.5±7.6 years) were visited twice. ActivPAL3TM (AP) and ActiGraph GT3X+ (AG) were worn during 7 consecutive days. A vector magnitude cut-point of <70 counts/15 seconds was applied for defining AG-measured SB. At the end of follow-up, participants completed (1) a single question (SQ) for sitting time on a usual weekday, weekend day and the last day of monitoring time, and (2) a computer-delivered 24-hour recall (24R) for the last two days of monitoring time. To assess reliability, the SQ and 24R were repeated at the end of the second visit and intraclass correlation (ICC) and standard error of measurement (SEM) were calculated. Validity for the three instruments was examined with Pearson's correlation and Bland Altman plots with AP as the reference standard.**RESULTS:** For the SQ on an average day, weekday, weekend day and the last day, the ICC ranged from 0.64 to 0.79, with SEM ranging from 1.03 to 1.42 hr/day. ICC for 24R was 0.89 for the last monitoring day and 0.72 for the second last day with SEM of 0.47 and 1.18 hr/day, respectively. The SQ showed poor correlation with AP (r= 0.093 to 0.333), with a mean difference of -3.53 hr/day (SD=2.33). In contrast, 24R showed moderate correlation with AP for both the last day (r=0.437, p=0.037), and the second last (r=0.620, p=0.008), with mean differences of 1.47 (SD 2.51) hr/day (last monitoring day) and 0.82 (SD 2.22) (second last day). Correlation was strong between AG and AP (0.81, p<0.001), the mean difference was -0.013 hr/day (SD 0.16), however, the limits of agreement were wide: -2.00 to 1.97 hr/day. **CONCLUSION:** When using self-report instruments the 24R is more valid for measuring time spent in SB in older adults than the SQ, which considerably underestimates time spent in SB in older people. AG with a vector magnitude <70 counts/15 seconds is a valid method for measuring SB in populations, but individual variation was high. Additional analyses will be done to examine whether pattern recognition improves the validity of AG measurement in older adults.

Board #56

Comparing A Questionnaire With Logbooks And Accelerometry To Assess Sedentary Behaviors And Active Transport

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INTRODUCTION: Measuring the different dimensions of physical activity (PA) is important to define strategies for PA promotion and obesity prevention. In this field, there is increasing interest for better assessment of sedentary behaviors (SB), e.g. time spent sitting for different occupations, and active transports (AT), e.g. walking and cycling, but few existing instruments appear relevant for this purpose. **PURPOSE:** This study compares the weekly durations of different SB and of AT as reported by questionnaire with their estimations using logbooks and accelerometry. **METHODS:** An adapted version of the Recent Physical Activity Questionnaire (RPAQ) including additional questions on AT and on various SB was administered to 100 subjects. Then, each subject prospectively wore a 3-axial accelerometer (Actigraph GT3X+), while filling in a paper logbook during 14 days. Variables of interest were weekly average 1) total sitting time estimated using the questionnaire or accelerometry data; 2) time spent in AT and in five specific SB (passive transports, sitting at work, during transports and during spare time for watching TV or for other sedentary occupations) estimated using the questionnaire or logbook data. Data are presented as means ± sem. Analyses used non-parametric paired tests, regression analyses and intra-class correlations.**RESULTS:** Preliminary results (n=35) indicate that the estimates of average weekly total sitting time obtained using the questionnaire (49.0±5.2 h/week) and accelerometry data (43.2±1.9 h/week) were not significantly different, but were poorly associated (r=0.25; 95%CI [-0.12;0.52]). The analysis of the first notebooks (n=7 at the time of submission) shows a modest or good agreement (ICC>0.60) between the questionnaire and the notebook estimates for time spent in active and passive transports, and for sitting time at work; but lower agreements for time spent sitting during passive transport or during spare time. **CONCLUSION:** Accelerometer devices provide high-frequency information on a subject's posture and total sedentary time but, used alone, do not provide the information required to associate these features to their purpose (e.g. work, leisure). Logbooks present the advantage of proceeding further to determine typologies albeit with non-negligible filling constraints. If the preliminary analyses are confirmed on the whole sample, the adapted RPAQ should offer a good compromise useful to specify some of the dimensions of work- and transport-related PA and sitting times.

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Board #57

The Association Between Two Accelerometer-derived Measures Of Gait Function; Gait Regularity And The Harmonic Ratio

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PURPOSE: Body-worn sensors with accelerometers are well-suited for assessment of gait function. Sensors will capture body movements throughout the entire gait cycle, as opposed to for example electronic walkways, which only capture footfalls. Several accelerometer-derived measures of gait function have gained considerable interest in recent years, perhaps particularly in elderly people, who are more prone to being unsteady when walking. One such measure is gait regularity, which can be found by an autocorrelation procedure, where successive steps and strides are correlated with one another. Little similarity between successive steps/strides will return a small correlation coefficient, indicating low regularity. The harmonic ratio is a measure of smoothness and rhythm of walking. Autocorrelation coefficients and harmonic ratios may reflect similar qualities in gait. In this paper, we investigate the association between these two measures of gait function in a population of community-dwelling elderly.
METHOD: Participants were recruited for a prospective study of gait and function in elderly people. They walked back and forth for a distance of 6.5 meters, with a dynamic start/stop of 2 meters at each end. Participants wore a sensor at their lower lumbar/sacral area, attached by a belt. For this paper, 2 walks at preferred speed were analyzed. Data were transmitted by Bluetooth-technology, and analyzed with in-house software. Step and stride autocorrelation coefficients and harmonic ratios were calculated for movements in the antero-posterior (AP), medio-lateral (ML) and vertical (V) direction. To investigate the relationship between the variables, Pearson product moment correlation coefficients were calculated between Fisher transformed autocorrelation coefficients and the harmonic ratios. **RESULTS:** Data for 73 persons were included in the analysis. The mean age of the participants was 75.6) (SD 3.2). 61% were women. Pearson product moment correlation coefficients were significant at 0.01-level, but tended to be moderate (r=.365-.555). **CONCLUSION:** To our knowledge, there has not been extensive research on the relationship between autocorrelation coefficients and harmonic ratios as measures of regularity and smoothness in gait. The findings of this study suggest that there is a relationship between the variables. It is possible that gait regularity and harmonic ratios mirror slightly different aspects of gait quality. Further research on the usefulness of both measures in the assessment of gait quality in elderly people is warranted.

Board #58

Evaluation Of Different Kind Of Pedometers Measuring Walking Steps At Different Speeds

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INTRODUCTION: A common method to measure physical activity is with a pedometer, which counts number of steps taken. The pedometer is seen as an acceptable tool by both researchers and the public, although, research shows that traditional pedometers are capable of both over- and underestimate steps taken. It is now common that pedometers are integrated in other devices, such as cell phones, which enables measurements by a product already worn by a huge part of the population. To assess the potential of pedometers in cell phones, and to contribute to increase physical activity and a better health, they need to be evaluated and compared with traditional pedometers.**PURPOSE:**to evaluate the measurement accuracy of a pedometer cell phone application compared to traditional pedometers, measuring walking steps at different speeds. **METHODS:** Walking steps was measured by two pedometers and one pedometer cell phone application, on one individual (Female, 38 y, BMI: 30) walking on a motorized treadmill (Attract), at 7% slope. Equipment: Yamax LS2000 (Y) (Yamax, Japan)on the right hip, Omron Walking Style X (O) (Omron Health Care, Japan) in the left chest pocket and an iPhone 4S (Apple Inc., California, USA. SW: iOS6.0.1), in the right chest pocket, using the Pedometer Ultimate GPS+ (A) (Arawella Corp., V: 3.3.2) (walking sensitivity medium level). All pedometers were carried according to the manufacturers' recommendations, and in the same position of all measurements. 200 walking steps were performed ten times at five speeds; 0.6, 1.2, 2.5, 3.0, 4.0 mph and the steps were also counted manually. The right target speed was held from the beginning of the measurement, and the pace of the steps was held with help of a metronome (Korg Micrometro MCM-1). Mean values and standard deviation was calculated. **RESULTS:** The steps were severely underestimated for all three pedometers at 0.6 mph (A=3.5±1.4, O=0.0±0.0 and Y=5.8±1.8) and 1.2 mph (A=5.2±3.1, O=137.4±39.5 and Y=21.2±17.7). The measurements could be regarded as good for both A (197.0± 7.7) and O (198.6±1.0) at 2.5 mph, where Y still underestimates (112.9±58.5). The same result at 3.0 mph (A=203.8±5.4, O= 199.2±1.9 and Y= 154.4±24.6). All pedometers measured about the same at 4.0 mph (A=170.3±15.7, O=185.7±6.4 and Y=171.7±20.2). **CONCLUSION**: The study shows that the evaluated pedometers cannot perform acceptable measurements in all five walking speeds, ranging from very slow to fast normal walking speed. However, both A and O, produce accurate measurements at speeds considered to be medium-fast. This limited study shows that A and O performs more accurate measurements compared to Y.

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Board #59

School-based Studies: Who Self-selects Into Physical Activity Monitoring?

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INTRODUCTION: School-based physical activity (PA) research provides an opportunity to sample children and youth from a variety of backgrounds and socioeconomic strata, yet a lack of data on non-responders means that sampling bias - with implications for the external validity of health research - can rarely be addressed. Investigating potential self-selection bias to specific protocols within studies may provide some insight into this important issue. **PURPOSE:** To explore self-selection bias in youths' PA monitoring by describing differences between youth who did and who did not comply with a 1-wk accelerometry wear-protocol in: health measures, self-reported PA and motivation for PA. **METHODS:** Grade 10 students from 10 high schools in BC, Canada, were invited to participate in the Health Promoting Secondary Schools Study. At baseline (fall 2011), 22% consented (n=441, 51% girls). Physical measures included: BMI, waist circumference, 20m shuttle run test and dominant arm grip strength. PA and facets of screen-time, as well as levels and types of motivation for PA were measured via questionnaires (SHAPES, BREQ). Students were fitted with an accelerometer (ActiGraph GT1M or GT3X vertical) and instructed to wear it on the right waist during waking hours for the next 7d. After excluding individuals with faulty units/files (n=8), valid accelerometry data ('valid data') was defined as 600min·d-1 on ≥3d (Kinesoft v.3.3.52).**RESULTS:** Valid data were provided by 58% of participants and a greater proportion of girls did so than boys (67% vs. 48%, $\chi 2$=15.3, p<.001). Boys with valid data performed better in the run (68±19 vs. 63±23 laps, t=1.81, p=0.04) and grip tests (38±7 vs. 35±8 kg, t=1.87, p=0.03) compared with boys without valid data. For girls, there were between-school differences ($\chi 2$=34.4, p<0.001) for compliance, and girls with valid data scored lower for external regulation of PA (1.9±0.7 vs. 2.1±0.9, z=-2.33, p=0.02). Boys and girls with valid data reported less time texting on the phone (0.8±1.5 vs. 1.7±2.4 hrs, z=-3.19, p<0.01; 1.6±2.4 vs. 2.7±3.2 hrs, z=-2.23, p=0.03; respectively). **CONCLUSION:** There was bias in our PA measurement due to non-compliance with the accelerometer protocol. Whilst it may not be possible to completely eliminate bias from research studies, it seems important for youth PA researchers to be aware of and discuss how non-compliance with accelerometer protocols might influence study outcomes and interpretation of results. Further research is needed to understand and address these issues in future studies.

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Board #60

Development and Validation of a Physical Activity and Heart Rate Monitor for Children Who are Overweight

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PURPOSE: Reduced physical activity (PA) is a contributing factor to childhood obesity. Children are encouraged to engage in 60 minutes of moderate-to-vigorous physical activity (MVPA) daily. Attaining this goal is difficult for children who are overweight (OVWT) as many walk at slower speeds and experience greater forces on their lower extremities thus reaching exhaustion before the metabolic equivalent (MET) of MVPA is reached. Currently available activity monitors are costly, require a cumbersome chest strap for heart rate (HR), and are based on healthy adult activity algorithms. Development of a PA+HR monitor with activity algorithms developed from OVWT children is needed. Cost, durability and function need to be considered. The purpose of this study is to develop and validate a monitor for OVWT children and compare to an age matched healthy weight group.**METHODS:** A tri-axial accelerometer has been developed and tested on 20 children, ages 8-15 of varying body mass indices (BMIs). Patterns for sitting, walking, running and jumping were analyzed. A multichannel monitor records multiple parameters from a variety of sensors (accelerometers, thermometers, heartbeat) located on the body. Blue tooth compatibility allows for effortless data transfer. Battery life allows 3 days of activity; a home charging unit is available.**RESULTS:** A novel algorithm has been developed for estimation of PA using multiple parameters to distinguish between activities. Fast recognition of activity type is performed by searching patterns of acceleration in frequency and time domains using spectral analysis. Five steps are needed in order to differentiate between walking and running. Further validation of the device will occur by measuring energy expenditure (indirect calorimetry) with telemetry as well as gait assessment using a wireless gait analysis unit. **CONCLUSION:** The current PA monitor successfully and consistently detects sitting, walking, running and jumping in children of different ages and BMIs and was tolerated well. Validation of the HR monitor will ensue followed by a clinical trial of the device with children enrolled in a fitness program.

Board #61

How Many Days are Needed to Measure Physical Activity with an Accelerometer in Older Adults?

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INTRODUCTION: Accelerometers provide valid and reliable measures of physical activity but have primarily been studied in healthy, young adults. Little is known about the reliability or wear time of accelerometers for measuring physical activity in older adults. Current protocols suggest 7 days to provide the best estimates of daily activity. **PURPOSE:** Our goal is to assess the test-retest reliability of the ActiGraph accelerometer in community-dwelling older adults and determine if the number of days worn (3, 5, or 7) impact the test-retest reliability of the measure. **METHODS:** Participants included 32 community-dwelling older adults (mean age 78.0 ± 5.5 years) who ambulated independently (mean gait speed 0.96 ± 0.28 m/s). Physical activity was measured using an ActiGraph GT1M accelerometer (ActiGraph LLC, Pensacola, FL) worn on the waist during waking hours for 7 days. Subjects recorded wear times of the accelerometer in a daily journal. Subjects wore the accelerometers for another 7 days approximately 1 week later. Physical activity was summarized for each time period as the mean counts per minute per day (cpm) averaged over all 7 days, the first 5 days, and the first 3 days. Paired t-tests were used to compare physical activity measures from time 1 and time 2 and intraclass correlation coefficients (ICCs) were calculated to estimate the test-retest reliability. **RESULTS:** The mean physical activity was similar for time 1 and time 2 for 7 days (135.4 and 135.3 cpm), 5 days (127.6 and 133.1 cpm) and 3 days (121.1 and 133.7 cpm); all $p>0.15$. The ICCs (95% CI) for 7, 5, and 3 days of wear were 0.93 (0.86, 0.97), 0.92 (0.83, 0.96), and 0.87 (0.73, 0.94), respectively. **CONCLUSION:** Compared to previous research in community-dwelling older adults (70+), the older adults in this sample demonstrated slightly lower levels of physical activity. Test-retest reliability for the ActiGraph accelerometer indicates moderate (3 days) to high (5 and 7 days) agreement in this older adult population. Taking into consideration accuracy of measurement and participant burden, our initial recommendation is at least 5 days of wear. The impact of weekend versus weekdays on physical activity measurement needs to be examined in future studies of older adults.

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Board #62

Validity Of Multiple-position Wearable Pedometers In Non-traditional Wearing Locations Under Controlled Conditions

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INTRODUCTION: Monitoring the daily steps taken and/or moderate-to-vigorous physical activity (MVPA) are effective targets to achieve health benefits. Recently, smaller and lighter pedometers, which permit multiple wearing positions, have become commercially available. The ability to use non-traditional wearing positions, not limited by attaching the device to a belt, increases the usability of pedometers. However, there is limited information on the effect of the location where the pedometer is worn on assessing both the steps and MVPA. **PURPOSE:** To examine the validity of counting steps and of computing MVPA-related indices when the pedometer is used in various wearing positions under controlled conditions. The following three pedometers with accelerometry were assessed in this study: Kenz e-style2 (KZ), Tanita Calorism Smart (TN) and Omron Calori Scan HJA306 (OM). **METHODS:** Nine young adult females (21.6+/-0.5 yr) wore 3 different pedometers simultaneously (for a total of 9 devices at 3 different positions) in a pants pocket, in a chest shirt pocket and in a shoulder bag while walking on a treadmill at four different speeds (3.3 to 6.0 km/h) and jogging at 7.8 km/h, for six minutes in each stage. The absolute percent error (APE) in steps and absolute error scores in MVPA indices (minutes for MVPA by KZ and METs*hr by TN and OM) were calculated to examine the pedometer accuracy between the criterion measures and pedometer-determined values. **RESULTS:** The step counting accuracy was influenced by the wearing position ($p<0.05$), speeds ($p<0.05$) and the wearing position * speed ($p<0.05$) for all devices. The accuracy was poor for pedometers worn in the pants pocket; and was the best when it was worn in the chest pocket, since no significant differences were observed compared with the criterion at all speeds. The KZ and TN worn in the pants pocket significantly underestimated the steps above 5.1 km/h (APE ranged between -24.7 to -10.3% and -25.1 to -9.7%, respectively). These pedometers used in the bag also underestimated the steps at higher speeds (-23.7% at 7.8 km/h for the KZ; -5.6% and -18.8% at 6.0 and 7.8 km/h for the TN). The OM worn in the pants pocket overestimated the steps at slower speeds (3.3 and 4.2 km/h; 16.4% and 8.5%). Regarding the accuracy of assessing the MVPA indices, similar trends regarding the wearing position effect were observed. **CONCLUSION:** The effects of the wearing position on evaluating both the steps and MVPA were shown for 3 pedometers: chest pockets appear to provide relatively accurate data, but pants pocket seem to be less valid under prescribed walking/jogging conditions. Moreover, differences in the accuracy among the models (brands) were indicated.

Board #63

Number Of Days Of Trunk Acceleration Measurements To Reliably Quantify Daily Walking In Older Adults

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PURPOSE: The quantity and quality of daily activities in older adults could provide information on their health status and fall risk. Ambulatory measurements with wearable accelerometers allow assessment of daily activities, and provide more specific information on walking episodes than mere step counters. Our study addressed the question how many days of trunk acceleration measurements are required to reliably quantify the amount of walking in older adults.**METHODS:** Twenty-six older adults wore a trunk accelerometer (MoveMonitor, McRoberts) for two weeks, on average 12 days apart. Day-time locomotion episodes were identified [1] for 6 days per measured week. Several parameters that quantify walking activity were calculated, i.e. the total number of episodes and the total, 25th percentile, median, and 75th percentile of the duration of these episodes and of the amount of steps per episode. To determine the effect of number of days measured on reliability, the means over 1-6 days from the first week were bootstrapped and compared to the mean of the second week (6 days), by calculating the mean absolute difference between weeks and the intra-class correlation coefficients (ICC). **RESULTS:**No systematic differences in any of the parameters were observed between complete weeks (all $p>0.36$). The mean absolute difference between 2 complete weeks ranged from 9-21% for all parameters, with highest values for the total number of strides (21%) and total duration of gait (19%).The ICC between 2 complete weeks ranged from 0.69-0.95, with lowest values for 25th and 75th percentile of the number of strides (respectively 0.69 and 0.78). The decrease in mean absolute difference was limited when analyzing more than 3 days, and all ICCs exceeded 0.65. **CONCLUSION:** To reliably quantify the amount of walking activity from ambulatory trunk acceleration data, a minimum of 3 days of measurements appears sufficient, and 6 days of measurements result in good to very good reliability. The relatively high mean absolute differences for the total amount of strides, duration and episodes over days indicate that substantial intra-individual variations occur between weeks. Further analysis will focus on other types of daily activities such as standing and lying down.

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Board #64

Accuracy Of Activity Monitors For Assessing Low Intensity Physical Activity: A Systematic Review

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INTRODUCTION: Researchers are focusing increasingly on relatively low intensity activity such as sedentary behavior and light-intensity activities as independent predictors of morbidity and mortality. Although activity monitors, most of which are accelerometer-based, are used widely to quantify physical activity and assess energy expenditure, the accuracy of different types of activity monitors for measuring intensity of sedentary to light activities is not well established.**PURPOSE:** The purpose of the present study was to systematically review the accuracy of activity monitors to assess the intensity of low intensity activities.
METHODS: The PubMed Central database was searched using the following keywords: (acceleromet* or "activity monitor" or "motion sensor") and ("intensity" or "metabolic equivalent" or "MET" or "METs") and ("validity" or "validation" or "calibration" or "equation*" or "algorithm"). Cross-validation data of the algorithm for adults obtained in the same study or previous studies, with at least one sedentary (≤1.5 METs) and one light-intensity activity (1.5-3.0 METs) were included in the search. Articles not showing measured intensity or information on the differences between predicted and measured intensity were excluded.
RESULTS: Nine articles contained sufficient data. Eight different activity monitors (ActiGraph, RT3, Actical, ActiHeart, Active style Pro, ActiMarker, ActivTracer, and Lifecorder) and several types of algorithms were identified. The accuracy of the regression models of the ActiGraph and Actical for low intensity activities was poor. The artificial neural network with the ActiGraph provided reasonable prediction assessed by cross-validation of the calibration study, despite the accuracy of independent groups being lower. Actiheart also provided a good estimate when combined with data on acceleration and heart rate. The regression models with discrimination between locomotive and non-locomotive activities had small errors for low intensity activities, especially sensitive accelerometers based on gravity-removal classification algorithms (i.e., Active style Pro). The accuracy of these models and accelerometers was approximately 10% or less for low intensity activities.**CONCLUSION:** Artificial neural networks, a combination of acceleration and heart rate data, and gravity-removal classification algorithms with a sensitive accelerometer provide relatively accurate measurement of the intensity of low intensity activities.
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Board #65

Shaker Table Validation Of Openmovement Ax3 Accelerometer

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INTRODUCTION: As designs of accelerometers shift towards uncompressed and unfiltered data capture, researchers are developing device insensitive algorithms. To ensure interoperability, steps need to be taken to support compensation for differences in construction. To support this step a shaker table characterization was made using the OpenMovement AX3 device [2] and compared with the similar GENEA device. **METHODS:** To enable a fair comparison the test was designed based on the methodology described by Esliger et al [1]. The primary aim was to establish any part of the device construction that heavily impacted the frequency response of the device and, secondly, if the device was suitable for capturing data describing human movement. In the test (n=35) devices were mounted to a single-axis shaker table (manufactured by Instron) and subjected to 14 sets of sinusoidal oscillations. Each set had a different stroke length and amplitude and each was run for a period of 100s and was designed with a different stroke length and amplitude that is falls within normal range of human movement. Sensors were mounted such that all the forces affected the z-axis only of the AX3 (as it has the most margin for error). Each AX3 was set to record with a range of ±8g and a sample frequency of 100Hz. The resulting data was post processed and the middle 60s used for analysis. **RESULTS:** The analysis of the data followed the procedure in [1] to establish both the inter- and intra-device coefficients of variation based on 1s epochs of the signal vector magnitude (SVM) in units of gravity (g) per second (s) calculated as $SVM\_gs=\sum|\sqrt{(x^2+y^2+z^2)}-g|$
Table 1 shows the results for each set of oscillations, recorded shaker table acceleration (from a calibrated sensor mounted next to the sensors) and also, for comparison, results reported in [1]

Table 1 - Comparison of AX3 and GENEA coefficients of variation						
Frequency (Hz)	**Stroke (m)**	**Measured Acc. (g)**	**CV intra GENEA**	**CV intra AX3**	**CV inter GENEA**	**CV inter AX3**
1.0	0.0124	0.05	3.9	1.75	5.3	1.15
1.0	0.0547	0.22	1.7	1.76	2.0	1.39
3.0	0.0127	0.466	0.8	1.27	1.4	1.87
2.5	0.0183	0.46	0.9	1.11	1.14	2.75
2.0	0.0298	0.48	1.0	1.04	1.4	1.27
1.5	0.0541	0.49	1.1	0.99	1.6	1.91
5.0	0.0079	0.79	1.0	1.01	1.5	1.76
3.0	0.0251	0.91	0.8	1.10	1.3	1.40
4.5	0.0153	1.25	1.5	1.09	2.1	1.94
4.0	0.0200	1.29	1.3	1.17	2.0	1.07
3.5	0.0266	1.31	2.1	1.17	2.6	2.49
3.0	0.0381	1.38	1.0	1.18	1.8	2.15
4.5	0.0206	1.68	3.4	0.96	3.7	1.47
3.0	0.0508	1.84	1.3	1.02	2.2	2.36
		Mean over 14 test conditions	1.8	1.19	2.4	1.78

CONCLUSION: The results of the experiment confirm that the AX3 device's inter- and intra-device variability is suitably stable for the purpose of capturing data on human movement. Furthermore, the results illustrate that the AX3 device is of similar performance to that of the GENEA device and, as such, parallel algorithm development for either device may be possible without a cross-device calibration step.

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Board #66

Objective Measurement of Resistance Training Exercises with a Wrist Accelerometer

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INTRODUCTION: The 2008 Physical Activity Guidelines for Americans recommends that all U.S. adults perform muscle strengthening activities on at least two days per week, in addition to performing at least 150 minutes per week of moderate intensity aerobic activity or 75 minutes of vigorous aerobic activity. Studies using objective methods of monitoring physical activity have focused mainly on the assessment of moderate-to-vigorous aerobic activity. To date, a method for objectively measuring muscle-strengthening activities (performed at home) has not been developed. **PURPOSE:** To examine use of a wrist-worn, tri-axial accelerometer-based monitor for measuring muscle-strengthening activities during upper and lower body weight lifting exercises. **METHODS:** Two male participants performed 10 different dynamic exercises, with 30 seconds of rest in between. A pair of 15-lb dumbbells was used to standardize the resistance. The exercises included biceps curls, modified upright row, lateral raises, shoulder press, bench press, squats, triceps extensions, triceps kickbacks, bent-over row (standing), and bent-over row (bench). **RESULTS:** Data from the GENEA were downloaded and acceleration versus time data for each of the three axes were plotted for all 10 exercises. Visual inspection of the graphs revealed that the tri-axial wave patterns were unique for eight of the exercises; two exercises (shoulder press and bench press) elicited similar patterns. This is not surprising considering that the movement planes in space are identical for those two exercises with the only difference being the orientation of the body relative to the movement planes.**CONCLUSION:** A wrist-worn tri-axial accelerometer can be used to discriminate eight out of 10 different types of resistance training exercises. Since differences in various dumbbell exercises can be seen on visual inspection, it should be possible to construct machine-learning algorithms to identify them. By determining the number of repetitions and the frequency of weight lifting sessions (bouts per week), the total volume of dumbbell resistance training can be estimated.

Board #67

Registrations Of Activities Of Daily Living, Measured By 9-DOF-sensors, Are Highly Reproducible In Healthy Individuals

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INTRODUCTION: Patients with neurological diseases such as stroke or cerebral palsy often encounter arm-hand problems during daily life. Assessment is important to determine the progress of arm-hand performance in patients during rehabilitation, and to ascertain the effectiveness of therapies. Many instruments are available to assess capacity or perceived performance, but instruments assessing actual performance are scarce. Inertial sensors can be used to assess actual performance. Before these sensors can be used, the reproducibility of execution of activities of daily living, measured with these sensors, should be determined. **PURPOSE:** Aim has been to assess the reproducibility of activities of daily living performed by healthy individuals, as measured with multiple 9-DOF sensors. **METHODS:** Thirty-three healthy individuals (mean age: 58.2 ± 5.0) participated. Four 9-DOF sensors, each containing a tri-axial accelerometer, gyroscope and magnetometer were attached to the dominant arm-hand and chest of the participant: on the dorsal hand, on the dorsal wrist, on the humerus and on the sternum. Data were registered during the execution of 5 repetitions of 2 tasks, i.e. 'drinking from a cup' and 'eating with knife and fork'. Tasks were first performed without instructions, and subsequently with instructions on how to perform the task. Signals were filtered with a 2nd order zero-time lag low-pass Butterworth filter (cut off frequency of 2.5 Hz). Intra class correlation coefficients (ICC) for the composed sensors and signal types were determined as a measure for reproducibility, both within and between subjects.**RESULTS:** Table 1 displays the mean ICC for all conditions. Both within-subject and between-subject reproducibility were high to very high for both tasks. Reproducibility was higher for the condition with instructions compared to without instructions. Reproducibility of the drinking task was higher compared to the eating task.

Table 1: Mean ICC ± stdev

	Within-subject reproducibility		Between-subject reproducibility	
	Without instructions	With instructions	Without instructions	With instructions
Drinking	0.84 ± 0.12	0.86 ± 0.11	0.68 ± 0.12	0.73 ± 0.12
Eating	0.63 ± 0.15	0.72 ± 0.14	0.65 ± 0.10	0.72 ± 0.10

CONCLUSION: Larger variability in the execution of the tasks without instructions explains the lower reproducibility compared to tasks with instructions. Within subjects, variability was lower compared to between subjects. The instrument as used in the current setting can be used to assess skilled arm-hand use in healthy individuals. Future research will focus on the investigation of the reproducibility of activities of daily living performed by patients.

Board #68

Validation of International Physical Activity Questionnaire (IPAQ): Test-retest reliability and Criterion validity against Intelligent Device for Energy Expenditure and Activity (IDEEA)

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INTRODUCTION: The Kuwait Physical Activity Questionnaire (KPAQ) is a self-administered recall instrument that is used to evaluate presumed low levels of physical activity (PA) among Kuwaiti adults. It incorporates the International Physical Activity Questionnaire (IPAQ) as the PA-measuring surveillance tool.**PURPOSE:** The purpose of this study was to validate IPAQ in terms of test-retest reliability as well as Criterion validity by comparing IPAQ data with data from Intelligent Device for Energy Expenditure and Activity (IDEEA), an advanced bi-axial accelerometer.**METHODS:** For test-retest reliability assessment, 71 subjects repeated KPAQ within 6-8 days after initial administration. PA energy expenditure (EE) scores are calculated for walking, moderate- and vigorous-intensity PA (in MET-min per week) as well as total energy score. Criterion validity (n=40) was also done to compare IPAQ data with data from Intelligent Device for Energy Expenditure and Activity (IDEEA). Spearman's correlation coefficients are reported for continuous variables; for categorical variables, cross-tabulation with chi-square statistics was used. **RESULTS:** For reliability, correlation coefficient (r) for IPAQ items reflecting PA EE ranged between 0.63 and 0.74, and was 0.79 for total PA EE ($p<0.001$). Daily Sitting time's correlation coefficient was 0.71. In criterion validity, mean IDEEA recording time was 6.44 days. EE (in MET-min/w) from IDEEA and IPAQ correlated significantly ($r=0.61$; $r^2=0.38$). **CONCLUSION:** KPAQ/IPAQ appears to be a reliable and valid tool for surveillance of PA.

Board #69

Validity of the Global Physical Activity Questionnaire in the National Health Survey - Chile 2009-10

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PURPOSE: To evaluate the validity of the Global Physical Activity Questionnaire (GPAQ) in a subsample of 2009-10 Chilean National Health Survey (NHS), through the use of accelerometers. **METHODS:** Population older than 15 years old recruited from different educational levels of the urban area of Santiago - Chile, that had answered the GPAQ ítem during 2009-10 NHS. Physical Activity (PA) was measured using accelerometers (ActiGraph GT3X) for a period of 7 days long. Measures of agreement, sensitivity-specificity and discriminant analysis were evaluated in order to generate an adjustment model. **RESULTS:** 158 out 306 participants used the accelerometers during 5 or more days. The mean age of the sample was 44.6 ±14.5 years old and included 55.7% females, 58.9% reported at least 8 years of education. According to BMI 66.4% were overweight. The concordance between GPAQ and accelerometers for the "insufficiently active" category, according to the WHO classification, was low (Kappa=0.24 $p<0.01$, Agreement=71,9%). The correlation of both measures, reported as minutes of PA per week, was Spearman's rho=0.35 $p<0.01$. Median differences between GPAQ versus accelerometers was 548 minutes of PA per week. The reported time of PA according to GPAQ was positively associated with being a male and having low educational level ($p<0.05$). PA measured by accelerometres was positively associated with being a male, higher educational level and negatively associated with BMI ($p<0.05$). Using the information of the accelerometres as a gold standard, GPAQ presented a sensitivity to detect a individual as insufficiently active of 0,44 and a specificity of 0,80. Through discriminant analysis, the variables (total minutes of PA during the day, sex, educational level and BMI) were identified as prognostic factors for a model that estimates the probability of being categorized as an insufficiently active. The predictive quality of the model has an acceptable discrimination (area under ROC curve = 0,76), with a sensitivity of 0,74 and a specificity of 0,61 (Youden=0,33). The model correctly classifies 63,5% of the subjects. The model allows to correct the national prevalence of insufficiently active subjects, reported in the 2009-10 NHS, from 27,1% to 53,5%.**CONCLUSION:** The validity of the GPAQ in the Chilean population is similar to the results from other studies. The prevalence of adjusted model is comparable with the results reported in the Latin American countries. The GPAQ overestimates the minutes of weekly PA. There is a missclassification error in the questionnaire, which can be moderately adjusted through a model that uses diary PA level reported by GPAQ, sex, BMI and educational level.

Board #70

Validity of the MyWellness Key Accelerometer in Free-living Normal Weight, Overweight and Obese Adults

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INTRODUCTION: The Technogym MyWellness Key is a relatively new, low cost accelerometer designed for use by the general public. It provides the user with feedback on their time spent in each intensity of physical activity (PA) and has the potential to be a valuable PA intervention tool. To date, limited research has investigated the validity of the MyWellness Key. **PURPOSE:** To examine the concurrent validity of the MyWellness Key at measuring PA in free-living normal weight, overweight and obese adults. **METHODS:** 78 participants (age 37.3±13.2 years, BMI 25.6±4.4 kg/m^2) wore a MyWellness Key and an ActiGraph GT3X+ accelerometer throughout waking hours for 7 days. ActiGraph-determined time spent in light, moderate and vigorous intensity PA was calculated using the Freedson cut-points. Data describing time spent in each PA intensity from the MyWellness Key were recorded using proprietary MyWellness web-based software. For both devices, mean minutes/day spent in each intensity of PA were calculated across the monitoring period and compared using Bland-Altman plots and Spearman correlation coefficients. Comparisons were undertaken between the differences in time spent in each intensity of PA between the MyWellness Key and ActiGraph across BMI groups (normal weight [BMI <25 kg/m^2] n = 35; overweight [25-29.9 kg/m^2] n = 31; obese [≥30 kg/m^2] n = 12) using Kruskal-Wallis tests. **RESULTS:** According to the ActiGraph, all participants registered time in both light and moderate intensity PA, whilst 34 participants registered time in vigorous PA. Average wear time (based on ActiGraph data) was 815±85 mins/day. Correlations between the MyWellness Key and ActiGraph ranged from moderate to strong for time spent in each intensity of PA (light r = 0.64; moderate r = 0.86; vigorous r = 0.45, all p <0.01). The MyWellness Key slightly underestimated time in moderate (mean difference: -7 mins/day, limits of agreement [LoA]: -34 - 21 mins) and vigorous (-5 mins/day, LoA: -23 - 13 mins) intensity PA, relative to the ActiGraph, with this underestimation particularly pronouncedfor light PA (-200 mins/day, LoA: -329 - -72mins). Mean differences in time spent in each intensity of PA between the MyWellness Key and ActiGraph did not differ significantly across BMI groups (p >0.05). **CONCLUSION:** The MyWellness Key provides a good estimate of time spent in moderate and vigorous intensity PA, relative to the ActiGraph. Time spent in light PA is underestimated at present using this device. The validity of the MyWellness Key is not influenced by BMI; it therefore has the potential to be a useful motivational tool for promoting increases in moderate and vigorous intensity PA in overweight and obese populations.

Board #71

Choice Of Pedometer Impacts Upon Daily Step Counts In Japanese Primary School Children

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INTRODUCTION: Step counts are widely used in many studies and surveys to evaluate physical activity objectively. While it is important to determine the accuracy of pedometers in controlled, laboratory settings, it is even more important under free-living conditions, where children actually utilize them. Children have different walking characteristics from adults, such as velocity and cadence, which can affect the evaluation of step counts by pedometers produced for adults. However, it is unknown whether using different pedometers for primary school children impacts the measurement of step counts in a free-living environment. **PURPOSE:** The purpose of this study was to examine whether daily step counts in a free-living environment differed in children when measured with different pedometers, including spring-levered and accelerometer-based pedometers. **METHODS:** Subjects were Japanese primary school children aged 6-12 years. First, we compared the Yamax digi-walker SW-200, the most widely used pedometer in research studies, and the Kenz Lifecorder EX (Suzuken), an accelerometer-based pedometer, in a small sample (n=31). Second, three accelerometer-based pedometers, the Kenz Lifecorder EX (Suzuken), EX-200 (Yamasa) and Active style Pro HJA-350IT (Omron Healthcare), were compared in larger samples from several primary schools (n=50 to 112 for each pair of comparisons). Subjects attached one or two devices on their waist at the mid-line of the right or right and left thighs, or put the Yamasa EX-200 into their pants pocket for seven days. **RESULTS:** The correlation between the SW-200 and the Lifecorder EX was strong, and the average difference was less than 3%. Thus, step counts obtained from the SW-200 and the Lifecorder EX were comparable. In larger samples, correlations between the Lifecorder EX and the EX-200 or the Active style Pro were strong, although the correlation between the Lifecorder EX and the EX-200 was moderate. Step counts obtained with the Lifecorder EX were the highest among the 3 pedometers. The differences between the LifecorderEx and the Yamasa EX-200 or the Active style Pro were 12% and 21%, respectively.**CONCLUSION:** The choice of pedometer substantially impacted daily step counts. Possible reasons include different acceleration thresholds, filters to avoid counting movements not technically considered walking, and attachment methods. A consensus on the appropriate pedometer for quantifying daily step counts is needed for evidence-based recommendations for health promotion.

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Board #72

Non-wear Algorithm Accuracy In An Overweight Population

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PURPOSE: Excluding non-wear from accelerometer data is crucial to avoid overestimation of inactivity. The most commonly used algorithm defines non-wear as consecutive zero counts within a time window of 60 minutes with allowance for 1-2 minutes of counts up to 100[1]. Adequacy of non-wear algorithms might depend on physical activity, sedentary behavior and BMI. People with overweight are expected to be more sedentary and to be at increased risk for misclassification of sedentary time as non-wear. Larger time windows have been proposed to decrease overestimation of non-wear. This study investigates how accuracy of non-wear algorithms relates to time window length. **METHODS:**Ten overweight participants wore the tri-axial CAM[2] in free living for at least two days. During the measurement they registered non-wear periods in a diary. Exact times of non-wear periods were checked in accelerometer data and used as comparator (checked non-wear). An algorithm derived non-wear period was defined as a time window with a signal within the noise level of the CAM, with interruption allowance for one minute. The time windows were varied from 20 to 120 minutes, with steps of ten minutes. Bias was the difference between checked and algorithm derived non-wear time. Bias and algorithm derived non-wear time were described as a function of time window length. **RESULTS:**Based on four participants, diary non-wear was 6.0% (±7.2%) shorter than checked non-wear. Larger time windows showed lower algorithm derived non-wear time. Percentage correctly algorithm derived non-wear increased from 85% (range 60%-99%) with a time window of 120 minutes, to 95% (range 86%-100%) with 20 minutes. In three participants, bias increased with window lengths between 20 and 60 minutes and remained virtually constant above the 60 minutes window length. In one participant, relation between window length and bias was reversed, but also stabilized above the 60 minutes window. **CONCLUSION:**Based on our results, we conclude that a short time window of 20 minutes is most accurate in the majority of an overweight population. In addition, results suggest that increasing time window above 60 minutes does not elicit changes in non-wear time or bias. The direction of the relationship between window length and bias seems participant-dependent. Although checking registered non-wear in acceleration data might increase precision, true non-wear is unknown. Subsequently, inclusion of participants with large deviation between diary and acceleration data should be considered carefully in validity studies.

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Board #73

Free-living Cross Validation of Actigraph-Gt3x+ And Actiwatch-64 For 24h Monitoring in Healthy Young Adults

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Sleep, sedentary, and physical activity behaviors independently impact health, yet are connected as they are bound by the 24h day. Continuous, free-living monitoring of the full 24h spectrum is needed to better understand the unique and combined impacts of these behaviors on health. Field standard devices in sleep (Actiwatch-64, AW64) and physical activity (Actigraph-GT3x+) have yet to be validated for the complementary behavior during 24h continuous monitoring. **PURPOSE:** We conducted a free-living validation study of the GT3x+ to measure sleep parameters as compared with the AW64 and concurrently, validated the AW64 to measure sedentary and physical activity behaviors as compared with the GT3x+. **METHODS:** Young adults (N=25, 57% women, age: 19.0 ± 1.1 years, BMI: 25.8 ± 5.9 kg/m2) wore both devices for 3 consecutive days and 2 consecutive nights, according to best practices for field-based studies (GT3x+ on hip during the day and wrist at night; AW64 continuously on the wrist). The Sadeh (1994) algorithm identified sleep/wake epochs for both devices and Freedson (1998) hip and Heil (2006) wrist thresholds were used to assess physical activity for the GT3x+ and AW64, respectively. Validity of sleep, sedentary, and physical activity metrics were evaluated using t-tests, intraclass correlation coefficients, and Bland-Altman plots with associated confidence limits.**RESULTS:** For sleep, the GT3x+ accurately assessed total sleep time (ICC=0.83), sleep efficiency (ICC=0.68), and wakefulness after sleep onset (ICC=0.53), but significantly underestimated sleep onset latency (ICC=-0.16; t=-2.87, p=.008). Bland-Altman plots showed significant bias for sleep onset latency only. For sedentary behavior and physical activity, the AW64 accurately assessed sedentary time (ICC=0.74), but overestimated light intensity (ICC=0.71; t=8.41, p<.0001) and underestimated moderate-vigorous intensity (ICC=0.21; t=-11.40, p<.0001) physical activities. Total counts per minute were only modestly correlated (ICC=0.41). Bland-Altman plots showed significant bias for light and moderate-vigorous physical activities. **CONCLUSION**: While GT3x+ showed accurate sleep assessment (with the exception of sleep onset latency) and AW64 showed accurate assessment of sedentary time, the AW64 did not accurately assess physical activity. The latter was likely due in part to a lack of uniform device placement and threshold discrepancies. Future validation work of existing and emerging technologies that may hold promise for 24h, continuous monitoring are needed, as well as feasibility studies that explore compliance and participant burden factors impacting 24h monitoring.

Board #74

Free-living Cadence (Steps/min) Values Associated with Traditional Accelerometer Activity Count Cut Points

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INTRODUCTION: Accelerometer data traditionally have been analyzed using previously established activity count cut points. However, there is growing interest in describing free-living ambulatory patterns in terms of the amount of time spent at different cadences (steps/min) and promoting cadences associated with moderate-to-vigorous physical activity (MVPA). A strong relationship exists between cadence and activity counts/min. Results from laboratory investigations suggest that MVPA is associated with cadences ≥100 steps/min. However, epidemiological studies indicate that this cadence is a rare phenomenon in free-living, and even rarer than activity count-defined studies imply. Concurrently collected data on cadence and activity count-defined behavior in free-living populations are lacking. **PURPOSE:** To describe cadence values associated with traditional activity count ranges for sedentary behavior (< 100 activity counts/min), light intensity physical activity (LPA, 100 ≤ activity counts/min < 1,952) and moderate-to-vigorous physical activity (MVPA, ≥1,952 activity counts/min).**METHODS:** Thirty-nine office workers (age: 39.7 ± 9.9 yr; BMI: 36.2 ± 8.4 kg/m^2; 26% overweight; 74% obese; 97% female) were instructed to wear an ActiGraph accelerometer (GT3X+ model; ActiGraph LLC, Pensacola, FL) 24 hr/day and provided valid data for three working days (≥ 10 monitored hr/day). Minute-by-minute cadence and activity counts were simultaneously collected using this same instrument. Cadence (means ± *SD*, 95% CI)was summarized for identified time spent in activity count-defined sedentary behavior, LPA, and MVPA, having first removed any non-wear time using a common SAS macro. **RESULTS:** Participants wore the accelerometer for 17.4 ± 2.0 hrs/day and averaged 0.38 ± 0.11 (0.35, 0.42) steps/min, 15.36 ± 3.64 (14.18, 16.53) steps/min, and 76.21 ± 24.95 (68.12, 84.30) steps/min during activity-count defined sedentary behavior, LPA, and MVPA, respectively. **CONCLUSION:** Cadence values associated with traditional activity count ranges for sedentary behavior, LPA, and MVPA were identifiable. The average (and 95% CI) cadence values associated with activity count-defined free-living MVPA are less than previously identified in controlled laboratory studies. Based on this interpretation of activity count-defined behavior, a cadence of approximately 70 steps/min may serve as a reasonable heuristic value to guide for promotion of free-living MVPA.

Supported by A contract with workplace wishing to remain anonymous.

Board #75

Validation of a Wrist-worn Activity Monitor in the Estimation of Energy Expenditure during Daily Activities

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INTRODUCTION: The Polar FA20 (FA20) is a wrist-worn activity monitor that measures accelerations and determines three types of physical activity (PA) intensities (light, health- and fitness-related activity) based on acceleration data. Furthermore, it determines PA energy expenditure (EE). It accumulates the measured activity throughout the day and provides a personal feedback about performed activity on the display of the monitor. As setting a step goal, giving direct feedback and keeping a step count diary are considered the key motivational factors for increasing PA with pedometers [1], the FA20 seems to satisfy requirements to be an effective intervention tool, however its measurement accuracy needs to be proven. **PURPOSE:** The aim of this study was to determine the accuracy of the FA20 activity watch in terms of activity recognition and EE. **METHODS:** 20 participants (10 women and 10 men, age: 41.7 ± 11.1 y, BMI: 24.0 ± 2.7 kg m^{-2}) performed nine activities for 3 min 5s: Slow, moderate, fast, up-hill and downhill walking, running, biking, cleaning the floor and playing badminton. Each Participant wore a FA20 on the dominant hand. Estimated time in each activity level was compared to the time each participant spent in < 3 MET, 3 - 6 MET and > 6 MET measured by a portable calorimeter (MetaMax 3B, Cortex, Leipzig, Germany) (IC). Estimated EE (in kcal/min) of the FA20 was compared with IC by Bland and Altman limits of agreement (LoA) analysis. **RESULTS:** The FA20 estimated time spent in light, health and fitness-related activity of slow walking, cleaning the floor, moderate and fast walking and running correctly. Walking uphill, cycling, cycling uphill and playing badminton were partially classified in lower activity than by IC ($p < 0.05$). During walking downhill, the FA20 classified significantly more activity as health- and fitness-related than IC ($p<0.05$). Compared to IC, the FA20 estimated moderate walking (mean bias: -0.08, LoA: -0.46, 0.31), fast walking (mean bias: -1.65, LoA: -2.14, -1.16), walking downhill (mean bias: 0.69, LoA: 0.36, 1.02) and running (mean bias: 1.97, LoA: -3.18, 0.76) accurately. **CONCLUSION:** The FA20 differentiated among several intensities of walking and running which makes it superior to common pedometers. The monitor gives the user a valid feedback about EE of several locomotor activities. Therefore, the FA20 might be an effective device for PA interventions.

Supported by Polar Electro Oy, Kempele, Finland

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Board #76

Cross-Device Comparison of Raw Accelerometer Data Under Laboratory Conditions

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INTRODUCTION: Several accelerometers are on the market to monitor physical activity. The accelerometer output used most often to measure activity intensity is counts. Activity counts are calculated by integrating the absolute values of filtered acceleration signals. However, cross-device comparison of counts is difficult due to a lack in transparency in the filters used for data processing. Today, not solely the activity intensity is of interest but also information about different activity types. Therefore, the community is demanding for raw data assessment. This enables additional data analyses that use more features of the accelerometer signal such as peak to peak acceleration (PPA) [1]. **PURPOSE:**The aim of this study was to investigate if commonly used products differ in PPA under simplest laboratory conditions. **METHODS:**One device each, GENEA, GT3X, and PARTwear (PW), was placed with the y-axis pointing upwards on a mechanical shaker (Toshiba, VF-S11), which oscillated in a circular pattern at a fixed radius of 35.5mm at 20 different frequencies (0.6 - 4.0Hz), for 60 seconds each. The devices were initialized to save raw data at their maximal dynamic range: GENEA ±6g, 40Hz logging frequency (LF); GT3X ±2.5g, 30Hz LF, PW ±8g, 40Hz LF. PPA was calculated for 1 second time intervals. Thereof, mean and variance of PPA values for each oscillation frequency were derived. Pearson correlation, ANOVA and descriptive statistics were applied to compare the devices' mean PPA to the criterion value (calculated PPA = $((\omega^2 \times r + 9.81)+(\omega^2 \times r - 9.81)) / 9.81$) [g]. **RESULTS:** All devices correlated significantly with the criterion ($p<.001$): r=.99 (GENEA), .99 (GT3X), 1.0 (PW). Mean difference to the criterion was -0.36g, -0.10g, -0.17g and mean variance of PPA within each oscillation frequency was 7.1%, 4.6%, 6.8% by GENEA, GT3X, PW, respectively (Figure 1).

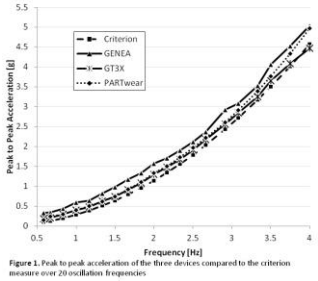

Figure 1. Peak to peak acceleration of the three devices compared to the criterion measure over 20 oscillation frequencies

CONCLUSION: GT3X and PW seemed to be more precise throughout all frequencies than GENEA. GT3X registered a beginning deflection at 3.5Hz. Hence, a dynamic range < ±2.5g may be insufficient to collect human accelerations in sports, which are possible up to 10Hz [2]. The present study revealed mean variances of PPA between 5 to 7% in the raw data assessment. This variance might be reduced when applying filters in post processing. However, filters used must be transparent and reproducible.

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Board #77

Estimating Free-living Energy Expenditure With A Portable Direct Calorimeter: Effects Of Ambient Temperature

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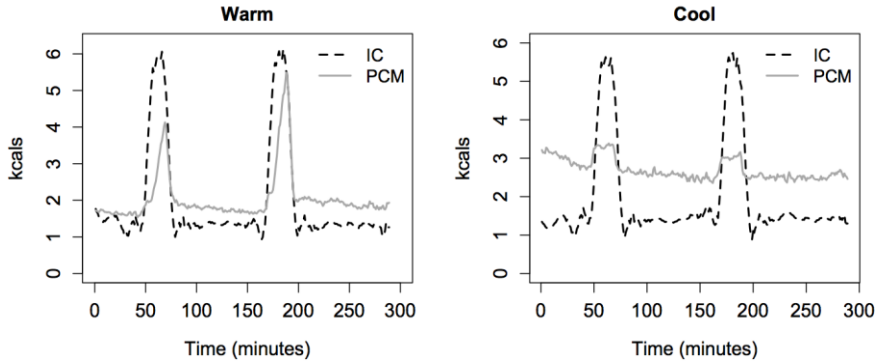
INTRODUCTION: Previous attempts at measuring free-living energy expenditure (EE) using direct calorimetry have been limited by the inability to accurately measure evaporative heat loss. The Personal Calorie Monitor (PCM, Metalogics Corp., Minneapolis, MN) is a portable direct calorimeter that measures total heat flux (i.e. the sum of conductive, convective, radiative, and evaporative).**PURPOSE:** To determine the validity of the PCM in warm (~24°C) and cool (~16°C) temperatures. **METHODS:** 31 Adult males and females (Mean±SD age = 29± 5 y, body mass index = 22.9±2.6) kg.m2) were studied for 5 h in a whole-room indirect calorimeter (IC) in warm and cool conditions. Participants wore the PCM on their upper arm while wearing jeans, closed toed walking shoes and a sleeveless t-shirt. Two, 20-minute treadmill-walking bouts (3 mph) were performed at hours one and three, respectively. The remaining time was spent seated at a desk watching television, using a computer, reading etc. Bias, 95% confidence interval (CI) of the bias and root mean squared error (rMSE) were used to compare EE estimated by the PCM to IC. **RESULTS:** Total EE (mean (95% CI)) measured by IC in warm and cool was 571 kcals (539, 602) and 578 kcals (546, 611), respectively. Total EE estimated by the PCM in warm and cool was 630 kcals (538, 721) and 714 kcals (642, 786), respectively. During warm, mean PCM minute-by-minute estimates tracked very closely with IC (Figure), resulting in a small bias over 5 h (59 kcals (-13, 131)). During cool, PCM estimates did not track IC (Figure), resulting in a large bias over 5 h (136 kcals (67, 205). The rMSE for PCM estimates during warm and cool were 147 and 186 kcals, respectively. **CONCLUSION:** The small bias reported during warm indicates the PCM will perform well on a group level under similar conditions. The inaccuracy during cool may be due to elevated heat flux caused by increased heat loss from the body to the cool environment. The large rMSE for both warm and cool suggest the PCM will be less accurate when used to estimate EE on individuals.



Board #78

Ambulatory System For Upper Limb Movement Assessment In Real Work Conditions - Focus On Wrist Joint

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PURPOSE: Work-related musculoskeletal disorders (WRMSDs) of the upper limb account for the main part of occupational diseases. Quantitative assessment of upper limb movements, including the analysis of joint angles, provides relevant information for WRMSDs prevention. Compared to optoelectronic system and electro-goniometer, inertial and magnetic measurement system (IMMS) technology combines an ease of use to a 3D spatial representation for all wanted segments, making the whole upper limb kinematic modelling possible "into the field". This abstract explores the analysis of wrist joint angles using IMMS and discusses the need for an IMMS-based ambulatory system in real work conditions. **METHODS**:Three wireless IMMS (Xsens, Netherlands) were placed on top of the hand, forearm and sternum of participants. A static calibration was used to deduce segment motions from IMMS motions. An optoelectronic system (Motion Analysis, CA) was used as a reference system (OPTO). OPTO-based segment motions were calculated using marker clusters fixed on hand and forearm IMMS sensors with a manual alignment procedure. IMMS-based and OPTO-based wrist motions were calculated as the relative motion between hand and forearm segments. Participants were asked to perform 5 simple flexion/extension (FE), 5 simple abduction/adduction (AA) and 5 simple pronosupination (PS) movements. **RESULTS**: Results showed a high correlation between IMMS-based and OPTO-based wrist angles in all active degrees of freedom (figure 1). However, a difference of 15-20° of PS motion was observed during simple FE movements.

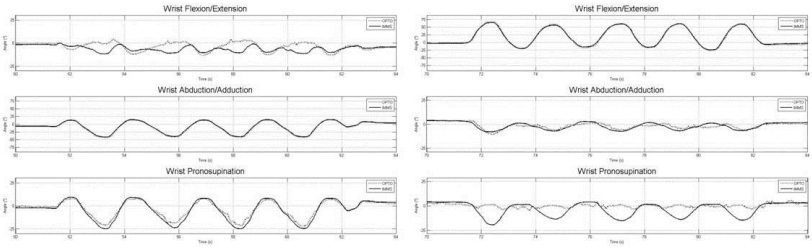

Figure 1. Plots show FE, AA and PS angles for OPTO-based (dotted) and IMMS-based (solid) models. Left: during simple AA movements. Right: during simple FE movements

CONCLUSION: These results show the potential of IMMS technology for modeling wrist angles. However, unexpected PS motion was observed during simple FE movements, highlighting an eventual cross-talk effect. This may be explained by an alignment error during static calibration. Expected use of IMMS for WRMSDs prevention requires accurate and interpretable joint angles to be compared to absolute values of comfortable ranges of motion. Investigations should be pursued to understand approximations made on the wrist model before an extension to other joints. Complementary functional calibrations or a whole upper limb definition as a kinematic chain represent possible ways of investigation.

Board #79

A Cross-Validation Study of the GENEA Accelerometer Waist Cut-Points

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INTRODUCTION: The GENEA is a triaxial, ±6g accelerometer-based physical activity monitor, that weighs 16g, measures 36mm x30mm x12mm and can be worn on the waist, wrist, or ankle. Esliger et al. (Med Sci Sports Exerc, 2011) developed cut-points for the GENEA worn at the waist, in order to estimate intensity categories (sedentary, light, moderate, vigorous) when adults perform structured activity bouts. PURPOSE: The purpose of this study is to determine the accuracy of the waist GENEA cut-points developed by Esliger et al. for predicting intensity categories across a range of lifestyle activities (home/office, ambulatory, and sport). **METHODS:**Each participant performed one of two routines, which consisted of seven activities. The activities in routine one included: filing papers, vacuuming, self-paced walking, treadmill walking at 6.4 km.hr-1, cycling 49 watts, basketball, and treadmill running at 9.6 km.hr-1. The activities in routine two included: computer work, treadmill walking at 4.8 km.hr-1, cycling 98 watts, moving a box, treadmill walking at 4.8 and 6.4 km.hr-1 with a 5% grade, and tennis. Each activity was performed for seven minutes with a four-minute break between activities. The GENEA was worn on the right hip and initialized to collect data at 80 Hz, and the signal vector magnitude (SVM) was computed in 1-s epochs. Oxygen uptake was continuously measured using the Oxycon mobile. A one-way chi-square was used to determine the classification accuracy of the GENEA cut-points. A cross tabulation table provided information on under- and over-estimation of GENEA estimations, and sensitivity and specificity analyses of the waist cut-points were performed. **RESULTS:**Final analysis included 106 participants (mean age 39.1 ± 11.2 years old; mean BMI 25.5 ± 4.6 kg/m2). For all activities combined, the GENEA accurately predicted intensity classification 55.3% of the time. Light intensity activities were overestimated 60.6% of the time, and vigorous activities were underestimated 43.2% of the time. For all activities combined, the sensitivity of the cut-points for the four intensity categories ranged from 0.244 to 0.958 and specificity ranged from 0.576 to 0.943. **CONCLUSION:**In this cross-validation study, the proposed GENEA cut-points had a low accuracy rate (55.3%) when engaging in 14 different lifestyle activities. Researchers should be cautious when applying the proposed cut-points.

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Board #80

Aging Research Evaluating Accelerometry (area): Methodologic Comparison Of Accelerometry Performance In The Very Old

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INTRODUCTION: Wrist-worn accelerometer use is likely to increase in clinically important groups such as older populations. However, there is a dearth of information regarding wrist accelerometry in older persons and a lack of easy-to-apply analytic algorithms.**PURPOSE:** To evaluate: 1. Can data from wrist, hip, arm, or thigh accelerometers equally reflect tasks of daily living? 2. Which accelerometry position best allows assessment of physical function? And, 3. Are accelerometry measures independent contributors to physical function in older persons? **METHODS:** We added an accelerometry component to a methods study at the University of Pittsburgh. Subjects wore multiple accelerometers: Actigraph GT3X+ on right and left wrist and right hip (80 Hz), a Sensewear on the left arm, and for 50 subjects, an ActivPal on the right thigh. While wearing a Cosmed oxygen monitor, subjects performed five sets of activities: (1) laying still, standing still; (2) upper body movement while standing: simulated dishwashing, dough kneading, dressing, folding towels; (3) upper body movement while walking: vacuuming, shopping; (4) upper body movement while sitting: writing, dealing cards, chair stands; (5) lower body movement: usual and fast paced walks for 20 meters performed with and without using arms. Subjects were asked to provide 7 days of free-living data while wearing all monitors. Other functional measures were collected at the same session. **RESULTS:** We have complete data on 71 older men and women (50% male), with a mean age of 79.5. Average body mass index (BMI, weight in kilograms over height squared) is 26.6. Average walking speed at usual pace (UWS) is 1.13 (±.15). After accounting for nonwear time, we examined correlations of selected variables from the free-living data with UWS, controlling for total valid minutes, age, gender and BMI. ActivPal step count (.31, P=.04), ActivPal sedentary time (-.32), P=.04), ActivPal Upright Time (.31, P=.05) all correlated with usual walking speed; ActivPal step time was similar (.30, P=.05) but neither of the position change variables were associated. Evaluation of the hip and wrist worn Actigraph GT3X+ with UWS and other measures of function is ongoing. **CONCLUSION:** We have created a data resource to understand the contribution of accelerometry to assessment of older populations. We seek collaborations with statistical groups (see abstract by B. He) to help us compare the accelerometry output from wrists, arm, thigh, and hip during specific activities and in free-living data to identify whether these measures add independently to estimation of daily activity in older people.

SUPPORT: Intramural Research Program, NIA.

Board #81

Validation of the It's Life! Monitoring And Feedback Tool

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INTRODUCTION: The It's LiFe! tool is a monitoring and feedback tool, developed together with end-users in a user-centered development process. The aim of the tool is to stimulate physical activity (PA) in chronically ill patients treated in primary care, by self-monitoring, goal setting and personalized feedback. The tool consists of an activity monitor (MOXX), a smartphone app and a web service. The MOXX is worn on the hip and connected with Bluetooth to a smartphone. On the app and on a secured website, patients monitor their activity in relation to a personal goal and receive feedback messages generated by the system. The care provider may check results on a secure webpage and will discuss individual results with patients during consultations. **PURPOSE:** The purpose of this study was to examine concurrent validity of the MOXX relative to the ActiGraph GT3X in healthy subjects and chronically ill patients (COPD and type 2 diabetes) in a laboratory situation and during activities in daily living (ADL). **METHODS: S**ubjects wore the two devices simultaneously with an elastic belt placed on the lower back. An incremental treadmill protocol was executed by eight healthy adults (24.1 +5.3 yrs) 3 to 11km/h and nine chronically ill patients (60.9 +7.1 yrs) 2 to 4.5 km/h. For ADL measurements five healthy adults (33.4 +11.6 yrs) and twelve chronically ill adults (61.6 +9.2 yrs) wore the devices during waking hours on 6-7 consecutive days. Pearson correlation between the ActiGraph and MOXX counts per minute was calculated. Values over 0.8 are rated good. Agreement between minutes per category (sedentary, moderate and vigorous intense activities [1]) measured by the different devices was analyzed using Bland-Altman plots for repeated measures. To gain further insight into misclassified counts, scatterplots were made. Data were corrected for non-wear time, using diary information. **RESULTS:** There was a good correlation between ActiGraph and MOXX counts during treadmill walking (R= 0.95 in healthy subjects and R= 0.83 in patients) and during ADL (R= 0.90 in healthy subjects and R= 0.87 in patients). The Bland-Altman plots showed no systematic bias between the two devices in minutes per category in healthy subjects. In patients, systematic bias occurred in the sedentary category, however the bias was in one direction per patient. The scatterplots showed that misclassification occurred around category thresholds. **CONCLUSION:** These analyzes suggest that the MOXX is capable of measuring PA and can be used in the It's LiFe! tool if patients wear the device at the same place every time. The effect of the It's LiFe! tool embedded in primary care on PA will be evaluated in a Randomized Controlled Trial.

Board #82

Valid Detection of Wheelchair Propulsion with a Simple Sensor Configuration

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INTRODUCTION: Wheelchair driving is the most important mobility-related activity for many people with no or a restricted ability to walk. An important group is formed by persons with a Spinal Cord Injury (SCI), who mostly are wheelchair dependent. Current devices attached to the wheelchair can not differentiate between self-propelled wheelchair propulsion and passive wheelchair driving ("being pushed"), or are complex with respect to sensor configuration and/or analysis.**PURPOSE:** The aim of this study was to assess whether a set of 2 accelerometers (one attached to the person, one to the wheelchair) allows a valid detection of self-propelled wheelchair detection. **METHODS:** Six wheelchair restricted persons with a SCI (age 29 to 60 yrs, 5 of them with a complete lesion) performed an activity protocol consisting of over 20 activities, such as several wheelchair driving speeds on a treadmill, manoeuvring, household activities (washing dishes, putting on a jacket), being pushed with and without self-selected arm movements, and driving outside with two different wheelchair types. Each activity had a duration of at least 30 seconds. Two Actigraph GTX+ accelerometers were used, one attached at the wrist, the other at the spokes of one wheelchair wheel. Based on the (vector) counts of the two units, a custom-made MatLab program differentiated between two categories: self-propelled wheelchair driving and other activities (e.g. being pushed, moving arms not related to wheelchair driving, making transfers). As reference method video recordings were used, analysed by 2 assessors. Validity was expressed in term of sensitivity and specificity scores.**RESULTS:** The mean duration of the activity protocol was 24.5 min. The mean number of minutes of self-propelled wheelchair driving was 13.1 (2.4) according to video analyses, and 13.0 (2.2) according to accelerometer data ($p=0.79$). The overall sensitivity was 94.0%, the overall specificity 95.5%. Disagreement between accelerometer and video analysis data was mainly the result of two parts of the protocol: wheelchair driving at a very low speed on a treadmill, and persons being pushed in the wheelchair while making excessive arm movements.
CONCLUSION: Two accelerometers and a simple count-based algorithm allow a valid detection of self-propelled wheelchair driving. Disagreement with video analysis mainly resulted from two unusual activities.

Board #83

Assessment of Body Posture Using Inertial Measurement Units: A Validation Study

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INTRODUCTION: Depression is a widespread psychiatric disorder among people of all ages and can be very severe with high suicide risk. Objective evaluation of psychomotor symptoms is important in diagnosing and managing depression. Emerging evidence suggests that body posture during walking changes with mood state and, conversely, that changes in body posture affect mood. Thus, monitoring body posture in real-time outside of the laboratory has potential in developing an adjunctive treatment for depression. Although angular data from wearable sensors like inertial measurement units (IMUs) have been validated for estimation of upper limb motions during gait and seated tasks, the feasibility and validity of using IMUs to measure body posture during walking has not yet been demonstrated. **PURPOSE:** The purpose of this study was to assess the validity of using IMUs to assess body posture during walking in healthy individuals. **METHODS:** Four adults (19 ± 0.8 yrs, 75% male) wore 3 IMUs (Yost Engineering Inc.) placed on the head, acromion and sternum. Four retroreflective markers were also placed on each IMU and foot. Subjects walked at normal speed while data were collected from the IMUs and an optoelectronic system (8 cameras; Motion Analysis Corp.). Gait cycles were detected using position data from the feet to detect heel strike. Postural angles were calculated with Matlab code and were averaged over gait cycles from 3 trials for each subject for the head (flex/ext), thorax (flex/ext) and shoulder girdle (elevation/depression) for each measurement system. **RESULTS:** Mean shoulder girdle angle and variability in head, thorax and shoulder girdle angles were similar for IMUs and the optoelectronic system, but mean head extension and thorax extension angles were slightly different between measurement systems. Mean postural angles were 1.6 ± 4.4 deg and 0.6 ± 4.5 deg for head extension, -4.8 ± 1.3 deg and -3.5 ± 3.2 deg for thorax extension, and -0.4 ± 0.8 deg and -0.7 ± 0.8 deg for shoulder girdle elevation, for the optoelectronic system and IMUs, respectively. Mean within-subject differences between IMU and optoelectronic systems were similar for all postural angles. Mean differences between IMUs and optoelectronic system during walking were -0.3 ± 3.6 deg for head extension, 1.3 ± 3.5 deg for thorax extension, and -0.3 ± 0.7 deg for shoulder girdle elevation, respectively. **CONCLUSION:** Results suggest that IMUs can be used to assess body posture during walking. Whether IMUs can detect the small differences in body posture associated with emotional expression needs to be tested in future studies.

Supported by University of Michigan Rackham Graduate Student Research Grant

Board #84

Methods For Validating Spatio-temporal Gait Parameters In Knee Endoprothesis Patients Prior To Clinical Field Study

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INTRODUCTION: Spatio-temporal gait parameters can objectively evaluate the outcome and mobility after knee arthroplasty particularly with regard to alternate surgical techniques. To gain insight into these parameters during ordinary activities of daily life and clinically relevant situations outside a specialized gait lab an unobtrusive mobile sensor system can be used for gait monitoring. **PURPOSE:** In preparation for a clinical field study a self-developed mobile system had to be evaluated in a well-planned clinical validation study with patients elected for knee endoprosthetic surgery. **METHODS:** We conducted a validation study to compute the relevant spatio-temporal gait parameters namely knee and pelvis angle with three small SHIMMER sensor nodes. The state-of-the-art standard in human gait analysis, the electro-optical marker-based motion capturing system VICON with eight infrared cameras, as well as two high-speed cameras were used for validation. One mobile sensor was placed on the pelvis. The other two sensor nodes on the thigh and shank were attached by kinesiotape on carefully selected positions to gain optimal anatomical data. Data recording took place simultaneously, while the data from the three SHIMMER sensor nodes was acquired via Bluetooth and synchronized by a host system with self-developed software. Five patients and five volunteers (n=10) walked a distance of 15 meters at three self-selected speeds with 6 repetitions each. The gait cycles compared were located at the middle of the track. Knee angles were estimated using the inertial sensor data which were merged and processed as described in [1]. A similar algorithm with adapted filtering was used to estimate pelvis angles. In addition to manual protocols pattern matching was used to ensure synchronicity with the VICON data. **RESULTS:** As the overall coefficient of correlation of all knee angular measurements was 0.99, the correlation of pelvis angular measurements swayed from 0.99 to lower levels dependent on human body structure. Every gait phase recorded from VICON could be clearly identified within the whole appropriate gait periods. **CONCLUSION:** The validation study showed a sound quality of the mobile sensor system. The sway of correlation in pelvis angle estimation is assumed to be accounted by the possible sensor position. Conditioned by the optical markers the sensor could not be attached on the sacrum.

[1]Schulze M, Calliess T, Gietzelt M, Wolf KH, Liu TH, Seehaus F, Bocklage R, Windhagen H, Marschollek M. Development and clinical validation of an unobtrusive ambulatory knee function monitoring system with inertial 9DoF sensors. Conf Proc IEEE Eng Med Biol Soc. 2012; 2012:1968-71.

Board #85

Assessment of the False Alarm Rate in a 3 Accelerometry-Based Fall Detector for the Elderly and methods to reduce it

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INTRODUCTION: Falls are a major concern for the elderly and their ability to remain healthy. Fall detection systems may notify emergency responders when no one apart from the injured is present. However, their real-world application is limited by a number of factors such as high false positive rates, lowcompliance, poor-usability and short battery lifetime. **PURPOSE:** In order to improve these aspects we have developed a miniaturized 3D accelerometer integrated in a belt buckle, the actibelt, and a fall detection algorithm. **METHODS:** We have used a new evaluation method to assess the upper limit of the false alarm rate of our algorithm using a large set of long term standardized acceleration measurements (100Hz, 3D) recorded under real life conditions. **RESULTS:** Our algorithm has a false alarm rate of seventeen false alarms per month and has the potential to be reduced down to at most three false alarms per month when activities which require the sensor to be removed are eliminated. In laboratory settings, the algorithm has a sensitivity of 100%. The algorithm was sucessfully validated using data from a real-world fall. **CONCLUSION:** Actibelt technology is a promising platform to automatically detect falls with a high sensitivity and a low rate of false alarms when linked to automatic detection of sensor removal. Applications range from fall detection monitoring and alarm services to establishing falls as outcome in clinical trials.

Board #86

A Comparison Of Commercial Systems To Evaluate Postural Control During Clinical Testing

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INTRODUCTION: Postural control is an important clinical feature in people with Parkinson's disease (PD). Traditionally postural control has been evaluated using force platforms to examine the change of centre of pressure but more recently body worn sensors incorporating accelerometers have been used to describe parameters such as 'Jerk' (rate of change of acceleration) and root mean square (RMS) values. With the increasing number of accelerometer-based devices available it is important to test the agreement between sensors to ensure comparability. **PURPOSE:** The study compared two commercial systems to measure postural control within a clinical environment using the parameters Jerk and RMS as outcomes. **METHODS:** Ten young healthy adults were recruited. Participants wore both the Opal (128Hz, ±6g, APDM, Portland, USA) and the AX3 (100Hz, ±8g, Axivity, York, UK) which were located on the lumbar vertebrae (L5). Participants were asked to stand still for 2 minutes with their eyes open, feet 10cm apart (barefoot) and arms crossed on their chest. Opal data were downsampled (100Hz) and data for both systems were low-pass filtered (Butterworth, 3.5Hz cut-off, MATLAB). Systems were compared using paired t-tests, Pearson's correlation and Intraclass Correlation Coefficient (ICC(3,1)). **RESULTS:** ICC indicated good agreement between the two systems for RMS but not for Jerk. For RMS there was a strong correlation between the two sensors and no consistent bias. The poor agreement (low ICC) for Jerk was explained by a bias toward higher values for the AX3 compared to the Opal, as shown by the t-test, rather than a poor correlation (Pearson's R) between the two systems (Table 1).

Table 1: Mean values of Jerk and RMS for the anterior-posterior (AP) and medio-lateral (ML) and combined directions for the two devices, and statistical outcomes (p, R, ICC). *Statistical significance (p<0.01).

Device	**Jerk [m^2/s^5]**	**Jerk AP [m^2/s^5]**	**Jerk ML [m^2/s^5]**	**RMS [m/s^2]**	**RMS AP [m/s^2]**	**RMS ML [m/s^2]**
AX3	6.162*	3.376*	2.785*	0.121	0.111	0.043
Opal	3.043	1.648	1.395	0.125	0.117	0.039
p - T-test	<0.01	<0.01	<0.01	0.368	0.248	0.289
R - Pearson"s	0.969	0.915	0.838	0.982	0.967	0.827
ICC	0.448	0.417	0.441	0.980	0.863	0.819

CONCLUSION: Agreement between both instruments was high for RMS values but not for Jerk, therefore caution must be taken when comparing data sets. Estimates of Jerk may be more sensitive than RMS to sensor hardware and processing techniques. Further work is required to establish agreement between sensors (Bland-Altman analysis will be presented), and identify robust protocols.

Supported by FP7 project V-TIME- 278169

Board #87

Comparing Energy Expenditure Prediction from an Accelerometer-Based Artificial Neural Network to Indirect Calorimetry

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INTRODUCTION: Hip-mounted accelerometers can provide objective, valid measurement of physical activity (PA) in most settings. However, the traditional cut-point approach to classifying PA intensity does not allow forthe determination of PA type and has limited use in accurately measuring energy expenditure (EE). A recent innovation is the use of artificial neural networks (ANNs) to better classify PA type and estimate EE in laboratory-based settings. However, to our knowledge, no previous studies have evaluated the accuracy of an ANN for estimating EE in a free-living setting.**PURPOSE:** To compare the ability of a hip-mounted accelerometer ANN to predict EE versus indirect calorimetry during performance of various activities in a free-living setting. **METHODS:** Twenty five participants (56% female, 36% overweight/obese, mean age 21.7) engaged in 14 different activities (lying down, sitting reclined and straight, standing, biceps curls, sweeping, squats, jumping jacks, stair climbing, walking slow and fast, biking slow and fast, and jogging) over the course of a 60-minute, free-living session. Activities represented a combination of exercise and lifestyle activities and comprised a range of PA intensities from sedentary to vigorous. During the 60-minute session, participants wore a portable metabolic analyzer (Oxycon, Cardinal Health) and a hip-mounted ActiGraph GT3X+ accelerometer. Participants were instructed to perform each of the 14 activities at least once, but they were free to choose the order and the length of time (1-10 minutes) spent in each activity. For analysis, participant data were processed using a 10-fold validation method, and an ANN was created from features extracted from ActiGraph data. Root mean square error (RMSE) and Pearson correlations were calculated for predicted MET values from the ActiGraph compared to the Oxycon.**RESULTS:** Measured MET values during the free-living session ranged from 0.8-12.5 METs, and participants spent an average of 40.5 minutes in MVPA (≥3.0 METs). RMSE for the ActiGraph was 1.9 METs, and the correlation between predicted and measured MET values was $r=0.71$ ($p<0.001$). **CONCLUSION:** The ActiGraph ANN provided similar RMSE values but lower correlations with METs than in a previously conducted, laboratory-based study. However, the correlation observed in the current study is similar than those from other accelerometer-based ANNs for measuring PA.

Supported by NIH grant R21 HL093395.

Board #88

Reliability And Validity Of Sensor-Based Sit-To-Stand Peak Power In Older Adults

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INTRODUCTION: Leg power is associated with mobility performance and fall risk. Vertical peak power during the sit-to-stand (STS) transfer can be estimated with hybrid motion sensors. However, test-retest reliability of sensor-based STS peak power is unknown, as well as the association between sensor-based STS peak power and clinical measures currently used for the assessment of mobility and fall risk. **PURPOSE:** To investigate test-retest reliability of sensor-based STS peak power in older adults. In addition, the association of sensor-based STS peak power with the Timed Up and Go Test (TUGT) and the Five Times Sit to Stand Test (FTSST) was investigated. **METHODS:** 31 older adults (21 females; 73-94 yrs) participated in a test and retest session separated by 3-8 days. During both sessions participants performed 5 STS trials at a normal movement speed. Vertical STS peak power was estimated based on data of a hybrid motion sensor worn on the right side of the hip. The sensor measured 3D-accelerations (±2 g), 3D-angular velocities (±300 deg/s), and 3D-orientation in the earth-magnetic-field (±2 Gauss). Participants also performed the TUGT and FTSST. Intra-class correlation (ICC) was calculated to determine relative reliability and was interpreted as: excellent ≥ 0.75; moderate to good 0.40-0.74; poor <0.40. The 95% confidence interval (CI) of the mean difference (d) between test and retest was calculated to determine absolute reliability. Zero in the 95%CI of d was considered to indicate good reliability. **RESULTS: Table 1.**Test-retest reliability of sensor-based STS peak power.

Outcome measure	**Test mean±SD**	**Retest mean±SD**	**d±SD$_d$**	**95%CI of d**	**ICC**
STS peak power (W)[a]	389.1±129.2	409.0±137.5	19.9±54.5	-0.8 to 40.7	0.96
STS peak power[a,c]	0.12±0.03	0.13±0.03	0.01±0.02	0.00 to 0.01	0.90
STS peak power (W)[b]	398.0±143.8	403.6±153.1	5.6±85.2	-25.6 to 36.9	0.84
STS peak power[b,c]	0.13±0.04	0.13±0.04	0.00±0.03	-0.01 to 0.01	0.70

[a]Average peak power of 5 STS trials; [b]Peak power based on 1 STS trial; [c]Dimensionless after scaling power for body mass and length.

Sensor-based STS peak power demonstrated excellent test-retest reliability. Furthermore, STS peak power showed medium associations with the TUGT (Pearson's r=-0.44; p=0.007) and FTSST (r=-0.33; p=0.06). STS peak power scaled for body mass and length showed strong association with the TUGT (r=-0.56; p<0.001) and medium association with the FTSST (r=-0.40; p=0.02). **CONCLUSION:** STS peak power can be assessed with excellent test-retest reliability in older adults based on a single STS trial. Associations between sensor-based STS peak power and TUGT and FTSST were medium to strong. This study shows that sensor-based STS peak power may be useful for clinical assessment of mobility and fall risk in older adults.

Supported by ZonMw.

Board #89

Detecting Indoor and Outdoor Environments Using the ActiGraph GT3X+ Light Sensor in Children

Jennifer Flynn, Dawn P. Coe, Chelsea Larsen, Brian C. Rider, Scott A. Conger, David R. Bassett, Jr. *University of Tennessee, Knoxville, TN.*

INTRODUCTION: To increase physical activity in children, some experts are recommending that children spend more time playing outside. To date, there have been no objective methods established for determining whether a child is indoors or outdoors. **PURPOSE:** The purpose of the study was three-fold: (1) to assess the reliability of the ActiGraph GT3X+ ambient light sensor, (2) to identify a lux threshold that will accurately discriminate between indoor and outdoor activities in children, and (3) test the accuracy of the lux threshold in a free-living environment. **METHODS:** In part one, a series of reliability tests were performed using 20 ActiGraph GT3X+ monitors under different indoor and outdoor lighting conditions. In part two, participants were asked to perform a total of 11 different activities (five indoors and six outdoors), each activity lasted six minutes with a 4-minute rest/transition period between activities.Indoor activities included: sitting reading a book, sitting watching television, standing in a hallway, standing near a window, and playing basketball in a gymnasium. Outdoor activities included: playing under a breezeway connecting two buildings, sitting under a shaded tree, standing under a shaded tree, sitting under direct sunlight, walking along a tree-lined sidewalk, and playing soccer on a field in the direct sunlight. In part three, preschool children wore the monitor during the school day. Children had to have at least four hours of wear time to be included in analysis and one minute lux values were determined for the entire duration of wear time. Part one: Cronbach's alpha was used to determine inter-instrument reliability of the light sensor and repeated-measures ANOVA was used to measure lux readings across the 11 conditions. Pairwise comparisons with a Bonferroni adjustment were then used to determine how the conditions differed. Part two: Optimal classifications of indoor and outdoor activity were determined by calculating the probability of correct classification. Part three: Percent accuracy was determined for overall day, indoor conditions, and outdoor conditions separately. **RESULTS:** Part one: The devices had Cronbach's alpha values of 0.992 for indoor conditions and 1.0 for outdoor conditions, indicating high inter-instrument reliability. Part two: The optimal lux threshold was determined to be 300 lux (88.3% classification accuracy). Part three: The results of the school-day validation determined that the monitor was 95.3% accurate in the overall detection of indoor and outdoor conditions (85.2% accuracy of outdoor environments, 97.4% accurate of indoor environments). **CONCLUSION:** These results demonstrate that, using a lux threshold of 300, the ActiGraph GT3X+ can accurately assess indoor and outdoor conditions in a preschool environment.

Board #90

Physical Activity Recognition from Body-worn Sensors: A Comparison of Free-living and Controlled Data Collection

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PURPOSE: Machine Learning (ML) techniques are being used to overcome the limitations of traditional accelerometer based assessments of physical activity. Most studies have used laboratory simulations of behavior to develop algorithms to classify behaviors. Studies of free-living activity are needed to improve the ecological validity of ML methods. With this aim, we develop and test an algorithm on free-living data and compare it to an algorithm trained on prescribed activities. **METHODS:** Two datasets were collected with comparable outcomes. One was controlled the other free-living. For the controlled study, two researchers wearing GPS and accelerometers completed a prescribed protocol of activities, noting the start and end times. We then collected a free-living dataset from 40 participants equipped with hip-worn accelerometer and GPS devices. Participants wore devices for 3-4 days each, resulting a total of 3230 hours of data. Participants also wore SenseCams, small cameras worn around the neck, which researchers used to manually annotate the data with "ground truth" activity labels. We classified data into five activity classes: bicycling, riding in a vehicle, sitting, standing, and walking/running using a random forest ML algorithm that employs 44 features computed from the data. We trained the ML on both the prescribed and free-living data and applied them to a held out sample of free-living data. **RESULTS:** Training the algorithms on the prescribed activity dataset to predict activities in the free-living dataset resulted in accuracy of 68.5 ± 11.2%. However, training the algorithms on the free-living dataset, using leave-one-user-out cross validation resulted in accuracy of 86.7 ± 7.9%, demonstrating the importance of training on free-living data. Additionally, by training on free-living data we can exploit the probabilities of transitioning between different activities by making a second layer of predictions using a hidden Markov model (HMM). Using the HMM to smooth the predictions from the random forest algorithm produced a significant increase in accuracy to 87.7 ± 7.7% ($p = 0.005$). We also demonstrate that the random forest algorithm can detect breaks from sitting. We detected sit to stand transitions on the free-living dataset with 13% false positive rate and 0.2% false negative rate. This is a significant improvement over the traditional method using the 100 count-per-minute cut-point, which resulted in a 26.4% false positive rate and 10.0% false negative rate.**CONCLUSION:** Algorithms developed on free-living data are superior to algorithms developed on behavior simulations (even in the real world) for classifying human behavior in the wild.

Board #91

The Quantity And Quality Of Patient Activity Influence In-vivo Wear In Total Hip Arthroplasty

R Senden, M Lipperts, IC Heyligers, B Grimm. *AHORSE dept. Orhopaedic Surgery and Traumatology, Heerlen, Netherlands.*

PURPOSE: In total hip arthroplasty (THA), the correlation between patient activity and in-vivo polyethylene (PE) wear has not been well studied although in simulators wear is reported per gait cycle. Other activities or postures (e.g. transfers, sitting periods) or the intensity of certain activities may be of greater influence on PE wear than step counts only. This study compares the physical activity of THA patients with low and high in-vivo wear using body-fixed Accelerometer sensors. **METHODS:** Two groups of primary THA patients were selected from a prospectively followed cohort based on their radiographic wear, resulting in a low wear (LW, <0.7mm,n=12) and high wear (HW, >1.0mm, n=13) group. Both groups received the same implant system and were matched for age, weight, BMI and follow-up time (table 1). Patients completed two questionnaires, the HOOS-PS for functional outcome and the SQUASH for activity. Activity was also measured using a 3D accelerometer (64x25x13mm, 18g) as activity monitor (AM) which was worn for 4 successive days at the non-affected upper leg. Validated algorithms, relying on published principles (inclinometer, peak detection) were used to derive quantitative (e.g. activity duration, counts) and qualitative (e.g. cadence, event distribution) parameters.**RESULTS:** The mean annual wear rate of the HW group was three times higher than the LW group, while functional outcome, self-reported activity and other patient or implant related factors were not different. The HW group had sign. more steps/day, more walking bouts, a higher percentage of daily time spent walking and less time sitting though with more short (<10min) sitting events (table 1). Moreover the HW group walked with a higher cadence (p=0.19). Wear only correlated moderately with # walking bouts (r = 0.49), # steps (r = 0.45) and # walking bouts ≤ 30sec (r = 0.50). **CONCLUSION:** The HW group scored more activity counts although by a lower factor than the threefold wear rate difference would suggest. Also the correlations between activity parameters and wear were at best only moderate. Higher cadence and event durations distributed more to shorter events suggest that in-vivo wear is influenced not only by the quantity but also by quality (intensity) of patient activity. This may have implications for patient advice on safe or critical activities and wear simulators to e.g. include intermittent movements.

Table 1: Demographics, scales and AM parameters of LW and HW group

		LW group	HW group	P-value
Demographics	Height (cm)	165.3 ± 6.9	170.6 ± 7.1	0.07
	Weight (kg)	76.8 ± 12.6	78.0 ± 10.8	0.82
	Age at OK (yrs)	64 ± 6	63 ± 8	0.67
	Wear (mm/yr)	0.55 ± 0.16	1.42 ± 0.37	<0.01
Scales	HOOS-PS	6.3 ± 5.1	6.9 ± 7.0	0.60
	SQUASH	3095 ± 2917	4235 ± 4359	0.45
AM	Duration sitting (min.)	534 ± 127	428 ± 148	0.06
	Duration walking (min.)	55 ± 22	83 ± 37	0.04
	Duration standing (min.)	218.2± 93.1	242.99 ± 70.52	0.46
	Duration Cycling (sec)	15.5 ± 35.2	299.04±760.11	0.20
	# Sit-stand transfers	29 ± 7	34 ± 12	0.18
	# Sit periods < 10min	18 ± 6	25 ± 11	0.05
	# Sit periods > 10min	11 ± 3	10 ± 4	0.42
	# Steps/day	3676 ± 1715	6167±3294	0.03
	# Bouts walking	126.6 ± 55.7	208.6 ± 99.5	0.02
	# Walking bouts < 30s	95 ± 51	170 ± 96	0.03
	# Walking bouts > 30s	32 ± 17	39 ± 11	0.22
	Cadence (steps/min)	85 ± 20	94 ± 11	0.19

Slide Session

Validation and Calibration

Tuesday, June 18, 2013, 8:30 am - 9:30 am

Campus Center Room 163

Moderator: Hans Bussman

8:30 – 8:45

CSTS and MARS Models Using Accelerometry and Heart Rate Predict Energy Expenditure of Preschoolers

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INTRODUCTION: Preschool-aged children have higher basal metabolic rates, heart rates and metabolic costs of movement than older children. Because the relationships between accelerometer counts (AC), heart rate (HR) and energy expenditure (EE) are confounded by growth and maturation, age-specific EE prediction equations are required. Mathematical modeling of these relationships has been limited to linear regression in preschoolers, unlike older children and adults, where advanced mathematical modeling has proven powerful in the prediction of EE.**PURPOSE:** We validated cross-sectional time series (CSTS) and multivariate adaptive regression splines (MARS) models to predict EE in preschoolers using advanced technology (fast-response room calorimetry, doubly labeled water method, Actiheart and Actigraph accelerometers and miniaturized HR monitors).**METHODS:** CSTS and MARS models for the prediction of minute-by-minute EE were validated in 50 preschool-aged children, ages 3 to 5 y, against room calorimetry and DLW. Free-living total energy expenditure (TEE) was measured over a 7-d period using the DLW method simultaneously with Actiheart and ActiGraph GT3X+ monitoring. CSTS and MARS models were based on subject characteristics (gender, age, weight, height), Actiheart (HR+ accelerometer counts, AC_x) or ActiGraph parameters (AC_x, AC_y, AC_z, steps, posture), and their significant 1- and 2-minute lag and lead values, and significant interactions.**RESULTS:** Relative to EE measured by calorimetry (mean ± SD, 1.08 ± 0.24 kcal/min), mean percent errors predicting EE were within 10% for 70% of cases with the CSTS and MARS models based on the Actiheart and ActiGraph+HR. Concordance correlation coefficients (CCC) were 0.82 and 0.92 for CSTS EE models, and 0.85 and 0.88 for MARS EE models. Relative to TEE measured by DLW mean percent errors were within 10% for 68% of cases with the CSTS and MARS models using Actiheart and ActiGraph+HR.**CONCLUSION:** CSTS and MARS models that capture the complex dynamics of EE and movement characteristic of preschool-aged children can be used for the quantitative assessment of EE.

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8:45 – 9:00

Testing a New Classification Algorithm to Capture Lifestyle Activities in Free-living Conditions

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INTRODUCTION: Types and durations of activities that people engage in during their daily routine are important to consider when studying links between physical activity, sedentary behaviors, and health. Within the framework of the SVELTE project, a classification algorithm using Gaussian mixture models capable of identifying 8 postures and activities from 3-axial accelerometer and magnetometer data was developed. This tool was initially parameterized with data from activities performed in controlled conditions.**PURPOSE:** The purpose of this study was to test the performances of this algorithm on field data, and to compare them with those of a commercially available device.**METHODS:** 20 subjects equipped with 2 hips-worn 3-axial accelerometers (1 MotionPOD, MOVEA; 1 Actigraph GT3X+, ActiLife) engaged in a set of indoor and outdoor activities (e.g. sitting at a desk, walking down the streets, shopping, cycling, using public transports, etc.). Subjects were free to perform activities at their own pace. Postures and activities were noted and timed by an observer. MotionPOD data were processed with the new algorithm, resulting in the subjects' postures being classified as lying down, slouched, sitting, standing, making few steps, walking, running, or cycling. The Actigraph's inclinometer provided a 3-class classification (standing, sitting, or lying). Confusion matrices were used to compare the outputs of each method to the observer's notes. Outputs from the new algorithm were considered at both the native 8-postures output and after grouping into the same 3 basic postures as the Actigraph data.**RESULTS:** Lying down and standing activities were better identified with the new tool than with the Actigraph (sensitivity = 99.9 vs. 90.2 %, and 97.7 vs. 91.7 %, respectively), but not sitting activities grouped altogether (57.7 vs. 73.4 %). Cycling outdoor and sitting when in a motorized vehicle proved difficult to identify for the initial lab-calibrated algorithm. Data from 10 subjects were used as a learning set to define a distinct 'outdoor cycling' category. The new 9-posture classification performed well on several common activities: lying down 99.9%, sitting at a desk 70.9 %, slouched 72.6%, all walks 76.8%, making few steps 51.2%, running 94.8%, and cycling on flat 80.1% (cycling sensitivity calculated only on subjects not included in the learning set).**CONCLUSION:** Although further improvements are required, the new tool already increases the panel of activities that can be detected and paves the way to interesting studies on lifestyle behaviors. It should also prove useful to improve energy expenditure calculations derived from motion devices.
Funding**:**ANR TECSAN

9:00 – 9:15

Is Accelerometry Really Measuring Travel-related Physical Activity During The Hour Before And After School?

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INTRODUCTION: Physical activity (PA) from active travel to and from school is commonly inferred by windowing accelerometry data during the hrs before and after school. However, no study has validated this method against travel diaries.**PURPOSE:** To investigate the convergent validity of using the hr-window before and after school to measure travel PA (against travel diaries), and to establish if either method describes between-travel-mode differences in travel PA.**METHODS:** Forty-nine students (13.8±0.6 yrs) attending a public high school in downtown Vancouver participated in a school-based study in fall 2012. Students were instructed to wear an accelerometer (GT3X+) on the right waist for the next 7d and to complete a travel diary, indicating: travel mode and start/stop times (hh:mm) for trips to and from school on each school-day. Students providing accelerometry data and travel diaries for at least one 'routine' school-day (no clubs and/or early or late travel to and from school) were included for analyses (n=24, 42% girls). Accelerometry files (1s epoch) were windowed (hr before, hr after, travel to, travel from) and uniaxial counts were converted to moderate-to-vigorous PA (MVPA; Evenson et al., '08) using ActiLife (v. 6.4.3).**RESULTS:** MVPA during the actual trip to and from school explained 66% ($p<0.01$) and 49% ($p=0.01$) of MVPA during the hr windows before and after school, respectively. Using transit was most commonly reported for travel to (53%) and from (45%) school, followed by walking (29%, 41%) and car use (18%, 14%). There were significant between travel-group differences in MVPA during the hr before ($F=11.05$, $p<0.01$) and during the actual trip to school ($F=5.82$, $p=0.02$); by either method, walkers were most active (20.3±9 min, 11.2±6 min, respectively) compared with transit (11±1.9 min, 6.8±3 min) and car users (3.4±0.8 min, 0.8±0.4 min). After school, MVPA was only different between travel modes during the hr after school window ($F=5.71$, $p=0.01$), but not the actual trip from school ($F=1.27$, $p=0.31$). In the hr after school, walkers were more active (16.2±5 min) than transit (11.6±3 min) and car users (7.5±4 min). It made no difference whether MVPA was calculated based on accelerometry data from 'routine' days vs. any weekdays for the hr before ($t=1.65$, $p=0.12$) or after school ($t=1.62$, $p=0.12$).**CONCLUSION:** Windowing accelerometry data during the hr before and after school may be used to crudely estimate travel PA. However, those who seek a precise estimate of travel PA may wish to consider including travel diaries or Global Positioning Systems. Why PA before and after school differs by travel mode - irrespectively of travel PA - warrants exploration.

9:15 – 9:30

Modeling Simultaneous Heart Rate and Accelerometry to Estimate Energy Expenditure

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INTRODUCTION: There is a need to investigate methods to improve upon the accuracy and precision of physical activity energy expenditure (EE) estimations. Purpose.To compare different linear segmented models to integrate heart rate (HR) and accelerometer (ACC) data to estimate EE. **METHODS:**147 adults underwent measures of anthropometrics, resting oxygen uptake (V02), and maximal V02. Each individual was then assessed for V02, HR and ACC while performing treadmill walking and running activities (1.0-4.0mph in 0.5mph increments, and 6,7 and 8mph: duration 5 min/stage) and simulated activities of daily living (computer work, vacuuming, mopping/sweeping, carrying/moving boxes and stair climbing/walking: 7 mins each). Mean HR, ACC and METs (measured activity V02 divided by measured resting V02) from each activity was then used in linear segmented regression modeling examining different a priori HR join knots to condition the cross over between using ACC and HR to predict METs. The Jackknife approach was used to compare root mean square error (RMSE) across evaluated models to predict METs before and after controlling for gender, BMI, resting and maximal V02. **RESULTS:** The overall sample (age=49±17 yrs, BMI=25.8±4.5 kg/m2, resting V02=2.88±0.46 mL/kg/min, maximal V02=34.2±10.1 mL/kg/min) was categorized into the following age ranges 1) 18-39 yrs (n=48), 2) 40-64 yrs (n=65), and 3) 65+ yrs (n=34), that completed a total of 667, 853 and 414 activities, respectively. Models conditioned to join ACC and HR at an individual HR walking response at 2.5mph was deemed the most accurate. The following models were then evaluated for accuracy to predict METs across all activities: Model 1 unadjusted: If HR<HR at 2.5mph, then METs=a1+b1*ACC, if HR≥HR at 2.5mph, then METs=a2+b2*HR; Model 2 unadjusted: If HR<HR at 2.5mph, then METs=a1+b1*ACC, if HR≥HR at 2.5mph, then METs=a2+b2*HR+b3*ACC; Model 3 was the same as model 2, but adjusted for covariates. Model 3 showed the greatest accuracy in predicting METs with RMSE values 0.94 METs (18-39yrs), 0.93 METs (40-64yrs), and 0.92 METs (≥65yrs). **CONCLUSION:** Integrating HR and ACC using a defined HR walking response to condition an ACC and HR model offers an accurate method to estimate EE. Future studies comparing this approach to other prediction methods are warranted.

This work was supported by funding source R01HL091019.

Slide Session

Special Populations

Tuesday, June 18, 2013, 8:30 am - 9:30 am

Campus Center Room 162

Moderator: Erwin van Wegen

8:30 – 8:45

Estimating Energy Expenditure Using Propulsion Power During Wheelchair Locomotion

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INTRODUCTION: The objective assessment of energy expenditure (EE) in individuals who use wheelchairs have yielded mixed results due to the increased EE associated with locomotion on different surfaces and different grades. The measurement of wheelchair propulsion power could improve on existing methodologies by quantifying the intensity associated with wheelchair locomotion.**PURPOSE:** To examine the relationship between hand rim propulsion power and EE during wheelchair locomotion.**METHODS:** Fourteen individuals who used manual wheelchairs were included in this study. Each participant performed five different activities for eight minutes each in a wheelchair with a PowerTap hub built into the rear wheel. The activities included wheeling on a level surface that elicited a low rolling resistance at three different speeds (4.5, 5.5, and 6.5 km·hr-1), wheeling on a rubberized 400m track that elicited a higher rolling resistance at one speed (5.5 km·hr-1), and wheeling on a sidewalk course that included uphill and downhill segments at their self-selected speed. EE was measured using a portable indirect calorimetry system (Oxycon Mobile). Stepwise, linear regression was performed to predict EE from measured variables. A repeated measures ANOVA was used to compare the measured EE to the estimates from the power models. A leave-one-out cross validation technique was used to determine the error and bias associated with each equation.**RESULTS:** EE and power were significantly correlated ($r = 0.694$, $p < 0.001$). Stepwise, linear regression analysis yielded three significant prediction models utilizing measured power; measured power and speed; and measured power, speed, and heart rate. Cross validation analysis indicated that both the root mean squared error (rMSE) and the bias associated with each equation were low. The model that demonstrated the best agreement ($r2 = 0.87$) and the lowest rMSE (rMSE = 0.74) was the model that utilized measured power, speed, and heart rate.**CONCLUSION:** EE can be accurately and precisely estimated based on hand rim propulsion power. Although the software configuration of the power meter used in this study would need modifications for long-term physical activity assessments, these results indicate that power could be used as a method to assess physical activity in people who use wheelchairs.

8:45 – 9:00

Measuring Physical Activity in Children with Cerebral Palsy who are Ambulatory

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INTRODUCTION: Children with cerebral palsy (CP) participate in less physical activity (PA) compared to their peers with typical development. Decreased activity is related to severity of motor disability. Multiple factors contribute to lower PA levels including decreased strength and coordination; limited cardiorespiratory and muscular endurance; and decreased functional mobility and gross motor skills. Activity-based interventions are often used to promote PA in children with CP. Valid and reliable measures are needed to examine PA levels.**PURPOSE:** This study examined inter-instrument reliability and concurrent validity of accelerometers relative to energy expenditure measures via indirect calorimetry in children with CP who are ambulatory.**METHODS:**Twenty five children with CP (mean age = 12.7 $\pm$ 3.8 years; 44% Male) wore accelerometers bilaterally on the upper arms (BodymediaSenseWear), hips (ActiGraph GT3X) and ankles (StepWatch) and a Cosmed K4b2 portable indirect calorimeter while performing a protocol which consisted of eight physical activity trials lasting 5-6 minutes. Activity trials included resting, writing, spraying and wiping a counter, folding laundry, playing X-Box active video games, and walking at three different self-selected speeds (comfortable, brisk, fast). Intra-class coefficient correlations (ICCs) were generated to evaluate inter-instrument reliability. Spearman correlations were calculated to evaluate concurrent validity between accelerometer outputs and VO2 measured by indirect calorimetry. Statistical significance was set at an alpha level of 0.05.**RESULTS:** Bilateral output from all three devices exhibited almost perfect agreement. ICCs ranged from 0.93 for BodyMediaSenseWear to 0.98 for ActiGraph. Validity was established between accelerometer activity and step count data and VO2 data. Spearman correlations were rho = 0.82 for vertical axis ActiGraph activity counts, rho = 0.81 for StepWatch step counts, and rho = 0.70 for BodyMedia step counts.
CONCLUSION: Accelerometry is a valid and reliable measure of PA for children with CP. Accelerometry may be useful to document PA levels in children with CP and to examine effectiveness of activity-based interventions.

9:00 – 9:15

Posture and physical activity measurement in youth with Cererbal Palsy: an activPAL monitor validity study

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INTRODUCTION: The valid measurement of posture and physical activity is important to establish accurate activity profiles of young people with Cerebral Palsy (CP). Research to date on this topic has been of low methodological quality due to use of measurement tools that have not been validated for use in the CP population.**PURPOSE:** To establish the validity of the activPAL physical activity monitor for the measurement of sitting, standing and walking time, transition and step number for both the affected and non/less affected lower extremity in young people with hemiplegic and diplegic CP Gross Motor Classification System (GMFCS) levels 1 and 2, using observational analysis as the reference standard. **METHODS:** Seventeen participants with spastic hemiplegic (n=9) and diplegic (n=8) CP GMFCS level 1 performed sitting, standing, walking and transitions in 2 controlled test protocols. Test protocols 1 and 2 involved activPAL wear on the affected limb and the non/less affected limb respectively. Both test protocols were captured by digital video recordings which were observed by two blind independent observers. The activPAL output was compared to observation data to assess the level of agreement using the Bland and Altman Method and intraclass correlation coefficients (ICC 3,1). **RESULTS:** Transition number measured by activPAL was identical to the observational transition number values. ICCs, Bland Altman mean differences and their upper and lower limits of agreement (ULOA and LLOA) for sitting, standing, walking time (seconds) and step count for both test protocols are tabulated as follows:

Test 1	**Sitting**	**Standing**	**Walking**	**Stepcount**
Mean difference	-1.77	0.77	1.00	4.06
ULOA	1.44	4.67	2.84	8.69
LLOA	-4.98	-3.13	-0.84	-0.57
ICC	0.49	0.59	0.99	0.96

Test 2	**Sitting**	**Standing**	**Walking**	**Stepcount**
Mean difference	-1.82	0.12	1.06	2.82
ULOA	1.37	4.92	4.27	7.68
LLOA	-5.01	-4.68	-2.15	-2.04
ICC	0.95	0.98	0.94	0.95

CONCLUSION: The activPAL monitor demonstrates clinically acceptable validity as a measure of transition number, sitting, standing and walking time when worn on both lower limbs. It demonstrated greater validity for standing time and lower validity for walking time when worn on the non/less affected limb. The validity of activPAL as a measure of step count for both lower limbs in this population is questionable and requires further research.

9:15 – 9:30

Pedometer and Accelerometer Derived Steps in Free-living Older Adults with Parkinson's disease or Osteoporosis

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INTRODUCTION: Studies under controlled conditions have shown a high level of agreement between pedometer and accelerometer derived steps in individuals with normal movement pattern. However, studies on correlations between pedometer and accelerometer derived steps in older adults with impaired gait are scarce. Furthermore, to clarify the potential feasibility of these instruments for use by researchers or clinicians, there is a need to evaluate these instruments under free-living conditions.**PURPOSE:**The purpose of this study was to compare self-reported pedometer steps per day with accelerometer derived steps in free-living older adults with Parkinson's disease (PD) or osteoporosis (OP).**METHODS:**Seventy-one participants 60 years or older with PD and 72 participants 65 years or older with OP wore a pedometer (Yamax LS2000) and an accelerometer (Actigraph GT1M or GTX3) simultaneously for one week during waking hours. Wear time and daily pedometer steps were recorded by the participants in a log sheet. Mean pedometer steps per day were compared with mean accelerometer steps. Accelerometer data was processed with ActiLife software 6.**RESULTS:**Fifty-one participants with PD (30 women; age 72.6 ± 5.3 years) and 61 participants with OP (59 women; age 75.6 ± 5.3 years) provided simultaneously recorded data for three days or more. Paired sample T-test and Wilcoxon signed rank test showed no significant difference between the two instruments in the OP-group (6035 ± 3257 and 6047 ± 2957, p = 0.956), but number of pedometer steps per day was significantly lower than accelerometer steps (4164 ± 3708 and 4967 ± 3191, p =0.002) in the PD-group. Bland-Altman plots demonstrated wide limits of agreement between the instruments in both PD (range = 6911 steps) and OP participants (range = 6794 steps).**CONCLUSION:** On a group-level there was a high agreement between self-reported pedometer steps and accelerometer derived steps in this sample of older adults with OP, but for older adults with PD the mean values for pedometer steps were systematically lower than accelerometer derived steps. The wide limits of agreement in both groups indicate that these two methods cannot be used interchangeable.

Supported by The Regional Agreement on Medical Training and Clinical Research between Stockholm County Council and KarolinskaInstitutet (ALF), and from the Swedish Research Council

Slide Session

Statistical, Computational and Data Processing Methods

Tuesday, June 18, 2013, 1:30 pm - 2:30 pm

Campus Center Room 163

Moderator: Soren Brage

1:30 – 1:45

Human Physical Activity Assessment Based on Sparse Representation

Shaopeng Liu[1], Robert X. Gao[2], Dinesh John[3], John Staudenmayer[4], Patty S. Freedson[4].
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INTRODUCTION: Machine learning techniques have been increasingly applied to physical activity (PA) assessment studies. In most of these studies, extracting and selecting the most relevant and informative features from the raw sensor signals is one of the typical and salient steps that would affect the accuracy of the devised algorithms in PA assessment. Yet it is not feasible or requires exponential computational complexity to identify the "optimal" feature subset out of a predefined "large" feature set *a priori*, since it is possible to extract hundreds and thousands of features from a signal of sufficient length.**PURPOSE:** The purpose of the study was to design a sparse representation based multi-sensor data fusion algorithm to bypass the feature extraction and selection procedure and perform PA assessment from the raw sensor signals.**METHODS:** The sparse representation based method represents a PA signal to be assessed/classified as a linear combination of the training signal space, which is constructed using the original raw sensor signals instead of extracted features as performed by conventional pattern classification methods. By finding the sparsest solution (coefficients) of the linear representation, the test PA signal can be uniquely represented and therefore classified by the predefined training space. The performance of the algorithm has been evaluated through experiments with a total of 105 healthy subjects (34.7±14.2 years). Each subject wore a multi-sensor system developed in a previous study, which consists of two tri-axial accelerometers placed at the hip and wrist, and one ventilation sensor secured to the abdomen (AB) at the level of umbilicus of the test subjects. Each subject completed one of the two groups of activities of various intensities (7 activities each group with 7 minutes per activity), including sedentary, household, locomotion, and sports activities. Results were compared against conventional techniques with carefully selected feature set, including k-nearest neighbor (kNN) and support vector machines (SVM).**RESULTS:** When the length of the training signals was divided into 2-second intervals, the accuracy of the classification of PA types is 89.4% (with a standard deviation of 5.6% over the 105 subjects), which is greater than using longer intervals of training signals. Furthermore, the devised sparse representation based algorithm outperformed two conventional techniques (kNN and SVM) with better assessment accuracy (mean) and inter-individual variability (standard deviation). Specifically, the classification accuracies by kNN and SVM are 88.1±10.1% and 72.7±16.8%, respectively.**CONCLUSION**: The presented algorithm is able to provide as good and even better assessment performance as other techniques with carefully selected feature set, and it has demonstrated that the choice of an "optimal" feature set for classification is no longer critical.

Supported by NIH UO1 CA130783

1:45 – 2:00

Estimating Energy Expenditure from Heart Rate and Activity Counts: a Bayesian Approach

Jeff Goldsmith[1], Jennifer Schrack[2], Vadim Zipunnikov[2], Luigi Ferrucci[3], Ciprian Crainiceanu[2].
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PURPOSE: Wearable devices promise to revolutionize the estimation of energy expenditure at the subject level by providing continuous collection of movement and heart rate data. However several challenges currently prevent accurate estimation, including the need for subject-level calibration of the relationship between heart rate and energy expenditure and the often unclear relationship between movement and heart rate data. In this work we seek to combine multiple data sources collected as part of the Baltimore Longitudinal Study on Aging and, using a Bayesian framework, derive subject-level energy expenditure estimates that take into account subject heterogeneity.**METHODS:**In-lab calibration data is used to estimate population- and subject-level relationships between heart rate and energy expenditure (VO2 ml/kg/min) at rest and four levels of exertion. Accelerometry and heart rate data gathered over one week in a free living environment are combined to estimate the subject-specific probability of activity across heart rates and the subject-specific threshold between inactive and active. Together, these sources of data allow the estimation of energy expenditure from free living observations in a way that accounts for subject-level differences.**RESULTS:**Preliminary results indicate the importance of subject-level calibration. In particular, failing to account for subject differences can lead to the over- or under-estimation of total daily energy expenditure by more than 500 calories. It is therefore crucial to develop estimation procedures that are tailored to subject data. Additionally, early results indicate that the proposed Bayesian procedure flexibly incorporates both in-lab and free living data to estimate subject-specific activity and heart rate distributions that can lead to reasonable energy expenditure estimates.**CONCLUSION:**Accurate estimation of energy expenditure depends on the collection and synthesis of data from multiple sources. Subject differences are fundamentally important to understand to prevent large biases from affecting energy estimates.

2:00 – 2:15

Machine Learning for Activity Recognition: Hip versus Wrist Data

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INTRODUCTION: Wrist-worn accelerometers are convenient to wear and are associated with greater compliance. However, validated algorithms for predicting activity type and/or energy expenditure from wrist-worn accelerometer data are lacking.**PURPOSE:** To compare the activity recognition rates of an activity classifier trained on raw tri-axial acceleration signal (30 Hz) collected on the wrist versus the hip.**METHODS:** 52 children and adolescents (mean age 13.7 +/- 3.1 y, 28 boys, 24 girls) completed 12 activity trials that were categorized into 7 activity classes: lying down, sitting, standing, walking, running, basketball, and dancing. During each trial, participants wore an ActiGraph GT3X+ tri-axial accelerometer on the right hip and the non-dominant wrist. For both hip and wrist data, features were extracted from 10-s windows and inputted into a L1 regularized logistic regression model using R (Glmnet + L1). The average classification accuracy was calculated over 30 training-validation-testing iterations.**RESULTS:** Classification accuracy, averaged over all 7 activity classes, for the HIP and WRIST algorithms was 91.0 +/- 3.1 % and 88.4 +/- 3.0 %, respectively. The HIP model exhibited excellent classification accuracy for sitting (91.3%), standing (95.8%), walking (95.8%), and running (96.8%); acceptable classification accuracy for lying down (88.3%) and basketball (81.9%); and modest accuracy for dance (64.1%). The WRIST model exhibited excellent classification accuracy for sitting (93.0%), standing (91.7%), and walking (95.8%); acceptable classification accuracy for basketball (86.0%); and modest accuracy for running (78.8%), lying down (74.6%) and dance (69.4%).**CONCLUSION:** Activity recognition was marginally higher using raw tri-axial acceleration signal from the hip versus the wrist. However, the small difference in performance may not be of practical significance in field-based studies. Both algorithms achieved acceptable classification accuracy.

Supported by NIH RO1 NICHD 55400

2:15 – 2:30

Support Vector Machines Classifiers Of Physical Activities In Preschoolers

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INTRODUCTION: Novel approaches to classify physical activities in young children are essential for identifying their characteristically sporadic physical activity patterns. Cost-effective, non-intrusive, valid and precise methods for the classification of physical activities in preschool-aged children are essential to determine physical activity behaviors, prevalence and determinants, dose-response relationships between physical activity and health outcomes, and intervention effectiveness.**PURPOSE:** The goal of this study is to develop, test, and compare multinomial logistic regression (MLR) and support vector machines (SVM) in classifying preschool-aged children physical activity data acquired from an accelerometer.
METHODS: 69 children aged 3 to 5 years old were asked to participate in a supervised protocol of physical activities while wearing a triaxial accelerometer (ActiGraph GT3X+). Accelerometer counts, steps and position were obtained from the device. We applied -means clustering to determine the number of natural groupings presented by the data. We used MLR and SVM to classify the six activity types. Using direct observation as the criterion method, the 10-fold cross validation (CV) error rate was used to compare MLR and SVM classifiers, with and without sleep.**RESULTS:** Altogether, 58 classification models based on combinations of the accelerometer output variables were developed. In general, the SVM classifiers had a smaller 10-fold CV error rate than their MLR counterparts. Including sleep, a SVM classifier provided the best performance with a 10-fold CV error rate of 24.70%. Without sleep, a SVM classifier based triaxial accelerometer counts, vector magnitude, steps, position and 1- and 2-minute lag and lead values achieved a 10-fold CV error rate of 20.16% and an overall classification error rate of 15.56%.**CONCLUSION**: SVM supersedes the classical classifier MLR in categorizing physical activities in preschool-aged children. Using triaxial accelerometer data, SVM can be used to correctly classify physical activities typical of preschool-aged children with an acceptable classification error rate.

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Slide Session
Sleep
Tuesday, June 18, 2013, 1:30 pm - 2:30 pm
Campus Center Room 162

Moderator: Iuliana Hartescu

1:30 – 1:45

Assessing Sleep With Wrist And Hip Actigraphy In Young Adults - Comparison To Simultaneous Laboratory Polysomnography

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INTRODUCTION: Laboratory-based polysomnography (PSG) is the gold standard technique for assessment and quantification of sleep. Wrist and hip actigraphy have been widely used to quantify sleep and physical activity, respectively. It remains unclear whether hip actigraphy is also a valid measure of sleep.**PURPOSE:** To compare sleep variables simultaneously derived from PSG, wrist actigraphy and hip actigraphy in healthy, young adults.**METHODS:** 72 healthy individuals (49% females) aged 22.0±0.2 years (mean±SD) were recruited from the Raine Study, a population-based pregnancy cohort study in Western Australia. Each underwent in-laboratory PSG while simultaneously wearing one GTX3+ actigraph (Actigraph, Florida, USA) on their non-dominant wrist and another on an elastic belt on the right hip. Estimates of sleep onset latency (SOL), total sleep time (TST), wake after sleep onset (WASO), and sleep efficiency (SE) were derived using standard proprietary equations for count based actigraphy and standard PSG definitions. The sensitivity and specificity of actigraphic estimates of sleep versus polysomnography-defined sleep were also assessed on a 60 second epoch-by-epoch basis.

	PSG	**Wrist**	**Hip**
SOL (min)	17.8 ± 14.1[a,b]	9.5 ± 9.2[c]	2.1 ± 3.9
WASO (min)	41.5 ± 45.8[a,b]	56.5 ± 44.0[c]	13.2 ± 18.4
TST (min)	392.5 ± 63.1[b]	383.8 ± 64.1 [c]	434.4 ± 54.0
SE (%)	86.7 ± 10.3[b]	85.3 ± 10.1[c]	96.5 ± 4.5

a = PSG vs wrist; b= PSG *vs* hip; c = wrist *vs* hip (all $p<0.05$)

RESULTS: Relative to PSG measures: SOL was underestimated by wrist and hip actigraphy; WASO was overestimated by wrist but underestimated by hip actigraphy; and TST and SE were similar by wrist actigraphy but overestimated by hip actigraphy (see Table). Compared to wrist actigraphy, SOL and WASO were less but TST and SE more when measured by hip actigraphy. The sensitivity, specificity and accuracy of wrist actigraphy were 91%, 44% and 85%, respectively and of hip actigraphy were 98%, 13% and 86%, respectively. **CONCLUSION:** A hip-worn GT3X+ actigraphcan not be used to accurately measure sleep variables in young adults using the standard equations due to its very poor ability to detect wakefulness during sleep. Although wrist actigraphy is widely used in both clinical and research settings the present study shows it to have a limited capacity to detect periods of wake during sleep when using standard equations.

Supported by: National Health & Medical Research Council Australia (No. 1027449)

1:45 – 2:00

Affordable Sleep Estimates using Micro-Electro-Mechanical-Systems (MEMS) Accelerometry

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INTRODUCTION: Although more aff¬ordable than polysomnography, actigraphic sleep estimates have disadvantages. Brand-specific diff¬erences in data reduction impede pooling of data for consortia to create large-scale cohorts, as for genome-wide-association-studies (GWAS). Secondly, online data reduction may not fully exploit movement information. Thirdly, sleep estimate reliability might improve by advanced analyses of tri-axial, linear accelerometry data sampled at a high rate. Such recordings are now feasible using a-ffordable micro-electro-mechanical-systems (MEMS). However, it might take a while before advanced analyses are validated and available.**PURPOSE:** To provide lab-databases and ongoing studies with backward compatibility when switching from actigraphy to MEMS accelerometry, we designed and validated a method to transform accelerometry data into the traditional actigraphic 'movement counts', thus allowing for the use of validated algorithms to estimate sleep parameters.**METHODS:** Simultaneous duplicate actigraphy and duplicate MEMS-accelerometry was recorded in fifteen healthy adults (23-36 years, 10M, 5F) during one night spent at home.Actigraphy was recorded as 'movement counts'/15-seconds epoch with two Actiwatches (Cambridge Neurotechnology Ltd., Cambridge, UK). MEMS-accelerometry was digitized at 50 Hz with two Geneactivs (ActivInsights Ltd., Kimbolton, UK).Passing-Bablok regression was used to optimize the transformation of MEMS-accelerometry signals to 'movement counts'. Actigraphic 'movement counts' and their MEMS-accelerometry estimates were used to calculate common sleep parameters. Reliability was evaluated both between and within the traditional actigraphs and MEMS-accelerometers using Bland-Altman plots.
RESULTS: Movement counts could be estimated from MEMS-accelerometry with high precision. MEMS-accelerometry had a better reliability than actigraphy; sleep parameter estimate agreement between two MEMS-accelerometers or a MEMS-accelerometer and an actigraph was better than agreement between two actigraphs.**CONCLUSION:** The algorithm allows for continuity of outcome parameters in ongoing actigraphy studies that consider switching to the new generation of MEMS-accelerometers. Their affordability and the algorithm with graphical-user-interface we here provide, makes objective sleep estimates in large-scale twin-sibling and GWAS cohort designs feasible.
SUPPORTED BY: Project NeuroSIPE 10738, of the Dutch Technology Foundation STW; and by the VICI Innovation Grant 453-07-001 of the Netherlands Organization of Scientific Research (NWO); The Hague, the Netherlands

2:00 – 2:15

Do Active Children Sleep More? A Cross-sectional, Longitudinal Analysis Using Accelerometry

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INTRODUCTION: Although it makes intuitive sense that participating in physical activity would promote better sleep, existing cross-sectional data have produced conflicting results. **PURPOSE:** To determine the relationships between objectively measured sleep and physical activity in young children followed from 3 to 7 years of age.**METHODS:** Repeated measures of physical activity and sleep were obtained by accelerometry in 242 children at 3, 4, 5, 5.5, 6.5 and 7 years of age. Children wore the accelerometer during all waking and sleeping hours for 5 days at each time point. Estimates of sleep duration were obtained using the Sadeh algorithm (Actilife). Physical activity was measured during awake hours only using the MeterPlus data reduction programme (counts per minute (cpm), time in sedentary, light, moderate and vigorous categories). Bi-plots were used to illustrate the relationship between sleep and physical activity. Multiple linear regression examined cross-sectional and longitudinal relationships adjusting for demographics and family characteristics.**RESULTS:** Data were available for a total of 7801 days from 242 children. Year-to-year tracking correlations ranged from r = 0.26-0.55 for hours of sleep, and r = 0.05-0.40 for measures of physical activity. Bi-plots suggested that sleep duration was not related to moderate-vigorous physical activity at any age, but rather was more closely aligned with time in sedentary or light activity. The bi-plots also showed that periods of night wakefulness were independent of day-time physical activity. Cross-sectional analyses showed that longer sleep duration was associated with lower activity (cpm), both before and after adjustment for confounders ($P < 0.001$). Ethnic minority children also slept less ($P = 0.033$-0.008). Longitudinal analyses used "average" cpm (at ages 3, 4 and 5) to predict sleep at 7 years of age. Children who slept more at age 7 did significantly less activity when aged 3-5 ($P = 0.033$) in univariate analyses, but this was no longer significant once adjusted for confounders ($P = 0.129$). A greater number of children in the household predicted less sleep at 7 years ($P = 0.018$). **CONCLUSION:** More active children do not sleep for longer periods at night than less active children, and in fact the reverse may be true. However, these analyses are complicated by the closed nature of the data; over a 24-hour period, if one time component increases (such as sleep duration), then at least one of the awake time components (ie. sedentary, light, moderate or vigorous time) must decrease. Thus it is uncertain whether the negative correlations observed are genuine, or simply an artefact of analyzing 24-hour time data.

2:15 – 2:30

Validation of the Zephyr Bioharness to Measure Obstructive Sleep Apnea Compared to Laboratory-Based Polysomnography

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Obstructive sleep apnea (OSA) is a major public health concern, but remains underdiagnosed and untreated due, in part, to the high cost, invasiveness, and inconvenience of the "gold standard" diagnostic tool, laboratory-based polysomnography (PSG). The Zephyr Bioharness is a chest-worn strap that captures physiological parameters, including heart rate, and breathing frequency and volume. The Zephyr Bioharness is commonly used to assess daytime activity metrics including energy expenditure and ventilatory thresholds.**PURPOSE:** To establish the diagnostic utility of the Zephyr Bioharness to identify apnea or hypopnea events with the criterion measure of laboratory-based PSG scored by certified technicians under the supervision of a board certified sleep specialist.**METHODS:**Participants were referred to the Mayo Clinic Arizona Sleep Disorders Center for suspected OSA. Eligibility criteria included being 35-60 years of age, BMI 27-35 kg/m^2, free of previous diagnosis of OSA or current CPAP use, other comorbid sleep disorder, or neurological disease. Stepwise non-linear mixed model (events nested within persons) analyses were used to develop an algorithm to predict PSG-scored apnea or hypopnea events from Zephyr biomeasures. The diagnostic utility of these models were assessed using area under the curve (AUC) for receiver operator characteristic (ROC) analyses.
RESULTS: Participants (N=24)were 54% men, 67% Caucasian, 39-60 years of age (mean age = 55.4 ± 5.4 years), 63% obese (mean BMI=30.6 ± 2.9 kg/m2), and 83% at 'high risk' for OSA (mean STOP-BANG score = 4.3 ± 1.7). Multivariate model results suggested that breathing frequency (t = -2.81, p = .005) and breathing volume (t = -8.05, p< .001) were independent predictors of apneas or hypopneas. Heart rate approached significance (t = 1.75, p = .08) but was not retained for ROC modeling. ROC analysis suggested that breathing frequency and volume produced good accuracy for classifying apnea or hypopnea events (AUC [SE] = .86[.0009], p < 0.0001).**CONCLUSION:** The Zephyr Bioharness may be a viable complement to laboratory-based PSG for diagnosis and ongoing assessment of OSA. Its utility may be particularly relevant for individuals with inadequate health insurance or persons living in rural areas where PSG is not feasible. Future work includes the development of a cloud-based platform that leverages the built-in bluetooth capabilities of the Zephyr Bioharness to allow for remote monitoring of OSA symptoms for healthcare providers.

Poster Session
Clinical Applications
Tuesday, June 18, 2013, 3:30 pm - 4:45 pm
Campus Center Auditorium

Board #1

Variability Of Postural Control With Time In Parkinson'S Disease

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INTRODUCTION: Inertial sensors are valid instruments for characterising postural control in PD subjects who exhibit abnormalities in sway measures during quiet standing [1]. However, most studies focus only on the absolute value of a specific sway measure during a quiet standing trial, without analysing if the measure varies with time due to fluctuations in motor control, attention and fatigue. **PURPOSE:** This study aimed to investigate the effect of time on metrics of postural control in PD and control (CL) subjects using accelerometer-based sensor data. **METHODS:** Twenty six PD patients (66.8±11.2 years, UPDRS III: 26.4±10.3) and 28 healthy, age-matched CL subjects (67.6±8.0 years) were recruited. Posture control was measured with the AX3 (Axivity, York, UK) sensor (sample frequency: 50Hz, range ±4-8g) placed on the lumbar vertebrae (L5), while subjects were standing with eyes open for 2 minutes. Accelerometer signals were transformed by MATLAB (R2012a) to a horizontal-vertical coordinate system and filtered with a low-pass Butterworth filter (3.5Hz cut-off frequency). Between group differences in anterior-posterior (AP), mediolateral (ML) and combined Jerk and RMS values (normalized by time) were evaluated over four consecutive 30s bouts (0-30s, 30-60s, 60-90s and 90-120s) using a two-way mixed ANOVA. **RESULTS:** Jerk (combined and AP) decreased over consecutive bouts, however there were no group or group*bout interactions for Jerk (Fig. 1). RMS decreased from the 1st and 2nd bouts before increasing again in the final bout. A significant group*bout interaction revealed that controls decreased their RMS more over the first two bouts whilst people with PD increased their RMS more in the final bout. **CONCLUSION:** Our preliminary results suggest that normalised Jerk and RMS change systematically with time. People with PD do not stabilise their RMS as quickly or for as long as controls, indicating a slow initial response and an inability to sustain that response. Future work will examine Jerk and RMS variability during a range of smaller time bouts (i.e. 5s or 10s) to add further insight into postural control in PD.

Supported by FP7 project V-TIME- 278169

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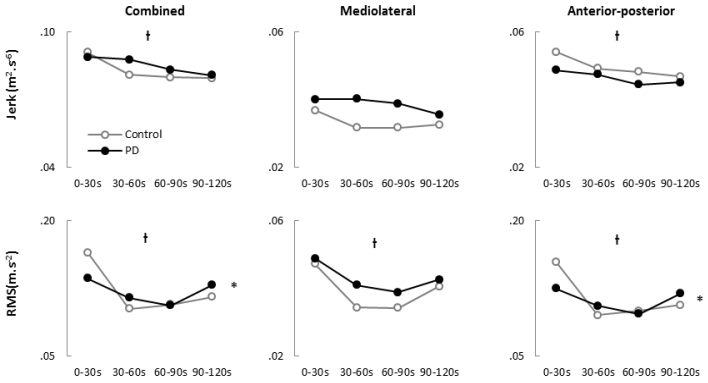

Fig 1. Postural control outcomes across 30s bouts. † effect of bout (p <.05), * group x bout interaction (p <.05).

Board #2

Accelerometry Based Assessment Of Anti-Parkinsonian Medication On Postural Control

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INTRODUCTION: Postural control during standing is a key clinical evaluation in Parkinson's disease (PD). Subjects with PD exhibit abnormalities in sway parameters during standing. The effect of L-Dopa on postural control in people with PD has not yet been examined. Understanding this effect will provide insights into the mechanisms underlying postural control in PD. **PURPOSE:** This study compared postural control in treated PD subjects (TPD: on L-Dopa) and untreated PD subjects (UPD: no L-Dopa) using an accelerometer-based sensor and also examined the effect of test duration on outcomes. **METHODS:**Eight TPD (77±8 yrs, UPDRS III: 25±11) and 18 UPD (63±10 yrs, UPDRS III: 28±10), together with 28 healthy controls (CL, 67±8 yrs) were recruited. Postural control was measured with an AX3 (Axivity, UK) accelerometer (50Hz, ±4-8g) placed on lumbar vertebrae (L5), while subjects were standing with eyes open for 2 minutes. Accelerometer signals were transformed to a horizontal-vertical coordinate system and filtered with a low-pass Butterworth filter (3.5Hz cut-off frequency). Group differences for anterior posterior (AP) and mediolateral (ML) Jerk, root mean square (RMS) values, the ellipsis including the 95% of the ML and AP trajectories, and the frequency below which is the 95% of the sensor data power spectrum (f95%) were tested using two-way ANCOVA, with test duration (0-30s, 0-60s, 0-120s) as a repeated measure and age as a covariate.**RESULTS:**TPD and UPD were comparable for disease severity (UPDRS III) however TPD were older than UPD ($p<.002$). Jerk increased for both groups with test duration (main effect). Group differences for RMS and RMS AP were greater for shorter test durations (Fig 1). The f95% reduced with increased test duration in UPD but increased in CL and TPD. There were no other group or group*test duration interactions for any other variable. **CONCLUSION:** Our preliminary results show that people with UPD tend to have lower RMS accelerations during standing than CL or TPD. Postural control in the AP but not ML direction was under-scaled for the UPD, suggesting that dopamine may be important for some aspects of postural control in PD. Shorter bouts of standing are more sensitive to detect differences in RMS associated with medication status in people with PD. However, it is unclear whether longer durations are required to detect differences for other measures such as Jerk and frequency domain based outcomes.

Supported by FP7 project V-TIME

Board #3

In-Home Activity Monitoring in Frail Elders: A New Measure of Function

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BACKGROUND: Mobility impairment and low physical activity (PA) are key components of the frailty syndrome. Traditional frailty assessment is based on self-report or semi-objective approaches (stopwatch) and may lack in accuracy for early identification of frailty-related functional decline. New technologies are emerging that allow a detailed quantification of PA characteristics in an everyday environment. The aim of this study was to compare traditional frailty measures and innovative sensor-derived PA parameters for discriminating between different frailty status groups. **METHODS:**In 20 older adults with confirmed frailty status (10 non-frail, 5 pre-frail, 5 frail) functional performance was measured conventionally by the 5-chair-stand, Alternate Step Test, Timed-up-and go (TUG), and gait speed. In addition, PA was quantified by a validated body worn sensor technology (PAMSys™, BioSensics LLC, MA, USA) during a 24 hours period. Specific parameters representing important mobility-related activities of daily living (percentage of walking, standing, sitting, lying, lying on side, number and duration of postural transitions, number of walking episodes, number of steps, and maximum continuous steps; longest walking episode, lying position [on side vs. supine]) were extracted from the PA raw data using specific algorithms. Discriminative validity of each parameter was evaluated using ANCOVA with adjustment by age. **RESULTS:**The majority of conventional performance-based mobility measures (except of the 5-chair-stand, p= .02) did not significantly discriminate between frailty groups (p= .06-.29). In contrast, a number of the proposed PA parameters (percentage of walking, standing, number of walking episodes, number of steps, lying on side, p= 0.001-.05) significantly discriminated between groups of frail, pre-frail, and non-frail older adults. **CONCLUSION:** Results highlight the validity of PA parameters to discriminate between different levels of frailty and emphasize the potential of objective PA assessment for frailty screening and diagnosis. Despite a higher discriminative validity, another benefit of PA assessment is it's robustness against floor effects compared to conventional in-clinic assessments (5-chair-stand) in the population of frail elders.

Board #4

Predicting Falls in Patients with Dementia using Accelerometry: Preliminary Results of an Unsupervised Field Study

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PURPOSE: Thirty percent of persons which are 65 years and older fall at least once a year. There are treatments in physical therapy to decrease fall risk. Persons could be well-directed treated, if falls can be predicted satisfyingly. It has already been shown in supervised laboratory studies that accelerometer data can be used to predict falls with a fair accuracy [1]. **METHODS:** Aim of our research was to predict falls in patients with dementia in short-term (3 month), mid-term (6 month), and long-term (12 month) periods based on gait parameters measured with a single waist-mounted accelerometer in an unsupervised setting. The study participants wore the sensor for one week every three months during their normal everyday life. Gait episodes were detected using an autocorrelation method [2]. After that, the accelerometric signals were automatically aligned to the body axes [3], because the sensor orientation could not be controlled in this field setting. Subsequently, several gait parameters were extracted from the data. Gait episodes of at least 20 seconds were used, because of reliability reasons. We used a 10-fold cross-validation and a decision tree induction method in order to classify each gait episode either being associated with a faller or a non-faller. Study participants were recruited from four local retirement homes specialized in dementia care. These institutions were chosen, because they record fall protocols as part of the Quality Assurance.**RESULTS:** We studied overall 55 people with dementia. The age of the participants was 82.8 ± 6.8 years (74.6% female). The number of gait episodes measured was 8,452, but only 3,806 gait episodes of 30 participants could be processed, because a part of the fall protocols were not available for this preliminary analysis. 86.2% gait episodes were classified correctly.**CONCLUSION:** The amount of measured gait episodes was very high in comparison with a supervised trail. We conclude that it should be possible to predict falls in patients with dementia using accelerometers.

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Board #5

Walking Stride Rates Patterns Children with Cerebral Palsy

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INTRODUCTION: Person's with cerebral palsy (CP) have been reported to participate in 13-53% less habitual physical activity than peers regardless of age or functional level.[1] Day to day stride activity levels has been documented to be negatively associated with functional walking skill in ambulatory adolescents with cerebral palsy (CP) as compared to typically developing youth (TDY).[2] **PURPOSE:** Describe daily walking stride rate patterns of young children and youth with CP and compare to a TDY cohort relative to age and functional level.**METHODS:** A cross sectional comparison cohort study examined walking stride rates developed from 5 days of StepWatch accelerometer (SW) data for 209 children with ambulatory CP, Gross Motor Function Classification System (GMFCS) levels I-III ages 2-13 years. Participants were compared to a sample of 368 TDY. Stride rates were defined as low (1-30), moderate (31-60) and high (>60 strides/min).**RESULTS:** For all youth with CP, non-walking activity levels significantly varied with age ($p = .005$) and were lowest at 8-9 years. Time spent at low intensity walking (1-39 stride/min) significantly increased with age ($p=.004$) and boys spent significantly more time at 40-60 strides/min (moderate intensity) than girls ($p=.006$). All children with CP walk less time per day than the TDY cohort regardless of GMFCS level ($p<.001$). Peak strides/min rates attained by TDY and participants at GMFCS levels I, II and III were 73, 70, 69 and 60 strides/min respectively ($p<.001$). Total number of strides and minutes spent at low and moderate stride intensities were significantly lower for all GMFCS levels compared to TDY ($p <.007$). Time spent at low intensity stride rates was not significantly different between GMFCS levels I and II for this sample.**CONCLUSION:** These results suggest that children and youth with CP demonstrate similar patterns with lower levels of walking activity relative to age and gender as TDY. This information has potential to inform and focus the intensity and dosing of intervention protocols aimed at enhancing habitual walking activity levels and participation in daily life.

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Board #6

Number Of Days Needed To Provide Reliable Estimates Of Habitual Physical Activity Using Geneactiv Accelerometer

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INTRODUCTION: Objective methods like accelerometers are feasible for large studies and may quantify variability in day-to-day physical activity better than self-report. The variability between days suggests that day of the week cannot be ignored in the design and analysis of physical activity studies. Thus an optimal number of days monitoring needs to be determined to obtain reliable estimates. **PURPOSE:** To determine number of monitoring days needed to obtain a reliable estimate of habitual physical activity. **METHODS:** Data are from a representative subsample (n=464) of the Mitchelstown cohort; a population based sample of 2047 middle aged Irish adults. The tri-axial, GENEActiv accelerometer was attached to the participants' wrist and worn for 7 consecutive days at 100Hz. Data were summarised into a signal magnitude vector (SVM min g) using 60s epochs. Each time interval was then categorised based on validated cut-offs[1]. Average percentage time per day spent in each activity type was calculated. Presented data are scaled to waking day (6am-12pm) wear time. Pairwise correlations determine the association between days of the week. Intraclass correlations (ICC) examined the proportion of variability between days in intensity categories and Spearman Browns formula was used to estimate the number of days required to obtain a particular reliability. **RESULTS:** Three hundred and ninety-eight adults (age 59.6±5.5yrs) had valid (greater than 10 hour's activity on all 7 days) accelerometer data. People were least sedentary during the week (52.2%) and most sedentary on Sunday (60.1%). In contrast, people were most active midweek; light (16.1%), moderate (30.9%), and least active during weekends, light (14.2%), and moderate (24.8%). Vigorous activity was low throughout the week (0.8%-1.1%). Range of pairwise correlations for activity across days were; sedentary (0.64-0.78), light (0.92-0.95), moderate (0.66-0.83) and vigorous (0.43-0.63), $p<0.01$. ICC for between day variability was high (0.72-0.94), except for vigorous activity on weekends (0.50-.55). The number of days needed to determine reliability varied across level of reliability and intensity; weekdays 0.80 (1-4 days), 0.85 (1-5 days), 0.90 (1-8 days), and 0.95 (2-16 days), and weekend days; 0.80 (1-4 days), 0.85 (1-5 days), 0.90 (1-9 days), and 0.95 (2-19 days). **CONCLUSION:** At least 4 weekdays and 4 weekend days of monitoring are required to achieve a reliability of 0.80. This is based on data recorded at 100Hz and aggregated to 60s epoch.

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Board #7

Physical Behaviour During The 4Th Postoperative Day After Hip Fracture - Part Of The Trondheim Hip Fracture Trial

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INTRODUCTION: Most hip fracture patients are old and frail. Early mobilisation is important for regaining function after a hip fracture, and the activity level early after the surgery can be important for regaining of function. **PURPOSE:** The purpose of this study was to evaluate if a geriatric comprehensive assessment and treatment in an ortho-geriatric ward early after hip fracture surgery can improve physical behaviour more than conventional treatment in an orthopaedic ward. **METHODS:** Activity data from317 out of 397 hip fracture patients included in a RCT were used. Physical behaviour was monitored for 24 hours the fourth day post-surgery by an activity monitor worn on the thigh. Primary outcome was total time spent in upright activities. Secondary outcomes were number of upright events and time spent in upright activities during night, morning, afternoon and evenings. **RESULTS:** Participants had a mean age of 83 ±6 years and 74% were women. 60% had intra-capsular fractures, and of them 65% were operated by use of arthroplasty. On the fourth day post-surgery, patients treated with comprehensive geriatric assessment in a geriatric ward spent significantly more time in upright position (median of 36 versus 29 minutes, p=0.042) and had significantly more upright events (p=0.029) as compared to patients treated with conventional treatment in an orthopaedic ward. Most upright time was spent during day and afternoon hours, and the pattern shown for participants in the ortho-geriatric group was more spread out throughout the day than for those in the orthopaedic group. **CONCLUSION:** Hospital treatment in a geriatric as compared to an orthopaedic ward early after a hip fracture surgery resulted in increased activity levels, with activity more spread out during the day. Further studies should assess the effect on physical behaviour early after the hip fracture surgery for physical behaviour and function later in the rehabilitation trajectory.

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Board #8

Effects Of Mindfulness-enhanced Versus Standard Nutrition Weight Management Programs On Physical Activity And Pedometer Usage

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INTRODUCTION: Recent evidence demonstrates that adding stress management to weight reduction programming may enhance health outcomes; however, few interventions have investigated the specific utilization of mindfulness training and how it may facilitate greater physical activity (PA). **PURPOSE:** This was an exploratory analysis to determine whether a randomized, 12-week weight-management program with an emphasis on mindfulness training (Stress: You're in Control; "SYNC") would have an effect on PA as measured by pedometer steps and caloric expenditure (kcals). Compliance with prescribed wear of the pedometer was also a focus of this analysis. PA counseling was not a formal part of this program.**METHODS:** 26 participants (16 SYNC, 10 CTRL) were randomized to either a standard nutrition counseling program or a mindfulness-enhanced weight management program. BMI between these groups did not statistically differ (32.7 vs. 32.0). They wore an Omron HJ-720ITC dual-axis pedometer for an 11+ week period. Data was analyzed for a 79-day interval. After eliminating the 1st and last day of wear and days with < 10 hours of wear, <100 steps, and > 50,000 steps were eliminated, leaving 1319 observations. A linear mixed model was used to analyze repeated measures data.**RESULTS:** Over the entire intervention period, the SYNC group (M = 5653, SD = 3851) recorded less steps/day than the CTRL group (M = 6176, SD = 4488; df = 1/24, f = 6.25, p = .0197) and recorded less kcals/day (SYNC: M = 193.7, SD = 156.7; CTRL: M = 259.9, SD = 216.9; df = 1/24, f = 19.25, p = .0002). Interestingly, the SYNC group wore the pedometer longer (SYNC: M = 15.2 hours, SD = 3.5; CTRL: M = 14.4, SD = 3.7; df = 1/24, f = 3.93, p = .0006). When time was added to the model, there was no day x group interaction for steps or kcals; however, there was a marginally significant interaction for hours of pedometer wear per day (df = 1/1291, f = 3.44, p = .064). For every day of the intervention, the SYNC group increased .016 hours of pedometer use compared to the CTRL group. Groups did not differ in days of pedometer wear (SYNC: M = 47.4, SD = 30.2; CTRL: M = 56.1, SD = 19.0). **CONCLUSION:** These data indicate that subjects in the SYNC group had less PA than the comparison group across the intervention. PA did not change for either group. While the mindfulness-enhanced program did not elicit changes in PA it may help to increase compliance with study procedures.

Board #9

Analysis of Crutch & Weightbearing Steps from Actigraph GT3X+ Activity Monitor Signals

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INTRODUCTION: Activity monitoring may provide a meaningful outcomes measure in rehabilitation intervention studies. If the aim is to quantify weightbearing activity, researchers must be able to accurately determine gait type (i.e., partial or full weightbearing) and measure step counts. The aims of this study were to: 1) test the accuracy of predicting step counts and gait types using RAW Actigraph GT3X+ signals collected in a range of crutch and weightbearing gaits typically seen in patients; and 2) determine if activity monitor location (waist vs. distal shank) impacts accuracy of predicting step counts and clinical gait types. **METHODS:** Initial methodological development, training, and testing were performed with repeated testing in four subjects. Proof of concept testing was subsequently performed using a blinded design in five subjects. Each subject wore two Actigraph GT3X+ activity monitors recording at 30 Hz. One monitor was worn at the waist and the other on the distal shank. Subjects performed five different gaits in random order: full weightbearing (FWB), simulated limp, weightbearing as tolerated on crutches (WBAT), partial weightbearing on crutches (PWB), and non-weightbearing on crutches (NWB). After instruction and adequate familiarization, subjects performed two passes over a 65 foot walkway. Steps were visually counted and recorded by two independent examiners and later verified through blinded analysis of video recordings of the trials. A separate blinded examiner analyzed the randomized and anonymized RAW activity monitor signals (vertical axis). The RAW signals were bandpass filtered (0.3 Hz to 3.5 Hz), smoothed using a triangular moving average, and then used to predict the type of gait and the number of steps performed in each trial. Predictions were compared to the actual gait type and the step counts obtained using video analysis. **RESULTS:** The blinded independent examiner correctly predicted 23 of 25 gait trials. Relative error ranged from < 2% of total step counts for FWB and WBAT gaits to 10% for partial weightbearing gait (~25% body weight). More accurate predictions resulted when the monitor worn at the waist than when the monitor was worn at the ankle. **CONCLUSION:** This study provides proof of concept for the use of the Actigraph GT3X+ in clinical research involving lower extremity injury patients. Predictions of step count and gait type from Actigraph GT3X+ RAW signals were sufficiently accurate for most clinical applications. More advanced signal processing methods may lead to even better results. Wearing the monitor at the waist provided better predictions than at the ankle.

Board #10

Measuring Function And Physical Activity Of Patients With Low Back Pain Using Ambulant Sensor Technology

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PURPOSE: Restrictions in function and physical activity (PA) due to low back pain (LBP) serve as an indication for medical treatment. The assessment of function and PA in LBP patients has been limited to subjective clinical scales and simple step counters. This study used inertia sensors to objectively measure function and PA of LBP patients before and after treatment and compares it to healthy controls. **METHODS:** 26 patients (43.6±13.2yrs) indicated for musculoskeletal medicine and 10 age-matched healthy controls (34.9±19.8yrs) were included. Function was measured using inertia-sensor based motion analysis (IMA) comprising 5 motion tasks (gait, sit-stand (STS), block step, forward-, backwards bending) while wearing a 3D accelero- & gyrometer at sacrum level. PA was measured using a 3D accelerometer which was worn at the upper leg for 4 successive days. Data was analyzed using previously validated algorithms producing parameters for function (e.g. sway, cadence) and activity (e.g. counts, durations). Moreover all patients completed the Oswestry scale for self-reported function. Measurements were done before (T0), direct (T1) and 3-4 weeks (T2) after first treatment. **RESULTS:** Compared to healthy controls, patients at T0 had a sign impaired function as measured by IMA, showing e.g. a lower cadence in gait, higher bending angle during STS and higher pelvic obliquity during block stepping. PA counts and durations of LBP patients at T0 were comparable to healthy controls ($p>0.05$). This suggests that patients perform everyday tasks independent of pain and complaints. Slightly ($p>0.05$) more transfers were found in patients suggesting that patients frequently change posture (table 1). After treatment, patients showed sign reduced pelvic obliquity during STS approaching healthy levels, which suggests that patients rely less on compensation mechanisms after treatment. No other changes in IMA assessed function were found, although patient reported function sign improved. This shows that both tools measure different aspects of function. PA did not improve sign. after treatment. **CONCLUSION:** LBP patients showed impaired function but not less PA than healthy controls. After treatment self-reported function is improved but only few and slight improvements towards healthy levels were found for objective function and PA. This shows the added value of ambulant sensors in objectifying clinical outcome assessment.

		T0 (n=26)	T1 (n=26)	T2 (n=19)	H (n=10)
GAIT	**Cadence (steps/min)**	88.5±16.2	95.9±16.1*	91.7±20.4	101.7±17.5*
STS	**Bending angle (°)**	47.2±7.3	45.9±5.5	44.1±12.9	42.0±6.3*
	Pelvic obliquity (°)	5.8 ±2.2	5.7±1.6	4.7±1.7*	4.6±1.2*
BLOCK	**Pelvic obliquity (°)**	15.8±5.6	15.5±4.6	15.2±4.6	11.8±3.1*
SCALE	**Oswestry (range0=best-100%)**	18.2±16.0	15.2±15.8	10.7±13.3*	/
PA	**# Steps**	6448 ± 2740	6861±3445	7483±3306	7961±3703
	# Walking bouts	193.8±72.4	203.9±101.9	214.9±93.4	205.2±103.9
	# transfers	61.2±23.1	56.1±23.1	46.7±13.3	51.1±13.3
	Duration resting (% of day)	60.7±13.2	60.9±14.7	60.3±10.9	62.9±12.0
	Duration Walking (% of day)	10.5±3.6	12.5±7.7	11.4±3.5	11.8±5.1
	Duration standing (% of day)	25.9±9.9	25.6±9.5	27.8±7.9	24.5±8.4

*with regards to T0

Board #11

Comparison Of Generalized And Individualized Approaches To Estimating Physical Activity Using Accelerometers In Older Adults

Todd Manini[1], Catrine Tudor-Locke[2], Walter T. Ambrosius[3], Robert Axtell[4], Matt Buman[5], Roger Fielding[6], Nancy Glynn[7], William Haskell[8], Don Hire[3], Abby King[8], Anthony Marsh[9], Dan White[10], Mike E. Miller[3], Juned Siddique[11]. *[1]University of Florida, Gainesville, FL. [2]Pennington Biomedical Research Center, Baton Rouge, LA.[3]Wake Forest School of Medicine, Winston-Salem, NC. [4]Southern Connecticut State University, New Haven, CT. [5]Arizona State University, Phoenix, AZ. [6]Tufts University, Boston, MA. [7]University of Pittsburgh, Pittsburgh, PA.[8]Stanford University School of Medicine, Stanford, CA. [9]Wake Forest, winston-Salem, NC. [10]Boston University, Boston, MA.[11]Northwestern University, Chicago, IL.*
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INTRODUCTION: Individualized activity count (AC) thresholds might provide a method to normalize accelerometry data against representative activities (e.g. walking).**PURPOSE:** The purpose of this study was to compare the time performing physical activity determined by individualized and generalized AC thresholds and evaluate the ability of each AC threshold to discriminate individuals with physical impairment_ a group expected to have low physical activity levels. **METHODS:** Men (N = 262) and women (N=579) aged 70-89 years enrolled in The Lifestyle Interventions and Independence for Elders Study (The LIFE study) wore an Actigraph GT3X on the right hip during a usual paced walk test over 400 meters and in free-living conditions. The individualized AC threshold was calculated as the average cts/min over the middle phase of the walking test. The following generalized AC thresholds were used as comparisons: 500, 760, 1000, 1500 and 2000 cts/min. Minutes of physical activity were normalized to wear minutes and expressed as a percent. Individuals with physical impairment were defined using a standard physical performance battery (Short Physical Performance Battery score<7: n = 191). Logistic regression was used to evaluate the ability of AC thresholds to predict the absence of physical impairment. **RESULTS:** Participants wore the monitor for a range of 5-21 days and for 61.3±8.1% of the day. Participants recorded 1230±571 cts/min during the walk test. Participants with physical impairments had fewer AC counts (977±508 cts/min, $p<0.01$). Participants spent 1.9±2.7% of their day above their individualized AC threshold and 6.7±5.4%, 3.5±3.7%, 2.1±2.7%, 0.82±1.6% and 0.35±1.0% of their day above 500, 760, 1000, 1500 and 2000 cts/min, respectively. Compared with those without physical impairment, those with physical impairment spent significantly less time performing physical activity above each generalized AC threshold (Range: 0.08-1.57% less time, $p<0.05$ for all AC thresholds), but more time above their individualized AC threshold (2.3±2.2% vs. 1.7±2.1%, $p<0.01$)). Physical activity time determined using generalized AC thresholds (odds ratios range: 1.15-1.24, $p<0.05$ for all), but not the individualized AC (odds ratio: 0.89, $p= 0.001$), were positively related to the absence of physical impairment. **CONCLUSION:** In contrast to generalized AC thresholds, daily physical activity levels determined by individualized AC thresholds were higher among individuals with physical impairment and were unable to predict impairment status. Normalizing accelerometry data to a standardized walk test might not be useful for estimating physical activity time in older adults.

Board #12

Correlations Between Free-living Accelerometry, Self-report And Laboratory Measures Of Physical Activity In Patients With Lumbar Spinal Stenosis

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INTRODUCTION: Both self-report and laboratory measures are commonly used in spine outcomes research. Recently, accelerometry gained attention from lumbar stenosis researchers for its distinct advantages, yet the role of accelerometry in this area remains undefined. **PURPOSE:** This study has two aims. First, to define baseline differences in accelerometry, laboratory, and self-reported outcomes between patients scheduled for lumbar stenosis surgery and matched controls. Second, to evaluate correlations of pre-to post-surgery changes in accelerometry with those in self-report and laboratory measures.**METHODS:** Accelerometry x7 days [Actigraph GT3x+], self-report [Swiss Spinal Stenosis Questionnaire, Neurogenic Claudication Outcome Score, Oswestry Disability Index, SF-36], and laboratory [Self-Paced Walking Test (SPWT) and Short Physical Performance Battery (SPBB)] measures were contemporaneously obtained at baseline for 16 patients and 10 matched controls, and repeated 6-months after surgery in patients. Accelerometry data was computed as daily count thresholds and activity bouts derived specifically for musculoskeletal research. Independent samples t-tests evaluated differences between group means. Spearman Correlations investigated relationships between interval changes in accelerometry and the other measures. **RESULTS:** At baseline, patients differed significantly ($p<0.05$) from controls in all self-reported measures, SPWT, and multiple accelerometry thresholds in the sedentary and light ranges. At 6-months, significant differences between patients and controls persisted in self-report, while differences were no longer significant for SPWT and accelerometry. Bout-based measures appeared more sensitive to change than daily count thresholds. Correlations for laboratory measures were weaker than those for self-report to accelerometry. Specific examples include strong correlations between moderate/vigorous range activity and the SF-36 physical component score ($r=0.5$ to 0.7) and the SSS physical function subscale ($r=0.6$ to 0.7), and between light range activity and the balance portion of the SPPB ($r=0.6$ to 0.8); plus moderate correlations between light range activity and the SPWT ($r=0.4$ to 0.6), and light/moderate range activity and the NCOS ($r=0.4$ to 0.6) and the ODI ($r=0.4$ to 0.5).**CONCLUSION**: In patients with lumbar stenosis, post-surgical improvements in accelerometry, especially activity bout lengths, are more sensitive to change linked to self-reported measures than laboratory assessments.

Supported by Stanford University PM&R Spine Research Fund

Board #13

Patient Activity As Measured By 3D Accelerometer Is Not Improved 10 Years After Total Knee Arthroplasty And Remains Under Healthy Levels

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PURPOSE: Restoring physical activity (PA) is a major goal of total knee arthroplasty (TKA) but no published evidence is available in long-term studies using activity monitors. This study compared PA of TKA patients at 10yrs post-op versus two control groups using a 3D accelerometer.**METHODS:**PA of 19 TKA patients at 10yrs post-op (TKA group, age at operation 63±7yrs, BMI 30±4) and 31 patients with end stage osteoarthritis prior to TKA (OA group, 63±7yrs, BMI 31±5) and 20 healthy age matched elderly (65±10yrs, BMI 24±3) was measured using one 3D accelerometer (AM, 64x25x13mm, 18g) which was worn at the non-affected (right in healthy) upper leg for 4 successive days. Data was analysed using previously validated algorithms, relying on published principles using the accelerometer as an inclinometer and using peak detection methods. In addition self-reported activity (SQUASH) and function (KOOS-PS) was scored by questionnaires.**RESULTS:**Compared to the OA group, the TKA group did not adopt a more active lifestyle as the time spend sitting, walking, standing, cycling and the # steps/day were comparable or transfer were even less. Also patient reported PA (SQUASH) was similar for both groups. In contrast function as measured by KOOS-PS was improved in TKA group. Qualitative aspects of activity were slightly improved in the TKA group, who walked with a higher cadence (90 ±11 steps/min) than the OA group (85±12 steps/min, p=0.148). In addition the distribution of activity durations differed showing sign. less short sitting periods <10min and less short walking bouts of 10-60s in the TKA group (Table 1). Compared to an age matched healthy group, both patient groups were sign. less active showing less # steps, less walking bouts and less # transfers. Both patient groups also walked with sign. lower cadence than healthy subjects, showing that even 10y after TKA, PA is not restored to healthy levels (Table 1).**CONCLUSION:** Despite an improved patient reported function, activity counts and durations were not higher 10yrs after TKA. This also means that PA did not reach levels of healthy controls. Fewer short sitting periods and short walking bouts but a higher cadence for TKA over OA patients indicate a qualitative difference in activity. Function and activity seem rather independent domains in TKA, which shall be addressed in patient education and rehabilitation programs.

Table 1: Mean ± SD for AM parameters and scales per group.

	OA (n=31)	**TKA (n=20)**	**Healthy (n=21)**	**p-value OA vs.TKA**	**p-value OA vs. H**	**p-value TKA vs. H**
% Sitting of day	64 ± 18	63 ± 16	57 ±10	0.84	0.14	0.19
% Walking of day	9 ± 5	10 ± 5	13 ± 4	0.67	<0.01	0.07
% Standing of day	27 ± 14	27 ± 13	30 ± 8	0.90	0.40	0.49
% Cycling of day	0.12 ± 0.4	0.25 ± 0.56	0.83 ±1.18	0.33	<0.01	0.06
# Transfers	39 ± 15	29 ± 9	46 ± 12	<0.01	0.06	<0.01
# Walking bouts	165 ± 82	134 ± 50	241 ± 76	0.14	<0.01	<0.01
# Steps	4711 ± 2934	4740 ± 3031	8373 ± 3029	0.97	<0.01	<0.01
# walking bouts <10s	36 ± 33	34 ± 21	58 ± 20	0.80	<0.01	<0.01
# walking bouts 10-30s	97 ± 46	73 ± 29	133 ± 41	0.03	<0.01	<0.01
# walking bouts 30-60s	25 ± 15	18 ± 8	35 ± 16	0.04	0.04	<0.01
# walking bouts 60-300s	8 ± 6	9 ± 9	13 ± 8	0.69	<0.01	0.08
# walking bouts > 300s	0.39 ± 0.74	0.70 ± 1.3	0.93 ± 0.87	0.27	0.02	0.52
# sitting periods < 1min	11± 5	6 ± 2	13 ± 8	<0.01	0.21	<0.01
# sitting periods < 10min	30 ± 115	19 ± 8	34 ± 13	<0.01	0.35	<0.01
# sitting periods > 10min	12 ± 4	12 ± 4	14 ± 3	0.62	0.17	0.08
Cadence (steps/min)	85 ± 12	90 ± 11	100 ± 6	0.15	<0.01	<0.01
SQUASH	2901 ± 2187	3189 ± 2583	7307 ± 4337	0.69	<0.01	<0.01
KOOS-PS	67 ± 20	29 ± 17	/	<0.01	/	/

Board #14

Detecting Not-wearing Periods During Activity Monitoring In Older Adults

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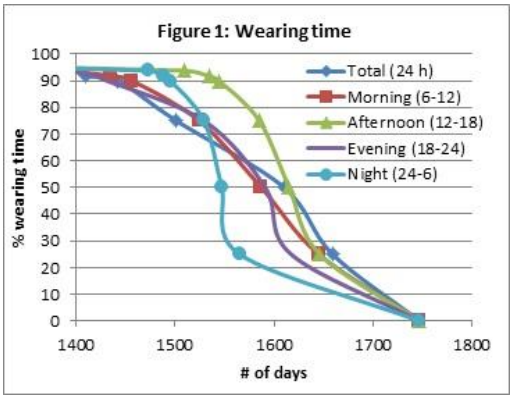
INTRODUCTION: Activity monitors can measure a subject's physical activity (PA), e.g. to quantify compliance with PA guidelines . Watz et al (2009) and Waschki et al (2012) stated that an activity monitor needs to be worn for at least 22-22.5 hours per day to obtain valid results on physical activity. Based on the wearing compliance and when a not-wearing period occurs (e.g. during day-time or night-time), a measurement can be either in- or excluded from analysis. **PURPOSE:** This study was performed to determine wearing compliance of an activity monitor, during a period of 2-3 months in older adults. Also, the time of day (morning, afternoon, evening and night) of the not-wearing periods was determined. **METHODS:** A total of 43 participants, aged 83.1 ± 7.2 years, were asked to wear an activity monitor (MoveMonitor, McRoberts BV, The Hague) based on a tri-axial accelerometer (DynaPort) for 2-3 months. The subjects were instructed to wear the accelerometer at all times, except during water activities (e.g. showering). Each week, the monitor was replaced in order to read out data and recharge batteries. To determine wearing compliance, we used an algorithm based on frequency analysis and threshold detection of the raw signal. This algorithm also allowed us to exactly determine the time of day (morning, afternoon, evening or night) of the not-worn periods. Only fully measured days (24 h) were used for analysis.**RESULTS:** Subjects wore the activity monitor for 6.8 ± 3.1 weeks. A total of 1747 days were used for analysis. Figure 1 shows the relative wearing time for the whole day (total, 24 h) and for parts of the day. On 1410 (80.7 %) days, the sensor was worn for more than 22 hours and on 1399 (80.1 %) for more than 22.5 hours (wearing compliance resp. 92 and 94%). Overall, wearing compliance was best in the afternoon. **CONCLUSION**: This study showed that older people, who have volunteered to wear an activity monitor, continue to wear it for longer periods of time with good wearing compliance. The time of day when a not-worn period occurs can be automatically detected and can be used for determining the validity of a measurement.



Board #15

Feasibility And Added Value Of Activity Monitoring In Clinical Practice

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INTRODUCTION: Many disorders in Rehabilitation Medicine have consequences for movement behaviour. Nowadays, movement behaviour can be objectively and accurately measured by activity monitors for a prolonged period. However, activity monitoring is still rarely used in clinical practice. **PURPOSE:** In this study we explored whether activity monitoring is feasible and of added value according to therapists and doctors. A secondary aim was to compare a simple with a more complex measurement device. **METHODS:** Patients diagnosed with chronic pain or a neurological disease were measured for five consecutive days, wearing both a simple system (Actigraph) and a more complex system (VitaMove). Measurements were evaluated by questionnaires and focus group meetings. **RESULTS:** In total, 29 measurements were performed in 22 patients, who were selected by 11 doctors and therapists; 23 measurements were used for evaluation/analysis. In 83%, information was found to be of somewhat or clear added value. Before the measurements, 82% of the therapists had a positive or open attitude towards activity monitoring in rehabilitation practice. Afterwards this percentage was the same, but there was a shift from open to positive. The complex VitaMove system was considered most valuable. **CONCLUSION:** Generally, activity monitoring was considered feasible and of added value, especially the VitaMove system. Doctors and therapists were positive about its use provided that reports are clear, understandable, and include relevant data. Critical remark was the additional load (time) for doctors/therapists and research assistants, as well as possible patient discomfort. This most probably does not outweigh its value.

Board #16

Effect Of Cannabinoid (dronabinol) Treatment On Physical Activity In Patients With Severe Anorexia Nervosa

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INTRODUCTION: Excessive physical activity plays a pivotal role in the pathophysiology of anorexia nervosa and is for many of the patients an incontestable part of the everyday life. Weight loss is presumably a substantial motivating force of excessive physical activity in anorexia nervosa. On the other hand, physical activity in general seems to have positively influence on depression and anxiety which is other aspects of the disease. Therefore, estimation and monitoring of PA is essential, especially when evaluating potential therapeutic approaches in patients with anorexia nervosa. **PURPOSE:** The purpose of this study was to investigate the effect of dronabinol, a synthetic cannabinoid agonist, on physical activity and bodyweight in women with severe and enduring anorexia nervosa.**METHODS:** In a double blinded, placebo-controlled crossover trial, the participants were randomized to receive dronabinol, 2.5 mg orally twice daily and matching placebo during 4 weeks, separated by a wash-out period with a similar length. For the purpose of estimating changes in the amount of physical activity, accelerometers were worn in the last week of each treatment period (2 x 7days). Changes in body weight, cortisol levels, and plasma leptin were assessed by repeated measurements during each intervention. **RESULTS:** Twenty-four females (mean age 33±13) with severe anorexia nervosa were enrolled in the study. Mean BMI at baseline was 15.7±1.7 kg/m^2. The mean physical activity expressed as mean count per minute was 454.3 ±42.0 $ctmind^{-1}$. The amount of moderate and vigorous physical activity remained unchanged during the trial, corresponding to a daily energy expenditure of approx. 1300 kcal. On average, in the treatment and placebo period, patients performed moderate and vigorous physical activity (1952-9498 counts) corresponding to approx. 68 min/day and 57 min/day, respectively, with a trend to significant difference between the groups ($p=0.054$). There were no differences between the groups in terms of amount of physical activity categorized in different intensity levels (low, moderate and high). During treatment with dronabinol, the patients increased their bodyweight by 0.73 kg compared to placebo ($p<0.01$). Furthermore, there was a modest but significant increase in plasma leptin and a converse decrease in the level of free urinary cortisol during dronabinol treatment compared to placebo. **CONCLUSION**: Accelerometry measurements among patients with severe anorexia nervosa demonstrated that a positive effect of dronabinol treatment on body weight was not caused by reduced physical activity energy expenditure.

Board #17

Physical Behaviour Early After Onset Of Acute Vestibular Neuritis, And How It Predicts Gait And Self-reported Function 3 Months Later

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INTRODUCTION: Little is known about activity pattern in patients with vestibular neuritis and how it relates function.**PURPOSE:** Describe physical behavior in adults early after onset of vestibular neuritis, and assess the association with gait and self-reported functioning 3 months later. **METHODS:** 24 participants admitted to a hospital and diagnosed with acute vestibular neuritis, were included. Physical behaviour over 7 days were registered by the ActivPAL® activity monitor, starting on day 1-2 after hospital admittance. Physical behaviour outcomes were mean daily time and number of events in seated/lying (sedentary), standing and walking, and step count during walking 3 months after disease onset preferred gait speed and gait variability (step time (s) and step length (cm)) were assessed by the GaitRite® electronic gait mat. Depressive symptoms were assessed by the Hospital Anxiety & Depression Scale (HADS), and dizziness by the Dizziness Handicap Inventory (DHI). We used linear regression to assess the effect of physical behaviour on function 3 months after onset of disease. **RESULTS:** Mean age was 55.3 ±11.8 yrs, and 87% were men. Mean daily sedentary time was 18.2 hrs, and walk time was 1.7 hrs. On average, participants took 7350±3288 steps per day. After 3 months, gait speed was 1.25±1.95 m/s, which is lower than for norm data for men aged 50-59 yrs (1.43 m/s). Mean HADS score of 4.9 indicate low depressive symptoms. A high number of sedentary events/high number of sedentary breaks, was significantly associated with low step-time variability, and high walk time was associated with higher gait speed and number of steps. Low intensity activity, indicated as high sedentary time and standing time, was associated with low scores on the HADS, suggesting less depressive symptoms for those with less intensity of activity in the acute phase. Physical behaviour in the acute phase did not predict self-reported dizziness 3 months later. **CONCLUSION:** This is one of the first studies to describe physical behaviour in vestibular neuritis patients. Different physical behaviour outcomes predict different aspects of gait and function 3 months after onset of disease. The association between physical behaviour in the acute phase and self-reported function 3 months later is less clear. Studies are needed to understand how physical behaviour relates to different aspects of function, both in vestibular neuritis patients and other patients groups.

Table 1. Physical behaviour early after onset of vestibular neuritis, and gait and self-reported function 3 months later

	Mean	SD	Min	Max
Acute phase				
No of sedentary events	76	28	27	156
Sedentary time (sec)	65440	12966	16704	80281
Stand-time (sec)	12611	6403	3364	33962
Walk-time (sec)	5950	2881	1514	11250
No of steps	7350	3288	1869	13217
3 months after onset of disease				
Preferred gait speed (m/s)	1.25	1.95	.91	1.71
Step-length variability (cm)	2.22	.74	1.26	4.08
Step-time variability (sec)	.02	.004	.01	.02
HADS (0-21)	4.89	4.40	1.00	18.00
DHI (0-100)	12.32	13.15	0.00	42.00

HADS and DHI: Higher scores indicate poorer function.

Table 2. Prediction of the effect of physical behaviour early after onset of vestibular neuritis on gait and function 3 months later (bivariate correlation coefficient, Pearson's r)

	Preferred gait speed	Step-length variability	Step-time variability	HADS	DHI
No of sedentary events	-.154	.129	**-.404**	-.188	-.300
Sedentary time	.174	-.299	-.327	**-.571**	-.326
Stand-time	-.266	-.018	-.032	**.627**	-.208
Walk-time	**.400**	**.601**	.108	-.174	-.096
No of steps	.260	**.627**	.140	-.045	-.085

Significant associations are marked in Bold.

Board #18

Physical Activity Levels at work Among Patient Care Unit and Construction Workers: Preliminary Findings

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INTRODUCTION: While construction and patient care unit (PCU) workers are employed in physically demanding jobs1-2, the contribution of their physical activity while at work in meeting recommended U.S. levels of physical activity3 (PA) is unknown. **PURPOSE:** To determine and compare the minutes of moderate and vigorous levels of physical activity while at work in and between PCU and construction workers. **METHODS:** Waist-mounted accelerometers (ActigraphGT3X, LLC; Ft. Walton Beach, FL) provided seven consectutive days of physical activity from a convenience sample of patient care unit (n=48) workers from two acute care hospital in 2011 and currently, from construction workers (n=10) with the goal of collecting data from a total of 60 construction workers from 5 comercial construction sites by March 2013. Participants completed daily logs documenting the hours at work. Accelerometer data while at work were parsed and from these data minutes spent for different levels of PA based on definitions of intensity levels4were calculated. **RESULTS:** PCU workers had PA levels while at work on average of 0 minutes of vigorous, 30 minutes of moderate, 1084 minutes of light and lifestyle, and 1308 minutes of sedentary PA per day corresponding to 0%, 1%, 45%, and 54% of the working time for their work week. Preliminarily, for the 10 construction worker collected so far PA levels while at work on average 0 minutes of vigorous, 255 minutes of moderate, 1070 minutes of light and lifestyle, and 1305 minutes of sedentary PA per day corresponding to 0%, 11%, 44%, and 45% of the total PA minutes contributed from the workday. **CONCLUSION:** Preliminary results suggest that construction workers achieve much more moderate levels of physical activity at work compared to PCU workers surpassing by approximately 1.7 times the weekly-recommended levels of moderate of 150 minutes. Messages for improving and promoting cardiovascular health for these two groups or workers must consider these results and contrasts.

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Poster Session
Behavior and Health Outcomes
Tuesday, June 18, 2013, 3:30 pm - 4:45 pm
Campus Center Auditorium

Board #19

Fall Risk Indicators in Daily Life Trunk Acceleration Data

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INTRODUCTION: Inertial sensor signals from human gait can serve to detect reduced dynamic stability and thus increased fall risk. Fall risk has been estimated from signals of long consecutive steady state gait, obtained under controlled conditions in the lab. We submit that measurements of gait patterns during daily life can improve fall risk estimates because they contain information complementary to lab-based assessments. **PURPOSE:** The aim is to find gait characteristics in trunk accelerations measured during daily life that can be reliably estimated and that are potential fall risk indicators. **METHODS:** Two consecutive weeks of three-dimensional trunk accelerations were measured in 48 older adults. From locomotion episodes we estimated gait characteristics, including local dynamic stability, gait variability, and spectral features. A negative binomial regression model for the estimates and the subjects' self-reported number of falls was used to assess the characteristics' potential to serve as a fall risk indicator. We further quantified the reliability of the estimates via the intra-class correlation (ICC) between first and second week assessments. **RESULTS:** The local dynamic stability in the medio-lateral direction ($p = 0.04$, ICC = 0.89), as well as the percentage of spectral power below 0.5 Hz in the medio-lateral direction ($p = 0.03$, ICC = 0.70) were reliable estimates that were significantly associated with fall history. **CONCLUSION:** One week of trunk acceleration measurements can provide reliable estimates of gait characteristics, several of which are potential fall risk indicators. These findings can serve as entry point in prospective fall risk studies.

Board #20

Postural Control During Standing Balance As A Biomarker For Healthy Ageing

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INTRODUCTION: Biomarkers to identify healthy ageing have become an important area of research. A recent systematic review has identified that impaired postural control during standing is associated with higher mortality rates [1]. Accelerometry may be useful to better understand the effects of ageing on postural control.**METHODS:** Twenty six older (64±5 years) and 24 younger (30±6 years) adults were recruited. Subjects wore a tri-axial accelerometer (100Hz, ± 4g range) located on the lumbar spine (L5) and were asked to stand still with their eyes open for 60 seconds. Data were transformed to a horizontal/vertical coordinate system, and analysed using MATLAB. The effect of age on mediolateral (ML) and antero-posterior (AP) Jerk, root mean square (RMS) values, the ellipsis including the 95% of the ML and AP accelerations and the frequency below which is the 95% of the sensor data power spectrum (f95%)[2] were examined using a two-way ANOVA with test duration (0-30s, 0-60s) as a repeated measures factor. **RESULTS:** Group main effects showed that older adults demonstrated greater RMS and ellipsis of acceleration and lower f95% (Fig 1). Older adults showed lower ML jerk over 60s but not the first 30s. The effects of age were more pronounced for RMS over the first 30s and more pronounced for AP f95% and ML jerk for the longer test. RMS decreased and Jerk and ellipsis of acceleration increased with the longer test duration.**CONCLUSION:** This study highlights that i) older adults have altered postural control compared to younger adults, particularly in the ML direction, and ii) it is important to measure postural control over different time periods to fully capture the effects of ageing on postural control. In this study, the first 30s of standing revealed RMS being sensitive to discriminate between groups. However, analysis over the full 60s was more sensitive to age differences in ML Jerk and AP f95%. This work supports the call for standardised tests of postural control [1].

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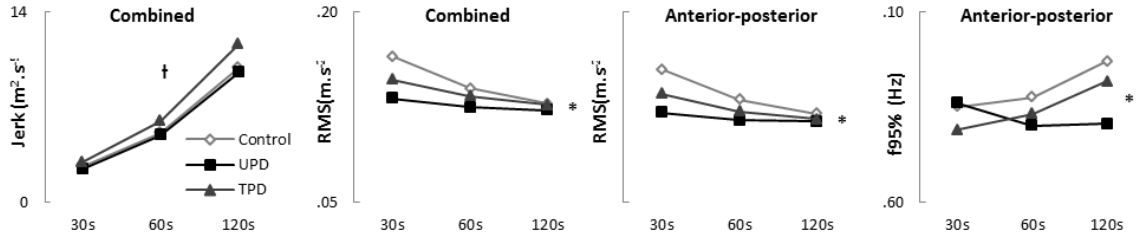

Fig 1. Postural control outcomes across test duration. † effect of duration (p<.05), * group x duration interaction (*p* <.05).

Board #21

Injury Prevention For Shod Vs. Minimal Footwear/barefoot Runners: Exploratory Study During Competition And Laboratory

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INTRODUCTION: Recently the number of long distance runners wearing minimal footwear or running barefoot (MF/B) increased considerably. There is an on-going debate about benefits and risks of running in MF/B compared to conventional shoes (SH) [1,2].**PURPOSE:** Purpose of this study was to investigate the effect of different types of shoes and different running techniques on acceleration of centre of gravity (CG).**METHODS:** Acceleration data (AD) was assessed by a mobile accelerometer (actibelt®) from 29 participants in a 24h run (1 male B 128km; 1 female SH 92km; 12 SH relay 323km; 15 MF/B relay 243km) and the author MD himself from 4 mountain runs (2 MF/B 54km, 2 MF/B 19km), 3 marathons (1 SH, 2 MF/B, 42km) and 2 half marathons (MF/B 21km). 3 runners were investigated during a treadmill test (TMT) (high speed camera system, coupled wireless stream of AD). AD was analysed with standardized algorithms using R.**RESULTS:** Analysable AD was retrieved during the author's runs and during the 24h run from both single runners and the MF/B relay team. Few useful recordings could be done in SH team (compliance problems). By analysing AD a general tendency for increased step frequency (SF) and reduced stride length (SL) in MF/B vs. SH can be confirmed. In the 24h run both SH and MF/B controlled gait speed via SF, correlation to SL was less obvious. TMT provided smoother curves for MF/B particularly in the up down AD and less power in the high frequencies in the Fourier spectrum. No severe injuries occurred (minor: toe nail off, cut in sole & DOMS, blister). Another individual known by author MD developed severe pain in one metatarsal joint after having changed to MF/B that needed surgery twice and led to severe persistent problems with running ability. **CONCLUSION:** Mobile accelerometry is a feasible technology to explore different running patterns outside of gait laboratories. The results show that MF/B was typically associated with different running patterns indicating a more effective use of evolutionary damping system. Well trained MF/B can run long distances without injuries, but others may face the risk of severe injury. More research is needed to translate biomechanical findings from laboratory and empirically observed injury rates into individual evidence based recommendations about running style and footwear.

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Board #22

Appetite Scores In The Morning Are Associated With Subsequent Sedentary Behavior

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INTRODUCTION: Sedentary behavior may be associated with obesity. In animal studies, appetite-regulating hormones influence spontaneous physical activity (PA), whereas in humans, there is no evidence for such an influence. **PURPOSE:** The purpose of this study was to investigate whether appetite conditions in the morning are related to subsequent PA, in particular, sedentary behavior. **METHODS:** This was a randomized crossover study. Nine healthy young male participants performed two exercise sessions (continuous and intermittent exercise) in a respiratory chamber. Energy requirements in the chamber were calculated individually as estimated basal metabolic rate (BMR) × 1.6 (physical activity level [PAL] of 1.6). Participants used a stationary cycling ergometer continuously for 40 and then 45 minutes in the continuous exercise trial, and for 5 minutes every 30 minutes 17 times in the intermittent exercise trial. Participants wore a tri-axial accelerometer (Active style Pro HJA-350IT; Omron Healthcare, Kyoto, Japan) on their waist. Appetite scores (i.e. hunger, fullness, prospective food intake) were obtained just after awakening under fasting conditions with a 100 mm visual analog score (VAS). Plasma concentrations of leptin and acylated ghrelin were obtained after appetite scores were recorded. **RESULTS:** Higher hunger scores were associated with higher accumulated consecutive minutes with metabolic equivalents (METs) ≤ 1.2 in both trials. On the other hand, higher hunger scores tended to be associated with higher accumulated consecutive minutes with METs ≤ 1.5 in both trials. The other parameters of appetite (fullness and prospective food intake) also tended to be correlated with accumulated consecutive minutes of sedentary behavior. There was no relationship between plasma concentrations of appetite-regulating hormones and any parameter of sedentary behavior. **CONCLUSION:** Although there was no significant relationship between plasma concentrations of hormones and sedentary behavior, subjective appetite scores were related to consecutive minutes of sedentary behavior, in particular, METs ≤ 1.2. The present study, therefore, suggests that desire of food intake may influence sedentary behavior irrespective of exercise loaded.

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Board #23

Sedentary Time And Psychological Health In Young Adults At High Risk Of Type 2 Diabetes

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INTRODUCTION: Sedentary (sitting) behaviour research has grown significantly in recent years. Health outcomes associated with sitting appear numerous and real, and often independent of moderate-to-vigorous physical activity (MVPA). However, measurement of sedentary behaviour is complex, with objective and self-report methods available to estimate total sedentary time, and self-report methods for estimating time and context of specific sedentary behaviours. Less has been documented about how these measures might be associated with mental health. **PURPOSE:** To examine the relationship between depression, anxiety and perceived health status and total and domain specific sedentary behaviour.**METHODS:** Baseline data from the Sedentary Time And Diabetes (STAND) randomised controlled trial were analysed. Overweight and obese adults at high risk of Type 2 diabetes were recruited (N=187; 68% female; 18-40 years, median 33yrs). Measures included objectively measured sedentary time (ActivPAL; Actigraph <100cpm), self-reported sedentary time (IPAQ-sitting; Marshall total and domain-specific sitting questionnaire), overall rating of health-related quality of life (HRQL) (EQ5D - visual analogue scale), anxiety and depression (Hospital Anxiety and Depression Scale). Linear regression was employed and controlled for age, sex, ethnicity, socio-economic status and MVPA. **RESULTS:** Objectively assessed sedentary time was not associated with any of the mental health outcomes ($p > .05$). Total sitting time derived from the IPAQ and the Marshall questionnaire were negatively associated with HRQL ($\beta = -.239$, $p = .012$; $\beta = -.172$, $p = .041$ respectively). When MVPA was added this relationship became non-significant ($p > .05$). There was a negative relationship between travel sitting time and HRQL ($\beta = -.243$, $p = .006$) that remained after controlling for MVPA ($\beta = -.214$, $p = .014$). No significant relationships were observed for any of the other sitting domains and HRQL ($p > .05$). There was a positive relationship between IPAQ total sitting and depression ($\beta = .272$, $p = .002$) and between TV time and anxiety ($\beta = .205$, $p = .021$). These relationships remained after MVPA was included ($\beta = .286$, $p = .003$; anxiety $\beta = .198$, $p = .029$). No other significant relationships were observed ($p>.05$). **CONCLUSION:** Some domains of sedentary behaviour are associated with poor mental health, with the direction of association not known. Further research needs to investigate different measures of sedentary behaviour, including self-report sedentary domains, and elicit direction of association, if any, between sedentary behaviour and mental health while accounting for plausible confounders.

Board #24

Effect of Age on Sitting and Walking of Office Workers on Work and Non-Work Days

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INTRODUCTION: Age is associated with levels of habitual physical activity and sedentary behaviour, with adults demonstrating lower levels of physical activity, and increased levels of sedentary behaviour as they get older. The effect of age on objectively measured the sedentary behaviour and physical activity of a work-aged population, within the context time spent at work, has not been previously explored. **PURPOSE:** To explore the association of age with sitting and walking in office-workers, on work days and non-work days.**METHODS:** Office workers from 4 employers in Glasgow, UK, wore an activity monitor (activPAL3) continuously for seven days, and kept a record of time awake. ActivPAL3 data, classified into periods of sit/lie, stand and walk, was reported as events (continuous periods of an activity/posture). Only waking data was analysed. To be included in analysis, full data was required for 4 days, with at least 3 work days. Outcome measures were the number and duration of sitting events, steps taken and time spent walking (scaled by waking hours), duration spent in prolonged (>30 min) sitting events (scaled by total time spent sitting), and average cadence. Associations of these outcome measures with age were calculated using Spearman correlation for work days and non-work days, separately, adjusting for multiple comparisons using Bonferroni corrections. **RESULTS:** Data was available for analysis from 45 office workers (30 female, BMI 26.9 [19.0-41.3] kgm-2). The age of participants was well distributed across the full working range mean 40±11 [20-61 years]. Age was not correlated with gender, BMI, self-reported health or employer, however older participants tended to spent longer awake ($r=0.28$, $p=0.07$). On working days, none of the sedentary or physical activity outcome measures were associated with age. However, on non-work days, older participants were moderately and significantly associated with a shorter duration of sitting ($r=-0.43$, $p=0.004$), walking for longer ($r=0.46$, $p=0.002$), taking more steps ($r=0.45$, $p=0.003$). **CONCLUSION:** For this group of office workers, age was only associated with levels of sedentary behaviour and physical activity on non-work days. It may be that habitual activity is more constrained by external factors on work days meaning that effects of age are suppressed. On non-work days, however, the direction of association was opposite to that expected, as older worker sat for less time, walked for longer, and took more steps than younger workers.

Board #25

Differences in Sedentary Behaviour at Work and Not at Work in Healthy Office Workers

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INTRODUCTION: Prolonged sedentary behaviour is a risk factor for ill health independent of the amount of physical activity performed by an individual. Measured objectively by an Actigraph, Australian office workers spent more time sedentary on work days (WD) than non work days (NWD), but more time in moderate-vigorous physical activity (MVPA). On WD, time sedentary was increased but MVPA was decreased during work hours (WH), compared to non work hours (NWH). **PURPOSE:** To explore differences in sedentary behaviour when at work and not at work, in UK office workers, using a direct measure of sitting (activPAL3). **METHODS:** Office workers, recruited from 4 employers in Glasgow, UK, wore an activPAL3 monitor continuously for 7 consecutive days, and recorded waking and working times in a diary. ActivPAL3 data, classified into periods of sit/lie, stand and walk, was reported as events (continuous periods of an activity/posture). Diary data was used to split data for the waking day, and for WH and NWH on work days. To be included in analysis, full data was required for 4 days, with at least 3 WD. The number and duration of sitting events, steps taken and duration of walking (scaled by waking hours, WH or NWH, as appropriate), and the duration of prolonged sitting events (≥30 min, scaled by total time sitting), were compared using paired t-tests (data normally distributed) between WD and NWD, and between WH and NWH on work days. **RESULTS:** Participants (n=45) were mostly female (67%), aged 41 (20-61) years, with BMI 27 (19-41) kgm-2. Wake time was longer on WD than NWD (15.9 vs. 14.5 h). On WD, WH and NWH were similar (both 8.0 h). On WD (compared with NWD) participants sat for longer (66% vs. 59%, $p<0.001$), in more individual events (3.5 vs. 3.3 events/h, $p=0.033$), but spent less time sitting in prolonged events (48% vs. 53%, $p=0.042$). Participants spent less time walking on WD (9% vs. 11%, $p<0.001$), but took a similar number steps (465 vs. 545 steps/h, $p=0.479$). During WH (compared with NWH) participants spent longer sitting (38% vs. 31%, $p=0.002$), in a similar number of events (1.8 vs. 1.8 events/h, $p=0.760$), but spent a similar time sitting in prolonged events (50% vs. 49%, $p=0.794$). Participants also walked for less time (7% vs. 12%, $p<0.001$) taking fewer steps (372 vs. 607 steps/h, $p<0.001$) during WH. **CONCLUSION:** Similar to office workers in Australia, those in the UK spent more time sedentary during WD and WH compared to non-work times. However, unlike the Australian workers, participants in the UK did not appear to spend a greater proportion of that sitting time in prolonged sedentary behaviour at work. Participants walked for similar amounts on WD and NWD, but spent much less time walking during WH than NWH.

Board #26

Can We Improve Movement Behavior In Young Adults With Cerebral Palsy With A Lifestyle Intervention?

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PURPOSE: Sufficient physical activity and low sedentary time are considered of major benefit to a healthy lifestyle. Nevertheless, research has shown that persons with cerebral palsy have low levels of physical activity and high sedentary time. During adolescence, there are many changes in life that affect adult lifestyle. Therefore, to assure healthy aging, applying a lifestyle program improve movement behavior seems beneficial at this age. The aim was to improve movement behavior with a lifestyle intervention. **METHODS:**Participants were randomly assigned to either an intervention or control group. The intervention group participated in a lifestyle program that aimed to permanently increase daily physical activity and fitness by achieving a behavioral change toward a physically more active lifestyle. The intervention had a duration of 6 months and consisted of individual counseling on daily physical activity and sports participation. Physical fitness training was offered during the first 3 months of the intervention. The control group received no intervention to improve physical activity and fitness, which is regular care in the Netherlands. Participants were measured before the intervention started and at 6 months (end of intervention) and 12 months. Daily physical activity was objectively measured for a period of 3 days using an accelerometry-based activity monitor (VitaMove). Physical activity and sedentary time were expressed as percentage of a 24-hour period. Furthermore, the number of prolonged periods of sedentary behavior (>30 min) was extracted from these measurements. Multilevel regression models were used to examine longitudinal effects of the intervention compared with the control group. **RESULTS:**On baseline, physical activity was low (8.5%) and sedentary time was high (82%). No significant effects over time were found for any of the parameters of movement behavior between the two groups. **CONCLUSION:**As there were no longitudinal effects of the intervention on daily physical or sedentary time we can conclude that the lifestyle program did not achieve a behavioral change toward improved movement behavior. Furthermore, the intervention did not elicit a change in sedentary behavior.

Board #27

Midlife Predictors Of Sedentary Behavior In Old Age: Age, Gene/Environment Susceptibility (AGES II)-Reykjavik Study

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INTRODUCTION: Studies have shown that more sedentary time is associated with metabolic and cardiovascular risk factors and increased risk of mortality. Sedentary time increases with age and older adults spend up to 80% of their waking time being sedentary. Preventing the development of a (highly) sedentary lifestyle among these adults may reduce adverse health effects resulting from sedentary behavior. Insights in the development of a sedentary lifestyle and its determinants are therefore essential. Although the determinants of physical activity are known, risk factors for sedentary behavior should not be assumed to just be the inverse of those for physical activity and should therefore be studied independently. **PURPOSE:** To examine the prospective associations between midlife determinants and objectively measured sedentary time in old age. **METHODS:** From April 2009 to June 2010, 590 participants (aged 73-98 years) of the AGESII-Reykjavik Study wore an accelerometer (ActiGraph GT3X) on the right hip for 7 consecutive days. On average 31 years earlier (during midlife) demographic characteristics, socioeconomic factors, lifestyle factors and biomedical factors were collected. Linear regression models were used to examine prospective associations between midlife determinants and sedentary time (<100 counts per minute) in old age. **RESULTS:**Both men and women spent most of their wear time (75%) sedentary. After adjusting for sex, age, follow-up time, minutes of moderate to vigorous physical activity, BMI, health status, mobility limitation and joint pain in old age, four determinants were still significantly associated with a higher percentage of sedentary time. 1) Participants with primary school level education had 11.7 minutes (p=0.04) more sedentary time in old age compared to college/university educated; 2) obese participants at midlife (BMI>30) had 21.6 minutes (p=0.007) more compared to those with BMI<25; 3) participants with a lower overall health at midlife (one or more of the following conditions diabetes, arthritis, heart disease, lung disease) had 25.0 minutes (p=0.03) more and 4) participants with a heart disease at midlife had 38.8 minutes (p=0.04) more sedentary time in old age. **CONCLUSION:**In this studylow level of education, obesity, poor overall health and the presence of heart disease at midlife significantly predicted an increase in the amount of sedentary time in old age. These results indicate the possibility of predicting sedentariness in old age, years before this behavior manifests. This information could be used in prevention programs reducing sedentary time in older adults and decrease risk of sedentary-related health effects.

Board #28

Self-reported Television Time and Health of Older Adults

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Television viewing (TV) is a commonly reported sedentary behavior (SB) that has been observed to have detrimental health effects on primarily young and middle-aged populations. Less is known about how TV impacts older adult (OA) health. **PURPOSE:** To explore the relationship between TV and health variables in OA. **METHODS:** Seventy-three OA (73.5±6 years) completed a self-report diary and the average time spent TV while sitting/lying was reported in mins/d. Participant anthropometrics and blood lipid profiles were analyzed. Spearman Rho correlation coefficients were calculated to determine the relationship between TV and health variables. One-way ANOVAs were conducted to examine if there were differences in health variables between low (n=24; ≤90mins/d), moderate (n=26; 91-170mins/d), and high (n=23; ≥171mins/d) TV. Tukey post hoc analysis was conducted if significant differences occurred at the $p<.05$ level. **RESULTS:** OA self-reported watching TV for 145±99mins/d. TV time was significantly related to waist circumference ($r=0.26$, $p=0.026$), body fat percentage ($r=0.35$, $p=0.003$), triglycerides ($r=0.324$, $p=0.005$), systolic blood pressure ($r=0.26$, $p=0.031$), and high-density lipoproteins ($r=-0.27$, $p=0.023$). There were significant differences in TG [$F(2,60)$ 4.128, $p=.020$], percent body fat [$F(2,70)$ 4.774, $p=.011$], and systolic blood pressure [$F(2,66)$ 8.293, $p=.001$] between low and high TV and body weight [$F(2,70)$ 3.413, $p=.039$], body mass index [$F(2,70)$ 3.573, $p=.033$], and systolic blood pressure between moderate and high TV. **CONCLUSION:**As OA increased their TV from ≤1.5hrs/d to ≥2.9hrs/d multiple health variables that are risk factors for chronic disease development worsened. Interventions to decrease TV and overall SB are of paramount importance.

Board #29

Resiliency In Vietnam-era Combat Veterans Associated With Decreased Sedentary Activity Levels

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INTRODUCTION: Sedentary activity has gained international attention due to the association with increased risk for cardiovascular disease, some cancers, depression, and other psychiatric illnesses. The Robert E. Mitchell Center for Prisoner of War Studies is a unique institution which holds the only longitudinal study of the long-term effects of the POW experience currently in existence. It has followed approximately 400 Vietnam-era repatriated prisoners of war (RPWs) for almost forty years and has examined the effects of extreme trauma- physical and psychological torture, prolonged captivity, and malnourishment endured by Vietnam RPWs, the longest held group of Americans to ever be taken as ombat prisoners. The majority of these Vietnam repatriates were resilient to any mental disorders such as posttraumatic stress disorder across a 40 year time span. Now in their 70s, these individuals have been well followed and their medical history is extensive. Examining the relationship between resilience and sedentary behavior will expand our understanding of activity level among individuals able to bounce back after trauma. **PURPOSE:** The study evaluated sedentary activity using actigraphy. Vietnam-era combat veterans were divided into three categories: Resilient (RPW-R), Non-resilient (RPW-NR) and a comparison group (CG), a matched subgroup of combat veterans, who did not experience captivity. **METHODS:** Sixty-six adult male subjects wore wrist actigraphs for seven days and nights. Sub-group membership was as follows: RPW-R (32), RPW-NR (15) and CG (19). Total sedentary activity, in minutes (fewer than 100 counts per minute) was compared among the three groups using an analysis of variance (ANOVA). Sixty-six subjects were evaluated with the goal of 120 by mid-2013. **RESULTS:** An ANOVA analysis indicated group differences were not statistically significant (F (df 2,65)= 1.397, $p = .25$). However, the effect size for comparison between RPW-NR and RPW-R indicated a moderate effect size of .42. A moderate effect size of .54 was also observed between CG and RPW-NR. On average, the RPW-NR group experienced almost 5 hours of additional sedentary activity per week compared to the other groups.**CONCLUSION**: Preliminary results suggest that resilient RPWs were more active with less sedentary activity compared to non-resilient RPWs. With continued data collection, it is anticipated additional participants, will increase the effect sizes and analyses will become statistically significant at the completion of the study.

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Board #30

A Randomised Controlled Trial Of Occupational Therapy To Promote Mobility In Care Home Residents

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PURPOSE: To evaluate the effects of the intervention of an occupational therapist on mobility for stroke survivors living in care homes. Setting: Care homes within England. **METHODS:** Care home residents with a history of stroke or TIA and not receiving end of life care were eligible to take part in the study. Intervention: A targeted three month occupational therapy programme. Mobility measures The Rivermead Mobility Index. **RESULTS:** 284 nursing and residential homes that catered for residents with stroke (n= 1055, mean age 86 years) were selected for study: homes were randomly allocated to the intervention arm and to the control arm. Participants were evaluated by independent assessors blind to study arm allocation before randomisation (0 months), three months after randomisation (at the end of the treatment period for patients who received the intervention). After adjusting for home effect and baseline characteristics, no significant differences were found in the mean Rivermead mobility index scores between treatment arms (0.02 (-0.27 to 0.32) P=0.88) at three months. **CONCLUSIONS:** The three month occupational therapy programme had no significant effect on mobility and independence. On the other hand, the variation in residents' functional ability, the prevalence of cognitive impairment, and the prevalence of depression were considerably higher in this sample than expected on the basis of previous work. Further research to clarify the efficacy of occupational therapy is required if access to therapy services is to be recommended in this population.

Board #31

Profiling the impact of Prolonged Sedentary Time on Cardio-metabolic Health

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INTRODUCTION: While still in its infancy, research has demonstrated the deleterious effect of prolonged sitting on various cardio-metabolic health outcomes; however, the exact nature of this association still remains unclear. To be able to provide clearer guidance on breaking up of sedentary behaviour it is necessary to, profile the sedentary behaviours that are related to cardio-metabolic health. **PURPOSE:** The purpose of this study was to examine the association between the number of breaks in sedentary time and cardio-metabolic health in a large nationally representative sample. **METHODS:**A sub-sample of adults (≥ 16 years) from the 2008 Health Survey for England who had valid accelerometry date for at least 1 day (i.e. ≥ at least 10 hours of wear time) were included in the study (N = 2353). The one minute epoch ActiGraph GT1M accelerometer data was analysed using KineSoft version 3.3.75. Sedentary time was operationally defined as <100 counts/min, and a break was considered as any interruption >100 counts/min. ANCOVA was used to test the association between the number of breaks in sedentary time and various health outcomes while controlling for wear time and total sedentary time. All statistical analyses were conducted using SPSS version 20. **RESULTS:** The mean age of the participants was 51.6 ± 18.1 years, 55% female, with a mean BMI of 27.5 kg/m^2. Independent of accelerometer wear time per day and total sedentary time, separate ANCOVA analysis revealed a significant association between number of sedentary breaks and mean waist circumference (cm) ($p<0.005$), BMI (kg/m^2) ($p<0.005$), mean Systolic blood pressure (mm/Hg) ($p<0.005$), and Total Cholesterol (mmol/l), ($p<0.005$). There was no significant associations between the number of sedentary breaks and HDL cholesterol (mmol/l), ($p=0.23$). These findings are corroborated when we took into account the association between the duration of sedentary time on all the above cardio-metabolic outcomes. **CONCLUSION:** The results indicate a beneficial effect of breaking up sedentary time on cardio-metabolic health. In addtion,these findings hold true when we test the association between duration of sedentary time and cardio-metabolic health outcomes. Further research is needed to address the following question 1) How long is too long; 2) How often should bouts of sedentary time be broken up; 3) is there a minimal duration and/or intensity required for breaking up sedentary time.

Board #32

Under The Physical Cliff: What Happens With Activity While You Age

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INTRODUCTION: Traditional methods of assessing physical activity primarily include questionnaires and health-interviews. To provide a more objective alternative, 631 participants of the Baltimore Longitudinal Study of Aging (BLSA) wore Actiheart physical activity and heart rate monitors over seven days. **PURPOSE:** Our goal was to analyze the activity data collected in the study to identify age-related patterns and trends in a well-functioning aging population. **METHODS:** For our analysis, we employed two methods, nonparametric smoothing of daily activity profiles and parametric regression modeling of total daily activity counts. Using nonparametric smoothing, we explored differences in activity patterns in four data-driven age strata: younger than 60 y.o., 60 - 67 y.o., 68 - 74 y.o., and older than 75 y.o. We also derived and analyzed cumulative activity intensities (CAI), daily summaries for faster visual exploration, separation, and comparison of large number of daily profiles. We parametrically modeled the association between age and log-transformed total daily activity using three-stage linear regression model with adjustment for potential confounders including sex, race, education, employment, and common age-related comorbidities. **RESULTS:** We identified and quantified a decreasing aging trend in activity circadian profiles, with key differences localized in 12:00pm-8:00pm interval. Our modeling of total daily counts translated to a 2% relative loss of activity counts for each increased year of age. Additionally, those who were employed were significantly more active than non-employed, regardless of age, and the only comorbid condition that contributed significantly to the model was a history of stroke. **CONCLUSION:**We analyzed a week of continuously monitored activity in 631 participants of the BLSA, quantified the yearly age-related loss of activity, and estimated the most common daily patterns of activity in this older population.

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Board #33

Associations Between Sedentary Behaviour Patterns With Body Fatness In Population-based Study Of Irish Adults

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INTRODUCTION: Studies have reported accelerometer-derived sedentary (SED) time is adversely associated with waist circumference (WC), whilst the number of breaks from SED activities is inversely associated with WC. **PURPOSE:** To assess whether SED behaviour patterns, including characteristics of breaks, are cross-sectionally associated with WC and whole body fatness. **METHODS:** A nationally representative group of Irish adults (n=1111, 18-85yrs) wore a uni-axial accelerometer (Actigraph, GTM1) recording 5-sec epochs for 2-4 consecutive days. Removing non-wear times resulted in complete accelerometry data (≥600mins/d for 2 to 4 days) for 894 subjects. There were no significant differences between those with complete data and those without. Subjects taking medications affecting body composition or mobility were removed (n=10). Mean time (mins/day) spent in SED activities and moderate-to-vigorous intensity physical activity (MVPA) was determined using published cut-offs adjusted for epoch length. Number of breaks from SED, break duration and intensity of activity during breaks, number and length of bouts of MVPA ≥10 mins were also calculated.SED was adjusted for length of monitor wear time using a residual method. Waist circumference (WC) was measured and fat mass (kg) determined by bio-electrical impedance, and adjusted for height (fat mass index FMI, kg/m^2). FMI was log-transformed using natural logs (logFMI). Relationships between MVPA and sedentary patterns with WC and logFMI were examined using multiple linear regression models adjusted for gender, age, smoking status and high alcohol intake and MVPA adjusted for wear time. **RESULTS:** Monitor mean daily wear time was 842.0 mins (SD 79.3). Majority was spent in SED (median 76.5% IQR (71.1, 81.0) with only median 5.4% spent in MVPA (IQR 3.7, 7.8). SED, break duration and activity intensity during breaks were all associated with WC and log FMI, but not number of breaks. MVPA was inversely associated with WC and logFMI ($p<0.001$), but not number or length of MVPA bouts.

	Waist circumference		Fat mass index (kg/m^2)	
	Standardised β-coefficient	B (SE)	Standardised β-coefficient	B (SE)
SED	0.12	0.03 (0.09)*	0.12	0.001 (0.0003)*
Break duration	0.14	35.3 (11.4)*	0.18	1.42 (0.36)*
Break intensity	-0.21	-2.62 (0.50)*	-0.24	-0.09 (0.02)*
Adjusted R^2	26.3		25.0	

*P<0.01

CONCLUSION: These analyses suggest that in a nationally representative group of adults where time spent in MVPA was low, SED behaviour patterns, including time spent in SED, length and intensity of activity in breaks, are associated with body fatness.

Supported by Irish Department of Agriculture, Fisheries and Food; Food for Health Research Initiative

Board #34

The Association Of The Frequency And Duration Of Sedentary Behaviors With Walking Speed In Older Adults: The Most Study

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An active lifestyle is associated with reducing the risk of morbidity and mortality in older adults. Recently, sedentary behaviors, such as watching TV and prolonged sitting, have been shown to be a risk factor for poor health. However, the impact of the frequency and duration of sedentary behaviors with the health of older adults is not known.**PURPOSE:** The purpose of this study was to examine the association between the frequency and duration of sedentary behaviors with gait speed, a well-known marker of health, in older adults.**METHODS:** The Multicenter Osteoarthritis Study (MOST) is an NIH-funded study of older adults with or at high risk of knee osteoarthritis (OA). Study participants wore a StepWatch Activity Monitor to record physical activity over 7 days. The following sedentary behaviors were examined: 1) The frequency of inactivity defined as the average number of bouts with no steps. 2) The duration of inactivity defined as the mean duration of bouts with no steps. We first calculated the correlation of these measures with gait speed from a 20-meter walk. Next, we examined via an F-test the unique contribution these parameters had with predicting gait speed. We adjusted values for age, sex, and Body Mass Index. **RESULTS:** Among 1,769 participants (67 ± 8 yrs, BMI 31 ± 6 kg/m2, female 60%), the frequency of inactivity was positively correlated with faster gait speed ($r= 0.22$, $p<0.0001$) while the duration of inactivity was negatively correlated with faster gait speed ($r= -0.25$, $p<0.0001$). We found the duration, but not the frequency of inactivity to uniquely predict gait speed independent of covariates (Duration: $F=15.1$, $p=0.0001$; Frequency: $F=1.87$, $p=0.17$). **CONCLUSION:**Sedentary behavior and in particular the duration of inactivity may be an important measure for poor health in older adults. Further study is needed to understand the clinical implications of sedentary behavior on function.

Board #35

Sedentary Behaviour And Physical Activity In Rheumatoid Arthritis

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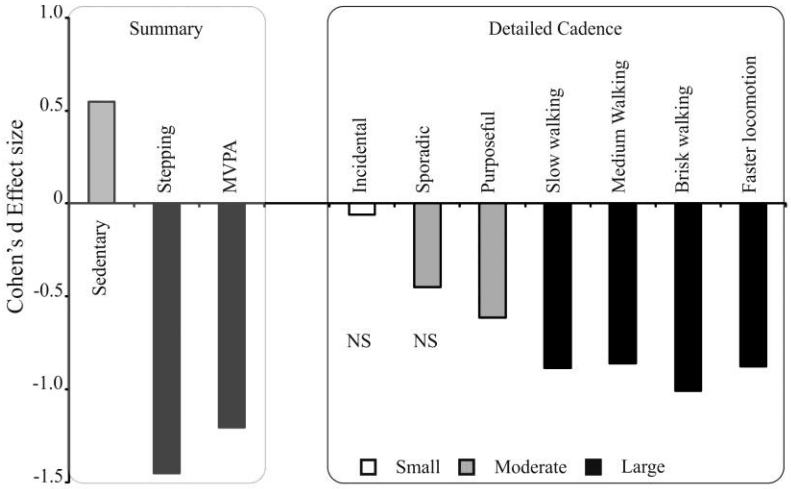
BACKGROUND: There is evidence that levels of physical activity are reduced in people with Rheumatoid Arthritis (RA). No studies to date however have objectively examined levels of time spent sedentary and activity profiles across different intensity levels[1] in people with RA in comparison to controls.**OBJECTIVE:** To evaluate physical activity profiles, including time spent sedentary in people with RA and healthy controls. **METHODS:** 19 people with RA and 19 controls matched for age, sex and BMI were recruited. Demographic details and clinical characteristics of the RA population were recorded. The activity profiles were recorded over five consecutive days using an Active PAL activity monitor. Data was explored using Anova and Cohen's d effect size, with a positive effect sizes indicating an increase in time spent in that behaviour. **RESULTS:** Figure 1 illustrates a significant increase in time spent sedentary and a general decrease in activity for people with RA across a range of cadences. Figure1 – NS represents a non significant difference. **CONCLUSION:** People with RA should be encouraged to increase their levels of physical activity and spend less time in sedentary behaviours to mediate against the long term effects of inactivity.

[1] Tudor-Locke C, Camhi SM, Leonardi C, Johnson WD, Katzmarzyk PT, Earnest CP, et al. Patterns of adult stepping cadence in the 2005-2006 NHANES. Preventive Medicine 2011.



Board #36

Sedentary Time by Physical Activity Level in Employed Women: Standard and Alternative Measures

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INTRODUCTION: Studies have shown health outcomes from sedentary behavior to be distinct from the influence of physical activity. However, little is known about associations between the two behaviors. Research in children has demonstrated increased sedentary time as compensation for physical activity and it has been posited that adults may do the same.**PURPOSE:** This study evaluated differences in time spent being sedentary between employed women who meet minimum exercise recommendations and those who do not. A second purpose was to consider alternative standards to categorize sedentary behavior from accelerometry in the context of technology developments.**METHODS:** Activity levels were assessed by the Actigraph GT3X+ over 7 days in 104 employed women (mean age: 44.4±11.8). Outcome measures were moderate-to-vigorous physical activity (MVPA) levels and percentage of time spent being sedentary. Three methods were used to calculate percentage of time in sedentary behavior: 1) Vertical axis counts <100, 2) <100 counts-min^{-1} on all three axes (vertical, anterior-posterior, medio-lateral), 3) <100 vector magnitude counts. Mean percentage of sedentary time was compared for participants who met minimum MVPA recommendations to those who did not, based on current physical activity guidelines. Additional analyses compared differences in the outcomes of the three calculations for sedentary time.**RESULTS:** Percentage of time spent being sedentary was significantly less in the group of participants who met MVPA recommendations (see Table 1). This was consistent for all three methods of sedentary time calculation and was observed after covariate adjustment using logistic regression analysis. Paired t-tests of the mean triaxial and vector magnitude calculations compared to the vertical axis showed significant differences for the outcome totals ($p<.001$).

Table 1. Comparison of sedentary time by physical activity level

Percent of time spent at <100 counts-min^{-1} as calculated by:	Met MVPA Recommendations n=42	Did Not Meet MVPA Recommendations n=63	p
Vertical Axis	59%	65%	<.001
Three Axes	45%	51%	<.001
Vector Magnitude	44%	50%	<.001

CONCLUSION: This sample of employed women did not appear to compensate for MVPA bouts with increased sedentary time. To date, the majority of studies using accelerometers have utilized a single axis for characterization of sedentary behavior. The current results demonstrate this measure may overestimate sedentary behavior. Validation of sedentary cut-points using triaxial accelerometry is needed to potentially provide more accurate estimates of sedentary behavior.

Board #37

Objectively Measured Physical Activity And Calcaneal Bone Health In Older Japanese Adults: The Nakanojo Study

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PURPOSE: The primary objective of this investigation was to relate the daily dose of physical activity to the likelihood that calcaneal bone stiffness would drop to a level associated with a high risk of bone fracture in subjects who were initially free of such risk. **METHODS:**Subjects were 500 (212 male and 288 female) free-living Japanese volunteers, initially ranging in age from 65 to 84 years. Daily pedometer/accelerometer data were collected continuously for 5 years. A calcaneal osteosonic index (OSI) was determined annually. **RESULTS:** Physical activity levels remained consistent over the 5 years. Year-end OSI values were higher in those with greater daily step counts and especially a greater duration of activity >3 METs. However, after controlling for baseline OSI, age and body mass, final OSI values were not significantly greater in the fourth than in the third activity quartile, where men and women, respectively, took means of 7700 and 7400 steps/day and/or exercised at an intensity >3 METs for means of 19 and 17 min/day. A multivariate-adjusted proportional hazards model predicted that the OSI values of men and women were, respectively, 2.6 (1.4-4.4) and 3.3 (2.1-5.3) and/or 2.8 (1.5-6.0) and 3.9 (2.6-6.9) times more likely to drop below the fracture threshold over 5 years in the two lowest activity quartiles (<7000 and <6900 steps/day and/or <18 and <17 min/day at >3 METs) than in the highest quartile (>9100 and >8800 steps/day and/or >30 and >25 min/day at >3 METs). **CONCLUSION:** After adjustment for potential confounders, the calcaneal health of seniors is associated with both the daily step count and the duration of activity at an intensity >3 METs. The bone health is optimal in elderly people who take at least 7000-8000 steps/day and/or spend at least 15-20 min/day at an intensity >3 METs.

Reference: Park, H., Togo, F., Watanabe, E., Yasunaga, A., Park, S., Shephard, R. J., & Aoyagi, Y. (2007). Relationship of bone health to yearlong physical activity in older Japanese adults: cross-sectional data from the Nakanojo Study. Osteoporos. Int., 18: 285-293.

Board #38

Gamified Physical Activation of Young Men - a Multidisciplinary Population-Based Randomized Controlled Trial (MOPO study)

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PURPOSE: Inactive and unhealthy lifestyles are common among adolescent men. The planned intervention examines the effectiveness of an interactive, gamified activation service, based on tailored contents, peer networks and participation, on physical activity, health and wellbeing in young men. We hypothesize that the activation group will have an improved physical activity, as well as self-determined and measured health compared with the controls. **METHODS:** This is the first study to combine a gamified service with objective continuous measurement of physical activity in daily life. Conscription-aged men (18 years) attending compulsory annual call-ups for military service in the city of Oulu in Finland (n = 1500) will be randomized to a 6-months intervention (n = 640) or a control group (n = 640) in 2013. A questionnaire on health, health behaviour, diet and wellbeing will be administered in the beginning and end of the intervention. Height, weight and waist circumference, body composition, grip strength, heart rate variability and aerobic fitness will be measured. The activation group utilizes an online gamified activation method including communal youth services, objective physical activity measurement, social networking, tailored health information and exercise programs. Daily physical activity of the participants will be monitored in both groups. The activation service will reward improvements in physical activity or reductions in sedentary behaviour. The performance and completion of the military service of the participants will also be followed.**RESULTS:** The results of this study will provide evidence on the effectiveness of the new service for increasing the activity and reducing inactivity in young men. The study also provides novel information on the health status, physical fitness, motivational factors and profiles of physically active and inactive young men. This information can be utilized in future development of tailored gamified services. Promotion of physical activity at young age provides an early intervention for preventing any future adverse health effects. Hence, the produced physical activation method has broad public health significance.**CONCLUSION:**The study will provide new information of physical activity, health and health behaviour of young men. Furthermore, a novel model including methods for increasing physical activity among young people will be developed and its effects tested through an intervention. This gamified service for activating young men will provide a translational model for community use. It can also be utilized as such or tailored to other selected populations or age groups.

Board #39

Relationship Between Number Of Steps Per Day And Body Weight Indicators Among Respondents With Metabolic Syndrome

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INTRODUCTION: The pedometer and accelerometer are among the most popular objective methods for assessing physical activity.**PURPOSE:** The objective of this study was to determine the relationship between number of steps per day, measured using an accelerometer, and the indicators of body weight [percent body fat (%BF), waist circumference (WC), waist-to-hip ratio (WHR), and body mass index (BMI)], among respondents with metabolic syndrome. **METHODS:** Overall, 675 respondents from five government agencies in Putrajaya, Malaysia were selected using multi-stage random sampling, and of these, 275 eligible employees with metabolic syndrome were consented to participate. The harmonized definition of metabolic syndrome was used to classify metabolic syndrome. Respondents were made to wear an accelerometer for two consecutive weekdays and one weekend day. IBM SPSS Statistics version 21 was used to analyze the data. **RESULTS:** The mean number of steps on a weekday (3803 ± 1531 steps per day) was significantly lower than that on a weekend day (4207 ± 2057 steps per day, $t(274) = -2.771$, $p = 0.006$). The number of steps per day was significantly inversely related with %BF ($r = -0.308$, $p<0.001$) and BMI ($r = -0.184$, $p = 0.002$). However, no significant relationship was observed between number of steps per day and WC and WHR. In this study, the number of steps per day significantly predicted %BF [$b = -0.002$, constant= 43.356, $t(273) = -5.358$, $p<0.001$] and BMI [$b = -0.001$, constant= 30.728, $t(273) = -3.088$, $p=0.002$] among respondents with metabolic syndrome. **CONCLUSION:** Overall, these results indicate an inverse relationship between number of steps per day and %BF and BMI among respondents with metabolic syndrome.

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Board #40

Objectively Measured Physical Activity And Appendicular Lean Tissue In Older Japanese Adults: The Nakanojo Study

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PURPOSE: Our objectives were to examine relationships between objective pedometer/accelerometer assessments of the amount and intensity of habitual physical activity undertaken and the overall loss of lean tissue mass and to compare the risk of lean tissue mass dropping below a sarcopenia threshold in subjects with differing levels of habitual physical activity. **METHODS:** Subjects were 468 free-living Japanese volunteers aged 65-84 years (200 men and 268 women), all residents of Nakanojo. Daily 24-h pedometer/accelerometer data were collected continuously for 5 years. Bioelectrical impedance measurements of lean body mass were made annually, with the sarcopenia threshold arbitrarily defined as an appendicular lean mass/height^2>1 SD below the mean for healthy young Japanese.**RESULTS:** Lean mass remained greater over the 5 years in subjects with higher daily step counts and especially with longer durations of exercise >3 METs. Categorizing data into physical activity quartiles and controlling for baseline lean mass and age, final lean mass plateaued for subjects in the third activity quartile (men and women with respective mean counts of 7800 and 7700 steps/day and/or mean durations of exercise >3 METs of 20 and 17 min/day). A multivariate-adjusted proportional hazards model predicted that over the 5 years, men and women in the two lowest activity quartiles (<6700 and <6800 steps/day) were, respectively, at 2.3 (1.4-4.5) and 3.0 (1.9-3.4) times greater risk of sarcopenia than those in the highest activity quartile (>9000 and >8400 steps/day). Likewise in terms of activity >3 METs, those taking <16 and <14 min/day were at 3.0 (2.0-6.0) and 3.5 (2.1-6.3) times the risk of those taking >28 and >22 min/day.
CONCLUSION: After adjustment for potential confounders, the lowest risk of developing sarcopenia was in elderly people taking at least 7000-8000 steps/day and/or spending at least 15-20 min/day at an intensity >3 METs.

Reference: Park, H., Park, S., Shephard, R. J., & Aoyagi, Y. (2010). Yearlong physical activity and sarcopenia in older adults: the Nakanojo Study. Eur. J. Appl. Physiol., 109: 953-961.

Board #41

Habitual Physical Activity And Immunological Function In Older Individuals: Preliminary Findings From The Nakanojo Study

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PURPOSE: In older adults, habitual moderate-intensity physical activity is one of the most important components of a healthy lifestyle. Little is known about relationships between habitual physical activity and immune function in older adults, although laboratory-based investigations suggest that appropriate volumes of exercise have positive effects on immune health. The purpose of the present investigation was to examine relationships between habitual physical activity and immune function in older individuals. **METHODS:** Participants were 20 women aged >65 (75 ± 3) years from the Nakanojo Study. All wore a uniaxial pedometer/accelerometer (Lifecorder, Kenz, Nagoya) continuously, 24 h/day, for 1 year. A proprietary algorithm determined the daily step count (midnight to midnight) with an intramodel reliability of 0.998 and an absolute accuracy of <3%. For the present investigation, we noted the daily step count and the daily duration of activity >3 metabolic equivalents (METs). As our indices of immune function, we assessed neutrophil phagocytosis (using Fluoresbrite® microspheres and a FACSCalibur™ flow cytometer) and the salivary concentrations of secretory immunoglobulin A (IgA) as determined by enzyme-linked immune sorbent assay using antigen-specific antibodies. **RESULTS:**Immune function showed an inverted U-shaped relationship to habitual physical activity. Step counts were significantly associated with neutrophil phagocytic function ($p < 0.05$), but just failed to reach a significant relationship with salivary IgA ($p = 0.059$). However, the duration of activity >3 METs was significantly associated with salivary IgA ($p < 0.05$). Based on statistically fitted quadratic equations, the optimal levels of habitual physical activity for immune health in this population corresponded to 6958 steps/day for neutrophil phagocytic function and 7747 steps/day and/or 17 min/day at >3 METs for salivary IgA.**CONCLUSION:** This preliminary study, based on objectively-measured yearlong physical activity, suggests an inverted U-shaped relationship between the daily amount of habitual physical activity and immune health in older women. Optimal levels are higher than observed in many surveys: 7000-8000 steps/day and/or 15-20 min/day of activity at an intensity>3METs, moderately vigorous activity for these elderly individuals.

Board #42

Effect of Group Instruction for Improving Physical Activity in Cold District

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INTRODUCTION: The group instruction for the care prevention is carried out with most of local governments in Japan. Because it is very important to control the soaring cost of health care in accordance with the rapid graying of Japan's population in the next decades. In Healthy Japan 21, physical activity and aiming steps are advocated. It was well known the most easily physical activity was to the walking. However, it is necessary to instruct it in consideration of the influence of temperature and the climate. Particularly, it is careful about the snowfall places and the cold districts where it is easy to slip a road surface. **PURPOSE:** The purpose of this study was to monitor the effect of group instruction for improving walking steps in middle aged and elderly women living in cold district. **METHODS:** Eleven middle aged and elderly women (67.6 ± 7.7 yrs) participated in this study. They lives in Hashikami-cho, Aomori, Japan. They participated in the group instruction that Hashikami-cho government office held once a week for approximately one year and put on an accelerometer (Lifecorder Plus, Suzuken, Japan). The collection of the data of the accelerometer went to once a month. At the same time, we advised about 0-10% increased aim steps of the next month. Measurement of physical activity was used the software (Lifelyzer 05 Coach, Suzuken, Japan) and referred to temperature and climate. On the last day, they wrote the impression of the accelerometer. Statistical proceedings were used t-test and correlation coefficient.**RESULTS:** It was seen the correlation between the mean steps of each month and the mean temperature ($r=.774$) and snowfall day ($r=-.769$). By the comparison of mean steps with the next month, significant difference was seen between February and March ($p<0.05$), and March and April ($p<0.01$). Although relations with steps and the temperature are strong, it is result of the instruction that the steps did not decrease when the temperature was becoming cold after September. About the impression of accelerometer, many subjects answered that motivation improved by put it on. **CONCLUSION:** This study suggests that the relations with mean steps of each month and the temperature and the snowfall are strong, but it may stop the decrease in steps by instruction. It is necessary to instruct in accordance with health condition and the environment of the subjects.

Table 1. mean steps, temperature and snowfall days of each month			
month	mean steps	temperature	snowfall days
Nov.	5396	6.7	6
Dec.	6155	1.6	13
Jan.	6069	-1.6	27
Feb.	6041	-1	26
Mar.	6968	4.6	7
Apr.	8879	8.5	0
May	9136	12.7	0
June	8775	15.8	0
july	9022	21.4	0
Aug.	8093	21	0
Sep.	8240	19.3	0
Oct.	8617	14.1	0

Board #43

Evolution of Physical Activity in Young Adult of Aomori Japan

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INTRODUCTION: Aomori Prefecture is the shortest life expectancy for both men and women in Japan, and well known that higher rate of obesity from children to adults. In addition, the main causes of death are cancer, heart disease and cerebral vascular disease. This mortality is higher than the national average, especially in people over the age of 40. These diseases were to cause by lack of exercise and disturbance of life style are known, promoting the amount of physical activity and lifestyle in the region is important. In the past, The Aomori Prefecture has done several times health survey, the majority of which is a nutritional survey, few researches on physical activity. Because it is due to turbulence of the lifestyle of youth, will cause mature lifestyle-related diseases, to reveal the amount of physical activity of young adult is important. **PURPOSE:** The purpose of this study was to investigate the characteristics of life and physical activity of young adult in Aomori. **METHODS:** 20 - 28 years and 16 young adults participated in this study. Physical characteristics of the subjects are as follows: height for men 172.9 ± 5.5 cm, weight 69.7 ± 7.5 kg, BMI 23.4 ± 2.7kg/m^2, women's height 157.3 ± 5.7 cm, weight 51.8 ± 8.2 kg, BMI 20.9 ± 3.3 kg/m^2. Subjects were measured physical activity in daily life and behavior patterns. Measurement of physical activity was used pedometer (OMRON HJ-203) and behavior patterns of daily life were obtained by subject self-reported. This study was conducted in autumn. Statistical proceedings were used *t* test and χ^2 test.**RESULTS:** The mean of men's physical activity were 5700 ± 1240 steps per day, and women's physical activity were 4207 ± 1217 steps, it was found that men's physical activity were higher than women. Physical activity of holiday was compared by weekday, physical activity of holiday were significant higher than weekday. According to self-reported data, the time of driving a car on weekday (2.0 ± 0.55 h) was longer than the time of driving a car on holiday (1.6 ± 1.15 h), and results of the time for holiday shopping was longer than weekday.**CONCLUSION:** The physical activity of young adult was higher on holiday, and it was found that men were more active. However, physical activity was low both on weekday and holiday. This result was suggested that could have been affected by the driving time of a car.

Board #44

Work-Related Ambulatory Activity and Sedentary Behavior of Overweight and Obese Office Workers

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INTRODUCTION: Office-based clerical work is purported to be primarily sedentary in nature and a barrier to the accumulation of healthful physical activity. **PURPOSE:** To describe baseline work-related ambulatory activity and sedentary behavior of overweight and obese office workers participating in a randomized controlled trial evaluating the effects of a treadmill workstation intervention. **METHODS:** Forty-one volunteers working in clerical jobs at a single office complex were asked to wear an ActiGraph accelerometer (GT3X+ model; ActiGraph LLC, Pensacola, FL) at all times (24 hr/day) for at least 4 working days. Ambulatory activity (steps/day and min/day of moderate-to-vigorous physical activity, MVPA [≥ 1952 activity counts/min]) and sedentary time (< 100 activity counts/min) were summarized for the 39 individuals (age: 39.7 ± 9.9 yr; BMI: 36.2 ± 8.4 kg/m^2; 26% overweight; 74% obese; 97% female) accruing ≥ 3 valid days of accelerometer data (≥ 10 monitored hr/day). Data are summarized as means ± *SD* for the entire monitored working day (noting percent taking < 5000 steps/day) and separately for scheduled working hours (8:00 a.m. to 4:30 p.m.). Contributions of ambulatory activity and sedentary time during scheduled working hours were calculated as percent of total daily values. **RESULTS:** Participants accumulated 5844 ± 2111 steps/day (41% accumulated < 5000 steps/day), 19.1 ± 16.3 min/day of MVPA, and 12.5 ± 1.7 hr/day of sedentary time during 17.4 ± 2.2 hr/day of daily monitored wear time. Over 8.0 ± 0.5 hr/day of monitored wear time during scheduled working hours (46% of total daily monitored time), participants accumulated 3109 ± 1254 steps/day (53% of total daily steps/day), 11.1 ± 11.0 min/day of MVPA (58% of total daily MVPA), and 5.7 ± 0.7 hr/day of sedentary time (46% of total daily sedentary time). **CONCLUSION:** Findings are consistent with the supposition that overweight and obese office workers accumulate the majority of their daily ambulatory activity and less than half of their daily sedentary time during scheduled working hours. Despite this, a substantial proportion of workers were sedentary in the context of accumulating < 5000 steps/day.

Supported by a contract with workplace wishing to remain anonymous.

Board #45

What is the Relationship Between Self-reported Physical Activity Intensity and Objective Outcomes?

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INTRODUCTION: Questionnaires can be used to efficiently collect information on physical activity and sedentary behaviour (PA&SB). An example, the Previous Day Physical Activity Recall (PDPAR) questionnaire, divides the day into 30 minute blocks and asks for the predominant activity type and activity intensity (AI) in each block. Pictorial references assist with AI categorization: Light intensity (L) with seated behaviours, and Moderate (M), High (H) or Very High (vH) intensities with progressively more vigorous upright behaviours. If children can distinguish between AI levels then the value of such data collection techniques can be demonstrated. Objective measurement of PA&SB can be used to assess children's consistency in choosing AI categorisation. **PURPOSE:** The purpose of this study was to examine the relationship between PDPAR outcomes and objectively measured sedentary, upright and stepping activity. **METHODS:** Forty three children (11-13y) completed the PDPAR and wore an activity monitor (activPAL) for up to 14 days. All data, where both PDPAR outcomes (07:00-24:00) and objective measures (24h/d) were successfully recorded, were used to examine the relationship between self-reported AI and objective outcomes. **RESULTS:** The participants successfully recorded 14,083 matching blocks of 30 minutes of PDPAR and objective data. 81.5% were self-reported as L, 14.3% M, 3.3% H, and 0.9% vH. Matched questionnaire and objective outcomes are reported by self-reported AI category in Table 1. There were significant differences in objective outcomes between L and M but not between H and vH self-reported AI categories. The large reduction in % sedentary between L and M indicated the participants were able to select AI based on the reference definitions proposed by the PDPAR. However, over 30% of both H and vH AI was sedentary. This indicates that 30 minute blocks were perhaps too coarse and that self-selected or shorter time intervals might have been more appropriate to allow adequate categorisation of H and vH AI. **CONCLUSION:** Within the context of the PDPAR, children used AI categories to describe a wide range of postural and stepping activity, at all self-reported AI levels. The questionnaire seems appropriate to provide outcomes that are different between the AI levels of L and M, but not the H and vH categories.

Supported by: Internally funded by GCU.

Table 1 Objective outcomes by self-reported Activity Intensity

			Objective measures for 30 minute blocks (mean and SD) *					
			Sedentary	Standing	Stepping	Steps	STS	Cadence
		Blocks (No.)	(%)	(%)	(%)	(/30mins)	(/30mins)	(steps/min)
Self-reported	Light	11484	75.2 (26.9) (A)	14.9 (17.9) (A)	9.9 (13.1) (A)	245 (364) (A)	2.3 (2.3) (A)	74.9 (17.1) (A)
Intensity	Moderate	2010	48.6 (32.6) (B)	26.2 (19.8) (B)	25.2 (21.8) (B)	663 (645) (B)	2.7 (2.3) (B)	80.6 (16.7) (B)
	High	461	36.8 (32.2) (C)	26.1 (17.4) (B)	37.1 (26.4) (C)	953 (738) (C)	3.2 (2.7) (C)	80.8 (14.8) (B, C)
	Very High	128	31.0 (25.1) (C)	29.3 (17.8) (B)	39.6 (23.8) (C)	1063 (741) (C)	3.5 (3.0) (C)	85.4 (17.4) (C)

*Different letter = sig diff of outcome between intensity categories (p<0.05 Mann Witney U with Bonferroni correction)

Board #46

Integrating Objective Measures (accelerometer/GPS/GIS) and Interviews to Determine Where Adolescents are Physically Active: the PEAR Project

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INTRODUCTION: GPS combined with accelerometry provides a precise measure of adolescents' use of their environment for physical activity. However data derived has only explained a small proportion of adolescents' daily physical activity and its use in intervention is restricted by limited contextual information. **PURPOSE:** This study combined objective measures of location (GPS) and physical activity (accelerometry) with qualitative spatial narratives and GIS to examine the main environments that contribute to daily physical activity in male and female adolescents living in urban and rural locations. **METHODS:** In Phase 1 of the PEAR Project (Physical Environment and Activity Relationships in Adolescence), 63 UK adolescents (13-14yrs; 29 females; 38 rural) were asked to wear an accelerometer (Actigraph GT3x+) and GPS receiver (Qstarz BT-Q1000X) for 7 days. Data were recorded at 10sec epochs and time matched to provide temporal, spatial (x,y co-ordinate) and activity data (CPM, MVPA) for each epoch. These data were imported into a Geographical Information System and visually interpreted to code time into events (and associated journeys) for key temporal (e.g. before school), spatial (e.g. home, outdoor/indoor, green space/non green space) and purpose (e.g. school, shopping, cinema, sport) contexts. Participant interviews (n=22; 9 males) using maps and photographs were used to confirm the interpretation of events and to provide additional contextual information. **RESULTS:** The final sample comprised 5,657 discrete events from 63 participants. Time spent in environments was similar for both sexes but females were consistently less active in all types of events. Walking and cycling journeys to school and other destinations were on average the most active event irrespective of gender or location of participants. *School journeys* contributed substantially to daily MVPA, particularly for urban adolescents (22% vs 17% of MVPA in males vs females and 33% vs 12% in urban vs rural participants). ***Non-school journeys*** contributed an additional 10% of MVPA for both male and females and 17% vs 1% for urban vs rural participants. ***School based activity*** contributed more to MVPA for rural vs urban participants. **CONCLUSION:** This integration of qualitative and quantitative methods provides unique data quantifying where, when and for what purpose adolescents use their environment and how this contributes to their daily physical activity. For example, males and females spend their time in similar environments but females are less active when there & non-school active travel contributes significantly to daily physical activity.
Supported byMedical Research Council: G1001164

Board #47

Effects On Presenteeism And Absenteeism From A Randomized Controlled Trial Among Health Care Workers

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INTRODUCTION:A worksite based lifestyle intervention successfully reduced average body weight and increased physical fitness in employees at a care unit. **PURPOSE:** The aim of this paper was to investigate the effects of these health improvements on presenteeism and absenteeism. **METHODS:** A 1-year cluster-randomized controlled trial was conducted on 144 employees working at a care unit in Denmark. Of those, 98 were selected to a target group, being women, overweight and health care workers. The intervention consisted of calorie limited diet, physical exercise and cognitive behavioral training during working hours 1 hour/week. The reference group was offered monthly oral presentations about healthy lifestyle. Absenteeism and presenteeism, defined as self-reported productivity and work ability were recorded at baseline and after 3 and 12-months intervention period. **RESULTS:** In intention-to-treat analysis, a significant effect of the intervention was found for productivity in the whole group after 3 months. However, it was not significant when tested in the target group and did not remain increased after 12 months. No significant between group effects on absenteeism or work ability was found. **CONCLUSION:** This study suggests that a body-weight reducing worksite intervention among employees in a care unit induces immediate, but not lasting improvements on productivity with no effects on absenteeism and work ability.
Trial registration: NCT 01015716.

Board #48

Walking Activity Of Children With Cerebral Palsy And Children Developing Typically: A Dutch-american Comparison

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INTRODUCTION: The most common cause of physical disabilities in pediatric rehabilitation is cerebral palsy (CP). These children demonstrate less walking activity than children developing typically and, therefore, are at risk for ending up in a vicious cycle of inactivity, deconditioning and deterioration of mobility. Increased understanding of differences in walking activity between countries may be useful for the development of activity stimulation programs for children with a physical disability.**PURPOSE:** To compare walking activity of children with and without CP between the Netherlands and the United States. **METHODS:** A cross-sectional comparison study was performed, including a convenience sample of 134 walking children aged 7-12 years with spastic CP, classified as Gross Motor Function Classification System (GMFCS) level I (walking without limitations: N=64), II (walking with limitations: N=49) or III (walking with aids: N=21), and 223 children developing typically from the Netherlands and the Pacific Northwest of the United States. Walking activity was assessed during a one-week period using a StepWatchTM Activity Monitor which sensitivity settings can be adjusted to register strides for the pathological walking patterns as found in children with CP. Outcomes were the daily number of strides, daily time being inactive and at low stride rate (0-15 strides/minute), and time spent at moderate (16-30 strides/minute) and high stride rate (31-60 strides/minute). Walking activity was compared between countries using multiple linear regression analyses. **RESULTS:** Walking activity of children developing typically was not significantly different between countries. Dutch children classified as GMFCS level I and II showed lower walking activity than their American counterparts ($p<0.05$), whereas Dutch children classified as GMFCS level III showed higher walking activity than their American counterparts ($p<0.05$).**CONCLUSION**: Despite no differences in walking activity of Dutch and American children who are developing typically, Dutch children with CP who walk without aids are less active in walking than their American counterparts, whereas Dutch children with CP who use walking aids appear to have higher walking activity than their American counterparts. Possibly, factors not collected in this study, such as school type or approach to sports activity, may influence walking activity of children with CP who walk without aids and for those who use walking aids differently in both countries.

Board #49

Are Perceived Fatigue And Actual Level Of Physical Activity Correlated In Patients With Multiple Sclerosis?

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PURPOSE: Both reduced physical activity and perceived fatigue are important consequences of Multiple Sclerosis (MS). However, their mutual association is not well understood. The aim of this study was to determine the correlation between perceived fatigue and aspects of home-based recording of motor activity in patients with MS. Found associations were checked for confounding by age, EDSS, disease duration, sub type of MS, anxiety, and depression.
METHODS: Fatigue was assessed with the Checklist Individual Strength (CIS20R), the Fatigue Severity Scale (FSS) and the Modified Fatigue Impact Scale (MFIS) and ambulatory physical activity was subsequently recorded (Vitaport) for 24 hours in ambulatory patients with MS. Multivariate regression was applied to determine potential confounding factors.**RESULTS:**No significant associations between fatigue scores and physical activity were found, except for the MFIS sub-scale 'physical activity' ($ß_{physical\_activity}$ ($ß_{p\_a}$) =-0.044; SE=0.020). The association between the FSS fatigue score and physical activity was distorted by age, MS-type, anxiety and depression and the association between the MFIS score and physical activity by age and depression. The inverse association between measured physical activity and the MFIS sub-scale 'physical activity' was significantly strengthened by adjusting for sub type of MS ($ß_{p\_a}$=-0.048; SE=0.020), age ($ß_{p\_a}$=-0.052; SE=0.019), depression ($ß_{p\_a}$=-0.083; SE=0.023) and anxiety ($ß_{p\_a}$=-0.070; SE=0.023)**. CONCLUSION:**In patients with MS, the association between severity of perceived fatigue and physical activity is absent or weak at best. Depending on the questionnaire for perceived fatigue used, patient characteristics such as type of MS, age, anxiety and depression are factors that may affect this relationship.

Board #50

Proximity Of GPS Measured Time Outdoors To Home In Adolescents

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INTRODUCTION: Time outdoors is a predictor of children's physical activity and has been associated with the development of obesity. There is concern that children are spending less time outdoors than in the past, that when outdoors they remain close to home, and that these factors negatively impact their overall physical activity. However, few studies have provided a quantitative assessment of the level and proximity of physical activity to home. **PURPOSE:** This study used objective measures of location (GPS) and physical activity (accelerometry) to examine the proximity of after-school moderate to vigorous physical activity (MVPA) to children's homes.**METHODS:** Children (n=953) taking part in the PEACH project were asked to wear an accelerometer (Actigraph GT1M) for 7 days and a GPS receiver (Garmin Foretrex 201) after school on three weekdays. Data were recorded at 10second epochs by both instruments. After-school (3.30pm to 8.00pm) accelerometer and GPS data were time-matched. Full postal addresses were provided by 342 participants, and were geocoded and the distance between each combined accelerometer-GPS datapoint and their home was calculated for each participant. Each datapoint was classified as MVPA if the accelerometer count/10seconds exceeded 382 (>2295cpm). Data were summarised in 100m categories up to a distance of 2.5km from home. The final sample comprised 82,401 observations from 306 children (age 11yrs; 130 males).**RESULTS:** Participants spent 30.4% of their time after school within 100m of their homes, where they accumulated 17.8% of their total after school MVPA. Differences in time within 100m of home were negligible between boys and girls, but girls spent a larger proportion of time in MVPA than boys (20.0% vs 15.4%). Children who travelled home from school by car spent more time (46.5% vs 29.8%) and accumulated more MVPA (22.6% vs 17.8%) within 100m of home than children who walked. Fifty-four percent of time and 52.5% of MVPA were within 400m of home. Females spent more time and accumulated more MVPA within 400m than males (57.6% vs 50.4% of time; 57.2% vs 47.3% of MVPA). Car travellers spent more time (65.4%) than walkers (56.9%) and MVPA within 400m (63.6% vs 53.1%) of home. Only 15% of MVPA is accumulated between 1km to 2.5km from home. **CONCLUSION:** Objective measurement of physical activity and location shows that a substantial proportion of children's time and MVPA outdoors after school is spent in close proximity (within 400m) of home. Patterns appear to differ by sex and by travel mode, with boys and those who walk to school being active further away from home.

Board #51

Studying Physical Activity in Children's Environments across Scotland (SPACES)

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INTRODUCTION: Environmental supportiveness for physical activity (PA) in children and adolescents has been subject to a small, but ever increasing, number of research programs in the last 10 years. The reasons for this surround the importance of the natural, built, and social environment for guiding our health behaviours, e.g. PA. The last 10 years has also witnessed the advancement of technology to a level where the spatial component of PA behaviour can be objectively measured (Global Positioning System devices, GPS) and mapped (Geographic Information Systems, GIS). However, a paucity of this type of research in Scotland merits investigation, especially with consideration to issues of social patterning (e.g. area deprivation) and dwelling characteristics (e.g. urban and rural living). **PURPOSE:**SPACES is a project designed to investigate the role of the built and physical environment on PA levels of Scottish youth (10-12 year old). The primary purpose is to investigate the extent to which neighbourhood characteristics (e.g. greenspace and access to facilities) are associated with moderate to vigorous PA (MVPA), whilst accounting for the role of urban/rural dwelling and area level deprivation. **METHODS:**Four main studies will compose SPACES: a systematic review focussing on studies published using GPS, GIS and accelerometry in youth; a technical investigation comprising of an accuracy and precision estimate of GPS devices; a small pilot study using GPS, GIS and accelerometry in 10-12 year urban (n = 20) and rural (n = 20) youth to test the feasibility of study protocols; and a larger, national level study (n = ~250), sub-sampling participants from the Growing up in Scotland (GUS) longitudinal study. The GPS devices available for comparison are the Garmin Forerunner 410 and the Garmin Foretrex 301 (Garmin Europe Ltd, UK), and the accelerometer devices being used are the Actigraph GT3X+ (Actigraph, Pensacola, FL). The GIS software will be ArcGIS (Environmental Systems Research Institute Inc., Redlands, CA). **RESULTS:** As a project outline, no results are available for dissemination at this stage.**CONCLUSION:**The focus of this project is to investigate, at the national level, the role of the environment in supporting the PA levels of youth. PA guidelines stipulate that children and adolescents should accumulate at least 60 mins of MVPA per day. This project will provide important information to assist with the challenge to increase PA levels in youth and thereby influence policies published in this area of public health.

Board #52

Seven Days Activity Monitoring in Workers with Musculoskeletal Pain: Daily Patterns, Associations with Symptoms

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INTRODUCTION: Musculoskeletal pain is highly common among the working population.It has been assumed that chronic pain may reduce the activity level in daily life, which in turn may aggravate pain and associated symptoms. However, it is not known whether pain impacts on daily activities among workers. Commonly accepted and validated protocols are needed to gain objective information about possible deviations in physical activity patterns in subjects with chronic musculoskeletal pain. **PURPOSE:** The aim of this cross-sectional study was to investigate the volume and time-pattern of daily physical activity in workers with chronic musculoskeletal pain compared with healthy controls. **METHODS:** Twenty-seven workers with chronic muscle pain primarily in the neck-shoulder region, and 27 age- and gender- matched controls participated in the study. Both groups were recruited from the same global manufacturing company within the industrial sector at a site in Sweden. Physical activity and sedentary behaviour were monitored for seven days, both during work and leisure time, using a single tri-axial accelerometer (PAL Technologies Ltd, Glasgow). Time spent walking, standing and sitting/lying and steps were calculated for each hour. The mean metabolic equivalent (MET) was estimated and used as a measure of energy expenditure. The coefficient of variation (CV) between daytime hours was calculated as a measure of variation. **RESULTS:** For overall daily activity, the mean standing time was significantly higher in the pain group (263 min/day) compared with controls (209 min/day) ($p=0.04$), whereas no difference was found in energy expenditure or sedentary time. The analyses of time patterns revealed lower energy expenditure in the evening and morning hours among those with pain (mean 1.6 MET/h) compared with the control group (mean 1.8 MET/h) ($p<0.05$). The pain group showed on average a smaller CV in MET (9%) than the control group (11%) ($p=0.02$), which indicated a reduced variation in physical activity. There were no significant associations between pain intensity and physical activity.**CONCLUSION:** Despite a normal level of total physical activity, workers with chronic musculoskeletal pain had an altered activity pattern in terms of reduced variation and a lower activity level in leisure time.

Board #53

Slow Walking Improves Insulin Action And Plasma Lipids More Than Intense Cycling During Similar Energy Expenditure

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INTRODUCTION: Current guidelines stress the importance of half an hour moderate to vigorous physical activity (MVPA). 30 Minutes of MVPA can be combined with 23.5 hours of sedentary behavior and sleeping. Increasing evidence suggests time spent sedentary to have an adverse influence on health, independent of energy expenditure. This implies that following current guidelines and being sedentary for the rest of the day is associated with increased health risk. To obtain similar daily energy expenditure less intense physical activity (Minimal Intense Physical Activity (MIPA)) concurs with reduced daily sitting time.**PURPOSE:** To test the hypothesis that a reduction of sitting time (by increasing MIPA) more effectively improves cardiovascular risk factors than a short daily amount of exercise combined with a sedentary lifestyle, if energy expenditure is kept constant.**METHODS:** Eighteen healthy subjects (age: 21±1.9 years, BMI: 22.6±2.6 kg/m2) followed each three randomized physical activity regimes for four days. Between each regime 10 days of unrestricted living were allowed. During the 'sitting regime', participants sat 14 hr/day. In the 'exercise regime', participants replaced 1hr of sitting by intensive cycling. This condition led to increased energy expenditure (~450 kcal). During the 'MIPA regime', participants replaced 4 hr/day of sitting by walking at a leisurely pace. In this condition energy expenditure was similar as during the 'exercise regime'. Physical activity was continuously (24 hr) assessed by an activity monitor (ActivPAL3) and a diary. After each regime participants performed an oral glucose tolerance test (OGTT) and blood samples were drawn to assess blood lipids. **RESULTS:** Area under the curve during OGTT for insulin was significantly lower after the MIPA regime compared to both sitting and exercise regimes: 6727.3±4329.4 vs 7752.0±3014.4 and 8320.4±5383.7 mU·min/ml, respectively. Triglycerides, non-HDL cholesterol and apo B plasma levels improved significantly in the MIPA regime compared to sitting regime (-22%, -10% and -8% respectively) and showed non-significant trends for improvement after exercise regime compared to sitting regime. **CONCLUSION:** Reducing inactivity by increasing the time spent walking at a leisurely pace is more effective in reducing plasma lipids and insulin levels than one hour of physical exercise, when energy expenditure is kept constant.

Board #54

Ambulatory Monitoring of EMG Activity During Outdoor Walking

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It was well known the most easily physical activity was to the walking. However the data was dependent on experimental setting and environments within several reports case. The Nordic Walking is a great fitness workout for people who are looking for a fun physical activity and maximum health benefits combined with convenience. The hip osteoarthritis was to one of the major reason for walking disability in Asian women. Especially it was symptoms of aged Japanese women. So it was well known therapeutic exercise as a walking was effected of prevention both lifestyle disease and osteoporosis. There are no data for outdoor Nordic walking in EMG activity. The purpose of this study was to evaluate the EMG activity during outdoor field ambulatory tests (FT) in between nordic walking (NW) and normal walking (W) on same environments road.There were sixteen subjects participated in this study. It was monitoring the Heart rate (HR) and Electromyogram (EMG, tibialis anterior, medial gastrocnemius, rectus femoris, biceps femoris, erector spinae, trapezius, biceps brachii, triceps brachii) with both hands nordic pole walking continuously at least one hour recording by portable data logger device(Biometorics, UK) by 1Kz sampling. One experimental trial was to consist of 8row 3.6 million matrix was saved and caluculated integrated EMG by VEE sicentific numeric analysis software. There were no significant different in heart rate response between nordic walking and without pole normal walking. This present study revealed differences in EMG activity. There were significantly higher (P<0.05) compared with pole walking and normal walking in tibials anterior. It was not showed any differences in erector spinal back muscle's activity between pole walking or not conditions. The involvement of the trunk, arm and shoulder muscles during Pole walking accounts for the increase in load distribution work at a given walking speed. Our result demonstrate that Nordic Pole Walking immediately enables all subjects with voluntary locomotion condition to walk future with less leg muscle activity rather than normal walking, despite longer walking periods. Nordic Pole walking could therefore, be a use exercise strategy for increasing the longer fitness of all healthy subjects.The experimental data and settings indicates that Nordic walk is most easily exercise with safety balance.This research shows that elderly persons who walking easily that walking is effective in slowing the rate of increasing EMG activity in the same exercise period. Further research is needed to explore the training effect, cost effectiveness and long-term benefits of Nordic Pole Walking.

Board #55

Sleep Quality, Physical Activity And Awakening Salivary Cortisol Response Among Police Officers: The BCOPS Study

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INTRODUCTION*:* Awakening cortisol response is a useful physiologic marker of hypothalamus-pituitary-adrenal (HPA) axis activity which could be related to chronic stress. Prior studies have examined the association of sleep quality and physical activity (PA) with HPA axis function but evidence is lacking among police officers who work under stressful conditions. **PURPOSE:** To determine whether sleep quality was associated with waking cortisol levels and profiles in police officers and whether physical activity moderated this association. **METHODS*:*** Participants were 464 police officers enrolled in the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study. Officers collected saliva at four time points: on awakening, 15, 30 and 45 minutes after waking. Data collection occurred between 2004 and 2009. Hours of physical activity in the past week were assessed using the Seven-Day Physical Activity Recall questionnaire. Sleep quality (good/poor) was assessed using the Pittsburgh Sleep Quality Index (PSQI) questionnaire. Hours of physical activity were categorized into two groups (low/high) using the median as a cut point and served as a potential effect modifier. The salivary cortisol values were the outcome. Repeated measures models were used for analyses adjusting for age, gender, race, education, marital status and rank. The autoregressive covariance model was used to account for interdependence among measurements within a subject. In addition, derived parameters including area under the curve, average and peak cortisol were compared between those with good vs. poor sleep quality. **RESULTS:** There were 349 officers with complete data. The association between sleep quality and awakening cortisol levels was dependent on physical activity. Among participants with low PA, awakening cortisol levels were higher for those with good sleep but the pattern over time was similar regardless of sleep quality. The adjusted average (15.0 ± 0.76 vs. 12.7 ± 0.77, $p=0.0321$) and peak cortisol (21.0 ± 1.1 vs. 17.7 ± 1.1, $p=0.0459$) levels were larger for those with good sleep than those with poor sleep quality. On the other hand, among participants with high PA, adjusted average (13.9 ± 0.70 vs. 14.0 ± 0.63) and peak (18.5 ± 1.01 vs. 19.1 ± 0.90) cortisol levels and pattern over time did not differ between subjects with good vs. poor sleep quality. **CONCLUSION:** Results indicate that poor sleep quality is associated with diminished awakening cortisol levels among officers with low PA. Future longitudinal studies could assess whether poor sleep quality predicts diminished waking cortisol response and elucidate the mechanism by which PA moderates this association.

Board #56

Physical Activity among Preschoolers at Childcare: Differences in Participation Indoors Versus Outdoor?

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INTRODUCTION: Preschoolers have been identified as participating in low levels of physical activity (PA). The childcare environment has been recognized as having a strong influence on participation. While outdoor playtime has been previously reported to facilitate increased PA among this population, research examining if PA levels of preschoolers differ during indoor and outdoor childcare hours is lacking. **PURPOSE:** The purpose of this study was to examine the differences in PA participation among preschoolers in centre-based childcare during indoor and outdoor playtime periods. **METHODS:** Thirty-one preschoolers (4.1 years ± 0.85) from five childcare centres in London, Ontario were fitted with Actical® accelerometers during childcare hours for one day. A 15-second epoch length was used. The on-site researcher kept a log of the children's accelerometer wear time and data on the times and duration that children spent indoors/outdoors for each centre. Using Kinesoft software, periods of *indoor* and *outdoor* playtime were compared using the "windows" feature of the program. Preschoolers' activity data was compared with Pfeiffer and colleagues age- and device-specific cut-points. Wilcoxon signed ranks tests were used to examine the difference between indoor and outdoor time for boys and girls combined, and then separately to explore sex differences. Multiple comparison bias was controlled using Bonferroni corrections to the per-comparison alpha. **RESULTS:** Analyses revealed that, on average, participants engaged in 0.54 minutes/hour (*SD* = 0.59) of moderate-to-vigorous physical activity (MVPA) and 14.42 minutes/hour (*SD* = 6.78) of total PA *indoors*, compared to 5.03 minutes/hour (*SD* = 4.92) of MVPA and 31.68 minutes/hour (*SD* = 10.83) of total PA *outdoors* ($p < .017$). While both boys and girls (boys: $z = 3.62$; girls: $z = 2.20$) participated in greater minutes/hour of MVPA outdoors, as compared with indoors, after the Bonferroni correction, this difference was only significant for boys ($p < .0083$). With regard to total PA, both boys and girls displayed a significant increase during outdoor playtime (boys: $z = 3.57$, girls: $z = 3.12$, $p < .0083$). **CONCLUSION:** Preschoolers engage in significantly more PA outdoors than indoors during childcare hours; this is particularly noteworthy, given that preschoolers in the current study spent most of their day indoors, yet accumulated the majority of their daily activity during the outdoor time afforded to them. In light of the low rates of physical activity participation among preschoolers enrolled in childcare, it is important that outdoor playtime be offered to encourage gross motor activity among young children.

Board #57

Improving The Context Of Activity Monitoring By Combining Objective Measures With Measures Of Use-of-time

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INTRODUCTION: Objective measures of physical activity, such as accelerometry, are often considered to be more accurate and reliable than self-report measures, and to provide more dependable data. **PURPOSE:** The aim of this study was to determine whether self-reported use of time measures can be used to provide context to objectively measured physical activity. **METHODS:** Previously sedentary adults (n=107) [age (mean±SD) 41±11 yr; body mass index 26.1±5 kg/m2; 66% female) were randomly allocated to a Control group (n=37) or a 6-week Moderate (n=37; 150 min/wk) or Extensive (n=36; 300 min/wk) exercise group. The exercise conditions involved a wide range of supervised and unsupervised physical activities ranging from cycling and resistance training to kayaking and bushwalking. Participants were measured at baseline, mid- and end-program and 3- and 6-month follow up with 24 h accelerometry (Actigraph GT3x) and the Multimedia Activity Recall for Children and Adults (MARCA), a computerised use of time instrument. The MARCA has shown reliability and criterion and convergent validity equivalent to accelerometry. Analyses were conducted using random effects mixed modelling. **RESULTS:** Accelerometry demonstrated that there was a significant and sustained increase in total activity (total accelerometer counts) at mid-program ($p=<0.001$) and end-program ($p<0.001$) measurement occasions in the intervention groups relative to the Control group. Use of time data revealed that to accommodate for the increased time spent in physical activity by end-program measurement (+22 min/d Moderate and +46 min/d Extensive, relative to Control), and in active transport (+23 min/d and +24 min/d), participants spent less time sleeping (-32 min/d Moderate and -30 min/d), watching television and playing videogames (-58 min/d and -62 min/d) and doing chores (-17 min/d and -26 min/d). Participants also spent more time using a computer (+33 min/d and +35 min/d).**CONCLUSION:** The combination of objective and use of time data allows researchers to determine not only shifts in activity and energy expenditure, but also shifts in specific activities, and hence to better understand potential health impacts.
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Board #58

How Many Steps/day Are Associated With Health Among Older Adults With Knee Osteoarthritis?

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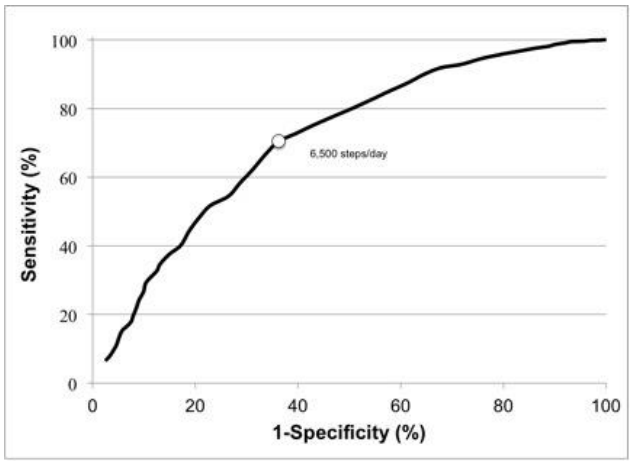
INTRODUCTION: For older adults, it is unclear how many steps/day to recommend for healthy outcomes, nor how many steps/day may be insufficient and associated with poor health. **PURPOSE:** To determine the number of steps/day associated with healthy and unhealthy gait speed among older adults with or at high risk of knee osteoarthritis. **METHODS:** Older adults were from the Multicenter Osteoarthritis Study, which is an existing cohort study with or at high risk for knee osteoarthritis. Steps/day were objectively recorded over 7 days with a StepWatch Activity Monitor. A clinic-measured speed of at least 1.2 m/s over a 20-meter course was considered "healthy", while below 1.0 m/s was considered "unhealthy" based on published definitions. We derived a Receiver Operator Curve (ROC) and determined the number of steps/day that 1) best predicted a healthy gait speed and 2) corresponded to 95% specificity for an unhealthy gait speed to minimize false positives.**RESULTS:** Among 1,757 participants with analyzable data (67 ± 8 yrs, BMI 31 ± 6 kg/m^2, female 59%), mean steps/day were 7,094 ± 2,917 [range 640 - 21,593] and 55.2% and 13.6% had healthy and unhealthy gait speeds, respectively. Walking at least 6,500 steps/day best predicted those meeting a healthy gait speed, while walking less than 1,800 steps/day was associated with walking at an unhealthy gait speed. **CONCLUSION:** Walking 6,500 and 1,800 steps/day represent heuristic values of a minimal step count goal and a 'red flag' for insufficient walking, respectively, for older adults with or at high risk of knee OA. Future studies are needed to replicate these findings.

Figure Receiver operating characteristic curve of steps/day predicting study participants (n= 1,757) with healthy gait speed ($\geq$ 1.2 m/s).



Board #59

Objective Measurement of Physical Activity and Sedentary Behavior Among Women Age 63-99 Years

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INTRODUCTION: There are several challenges in describing physical activity and sedentary behavior among older adults: data from objective measures (e.g., accelerometers) is limited, methods for quantifying activity are inconsistent due to lack of consensus on accelerometer thresholds, and accelerometer technology changes over time. In particular, newer accelerometers have a low frequency extension (LFE) option recommended for use in older adults by the manufacturer, with a lack of studies on how this mode affects interpretation of accelerometer data. **PURPOSE:** This study of United States women age 63-99 describes moderate to vigorous physical activity (MVPA) using different accelerometer thresholds and sedentary behavior, and compares findings using the regular and LFE accelerometer option. **METHODS:** The Women's Health Initiative enrolled postmenopausal women ages 50-79 from 1993-1998 into one or more randomized trials or an observational study. Women enrolled in the Women's Health Initiative ancillary study (Objective Physical Activity Study and Cardiovascular Health) comprised this sample (n=515 of a sample that will reach ~7000). They wore an ActiGraph GT3X+ accelerometer for one week. To be included in the analysis, participants wore the monitor at least 10 hours/day for 4 days in the past week. Non-wear was defined and dropped as described by Choi et al., 2011, using 60 consecutive minutes. MVPA, vigorous activity, and sedentary behavior were calculated with and without the LFE option. **RESULTS:** Average accelerometer wear time was 14.2 hours/day (14.5 hours using LFE). The overall average counts/minute was 144.0 (standard deviation (SD) 73.2) compared to the LFE of 175.6 (SD 82.1). MVPA estimates varied depending on the threshold chosen, vigorous activity rarely occurred, and the majority of their awake time was spent in sedentary behaviors (table). **CONCLUSION:** Use of the LFE option yielded higher wear time, overall counts, and MVPA, but lower sedentary behavior. The choice of thresholds had a major effect on estimated MVPA. Future studies need to confirm that the LFE option is preferred in older adults and determine its validity as a measurement tool (e.g., by comparison to direct observations) and predictor of health outcomes compared to the regular mode option.

Cutpoint Reference	ActiGraph Cutpoint in counts/minute	Using Regular Option: Mean (SD)	Using Regular Option: Percent Wear Time	Using LFE Option: Mean (SD)	Using LFE Option: Percent Wear Time
MVPA, minutes/day:					
Troiano et al., 2008	>=2020	4.9 (8.7)	0.6	6.1 (9.7)	0.7
Copeland et al., 2009	>=1040	24.9 (22.8)	2.9	32.4 (27.2)	3.7
Matthews et al., 2005	>=760	192.2 (62.9)	22.6	225.5 (66.9)	25.9
Vigorous activity, minutes/day: Troiano et al., 2008	>=5999	0 (0.06)	0	0 (0.1)	0
Sedentary behavior, hours/day: Matthews et al., 2008	<100	10.2 (1.4)	71.8	9.8 (1.5)	67.6

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Board #60

Physical Activity In Patients With Ankylosing Spondylitis Compared to Healthy Controls

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INTRODUCTION: Ankylosing spondylitis (AS) is a rheumatic inflammatory disease that mainly affects the axial skeleton. Important symptoms comprise pain, (morning) stiffness, fatigue, reduced mobility and limitations in the physical function. Likely this will lead to a decrease of physical activity (PA) compared to a healthy population. **PURPOSE:** The aim of this study was to compare patients with AS and healthy controls regarding their PA, using a tri-axial accelerometer.**METHODS:** In this cross-sectional study, PA was measured using an Actigraph GT3X+ attached to the lower back by means of an elastic belt. Subjects wore the device for 7 consecutive days, during waking hours. From the output, total activity counts per day was calculated, as well as the average minutes per day subjects spent in light i.e. <3.00 Metabolic Equivalent of Task (MET), moderate (3.00-5.99 MET) or vigorous PA (>6.00 MET). Subjects also completed an online questionnaire including the BASDAI (disease activity, 0 no symptoms to 10 worst symptoms), BASFI (limitations in physical function, 0 no limitations to 10 most limitations), disease duration in years (patients only), height and weight. **RESULTS:** A total of 135 AS patients (mean age 51 ± 13 y; 60% males; disease duration of 17 ± 12 y) and 100 healthy controls (mean age 44 ± 12 years; 66% males) were included. Patients with AS were significantly older, P <0.001 and had a mean ± SD body mass index (kg/m^2) of 26.0 ± 4.3, compared to 24.8 ± 5.0 in controls (NS). Patients showed the same total amount of PA as well as time spent in low and moderate PA as controls (Table 1). Controls spent slightly more time in vigorous PA. Patients reported significantly higher on the BASDAI 4.3 ± 2.2 and BASFI 4.1 ± 2.6 opposed to controls 1.3 ± 1.2 and 0.38 ± 0.7 respectively, (both P <0.001).
CONCLUSION: Despite experiencing more limitations and disease activity, patients with AS scored a similar amount of total PA as controls and spent equal time in light and moderate PA, except for vigorous PA even though the patients were older. This study indicates the importance ofincluding objective measures of physical functioning in patients with AS.

Table 1: comparisons of the accelerometer output for AS patients and controls

	Patients (AS) (N=135) *Mean ± SD (%)*	***Controls (N=100)*** *Mean ± SD (%)*	***P-value***
Days worn	6.4 ± 0.9	6.6 ± 0.9	NS
Total activity (counts a day)	885938 ± 324690	940838 ± 326982	NS
Time active (min a day)	830 ± 80 (100%)	894 ± 421 (100%)	NS
Time in light PA (min a day)	792 ± 76 (95.4%)	847 ± 398 (94.7%)	NS
Time in moderate PA (min a day)	37 ± 25 (4.5%)	44 ± 35 (4.9%)	NS
Time in vigorous PA (min a day)	1.1 ± 3 (0.1%)	3.3 ± 6 (0.4%)	<0.001

NS, not significant; P-value: independent t-test or Mann Whitney U-test (depending on distribution)

Board #61

Changes In Physical Activity Pattern And Bone Mineral Accrual In Peripubertal Boys: Longitudinal Associations

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INTRODUCTION: One of the key determinants of adult skeletal health is the maximization of bone mineral mass during growth and maturation. Physical activity (PA) in combination of fat free mass (FFM) and fat mass (FM) contribute to high extent in bone mineral accrual, however, PA changes significantly during puberty.**PURPOSE:** The purpose of this study was to examine possible associations between changes in PA exposure to bone mineral development during one year observation period in peripubertal boys. **METHODS:** Participants of this study were 172 boys aged 11-to 13-years at the beginning of study, who performed the same tests with one-year interval. The tests included sexual maturation and bone age assessment, physical activity, and bone mineral and body composition measurements. Everyday physical activity values were measured with 7 day accelerometry and bone mineral and body composition parameters by DXA. **RESULTS:** Sedentary PA (+5.6%) was significantly increased ($p<0.05$), whereas light PA (-13.6%), moderate PA (-10.6%) and total PA (-6%) were decreased ($p<0.05$) after 12-month study period. Significant increases ($p<0.05$) in vigorous PA (+20.7%) and a trend to decrease ($p>0.05$) in moderate-to-vigorous PA (-4.5%) were observed after 12-month study period. Changes in sedentary PA were negatively related to changes in whole body bone mineral density (BMD), lumbar spine BMD, femoral neck BMD and femoral neck bone mineral content (BMC) ($r>-0.175$; $p<0.05$). Changes in femoral neck BMD were explained by changes in FFM, vigorous PA and sedentary PA ($R^2x100=37.7\%$; $p<0.001$) and changes in femoral neck BMC were explained by changes in FFM and sedentary PA ($R^2x100=53.3\%$; $p<0.001$). **CONCLUSION:** Beyond of an independent effect of FFM on the skeleton, the increase in sedentary PA emerged as one of the main PA predictor of bone mineral acquisition during 12-month observation period in peripubertal boys.

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Board #62

Physical Activity Levels During School Recess: Novelty Effects During an Intervention

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INTRODUCTION: Low levels of daily physical activity (PA) are being reported in children, which have negative consequences in their development and health. Children spend the major part of their day in schools, which makes them strategic settings to promote PA. Time spent in recess is a daily period during which children can participate in moderate-to-vigorous physical activity (MVPA). Changes in playgrounds have been shown to increase PA during recess but there's a need for better understanding how those changes occur. **PURPOSE:** The purpose of this study was to investigate the effects of introducing playground markings and making play equipment available during recess on children's PA levels. Another aim was to investigate the novelty effect on physical activity and determine if changes were sustained during 1-month after introducing the intervention.**METHODS:** Fifty-six boys and 41 girls (8.2 ± 1.1 yrs) from 2 elementary schools (control and intervention) in northern Portugal participate in this study. Children were measured for height and weight and wore an Actigraph accelerometer that recorded PA every 5 seconds during the 30-min recess in morning and afternoon. Data were collected at baseline (M1) and 1 (M2), 2 (M3) and 4-weeks (M4) following the playground changes in the intervention school (IntSc) and at M1 and M2 in the control school (ConSc). **RESULTS:** Gender was a significant predictor of physical activity during recess, with boys spending more time in MVPA than girls. Positive and significant intervention effects were found for percent time in MVPA ($p<0.01$). PA levels in the intervention group (MVPA) were significantly higher ($p<0.01$) than in the control group. On average at M2 (1-week later), children in the intervention engaged in MVPA for 37.9% of the recess time compared to 32.2% in the control school. There was also a significant decrease in time-spent being sedentary, dropping from an average of 40.9% to 25.5%. The effect of the intervention was significantly stronger for girls than for boys ($p<0.001$). However, when children in the IntSc were measured at M3 and M4, time spent in MVPA decreased (31.7% and 26.0%) and sedentary time increased gradually (32.5% and 40.0%), returning to the initial levels observed at M1. **CONCLUSION:** Changes in playground design and equipment resulted in significant increases in children's recess PA after 1-week. However, within 1-month of the intervention, after novelty wore off, MVPA levels and sedentary time tended to return to the initial levels. This study shows that for increasing recess PA, introducing playground changes may not be sufficient for warrantying long term increases in children's MVPA.

Board #63

Profiling The Impact Of Active School Travel On Physical Activity And Sedentary Behaviour

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INTRODUCTION: Active travel to and from school may make an important contribution to overall physical activity levels in young people. However if active travel leads to a compensatory effect of decreased physical activity or increased sedentary behaviour at other times of day its beneficial effects may be minimalized. Linking self-reported active school travel to objectively measured, time stamped physical activity data allows the quantification of these associations. **PURPOSE:**To assess differences in objectively measured MVPA and sedentary time daily, before school (8-9am) and after school (3-4pm) between active and non-active school commuters. **METHODS:**Participants (n=984, mean age 10.1, 47% Male, mean BMI 18.0kg/m^2) were from the 2008 Health Survey for England. Raw accelerometer data files were processed using KineSoft version 3.3.75. A dichotomised (yes/no) active travel variable was derived from self-reported walking and cycling to school. Separate MANCOVA models were used to test the association between active travel and average weekday physical activity, average weekday sedentary time, average weekday 8-9am physical activity and sedentary time and 3-4pm physical activity and sedentary time. All analyses controlled for wear time, gender and age. All statistical analyses were conducted using SPSS version 20. Mean difference (MD) was calculated as active travel (yes) - no active travel (no). **RESULTS:**MANCOVA models revealed that there was a significant effect of active travel on average weekday MVPA (MD=12.35, $p<0.001$) although average weekday Sedentary time was not significant (MD= -4.92,$p=0.36$). However further analysis revealed differences between groups between 8-9am for both MVPA (MD=4.814, $p<0.001$) and sedentary time (MD= -2.71,$p=0.021$) and between 3-4pm for MVPA (MD=3.18,$p<0.001$) and sedentary time(MD=-2.55,$p=0.001$). **CONCLUSION:** Active commuting to and from school makes a significant contribution to young people's physical activity levels. Encouraging active travel may therefore be a suitable vehicle to increases young people's physical activity.

Board #64

Parent-Child Physical Activity Relationships using Accelerometers

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Regular physical activity (PA), in youth, needs to be promoted to prevent obesity and subsequent clustering of CVD risk factors. Influences of parental PA on adolescents' activity level have been studied with discordant results, using different methods, making it difficult to compare the influence of parents in their child PA patterns. In this sense, parents are recognized as one of the factors of influence on physical activity of children and can therefore act to prevent obesity and other health problems. **PURPOSE:** (I) determine the prevalence of overweight and obesity in the sample studied, (II) verify the levels of PA, analyze the differences between gender and different ages, and the number of subjects that meet the current recommendations, (III) investigate how the parents PA is related to the PA of their children. **METHODS:** The sample consisted of two separate groups: Children - 131 adolescents (48 boys and 83 girls:), aged between 12 and 16 years. Parents Group - 38 Adults (father / mother of the previous group of students), 11 male and 27 female. PA was objectively measured over 7 and 5 consecutive days of monitoring, (respectively the group of students and the group of parents) by accelerometers (MTI Actigraph GT3X) and the classification of the level of PA has been performed by Evenson et al. (2008) and Troiano et al (2008) cut-off points.**RESULTS:** The main results showed that boys are more active than girls ($p<0.05$). Only a small proportion (16.8%, for 5 days) of adolescents meet up current recommendations for PA, this means, one hour per day, most days of the week of moderate to very vigorous PA. Compliance of parents' PA recommendations (47% meet up with 4 or more days) has a significant contribution in the amount of minutes spent in moderate to vigorous PA by adolescents of both genders, mainly in the case of the mother-daughter relationship.**CONCLUSION:** In this context, it is important the implementation of strategies that contribute to increase the students moderate to vigorous PA. At this level, female subjects seem worth special attention. Note also the role of parents in the implementation and maintenance of active and healthy lifestyles from childhood.

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Board #65

Risk Of Running Injuries In Minimal Footwear/barefoot Runners - New Hypothesis Generated By Crowd Sourcing

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PURPOSE: There is an on-going debate about incidence of injuries in minimal footwear/barefoot (MF/B) runners compared to runners using conventional running shoes (SH) [1-5]. Aim was to investigate the method viability and to archive first insights on running behaviour, kilometric performance and injuries in the past. **METHODS:** An online questionnaire was set up using google forms advertised by "barefoot runners society" and by the newsletter of "free heel running pad". Runners were eligible to fill out the questionnaire, if they were used to run with SH some time ago, but then, after a certain transition phase, run mostly either in MF/B. The questions were about running distance, number of injuries during last SH phase and transition phase, and if MF/B was used. **RESULTS:** 204+ runners filled out the questionnaire within 2 weeks. Sex ratio male/female was about 3:1, mean age was about 40 y. More than 90% of the datasets could be included in the analysis. We found a considerably increased risk of injury during period of changing from SH to MF/B running. This was also reflected in a number of the free text reports ("too much too fast"). Injury rate per km seems to be smaller in MF/B than in SH running, after the transition period has been managed (see also [4]). **CONCLUSION:** The risk of injury during transition phase in the group of responders ("crowd sourcing") is considerably higher compared to habitually running either SH or MF/B; however there is a risk of bias. The data seem to confirm the need of special guidance to the runner, especially in the transition phase, to reduce the incidence of injuries. Future research into the right "dosage" of MF/B running in the transition period is warranted. It is well known that MF/B runners have a higher step frequency. Therefore we have to conclude that there must be a strong beneficial effect on injury rate per step in case of trained BF/M runners.

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Board #66

Activity Profile of Menopausal Women Using the activPAL Professional Physical Activity Monitor

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PURPOSE: Daily physical activity is a behavioural factor that plays a role in the etiology and prevention of many diseases. Nowadays, physical inactivity is related to many health issues and it has become a public health priority. In particular there are few reports on the effect of a physical activity programme on climacteric symptoms. Recently the importance of exercise, and its incorporation in the treatment has been pointed out. However, there is also a need to investigate the levels of activity that are not related to the therapy. It is very possible that these activities are an important factor; moreover knowing the levels of daily activity will help to tailor a programme of physical activity. This paper describes the daily activity profile of menopausal women. **METHODS:**Data for this study was collected from five menopausal middle-aged women whom agree to participate as volunteer. The daily physical activity was evaluated with the activPAL physical activity monitor for six consecutive days. The activPAL is a single thigh mounted accelerometer based device, measuring 53 × 35 × 7 mm and weighing 20 g. It provides 2 types of information: (1) steps and activity counts and (2) inclinometer information, used to determine posture. The activPAL was worn on the midpoint of the anterior aspect of the thigh and an adjusted-velcro pouch to hold the monitor.**RESULTS:**The average number of steps was about 6400 steps per day. One participant had a significant number of steps during the weekend and much less steps during weekdays. The average time spend in sitting/lying position was about 73%, whereas the standing time was about 20% and the stepping time was about 7%. **CONCLUSION:**Results showed a ”low active” behaviour for this group, which is in concordance for the average adult. A recommended increase of 3000 steps per day (1 h walking) might be enough to achieve suggested goal of 10,000 steps per day. For most people this could be more attractive and easy to achieve rather than to enrol in an exercise programme. The activity profile then could be used to personalise a set of activities (leisure activities or exercise programme) that help to reach an “active” level of physical activity. It is also clear that these levels of activity must be correlated with the menopausal complaints. Thus a further research is required.

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Board #67

Accelerometer-Determined Steps Per Day in Norwegian Adults and Older People

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PURPOSE: There is a lack of large-scale comparable data on the population levels of physical activity in Scandinavia. The purpose of the study is to present normative data on accumulated steps per day across age and sex in a representative population of adults and older people living in Norway (20-85 years). **METHODS:** In 2008 and 2009, we conducted a cross-sectional population-based multicentre study of accelerometer-determined steps per day. Data was collected using the threshold crossing mode embedded in the ActiGraph GT1M accelerometer. A total of 3,251 participants provided valid physical activity assessments that met all inclusion criteria. **RESULTS:** Overall, women and men accumulated 7951 (95% CI: 7802 to 8101) and 8113 (95% CI: 7973 to 8252) steps per day, and there was no differences between the sexes. A total of 23% of the participants accumulated at least 10,000 steps per day (95% CI: 21 to 24). Steps per day remained steady with age, until 65 years, after which a decline was observed. For those aged 65 or older, the estimated yearly decrease was 215 steps per day (95% CI: 168 to 263). **CONCLUSION:** This is the first large-scale assessment of step-defined physical activity in Scandinavian adults and older people, and can serve as normative data for this population. However, to assess national and international trends in physical activity, a recurring surveillance system must be established using comparable methods and data reduction procedures. Furthermore, such a surveillance system should include a thorough description of recruitment strategies and flow of invitees in order to ensure the generalizability the results obtained.

Board #68

QMedic: Next Generation Personal Emergency Response Systems (PERS) for Older Adults

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Founded by MIT scientists, QMedic is the first wearable emergency response platform designed for older adults that adaptively samples high-resolution sensor data in free-living environments without requiring battery recharge. Worn on the wrist or neck, QMedic's device broadcasts real-time sensory data to the cloud, where it can be analyzed by clinicians and researchers to study activity levels, wear/non-wear patterns, sleep, balance, falls, and other disease-related behaviors. QMedic objectively measured outcomes are then delivered in real-time to caregivers' phones and mobile devices to ensure loved ones get the care they need, when they need it. QMedic was named one of three finalists in the prestigious 2012 Amazon Web Services Global Startup Challenge (in the Big Data and High Performance Computing category) out of over 2500 companies. The company was also a finalist for the 2012 AARP Startup Challenge. The company is a recipient of an SBIR contract from the National Cancer Institute, through which it has built a highly scalable platform to collect, store, and analyze high-resolution sensory data in the cloud. In our presentation, we will demonstrate key aspects of our technology.

Board #69

Event-based Physical Activity- How Is Wheelchair Physical Activity Accumulated?

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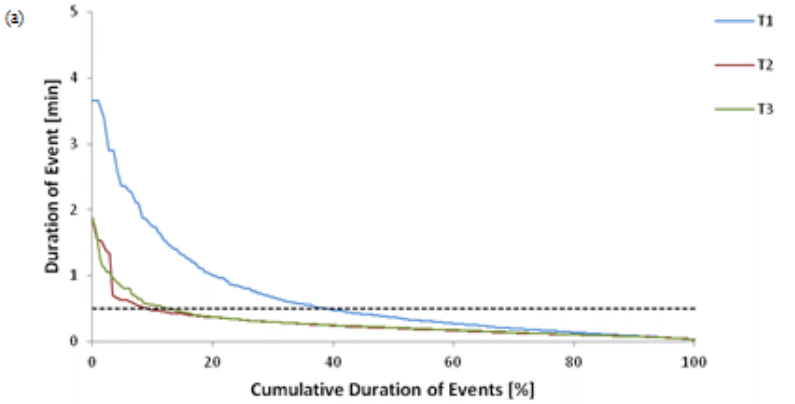
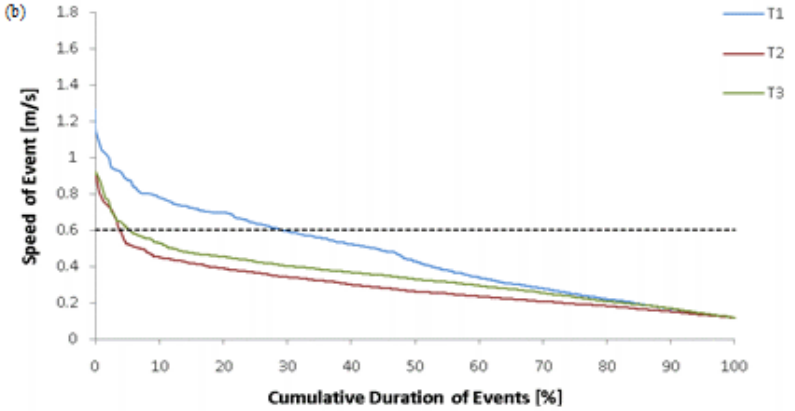
INTRODUCTION: A single uninterrupted wheelchair movement period/bout can be defined as a Physical Activity (PA) event. Determining the duration of individual wheelchair PA events provide further understanding of how PA is accumulated. The duration of wheelchair PA events can also be used to assess the adherence to PA guidelines. **PURPOSE:** To investigate wheelchair PA levels and how PA events change between the rehabilitation and community settings. **METHODS:** PA levels of 11 wheelchair users with spinal cord injury (42±14 years) were measured for seven consecutive days. Wheelchair PA was measured using a validated monitoring system consisting of an accelerometer attached to the rear wheel. Patients were measured at three time points: in a rehabilitation setting prior to discharge, six weeks and six months post discharge. The distributions of individual events were analysed using cumulative graphs. The duration of individual forward events performed over 1 week were sorted from longest-shortest duration and plotted against the cumulative percentage of the total duration of forward propulsion. The same technique was repeated for the speed of individual events. **RESULTS:** In the rehabilitation setting patients propelled their wheelchair for an average of 56±19 minutes and 1,665±747m /day. Participants propelled their wheelchair forwards at an average speed of 0.75±0.11 m/s. There was no statistical difference in total duration, distance and average speed between all time points. In the rehabilitation setting over 60% of the total forward duration was made up of events shorter than 30 s in duration and at speeds less than 0.6 m/s. In the community setting PA events tended to be slower and shorter in duration. Figure 1 shows an example of the cumulative duration and speed of individual events for one participant. **CONCLUSION:** Although on average there was no significant difference in total PA between the different settings, there was a difference in the way that PA events were accumulated. PA events tended to be longer and faster in the rehabilitation setting than in the community. This may be due to difficulties propelling a wheelchair in the community, for instance uneven terrain, short corridors and confined spaces, particularly within the home environment. It is important for wheelchair users to be trained to propel for longer durations and at higher intensities as they areunlikely to gain health benefits from slow, short PA events.





	T_1	T_2	T_3
Average daily forward duration (min)	56	32	41

Figure 1 Cumulative percentage of total duration of forward wheelchair propulsion events per week for one participant at the rehabilitation setting (T_1), six weeks post discharge (T_2) and six months post discharge (T_3) for, (a) the duration of individual events, and (b) the speed of individual events. Horizontal dashed lines indicate 30 s and 0.6 m/s.

Board #70

Associations between Daily Postural Transitions and Weight Status in 9-11 year old School Children

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INTRODUCTION: Childhood obesity increases the risk of health problems both during childhood and in adult life. While the causes of obesity are complex, it is acknowledged that physical activity (PA) levels influence children's obesity levels. Research into children's PA has tended to concentrate on total volumes of activity, while postural patterns of PA have received less focus.**PURPOSE:** To investigate the relationships between weight status and the postural patterns of free-living PA of 9-11 year old school children. **METHODS:** Healthy children aged 9-11 years were recruited from two schools in the West of Scotland. PA in terms of steps taken and posture (stepping, standing, sitting/lying) was measured using an *activ*PAL3 activity monitor for up to seven 24-hour periods (minimum 1 weekend day, 3 week days). The sample was divided into two groups by comparing the participants' BMI against UK 1990 reference data as follows: Non-obese (BMI < 95th centile); Obese (BMI ≥ 95th centile). **RESULTS:** Data were analysed for 41 participants (18M:23F) aged 10.3 ± 0.6 years (median ± IQR).There was no difference between the two groups in mean daily step count or the time spent stepping (Table 1).

Table 1 Objectively measured PA outcomes by weight status

Mean Daily Figures	**Non-obese (N = 29)**	**Obese (N = 12)**
Steps	11,325 (2,200)	10,440 (2,311)
Duration (hours):		
Stepping	2.3 (0.4)	2.2 (0.4)
Standing	3.7 (0.8)	3.1 (0.8) *
Sitting/lying	18.0 (1.0)	18.7 (0.9) *
Posture Transitions:		
Standing ↔ Stepping	955.5 (114.8)	893.0 (121.0)
Sitting/lying ↔ Standing	408.5 (109.7)	325.9 (83.0) *

Figures shown are mean (SD). * denotes significant difference ($p < 0.05$)

There were, however, significant differences in daily standing and sitting/lying durations of over 30 minutes a day. The number of transitions between different postural states was also analysed e.g. moving between sitting/lying and standing, or between standing and stepping. The non-obese group carried out significantly more transitions between sitting/lying and standing than the obese group. This amounted to an average of 82.6 (25.3%) more transitions per day. This indicates that in addition to being upright more each day, the non-obese group broke their activity up more. The combination of more upright time together with a higher number of postural transitions could make a significant contribution to the difference in weight status of the two groups. **CONCLUSIONS:** Obese children performed less postural transitions between sitting/lying and upright than non-obese children. Further event-based analysis of the differences in children's postural patterns may help inform interventions to reduce obesity in children.

Board #71

Collecting Baseline Data on Physical Activity and Health as part of a Regional Travel Survey

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INTRODUCTION: The Nashville Area MPO completed their regional transportation survey in December 2012. This travel survey included a health and physical activity component in which 11,752 persons were asked six basic health questions. A subset of those study participants wore a GPS and accelerometer, some of whom also completed an extensive health questionnaire. This paper outlines the study methodology and presents study results. **PURPOSE:** The goal of the study was to collect baseline data that will allow the MPO to quantify the effect that including health and safety criteria in the evaluation and ranking of future transportation projects (required in the 2035 Nashville Area Regional Transportation Plan) has on the overall health of Nashvillians. **METHODS:** The health and physical activity component included the instrumentation of 1,916 persons in the region with a GPS and 1,006 with an accelerometer in tandem for four consecutive days. The data collected by these devices, along with the data from a health questionnaire will be used evaluated in tandem with GIS data from the region to evaluate the effect of the built environment on the health and physical activity of participants. The health questionnaire collected related details and perceptions from study participants. The survey included elements based on questions from common health surveys including the IPAQ long and short forms and the BFRSS 2011. **RESULTS:** Data analysis is currently underway, and will be completed this spring. Preliminary results comparing the health survey and objective physical activity data collection demonstrate significant discrepancies between participants' perceived levels of activity and the actual levels of activity captured by the GPS and accelerometer equipment. For example, 67% of persons instrumented with an accelerometer that reported they do at least some vigorous activity in a given week failed to collect even one minute of vigorous activity during their four day travel period. There is also analysis being conducted which compares perceived 'overall health' with the actual BMI (reported height and weight) for both adult and child participants. **CONCLUSION:** The study proved that GPS and accelerometer technologies can be used effectively for collecting good, precise information about where, when and at what intensity physical activity occur as part of a large-scale regional travel survey. Collecting these data is both feasible, and advantageous. It is recommended that transportation and planning professionals continue to work with health professionals to explore and quantify the intersection between health and transportation.

Board #72

Changes in Daily Activity Patterns with Advancing Age among US Men and Women

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INTRODUCTION: Previous population accelerometer data indicates that men are more physically active then women in adulthood. However with advancing age, men become more sedentary than women, but no systematic studies have focused on this potential crossover by sex in activity pattern with age. **PURPOSE:** To examine the changes in daily and hourly PA patterns by age and sex; to examine whether sex differences in activity are independent of a priori covariates and confounders. **METHODS:** Accelerometer data from 5,792 men and women aged ≥20 years from the 2003-2006 NHANES, with 4+ valid days (≥ 10 hrs·d^{-1}) of wear-time. Physical activity (PA) was examined as average counts per minute (CPM) during wear-time and minutes spent in sedentary (<100 counts), light (100-759), and lifestyle and higher activity (≥760), both daily and hourly. Regression analyses adjusted for valid weartime minutes, age, race, education, marital status, household size, BMI, self-rated health, number of unhealthy days, number of chronic conditions, employment status, and hours of television viewing. All analyses were examined by sex and accounted for survey weights. **RESULTS:** Overall PA levels reached the highest levels around age 30 and gradually declined with advancing age. In adjusted models, men had slightly higher PA levels than women from ages 20 to 49, with converging levels at ages 50-59. A separation occurred among those aged 60 and over: older women spent significantly more time in overall activity than older men (ages 60-64, ≥70: $p<0.05$; 65-69: $p<0.10$). In men, the decrease in overall activity with age was mainly in light, lifestyle and MVPA minutes; in contrast, levels of light intensity activity remained fairly constant (~30%) for each age-group of women. Periods of daily activity were condensed throughout the day with increasing age. Compared to women, men had fewer CPM in the evening (ages ≥70), more sedentary minutes early to mid-morning and afternoon (ages 60-69; ≥70), fewer light intensity minutes throughout the day (ages 60-69; ≥70), and more lifestyle minutes until early evening (60-69; ≥70, all $p<0.05$). **CONCLUSION:** The observed gender crossover in overall activity remained independent of covariates and confounders. Men did not appear to replace lost MVPA and lifestyle activity with light activity, suggesting that women may engage in necessary activities longer into older age than men.

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Board #73

Objectively And Subjectively Measured Physical Activity: Associations With Cognition And Academic Achievement In Adolescents

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BACKGROUND: Physical activity has a positive effect on cognitive performance in adults. Therefore, physical activity may stimulate cognitive performance and thereby academic achievement in adolescents as well. However, the association between physical activity and cognitive performance in adolescents is still unclear, because only a few studies investigated this association and reported mixed results. One shortcoming of these studies is the lack of an objective instrument to measure physical activity. Physical activity was generally based on self-report, a method that is sensitive for social desirability and recall bias. Therefore, we investigated associations in adolescents between objectively and subjectively measured physical activity on the one hand and cognition and academic achievement on the other hand, controlling for covariates.**METHODS:**Cross-sectional study in 441 students (grade 7 and 9). Physical activity was measured objectively by accelerometry. Participants wore an accelerometer (ActivPAL3™) one week (24 hrs/day). Physical activity was measured subjectively by questionnaire (IPAQ-A). Cognitive performance was measured by two neuropsychological tests (D2 test of attention, Symbol Digit Modalities Test). Academic achievement (scores Dutch, mathematics, English) provided by the school. Aerobic fitness and body mass index measured were measured objectively. Socioeconomic status, pubertal phase measured by self-report. Regression analysis was used to analyse associations between physical activity and cognition and academic achievement.**RESULTS:**Objectively measured physical activity was not associated with cognitive performance and negatively association with academic achievement ($\beta = -.110$, $P = .030$). Subjectively measured physical activity was not associated with cognitive performance and academic achievement.**CONCLUSION:**Objectively measured physical activity is negatively associated with academic achievement in adolescents. Our results are in contrast with the majority of studies reporting positive associations between physical activity and cognitive performance / academic achievement. Several reasons indicate that our objectively measured results are more reliable than our subjectively measured results (i.e. missing values, previous research).

Board #74

Using Activity Monitor as Part of an Activation Method - A Pilot Study in Young Men

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INTRODUCTION: Despite the known benefits of physical activity (PA), recent evidence consistently demonstrates that a majority of adolescents do not meet current PA recommendations. Wearable monitors that provide feedback to users have been used in longitudinal interventions to motivate research participants and to assess their compliance with program goals. However, data on their use and effectiveness are scanty on young men.
PURPOSE: To examine whether a wrist-worn physical activity monitor has an effect on the amount of daily PA in young men. This pilot study is a part of a larger MOPO study [1].
METHODS: A representative sub-population (N=280) from a population based sample (N=778) of conscription-aged men (mean 17.9, SD 0.7 years) was recruited for a three-month physical activation pilot trial. Participants were randomized to an intervention (N=141) and a control (N=139) group. The intervention group had a wrist-worn physical activity monitor (Polar Active, Finland) showing the daily PA during the whole study period. In addition, access to a gamified activation service was provided from the second week until the end of the trial. For the control group daily PA was measured by identical but blinded activity monitors during the entire trial.
RESULTS: Activity data from 73 (52 %) and 92 (66 %) men from the intervention and control groups, respectively, were collected during the trial and a total of 7069 days were included for analysis. Around 70 % had more than ten hour daily usage time. The average time spent on moderate or vigorous PA (> 3.5 MET) in the intervention and control groups during the five time points is shown in figure 1. PA during the first week increased in those wearing activity monitors providing feedback compared with controls (p=0.035). During the second week the activity level of intervention group remained at the same level. However, the difference between groups was not statistically significant and the level of activity decreased during the rest of the trial.
DISCUSSION: Wrist-worn activity monitor motivated young men to increase their daily PA at the early phases of the trial, but this increase was not sustained. Activity monitors may be a tool when planning future studies involving physical activity interventions and developing comprehensive, attractive services for the optimal motivation of young men.
REFERENCES:
[1] Ahola et al. BMC Public Health 2013; Jan 14;13:32,2458-13-32.

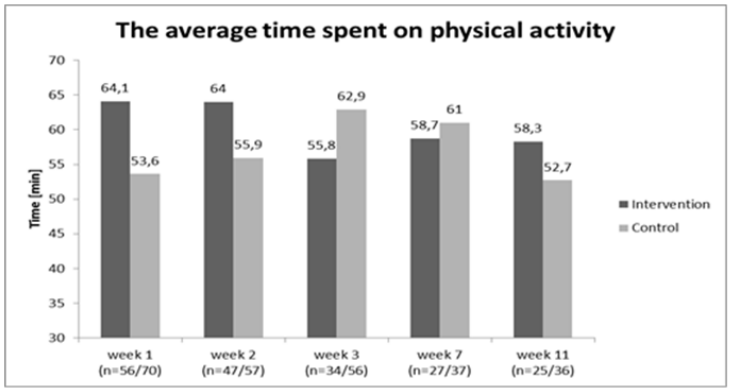

Fig.1. The objectively measured average time spent on moderate and vigorous physical activity during five different wee 7, 11) of the trial in the intervention and the control groups.

Board #75

Objectively Quantifying Physical Activity in an Evidence-Based Program for Older Adults

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INTRODUCTION: Older adults are the least like age group to meet physical activity (PA) recommendations. To rectify this, many Medicare programs cover PA programs such as EnhanceFitness (EF)--a structured, group-based PA class held in community settings across the U.S. While evidence-based, the amount of objectively measured PA obtained through EF is unknown. **PURPOSE:** To use accelerometers and behavioral observations to objectively quantify the amount and intensity of PA during EF classes and examine different accelerometer metrics for doing so. **METHODS:** Participants across 5 EF classes (mean age = 78, 35% male) wore either an Actigraph GT3X (N = 25) or wGT3X+ (N = 21) around the waist above the right hip during class. Trained observers used interval recording techniques to classify minutes (mins) spent in various PA types (e.g. aerobic, strength) during each class. Accelerometers recorded movements in 15 second epochs using the low frequency extension (LFE) for the wGT3X+. Time spent in different PA intensities was estimated from vertical axis accelerometer counts (counts•min-1) using established cut points for sedentary (≤ 100), light (101-759), lifestyle (760-1951), and moderate (1952 or higher). We also estimated PA intensity using the vector magnitude (VM) values from all three axes for light (0-2690 counts•min-1) and moderate (2691 or higher counts•min-1) PA. Vigorous PA was not examined separately from moderate as < 1 min was recorded. **RESULTS:** Behavioral observations showed that EF participants spent a mean of 49 mins standing, 21 mins aerobic, 18 mins strengthening, 14 mins stretching, and 2 mins in balance activities. The mean accelerometer values were: 28.3 mins sedentary, 22.6 mins light, 8.3 mins lifestyle, 1.8 mins moderate activity, 49.9 mins light using VM, and 11.1 mins in moderate activity using VM. The wGT3X+ with the LFE recorded 5 mins less sedentary time and 5 mins more light PA. **CONCLUSION:** While 21 minutes of EF class time was classified as aerobic very little of the activity met the moderate intensity threshold by accelerometer. Even though observations showed movement throughout class (only 11 mins sitting), ~50% of class time was captured as sedentary by accelerometers. Using a lower threshold of 760 counts•min-1 or higher or the VM moderate PA threshold, EF participants achieved ~10 minutes per class towards meeting PA guidelines. This suggests programs such as EF could be improved to help older adults reach aerobic PA guidelines. At the same time, using a lower counts•min-1 threshold, VM values, and/or the LFE may more closely approximate actual activity level among older adults but further research is warranted.

Board #76

Sleep Disorders and Physical Activity among U.S. Adults: National Health and Nutrition Examination Survey

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INTRODUCTION: Sleeping disorders (SD), common medical conditions that are characterized by repetitive bouts of apnea and hypopnea during sleep, have been linked to serious medical conditions such as cardiovascular morbidities, day-time sleepiness, and impaired cognitive function. There appear to be associations between physical activity (PA) and SD, however little research has been conducted investigating these relationships. **PURPOSE:** To examine the relationship between SD and PA using a national representative sample of US adults. **METHODS:** Data from the 2005 to 2006 National Health and Nutrition Examination Survey (NHANES) were analyzed for this study. A total of 3,060 adults (Mean age = 50.49 years), who had valid responses on outcome variables (i.e., diagnosis of SD and presence of sleeping problem) and a minimum of four valid days of objective PA monitoring were included in the analysis. Participants were grouped based upon responses to SD questions [no sleeping problems (NP), reported non-diagnosed sleeping problem (SP), and reported diagnosis with sleeping disorder (DSD)].The Actigraph AM-7164 accelerometer was used to measure the average duration of minutes spent in moderate or vigorous physical activity (MVPA). Participants were divided into four groups created using quartiles of MVPA. Multinomial logistic regression was used to examine the association between SD and PA after controlling for covariates (i.e., age, race, and BMI). SAS v9.3 SURVEY procedure was used to account for complex sampling design in NHANES. **RESULTS:** Analysis revealed that among US adults an estimated 6.9% (SE = .48) reported DSD, 18.0% (SE = .57) reported SP, and 75.1% (SE = .58) reported NP. SD was significantly associated with MVPA when controlling for covariates (Wald x^2 (6) = 34.53; $p < .001$). Using NP as a reference category in SD, participants in the highest quartile of PA ($\geq$ 75%) were less likely to report SP (OR = .60; 95% CI: .38 - .94) and DSD (OR = .40; 95% CI: .24 - .66), respectively, compared to those in the lowest quartile of PA ($\leq$ 25%). Participants in the third quartile of PA (50% - 75%) were less likely to report SP (OR = .65; 95% CI: .43 - .98) and DSD (OR = .31; 95% CI: .18 - .54), respectively, compared to those in the lowest quartile of PA. **CONCLUSION:** These results indicate that adults who were less physically active may be at an increased likelihood of SD, when compared to those who are more active. It is important for health care professionals to continue developing methods for increasing adult participation in PA to decrease the risk of developing SD.

Board #77

Association Between What You Can Do (physical Function) And What You Do (physical Activity)

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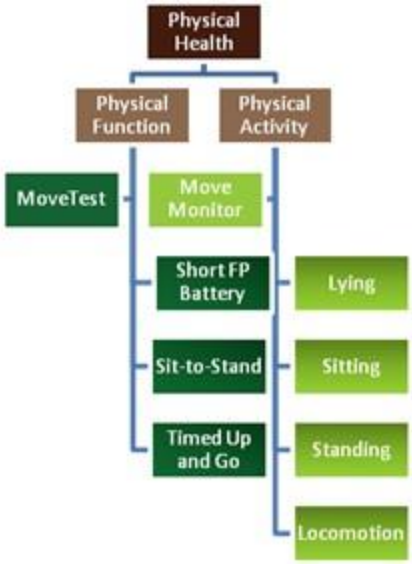
INTRODUCTION: Guidance documents for development and validation of patient-reported outcomes (PROs) recommend the use of conceptual frameworks (FDA 2009). However, Gimeno-Santos (2012) concluded that none of the available instruments for measuring dimensions of physical activity or related constructs meets this recommendation. A conceptual framework is a visual or written product that explains the main things to be studied and the presumed relationships among them (Miles et al. 1994). We aimed to develop a framework using physical health as general concept; physical function (PF) and physical activity (PA) as domains, and performance tests and types of activity as subdomains (see figure). **PURPOSE:** Analysing intra- and inter-relations between outcomes of supervised PF and PA in daily life in older adults using a conceptual framework.**METHODS:** Fifty older adults (83,7 ± 6,9 yrs.) were recruited from either a care home or the general community. PF was measured with the Short Physical Performance Battery (SPPB), 3x Sit-to-Stand (STS) and the Timed Up and Go (TUG). During two tests (3x STS and SPPB-Gait) the subjects performed at their preferred speed. PA was measured day and night for one full week. They were instrumented with a single body fixed sensor (DynaPort). Outcomes were analysed using commercially available software (McRoberts). Types of activities were determined; from these 1) total duration, 2) number of periods, 3) mean period duration and Spearman correlations were calculated. **RESULTS:** All 15 correlations between PF outcomes were significant (13 at $p< 0.01$ and 2 at $p< 0.05$), while 33 out of 66 correlations between PA outcomes were significant (27 at $p< 0.01$ and 6 at $p< 0.05$). From the 48 correlations between PF and PA outcomes 34 were significant (26 at $p< 0.01$ and 8 at $p< 0.05$) (see table for R and p values). **CONCLUSION:** TUG, SPPB-Balance, SPPB-STS and SPPB-Total outcomes correlated markedly better with the PA outcomes than the STS and SPPB-Gait outcomes. This suggest that when older adults have to perform at their maximum capacity during the PF test, the outcomes correlate better with PA outcomes in daily life. We conclude that the observed relationships support the adopted conceptual framework.

	LYING			SITTING			STANDING			LOCOMOTION		
	Total	Periods		Total	Periods		Total	Periods		Total	Periods	
	dur.	n. dur.	count	dur.	n. dur.	count	dur.	n.dur.	count	dur.	n.dur.	count
3xSTS	.249 .108	.166 .289	-.046 .770	.045 .775	.269 .081	-.270 .081	-.246 .112	.305 .047	-.356 .019	-.358 .019	-.092 .556	-.427 .004
TUG	.346 .021	.208 .175	-.070 .654	.127 .410	.489 .001	-.463 .002	-.501 .001	.319 .035	-.552 .000	-.488 .001	-.023 .882	-.651 .000
SPPB BALANCE	-.230 .133	-.211 .169	.140 .364	-.124 .422	-.470 .001	.418 .005	.482 .001	-.209 .174	.538 .000	.577 .000	.264 .083	.611 .000
SPPB GAIT	-.284 .062	-.164 .286	.041 .790	-.079 .609	-.292 .054	.262 .086	.335 .026	-.150 .331	.319 .035	.307 .043	.030 .847	.419 .005
SPPB 5xSTS	-.179 .244	-.034 .829	-.029 .854	-.234 .126	-.532 .000	.514 .000	.447 .002	-.492 .001	.645 .000	.622 .000	.051 .740	.724 .000
SPPB TOTAL	-.266 .081	-.207 .179	.106 .494	-.178 .247	-.526 .000	.486 .001	.516 .000	-.314 .038	.595 .000	.598 .000	.155 .316	.700 .000



Board #78

'Home' and 'Away': Location-Based Differences in Walking in Individuals with Intermittent Claudication

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INTRODUCTION: Combining Global Positioning Systems (GPS) with activity monitors has the potential to provide quantity, intensity, type and location information on physical activity (PA). Intermittent Claudication (IC) is a chronic vascular condition causing cramp-like leg pain when walking due to insufficient blood flow. Consequently, these individuals have impaired walking function limiting daily PA and lowering health-related quality of life. PURPOSE: This study tested the feasibility of using both GPS and an activity monitor to measure PA in individuals with IC. The aim was to determine if there were location-based differences in the walking characteristics of individuals with IC during periods at home compared to away from home. **METHODS:**Five participants (all male; mean age 69 [64 - 74 years]) wore an activity monitor (activPAL, PAL Technologies) and carried a GPS device (AGL3080, AMOD Technology) for 7 consecutive days. GPS data (sampled every 5s) was cleaned based on speed (≤8m/s) and self-recorded GPS quality. Distance from home, derived from GPS data, was used to categorise location as 'Home' (≤50m) or 'Away' Time-stamped activity data, classified as sit/lie, stand or walk, was matched to the GPS. All walking events (continuous periods of walking) were coded as home or away from the GPS output. Duration of walking, number of steps and mean cadence of the walking events were compared (Mann-Whitney U) for the two geographical conditions home and away for the group and individually. **RESULTS:**Participants had six (n=3) or seven days data available for analysis, a total of 8,167 walking events. In total, participants walked 59±31 (33 - 112) min/day, taking 4,734±3,031 (2,512 - 10,072) steps/day. Participants spent similar amounts of time and steps when walking at home (34±9 min/day, 2,345±664 steps/day) compared to walking away (25±23 min/day, 2,389±2,438 steps/day). For the group as a whole, walking events at home, compared to those away were significantly shorter (10±13s vs. 32±75s, $p<0.001$), contained significantly fewer steps (12±19 vs. 50±141 steps, $p<0.001$) and had a significantly lower mean cadence (71±26 vs. 75±25 steps/min, $p<0.001$). Individually, participants followed the same pattern as the group, except that two participants did not show a significant difference in the cadence of walking events.**CONCLUSION:** Using GPS in conjunction with the activPAL activity monitor home-based walking activities can be distinguished from those based away from home, allowing for a more detailed picture of an individual's walking activity. Individuals with IC walked in significantly longer continuous periods, with more steps at a higher cadence when away than at home.

Board #79

School-day Physical Activity In Elementary School Children: When And How Much?

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INTRODUCTION: Current data suggest that few children are meeting physical activity (PA) guidelines. The school day has been targeted for PA-based interventions; however, with the exception of recess, there is little information on when children engage in PA during the school day.**PURPOSE:** The purpose of this study was to examine temporal characteristics and variability of PA accumulation across the elementary school day in an effort to better inform PA intervention approaches. **METHODS:** Using a wrist-mounted GENEActiv accelerometer, we collected six days of accelerometry data from 133 children in first, third, and fifth grades who were participating in the Intervention of PhysicaL Activity in Youth (IPLAY) study. Raw acceleration data (g) were collected at 75 Hz, filtered, and vector summed over a 1-second interval. We then used calibration-derived intensity cutpoints to determine the amount of time spent in moderate-vigorous PA (MVPA). School-day MVPA was quantified during distinct custom intervals (i.e., entire school day, class time, break time, PE) to determine MVPA accumulation and inter-child variability in the time spent in MVPA across the school day. **RESULTS:** Children spent a mean of 30.3% (122 min.) of the entire school day, 27.8% (95 min.) of class time, 42.2% (17 min.) of PE, and 49.3% (18 min.) of break time engaged in MVPA. The maximum percentage of time spent in MVPA across each custom interval was 43.2% (176 min.), 41.7% (152 min.), 69.3% (34 min.), and 72.5% (33 min.) of the entire school day, class time, PE, and break time, respectively. Break time and PE demonstrated the greatest inter-child variability between the minimum and maximum percentage of time spent in MVPA. A main effect of grade was found for the entire school day and class time, such that younger grades spent a significantly greater percentage of time in MVPA than did older grades. During break time, boys spent a significantly greater percentage of time in MVPA than did girls. No main effect of weight status was found.**CONCLUSION:** Our results suggest that elementary school aged children, regardless of weight status, are meeting/exceeding recommended amounts of school-day MVPA. Despite these findings, which may be due to the use of raw acceleration data summed over a one second interval, there is still room for increasing MVPA across the school day. Specifically, based on the mean and maximum values of school-day MVPA, it may be possible to increase mean school-day MVPA by up to ~50 minutes. Based on considerable inter-child variability across all custom intervals, the potential for increased MVPA exists across all intervals of the school day.

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Board #80

Non-Sedentary Physical Activity (NSPA): A Relevant Way of Examining Physical Activity Levels in Advanced Age Adults

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BACKGROUND: Physical activity interventions and dose-response recommendations routinely focus on attaining levels of moderate to vigorous intensity activity (MVPA) to achieve positive health outcomes. However, evidence shows that older adults are less likely to engage in MVPA than younger adults. Recent research has showed that even increasing lighter intensity activities can have positive health outcomes in both community dwelling and institutionalized older adults. Also, given the health risks of being sedentary (sitting), interventions focusing on reducing sedentary time and increasing non-sedentary physical activity (NSPA) may be more realistic and therefore more successful. **PURPOSE:** This study aimed to describe the activities of older adults in terms of time spent in sedentary and non-sedentary behaviors and to determine the convergent validity of a self-reported measure of NSPA against accelerometry.**METHODS:** 48 adults aged 80 and over wore an Actigraph GT3X accelerometer and completed a use of time recall, the MARCA (Multimedia Activity Recall for Children and Adults), over a period of one week. NSPA was determined by accelerometer cut point count.min-1 $\geq$ 100 and by activities classified by METs through the MARCA. Convergent validity of the self-reported and objective measures of NSPA was determined by Spearman's correlation coefficients.**RESULTS:** Participants were on average 85 years (Mean 84.9 SD 1.62) and equally distributed by sex (24 male, 24 female). The convergent validity of the measure of NSPA between the MARCA and accelerometry was (rho = 0.59). Overall, 26% of daily EE resulted from sleeping, 36% from activities requiring 1-1.9 METs (eating 4.7%, sit/talk 4.0%, puzzles and crafts 2.9%, reading 6.5%, TV 8.8%), 17% from activities requiring 2-2.9 METs (self-care, chores and shopping in about equal measure), and 21% from MVPA. **DISCUSSION:**A substantial proportion of daily energy expenditure comes from NSPA in advanced age adults, notably from chores, self-care and shopping. This time can be accurately captured with use of time instruments. Focusing on increasing NSPA rather than MVPA could be a more feasible way to increase activity in advanced age adults. In particular, interventions might best look at reducing activities at the 1-1.9 MET range such as watching television, and increasing activities at the 2-2.9 MET level.

Board #81

Is All Screen-time Sedentary? Feasibility Of Wearable-cameras To Assess Different Types Of Screen-time

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INTRODUCTION: Self-reports assessing sedentary behavior (SB) often use screen-time to assess time spent in SB (Clark-2008). Recent media technology includes for example smart phones and tablets that might not be exclusively sedentary and that have not been investigated in free-living settings. **PURPOSE:** The purpose of this feasibility study was to investigate the utility of wearable-cameras and accelerometers to assess SB during different types of screen-time.**METHODS:** Three participants (age: 29±5.3 years) wore a SenseCam wearable camera and an Actigraph GT1M accelerometer during two week days of free-living activities and completed a questionnaire on SB (Salmon-2003). Leisure screen-time was identified by annotating SenseCam images into categories of screen-time types following a protocol derived from the questionnaire. Mean counts per minute (mcpm±SD) within screen-time type were calculated using time-aligned ActiGraph data.**RESULTS:** 17,452 SenseCam images were reviewed with an average daily wear-time of 12 h 10 min. Number of episodes detected were 7 for TV use, 2 for TV use while playing an instrument, 9 for computer use, 5 for computer use while playing an instrument, 2 for mobile phone use, 1 for mobile phone use while using a tablet, 1 for using a mobile in public transportation and 1 for using a tablet in public transportation. Mean duration and mcpm were 18.0±33.3 min and 90.5±100.3 mcpm for TV use, 6.6±2.7 min and 47.6±47.3 mcpm for TV use while playing an instrument, 18.0±24.5 min and 95.9±113.3 mcpm for computer use, 11.8±11.7 min and 402.4±878.5 mcpm for computer use while playing an instrument, 1.7±1.7 min and 3385.7±4788.1 mcpm for mobile phone use, 7.0 min and 19.2 for using a mobile phone and tablet simultaneously, 7.5±5.3 min and 44.3±42.1 mcpm for tablet use and 2.1±0.3 min and 0±0 mcpm for using a tablet while eating. Above the 100 count threshold of SB were 30% of episodes in computer use, 33% of episodes in TV use, 25% of episodes in mobile phone use and 0% of episodes in tablet use. **CONCLUSION:** Wearable cameras appear to offer an objective method to measure type and context of media exposure. However there are limitations in assessing mobile phone use and listening to music. We aim to develop a pilot to assess media use and SB in children, to understand their exposure to media and SB.

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Board #82

Effect Of High Individual Motivation On Ambulatory Physical Activity In Swiss Army Recruits

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INTRODUCTION: Newly developed methods to quantify physical demands during military basic training (MBT) allow to assess ambulatory physical activity energy expenditure (PAEE) and distance covered on foot (DoF) with body-fixed acceleration and heart rate sensors [1, 2]. High physical demands, which are common in MBT, are relevant injury risk factors. Further, highly motivated recruits tend to sustain more injuries then their less motivated peers. This leads to the question, if enhanced injury incidences in highly motivated recruits are due to increased physical activity.**PURPOSE:** The purpose of this study was to examine, if highly motivated recruits compensate the lacking effort of their less motivated peers in physically demanding activities by greater daily PAEE and DoF. **METHODS:** Two groups of 50 recruits were asked to wear triaxial acceleration sensors (PARTwear, HuCE microLab, Biel, Switzerland) during waking hours to assess daily PAEE and DoF. The sensor data was collected during week 2 and 3 of MBT. The participants were assigned to 2 companies of the same MBT school and therefore, passed the same military training program. Motivation and physical fitness were assessed in week 1 of MBT with a questionnaire (achievement motivation inventory, AMI) [3] and a fitness test, respectively. The data of the variables AMI, fitness and body mass index (BMI) were stratified into 4 groups each. Group differences were analyzed with a Oneway Anova. Multivariate Linear Model was used to examine the influence of different variables (company affiliation, week, age, AMI, fitness, BMI) on PAEE and DoF. **RESULTS:** The least motivated quartile of recruits had a PAEE of 11.2 MJ/d and covered 17.5 km/d on foot, whereas, the highest motivated quartile spent 11.0 MJ/d and marched 15.4 km/d. However, those differences were not statistically significant. Analysis revealed company affiliation to be the only significant variable influencing daily DoF (R^2= 0.229, p= 0.031). None of the analyzed variables had a significant effect on PAEE. **CONCLUSION:** Highly motivated recruits do not appear to compensate for their less motivated peers. Unmotivated recruits might be less efficient in task fulfillment or get extra exercise as punishment. Although, the same military training program was executed, company affiliation had a significant influence on daily DoF. In conclusion, body-fixed sensors are a useful tool to quantify PAEE and DoF in different settings and can be used to answer newly arising questions.

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Board #83

Intensity of Physical Activity and Obesity in an Irish Cohort Using GENEActiv Accelerometers

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INTRODUCTION: Estimates of physical activity (PA) levels are typically derived from self-report questionnaires which are subject to response bias and recall bias. This study utilizes accelerometers, which objectively measure movement intensity and are not subject to the biases of self-report questionnaires. Rising obesity rates is now a major public health problem for Ireland. **PURPOSE:** To determine PA levels among a sample of middle aged Irish adults and to explore the association between intensity of physical activity and risk of obesity. **METHODS:** Data are from a subsample (n=464) ofthe Mitchelstown cohort; a population based sample of 2047 middle aged Irish adults. PA was measured over the course of seven days using the GENEActiv accelerometer. Only respondents who wore the monitor on their wrists and who returned the accelerometer with seven valid (10 or more hours of wear time) days of data were included in the analysis. PA levels were based on published cut-offs[1] and non-wear time was determined using an appropriate algorithm[2]. Logistic regression was utilised to explore the association between intensity of PA levels and obesity (BMI≥30) adjusting for sex, age, smoking status, dietary quality-score (1-5), education, hypertension and wear-time. **RESULTS:** Valid data were available on 397 respondents aged 48-72 years. The majority of wear time- 54% for men and 53% for women- are sedentary. Total average daily moderate-to-vigorous-physical-activity (MVPA) was 327 minutes (5.5 hours) for men and 315 minutes (5.3 hours) for women. At ages 50 to 59, both men and women accumulated approximately 30 minutes more MVPA than at ages 60-69. Of respondents 32% were obese. On average obese people were found to accumulate one hour less daily MVPA than non-obese (BMI<30) persons ($p<0.001$), after adjusting for sex. In a fully adjusted model an association was found between quartiles of daily minutes of MVPA and obesity (overall $p=0.01$). Those in the lowest quartile had an OR=3.97 (95% CI, 1.65-9.55) ($p=0.002$) compared to those in the highest quartile. **CONCLUSION:** The findings indicate that the majority of adults' wear-time is sedentary and that people with obesity on average accumulate less MVPA per day compared to people without obesity. The study highlights the need to promote PA and to achieve a healthy weight status.

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Table 1: Risk factors and associated odds ratios for obesity

Demographics	**OR in univariate model(95% CI)**	**P-value**	**Adj OR in multivariate model (95% CI)**	**P-value**
Age (years)	1.01 (0.98-1.06)	0.34	0.95 (0.90-1.01)	0.12
Sex Men Women	 1 0.65 (0.43-0.99)	 - 0.05	 1 0.95 (0.51-1.78)	 - 0.88
Education Primary Secondary Tertiary	 1 1.04 (0.63-1.72) 0.39 (0.20-0.76)	 - 0.87 0.01	 1 1.07 (0.52-2.17) 0.30 (0.12-0.80)	 - 0.86 0.02
Smoke Never Former Current	 1 1.26 (0.79-2.01) 0.55 (0.27-1.12)	 - 0.07 0.18	 1 0.95 (0.49-1.84) 0.29 (0.12-0.76)	 - 0.88 0.01
High Blood pressure No Yes	 1 4.03 (2.57-6.32)	 - <0.01	 1 6.62 (3.56-12.3)	 - <0.01
DASH quintiles 1st 2nd 3rd 4th 5th	 1 1.23 (0.60-2.54) 0.80 (0.37-1.76) 1.19 (0.56-2.54) 0.75 (0.35-1.61)	 - 0.58 0.58 0.66 0.45	 1 1.38 (0.57-3.33) 1.05 (0.41-2.71) 1.68 (0.66-4.28) 1.00 (0.39-2.60)	 - 0.48 0.91 0.28 0.99
Weartime (Daily mins)	0.99 (0.99-1.00)	0.29	1.0 (0.9-1.0)	0.12
Daily mins MVPA (quartiles) 4th 3rd 2nd 1st	 1 1.06 (0.54-2.06) 2.18 (1.17-4.07) 2.86 (1.55-5.30)	 - 0.87 0.01 <0.01	 1 1.59 (0.66-3.83) 2.55 (1.09-5.93) 3.97 (1.65-9.55)	 - 0.31 0.03 <0.01

Board #84

Activity Levels of Patients post Total Hip Arthroplasty

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INTRODUCTION: Patients with hip osteoarthritis (OA) limit their activity levels because of pain. After total hip arthroplasty (THA), since pain is decreased, activity levels should increase. Yet, activity levels may be related to daily habits and patients may self-limit due to their previous longstanding physical impairments. Activity profiles of patients with hip OA were compared to healthy cohorts. **PURPOSE:** To evaluate activity profiles on patients' presurgery, and three, six, and twelve months post THA as compared to age matched controls. **METHODS:** Twelve subjects with end stage hip osteoarthritis were recruited before undergoing THA from 2 orthopedic surgeon practices in Des Moines, IA. Eight age and gender matched control subjects were recruited from the Des Moines University community. The activity profiles of all subjects were evaluated using accelerometer monitors (GT3X), worn during waking hours over 7 consecutive days. Measurements were collected pre surgery, and 3 months, 6 months, and 12 months post surgery. Volume and rate (counts), and time at sedentary, low, light, moderate and vigorous activity level data were derived from the actigraphy monitors. Two-way ANOVA mixed design (group x time) was used to detect group differences, alpha set at 0.05. **RESULTS:** The daily activity time was not different between groups (THA: 537 ±32 min; Control: 569 ±39 min). Time in moderate to vigorous activity (THA: 22 ±5.3 min; Control: 39 ±6.5 min , p= 0.029), counts of activity (THA: 313K ±32K counts; Control: 410K ±39K counts, p= 0.048), and counts of moderate to vigorous activity (THA: 59K ±19K counts; Control: 138K ±23K counts, p= 0.005) all showed group effects but not time or interaction effects. While some moderate increases were observed for the THA patients in the average time of moderate to vigorous activity, the average daily activity counts, and the average daily moderate to vigorous activity counts at 12 month assessment, the group effect difference remained. **CONCLUSION:** Differences between quality of activity, and time and quality of moderate and vigorous activity exist between patients and controls. Even though cadence, stride length and speed of gait increased post THA, their activity level remains similar to their presurgical level. Both time and intensity of activity is highly variable and individually dependent between subjects and controls. THA improves pain and function but does not seem to affect activity levels. Health professionals must realize that improving overall physical health will not occur automatically after THA.
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Board #85

Cardiorespiratory Fitness and Objective Measures of Physical Activity Among Clearnes During Work and Leisure Time

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INTRODUCTION: High physical work demands in combination with a low cardiorespiratory fitness have previously been shown to infer a high relative workload and excessive risk for cardiovascular mortality. **PURPOSE:** The aim of this study is to examine the relative workload and cardiovascular risk factors in cleaners work by objective measures of physical activity and intensity during work and leisure. **METHODS:** Data were obtained from baseline data in a cluster-randomized controlled study performed on cleaners. Health Check composed of physical measurement and estimation of cardiorespiratory fitness. Diurnal measurement consisting of objective measurements of occupational and leisure time physical activity, using four accelerometers (Actigraph GT3X+), activity intensity (Actiheart) and ambulatory blood pressure (SpaceLabs Medical 90217). Measurements of physical activity and intensity were conducted over a period of at least two work days and two leisure days whereas ambulatory blood pressure was conducted for a 24 hour period.**RESULTS:** Baseline data from 108 cleaners with combined objective data of physical activity for more than 1800 working hours, 5300 leisure hours and 3100 sleeping hours. The cleaners had an average cardiorespiratory fitness of 24.8 mlO_2/min/kg. The percentage time spent sedentary (Lie and Sit) was 29.5 % during working hours; 61.1 % during leisure after work and 59.4 % during entire leisure days. The cleaners performed on average 1268, 514 and 485 steps per hour during working hours, leisure after work and leisure day respectively. A beneficial effect on cardiorespiratory fitness could be expected at activity levels around 60 % of heart rate reserve, however the cleaners in less than 2% of the time reached or exceeded this level. The average ambulatory blood pressure (systolic/diastolic) was 124/81 mmHg during working hours, 121/77 mmHg during leisure hours. **CONCLUSION:** Despite a generally low amount of sedentary time and high number of steps per hour at work, the cleaners have a very low cardiorespiratory fitness. This may be explained by the negligible amount of time spent at a high intensity of physical activity.

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Board #86

Associations Of Pedometer/accelerometer Data And Maximal Walking Speeds With Pulse Wave Velocities: The Nakanojo Study

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PURPOSE: This study examined the relative contributions of habitual physical activity and aerobic fitness to the prevention of arteriosclerosis. Since aerobic fitness depends strongly on habitual physical activity, our primary hypothesis was that arterial stiffness would be more strongly associated with an accurate yearlong accelerometer measurement of physical activity than with a walking speed estimate of aerobic fitness. **METHODS**: Ninety-seven male and 109 female volunteers aged 65-84 years from the Nakanojo Study wore a pedometer/accelerometer (Lifecorder, Kenz, Japan) continuously, 24 hours per day, for a 1-year period. The daily step count and the duration of moderate-intensity physical activity (>3 metabolic equivalents [METs]) were recorded. Subjects walked along an 11-m flat walkway as fast as they were able, and pressure sensors and a stop watch measured the speed between 3 and 8 m. Central arterial stiffness was determined using an automated waveform analysis of cardio-femoral pulse wave velocity (cfPWV).**RESULTS**: After statistical adjustments for sex, age, mean arterial pressure and smoking habits, the cfPWV was negatively associated with the number of steps taken, the duration of activity >3 METs, and the maximal walking speed ($P < 0.05$). Multiple stepwise regression analysis showed that habitual physical activity (either daily step count or duration of activity >3 METs) and maximal walking speed added significantly to predictions of cfPWV. The percentage contributions to total variance attributable to habitual physical activity and aerobic fitness were 11.0% and 3.8% (for step count) and 7.1% and 3.9% (for duration >3 METs), respectively. **CONCLUSION**: Year-averaged habitual physical activity and maximal walking speed are both significantly associated with cfPWV in older men and women. In contrast to findings from studies using potentially fallible questionnaires, cfPWV is more closely correlated with objective measures of year-averaged physical activity than with a maximal walking speed assessment of aerobic fitness.

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Board #87

Results From An On-going Study Of Physical Behaviour In Healthy Individuals Above 70 Years

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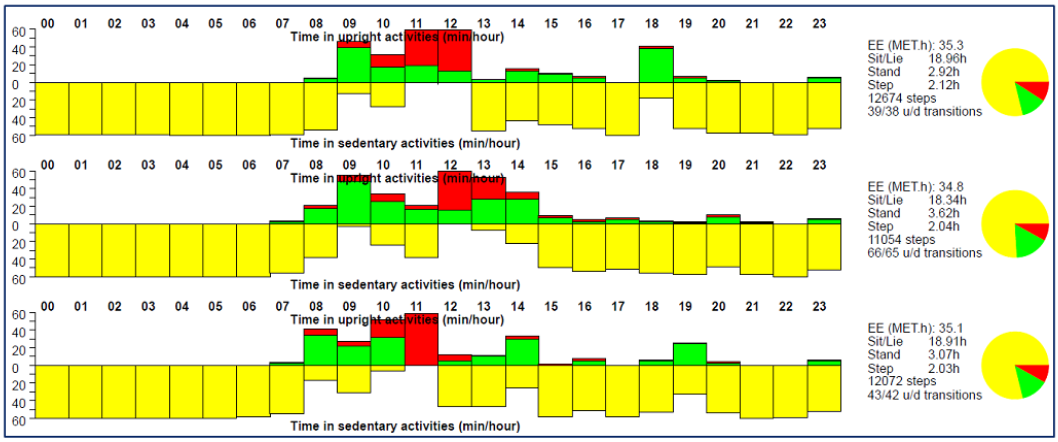
INTRODUCTION: The objective measurement of physical behaviour has become increasingly popular during the last decade, but there is still a limited amount of knowledge about the physical behaviour of elderly people. **PURPOSE:**To describe physical behaviour and its relation to function in a group of healthy ambulatory elderly above 70 years. **METHODS:**Participants are recruited from an on-going study "Gait as an indicator of health and function", where home-dwelling ambulatory elderly above 70 years are included. Participants are asked to wear activity monitors. Data is presently being collected by use of a three-axis accelerometer-based activity monitor (ActivPAL3^{TM} PAL technologies Ltd., Glasgow, Scotland). The activity monitor is attached on participants' thigh and data from three complete 24-hours days is being analysed. A software-package process the acceleration data, and summarises behaviour as time in sedentary (sitting and lying) and upright (standing and walking) position, number of transitions from sedentary to upright, and number of steps during walking (Figure 1).

Figure 1: Example of three days of activity monitoring with ActivPAL for one subject.



Yellow colour indicate sedentary time, green colour standing time and red colour walking time

RESULTS: Twelve participants, eight women and four men (76 ± 2.5 yrs) with a body mass index of 26 ± 4 have so far been included in this study. For more information about the participants, see Table 1. The participants spent 79 ± 9 percent of their time in sedentary behaviour, 14 ± 7 percent in standing and 7 ± 4 percent in walking. Number of steps during the three days was in total 24 032 ± 13 845 steps. During spring 2013 more participants will be included. Further analyses of relations between activity and function will be prepared before the ICAMPAM when data collection is completed.**CONCLUSION:** In this on-going study it has been found that in a small group of elderly above 70 years with a walking speed of 1.14 m/s, approximately 12 hours during daytime were spent in sedentary positions while only five hours were spent standing or walking. Number of steps was approximately 8000 steps daily.

Table 1: Descriptive measures of activity and function

Measure	**Average**	**Standard deviation**
72-hour Sedentary events *h*	56:53:28	06:31:38
72-hour Standing events *h*	10:02:22	04:52:08
72-hour Walking events *h*	5:04:13	02:42:50
72-hour Steps *nb*	24032	13845
Preferred walking speed *m/s*	1.14	0.19
Preferred walking speed during dual-task *m/s*	0.92	0.25
Grip strength *kg*	24.1	7.4
Knee extension (average between left and right) *N*	280.3	121.8
Falls Efficacy Scale-International (FES-I) *points*	20	3.5
Number of sit-to-stand in 30 secs	14	4.3

Board #88

Is The Effect Of Sleep Duration On BMI In Children Independent Of Behavioural And Environmental Conditions?

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INTRODUCTION: The observed association between short habitual sleep time and increased BMI in children may be a reflection of an underlying lack of structure within the home. The level of "chaos" (noise, crowding etc.) in the home has been negatively related to developmental outcomes, health and sleep problems during growth. However, whether household chaos affects sleep duration is uncertain, and to date, no study has used objective measures of sleep to examine these relationships. **PURPOSE:**To investigate the relationship between sleep duration and chaos in the home environment using accelerometry as an objective measure of sleep. We also sought to investigate if the relationship between children's sleep duration and BMI is independent of measures of household organization. **METHODS:**Participants were aged 4-9 yrs (n=328, 55% female) randomly selected from a larger sample of children involved in the MInT study, a randomised control trial. Data were collected on the structure of the home environment using the Confusion, Hubbub, and Order Scale (CHAOS). Height and weight were measured using standard techniques, and body mass index (BMI) was calculated. Sleep and physical activity over 7 days were assessed using accelerometry. All other variables of interest (television viewing, maternal size, maternal education, and income) were measured by questionnaire. **RESULTS:**In the univariate analysis chaos score was significantly, although weakly, associated with lower sleep duration (-0.03 hrs/day, P=0.02), although this association was no longer significant after adjustment for age and sex (-0.02 hours/day, P=0.06). Sleep was negatively associated with BMI (-0.44 kg/m2, P<0.05) when adjusted for age and sex, and remained independently associated with BMI after adjusting for chaos (-0.44 kg/m2, P<0.05). Further adjustment for ethnicity, maternal education, household income, number of people in the household, activity and TV viewing weakened the association between sleep and BMI (-0.33 kg/m2, P=0.10). In multivariate analyses only ethnicity, physical activity and time spent watching TV were independently associated with BMI.**CONCLUSION:**Shorter sleep duration is associated with increased BMI independent of age and sex. The absence of confounding by household covariates and the independent effects of sedentary time and physical activity on BMI suggest other behavioural and/or biological mechanisms may explain excess weight in children.

Board #89

The Relationship Between Sleep And Daytime Activity In Preschool Children

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INTRODUCTION: Children undergo significant changes in sleep during the preschool years (~3-5 years). Daytime naps diminish as children transition to exclusive nighttime sleep bouts. Research suggests that sleep duration is related to the quantity of physical activity, but few studies have addressed the preschool years when dramatic transitions in sleep occur.
PURPOSE: The purpose of this study is to explore the relationship between weekday sleep and total daily physical activity in preschool children. **METHODS:** Actigraphy data was collected from 22 preschool children (7 males, 15 females) using the Respironics Actiwatch Spectrum Device for 24-hrs per day for 16 days. Weekday data was evaluated for daytime and nighttime sleep and daytime total physical activity. Height and weight were also measured for computing body mass index (BMI).**RESULTS:** Not surprisingly,the number of weekday naps negatively correlated with age ($r = -0.455$, $p = 0.05$) and average nap duration was negatively correlated with average nighttime sleep duration ($r = -0.603$, $p = 0.005$). Weekday nighttime sleep duration positively correlated with activity (average maximum activity counts; $r = 0.472$, $p = 0.026$). Earlier bedtimes were associated with greater overnight sleep duration ($r = -0.809$, $p = 0.000$) and greater daytime activity ($r = -.468$, $p = 0.032$). There was a significant negative correlation with child's BMI and the number of naps taken during the weekday ($r = -0.534$, $p = 0.018$), but there was no significant correlation between BMI and activity or nighttime sleep duration ($p>0.3$). Notably, there was a significant gender difference in average nighttime sleep duration ($t(20)= -3.084$, $p=0.006$) and average activity per min ($t(20) = -2.767$, 0.012), with females getting more than males in both cases.**CONCLUSION:** These data begin to shed light on the interactions between physical activity and mid-day and overnight sleep in preschool children. Physical activity is associated with earlier bedtimes and longer bouts of nighttime sleep. Intriguingly, greater BMI was associated with reduced nap frequency. It is possible that nutrition or metabolism may also be important factors contributing to the need to nap. Gender differences may be explained by typical accelerated development in females. Further research is necessary to determine how sleep and physical activity relate to other factors such as health and behavior, emotional health, and cognitive performance.

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Board #90

Associations between Daytime Sleepiness and Sleep Duration with Accelerometer-Measured Physical Activity in the NHANES 2005 - 2006

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PURPOSE: National estimates show a high prevalence of daytime sleepiness and related daytime function difficulties. Sleep duration and feelings of daytime sleepiness may influence levels of physical activity (PA), a key aspect of daytime function that contributes to a healthy lifestyle. We examine whether self-reported daytime sleepiness and sleep duration are associated with levels of objectively measured PA in community- dwelling US adults. **METHODS:** In the 2005-2006 NHANES 2,617 adults aged ≥ 20 years had ≥ 4 valid days (≥ 10 hours/day) of hip-worn accelerometer wear-time. PA was examined using average counts per minute (CPM) during wear-time and time (min/day) spent in sedentary, light, lifestyle, and moderate-to-vigorous (MVPA) physical activity. Feelings of daytime sleepiness and average sleep duration (hours/weekday night) were self-reported. Weighted regression analyses by age group (< 50 years versus ≥ 50 years) adjusted for potential confounding variables, including sociodemographic characteristics, health characteristics and behaviors, and night-time sleep-related characteristics. **RESULTS:**Approximately 20% of respondents in each age group reported daytime sleepiness often or almost always; of these participants, 50% slept on average ≤ 6 hours nightly. Reporting of often or almost always experiencing daytime sleepiness was related to decreased activity and increased sedentary time, while sleep duration was not consistently associated with these activity outcomes. Associations were more pronounced in respondents age < 50 years than in respondents age ≥ 50 years and for higher intensity activity than lower intensity activity. For example, the daily average minutes of MVPA were 26.1 (95% CI: 24.1, 28.1) for younger respondents who never had daytime sleepiness compared to 20.4 (95% CI: 17.2, 23.7; p = 0.007) for those who often or almost always had daytime sleepiness, representing a 22% difference. In younger respondents, daily average minutes of light activity for those who never had daytime sleepiness was 267.9 (95% CI: 261.7, 274.0) compared to 252.8 (95% CI 243.4, 262.2; p value = 0.010), representing a 6% difference. Adjusting for additional risk factors attenuated these associations between daytime sleepiness and activity outcomes for both age groups. **CONCLUSION:** In a nationally representative US sample, daytime sleepiness was related to lower physical activity among younger adults, particularly for higher intensity activity. However, sociodemographic, health and sleep-related characteristics accounted for most of the association. Sleep duration was not consistently associated with physical activity.

Board #91

Sleep Duration And Sleep Variability Are Associated With Dietary Risk Factors For Obesity In Children

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PURPOSE: Lack of sleep and increased consumption of energy-dense foods and sugar-sweetened beverages (SSB) have all been suggested as factors contributing to the increased prevalence of overweight and obesity. The aim was to examine whether objectively measured mean and weekly variability in sleep duration as well as parent-reported sleep problems are independently associated with proposed dietary risk factors for overweight and obesity in 8-11 year old children. **METHODS:** A total of 1021 children from nine Danish schools were invited to participate and 834 accepted. An ActiGraphTM accelerometer (GT3X+ or GT3X) was worn for 7 days and 8 nights on the waist. To estimate sleep duration from the accelerometer, self-reported bedtimes and waking times were used as the possible window of sleep and scored in ActiLife6. Weekly variability in sleep duration was calculated by adding the numerical difference between the mean and each day of measurement divided by the number of days measured. A higher score then indicates a large weekly variability. The Children's Sleep Habits Questionnaire (CSHQ) was filled out by the parents. Diet was recorded using a web-based food record for 7 consecutive days. A minimum of 3 weekdays and 1 weekday of registered sleep and food records were considered necessary; hence 669 mainly normal weight and apparently healthy children were included in the current analytical sample. Covariates included age, sex, Tanner stage, height, weight, screen time, moderate-to-vigorous physical activity, highest education of parents and number of parents born in Denmark. The study is part of the OPUS (Optimal well-being, development and health for Danish children through a healthy New Nordic Diet) School Meal Study*. **RESULTS:** Independent of potential confounders, sleep duration (hours/night) was negatively associated ($P \leq 0.001$) with energy density (ED) of the diet (β=-0.35 kJ/g), added sugar (β=-1.83 E%) and SSB (β=-1.05 E%). Furthermore, variability in sleep duration (min/night) was positively associated ($P \leq 0.02$) with added sugar (β=0.35 E%) and SSB (β=0.21 E%), and CSHQ-score was positively associated with ED (β=0.16 kJ/g, P=0.04).
CONCLUSION: Our study suggests that short sleep duration, high sleep duration variability, and experiencing sleep problems are associated with a poor, obesity promoting diet in children. This finding suggests that either sleep influences diet or that both a poor diet and poor sleep may be part of a cluster that characterizes certain subsets of the population. The causal relationship needs randomized controlled trials to be elucidated.
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