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Human Kinetics
CONFERENCE ABSTRACTS

The 8th International Conference on Ambulatory Monitoring of Physical Activity and Movement

We are pleased to present the first special issue of the *Journal for the Measurement of Physical Behaviour*. This special issue features, for the first time, the abstracts of all the posters that were presented at the 8th International Conference on Ambulatory Monitoring of Physical Activity and Movement (ICAMPAM).

The ICAMPAM conferences are hosted biannually by the International Society for the Measurement of Physical Behaviour (ISMPB). Our society is a non-profit scientific society that focuses on issues related to ambulatory monitoring, wearable monitors, movement sensors, physical activity, sedentary behaviour, movement behaviour, body postures, sleep, and constructs related to physical behaviours. Therefore, the published abstracts of this special issue focus on the objective measurement and quantification of physical behaviours such as:

- all free-living physical behaviours (including sleep) in its different forms (volumes and patterns which could give an indication of quality)
- measurements that are unrestricted, prolonged, and unsupervised
- measurements of physiological responses (e.g., energy expenditure) that are directly related to physical behaviours
- a wide range of applications: clinical, public health, behaviour sciences, etc.

The ICAMPAM conferences are designed to provide a forum for researchers and students to discuss the latest developments in physical behaviour monitoring using wearable devices. This first virtual conference, like all of the previous in-person meetings, served as a meeting point for young scientists and renowned experts in the field of health sciences, engineering, medical sciences, physiology, psychology, sports sciences, and more. The organising committee paid special attention to create a conference programme where many young scientists had the opportunity to present their work. The virtual format featured 20 invited speakers who gave live or pre-recorded talks on a wide range of topics, including a major collaborative venture between pharma and academia, a DEI session, and a lively debate. The keynote presentations will be available to ISMPB members via our website.

We hope that the contents of this special issue will be informative to our readers and to new readers interested in objective measurement of physical behaviours.

On behalf of the organizing committee,

Jeff Hausdorff & Martina Mancini, ICAMPAM 2021 Co-chairs

Malcolm Granat, ISMPB President

ICAMPAM Conference Abstracts

Applications: Clinical Populations

Association Between Physical Activity and Sleep Quality Among Hospitalized Older Adults With Dementia

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Introduction: Hospitalized older persons with dementia are at increased risk of poor sleep quality, associated with worse health outcomes, including cardiometabolic derangements and delirium. Physical activity has been associated with better sleep in non-acute care settings. The aim of this study was to assess the association between daytime physical activity and sleep quality in hospitalized older persons with dementia. Methods: This was a secondary analysis of an ongoing cluster randomized controlled trial. The sample included 259 participants diagnosed with dementia. Daytime physical activity and sleep quality were measured using the MotionWatch 8 (MW8). Sleep quality was defined by four characteristics: sleep duration, sleep efficiency, sleep latency, and sleep fragmentation. Linear regressions were conducted to test the associations between physical activity and sleep quality. Results: Most participants were either non-Hispanic Black (47.9%) or non-Hispanic White (49.8%), female (60.2%), with a mean age of 81.36 ± 8.24, and indicated significant cognitive impairment (MoCA = 10.73 ± 6.94). Higher levels of daytime physical activity were significantly associated with sleep duration (β = .17, t = 2.8(253), p = .006), sleep efficiency (β = .18, t = 3.0(253), p = .003), and sleep fragmentation (β = −.23, t = −3.74(253), p < .001), but not sleep latency (β = −.05, t = −.78, p = .435). All models were adjusted for age, gender, race, and comorbidities. Discussion: Findings suggest that daytime physical activity may increase sleep duration, improve sleep efficiency, and decrease sleep fragmentation among hospitalized older persons with dementia. This study highlights the need to promote daytime physical activity to improve sleep quality among older persons with dementia during hospitalization.

Automated Event-Based Algorithm for Quantifying Daily Life Ischemic Events in Peripheral Artery Disease

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Introduction: This study aimed to compare different algorithms in the implementation of an event-based analysis method of the daily walking pattern using wearable monitors to quantify walking pain manifestation (WPM) and stop-induced by walking pain (SIWP) in people with lower extremity peripheral artery disease (PAD). Methods: During a 7-day free-living period, 21 PAD participants wore a wGT3X+ accelerometer and a watch on which they were asked to press an event marker button to record WPM and SIWP. We compared different algorithms of first removing short (≤15s) walking or stopping bouts and assigning SIWP within 15s or 60s after the end of bouts. Then, the daily pain-free walking time and maximal walking time were computed. Results: Figure 1 shows that removing short walking bouts first yielded lower WPM/week and higher SIWP/week compared to our original algorithm and to removing short stopping bouts first (P < 0.05). Consequently, it provided significantly lower pain-free and maximal walking times (P < 0.05) than both algorithms. It also provided higher maximal pain-free walking time than Gardner and Strandness tests and higher maximal walking time than Strandness test only (P < 0.05). Discussion: When implementing an

aim of this research was to determine the feasibility of the Smartphone Ecological Momentary Assessment (SEMA) to measure PA and SB in shift workers. Methods: Full-time workers (N = 128) received five SEMA prompts per day, for 7–10 days. The prompt survey included questions (n = 8) about PA and SB, location and time spent in the activity. SEMA prompts sent to shift workers were tailored according to work schedule, while prompts were sent at the same time of day for non-shift workers. One-Way ANOVA was used to assess outcomes in shift workers and non-shift workers. Results: Participants included 75 shift workers and 53 non-shift workers, 58% were female, and the mean age was 36 (SD = 11) years. Compliance for completed prompt responses were similar between shift workers (64%) and non-shift workers (67%) (P = .85). Missed prompts showed significant difference between the groups (P = .046). The findings related to prompt response showed that the most frequently answered SEMA was the first prompt of the day (24%), while the 5th prompt received the least responses in both shift and non-shift workers. Self-reported physical activity was similar for shift and non-shift workers, but sedentary behaviour showed a significant difference between the groups. Discussion: Compliance for SEMA in our study is lower (63%) compared to other studies using EMA in older adults (92%) and adults (71%). Therefore, to increase compliance in future, studies with shift workers including a post evaluation of the mobile EMA could be useful to understand usability. Keywords: shift work, ecological momentary assessment, physical activity, sedentary behaviour

Validity of Smartphone-Based Measurement of the Five Times Sit-to-Stand Test

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Introduction: Measuring physical function has been identified as a key factor for detecting early onset of functional decline in community-dwelling older adults. Instrumenting standardized clinical tests with inertial measurement units and smartphones can potentially enhance the sensitivity of clinical tests. Recently, an instrumented test battery has been developed in an app-format, designed for unsupervised self-testing in a home-setting. The test battery includes the Five Times Sit-to-Stand. The aim of this study was to evaluate the concurrent validity of the smartphone-based test using a camera system and force plates as gold standard. Methods: A convenience sample of community-dwelling older adults, 60 years and older, is being recruited in Trondheim, Norway. A smartphone (Samsung Galaxy S8) was fixed to the thigh in a position similar to when being worn in the trouser pocket. For the camera system (Vicon, 200 Hz), the pelvis and right femoral coordinate systems were built according to. Pelvis and hip angles in the sagittal plane were calculated using Euler angles. The test ends when the body touches the chair; the seat contact was identified from a force platform (AMTI 1000 Hz) under the chair. The initial and final stand/sit events were identified from the angular velocity of the pelvis in the sagittal plane according to previous studies. We used the Bland-Altman test to calculate the limits of agreement. ICC (3,1) was used to assess inter-rater reliability. Results: Preliminary results reported in Figure 31 include a total of 30 trials from the first 17 participants. Discussion: The data collection and analyses are still ongoing. The measurement of the first sit-to-stand transition is the least accurate one but still with a maximum difference of 350 ms. Preliminary results support the hypothesis that a pocket-worn smartphone can be a valid tool for self-administering and instrumenting the five times sit-to-stand test.

Technology & Algorithm Development: User Centered Design

Monitoring Gait Developmental Trajectory in Preterm Children: A Sensor-Based Approach

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Introduction: Preterm children have an increased risk of motor delay. Gait analysis and wearable technology allows the assessment of motor performance in toddlers, identifying early deviations from typical development. Using a sensor-based approach, gait performance of preterm and full-term toddlers at different risk of motor delay was analysed. The aim was to measure quantitative differences among groups and provide a tool for early monitoring gait development. Methods: Three groups of 2 year old toddlers, matched for age and walking experience, participated in the study: preterm at high risk of motor delay (Hrisk-PT, n = 8, born at < 28 gestational weeks or with < 1000g of body weight), at moderate risk (Mrisk-PT, n = 21, born at 28–36 gestational weeks), and at low risk (FT, n = 17, born full-term). Children walked at self-selected speed wearing three inertial sensors on the lower back and on the shanks. Temporal parameters, short- and long- term variability, symmetry, and nonlinear metrics of trunk kinematics (i.e. harmonic ratio, recurrence quantification analysis, multiscale entropy) were calculated and statistically analysed with respect to risk of motor delay (Kruskal-Wallis test, significance level 5%). Results: For increasing risk of motor delay (from FT to Hrisk-PT), children showed significantly longer stride-, stance- and double-support-time, higher short-term variability and lower multiscale entropy values on the frontal plane (Figure 32). No difference was found for the other parameters. Discussion: Sensor-based gait analysis allowed differentiating gait performance of toddlers at different risk of motor delay, highlighting a less mature motor performance in those at higher risk (i.e. higher variability, lower complexity). The proposed set of parameters can serve as biomarkers for the early detection of the risk to develop persistent motor impairments.

Multimodal Cues for Gait Rehabilitation With Smart Glasses in Persons With Parkinson's Disease (PD): A Methodology for the Selection of Effective Design Solutions

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Introduction: Persons with PD are affected by motor impairments that compromise their autonomy. Recent advances in wearable systems showed that sensory biofeedback (BF) can improve gait in PD. Through verbal BF, an existing smartphone-based gait rehabilitation system (CuPiD-system) makes PD subjects better aware of their gait performance. Thanks to Smart Glasses (SG), real-time visual and haptic cues are also feasible: this study describes strategies to design an innovative mHealth system obtained by integrating the smartphone-based CuPiD-system with SG. The aim is to rehabilitate postural and transient gait disturbances and to provide gait training at home for persons with PD. Methods: We performed a pilot trial on five subjects not belonging to a particular category of users, following a Human-Centered design research approach. We proposed sensory BF suggesting a rhythm to be followed: auditory by wireless earphones, visual and haptic by the SG. We analyzed the subjects' qualitative and quantitative responses through an interview and a specific gait analysis protocol. Results:

This testing phase investigated how sensory BF influences the user's gait, the most efficient cues to improve user's performance, and acceptance of the mHealth system. We applied an ad-hoc redesigned version of the Quality-Function-Deployment (QFD) design tool to manage the complexity of the collected data, Figure 33. Discussion: While visual BF improves spatial gait parameters, auditory and somatosensory BF improve temporal gait features (cadence). QFD's results confirm the role of sensory BF on gait rehabilitation: auditory and haptic BF reach a higher efficacy than the visual one. Some critical aspects emerged: the gap between the user's cadence and the target one; the subjects' sensory preferences. In the next phase on PD subjects, the target cadence will be subject-specific, and questionnaires should be used to evaluate subjects' sensory preferences and integrate them into the QFD matrix.

Technology & Algorithm Development: Future Perspectives

Defining Continuous Walking Events in Free-Living Activities: Mind the Gap?

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Introduction: Free-living activities range in duration, intensity, and are typically interspersed with interruptions of other behaviours; for example, standing events within walking bouts. Currently, there is no standardised method of characterising continuous walking. Processes that identify and describe interruptions that occur during walking are needed to better understand overall compliance to physical activity guidelines. This study seeks to develop a robust method of characterising continuous walking measured by an activity monitor. Methods: Participants (n = 24) were asked to wear the activPAL activity monitor for seven days to measure physical behaviours. A defined cadence threshold was specified as 100 steps/minute based on moderate-to-vigorous physical activity (MVPA) for a healthy population, and an algorithm was developed to re-define continuous walking events. The algorithm grouped walking events with short standing events as one single bout, provided the average cadence of the bout did not fall below the defined cadence threshold. Results: The average total time spent walking per day before applying the grouping algorithm was 123.1 ± 36.6 minutes and after grouping was 126.3 ± 38.0 minutes ($p < 0.001$). The lower the defined cadence threshold, the higher the average time spent in MVPA (Figure 34). Furthermore, the composition of the grouped events comprised of short standing events and a few long walking events. Compliance to physical activity guidelines did not change as a result of grouping; however, there was an increase in the average time spent in MVPA ranging from 0.30 to 11.2 minutes after application of the grouping algorithm. Discussion: This study provides a robust and practical methodological approach to combining short interruptions in continuous walking by considering the intensity and duration of the activities included; therefore, providing a comprehensive evidence base to apply to physical activity guidelines and epidemiological studies.

Sensor-Based Ambulatory Assessment of Gross-Motor Development in School-Children: Influence of Age, Sex, and Anthropometry

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Introduction: Timely motor development in childhood is the foundation of healthy adult life. Several approaches have been proposed, but recently, wearable inertial sensors allowed its quantitative assessment in ambulatory conditions. The present study is comprised in the I-MOVE study and aims to analyze gross motor development in school children with respect to age, sex, and anthropometric characteristics. Methods: 150 children from primary school participated in the study, 72 first- (38M, 34F; age 75 ± 5 months) and 78 third grade (48M, 34F; age 108 ± 6 months). Anthropometric characteristics (height, weight, triceps and subscapular skinfold thicknesses) were collected according to standardized procedures. Children walked at self-selected speed (NW) and in tandem (TW) wearing three inertial sensors on the lower back and on the shanks. Temporal parameters, short- and long-term variability, and nonlinear metrics of trunk kinematics (i.e. recurrence quantification analysis, multiscale entropy) were calculated and statistically analyzed (Kruskal-Wallis test 5%). Results: Stance and double support duration increased during NW and decreased during TW with age independently from sex, while their variability decreased. Automaticity (i.e. recurrence indexes) increased with age during NW more in female than in males, while it decreased during TW independently from sex. Complexity (i.e. entropy) increased with age during TW. No dependency on height or weight alone was identified independently from age, while overweight (i.e. BMI and skinfold thicknesses) was associated to a reduction in the development of automaticity during TW independently from sex. Discussion: Both sex and anthropometry resulted to influence motor development in the target population, in particular overweight appears to delay the maturation of automaticity.

Timing of the Associations Between Objectively-Measured Physical Activity Levels and Glycemic Control and Variability Indices in the General Population: Results From the Food & You Digital Cohort Study

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Introduction: Disturbances of glycemic control and large glycemic variability in people without diabetes (DT) have been associated with increased risk of type 2 DT, cardiovascular diseases, and cancers. It is therefore important to identify lifestyle-related drivers such as physical activity to reduce glycemic variability and improve glycemic control among adults without DT. Methods: We analyzed data from 85 participants without DT of the Food & You digital cohort. Physical activity, expressed as daily step count and assessed objectively using mHealth technologies (smartphone health apps or wearable activity trackers), was studied in relation to glycemic control and variability indices using generalized estimating equations models controlled for age, sex, BMI, smoking status, self-declared stress level, and for the daily step count measurement method. Glycemic indices were evaluated using data collected from 13 days of continuous glucose monitoring. Results: This study revealed no association between daily steps and glycemic indices of the same day. Our results suggest rather that every 1000 steps/day increase in daily steps was associated with a 0.3588 mg/dL, a 0.0917 mg/dL, and a 0.0023 % decrease in the maximum of glucose values, mean glucose, and in the glucose management indicator of the following day, respectively (95% CI −0.6931 to −0.0245; 95% CI −0.1793 to −0.0042; 95% CI −0.0044 to −0.0002). Discussion: Increasing the level of physical activity was linked to blunted glycemic excursions during the next day among individuals without DT. Because health-related benefits of a healthier lifestyle can be long to be observed, such potential short-term physiological benefits associated with certain behaviors could be integrated into health-related apps as personalized feedback to motivate individuals to engage in healthy behaviors. Our study gives also some insights into the