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Brief article

Monitoring sedentary patterns in office employees: validity of an m-health tool (Walk@Work-App) for occupational health

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ABSTRACT

Objective: This study validated the Walk@Work-Application (W@W-App) for measuring occupational sitting and stepping.
Methods: The W@W-App was installed on the smartphones of office-based employees (n = 17; 10 women; 26 ± 3 years). A prescribed 1-hour laboratory protocol plus two continuous hours of occupational free-living activities were performed. Intra-class correlation coefficients (ICC) compared mean differences of sitting time and step count measurements between the W@W-App and criterion measures (ActivPAL3TM and SW200Yamax Digi-Walker).
Results: During the protocol, agreement between self-paced walking (ICC = 0.85) and active working tasks step counts (ICC = 0.80) was good. The smallest median difference was for sitting time (1.5 seconds). During free-living conditions, sitting time (ICC = 0.99) and stepping (ICC = 0.92) showed excellent agreement, with a difference of 0.5 minutes and 18 steps respectively.
Conclusions: The W@W-App provided valid measures for monitoring occupational sedentary patterns in real life conditions; a key issue for increasing awareness and changing occupational sedentariness.

Monitorización de patrones sedentarios en oficinistas: validación de una aplicación móvil (Walk@Work-App) en salud laboral

Palabras clave:
Promoción de la salud a través de tecnología móvil (m-Health)
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RESUMEN

Objetivo: Validar la aplicación móvil Walk@Work (W@W-App) para monitorizar los patrones de actividad y sedentarios en el trabajo.
Método: W@W-App se instaló en teléfonos móviles de oficinistas (n = 17; 10 mujeres; 26 ± 3 años). El tiempo sentado y el número de pasos se midieron mediante un test de laboratorio y bajo condiciones habituales. Las diferencias entre W@W-App y las medidas de referencia (ActivPAL3TM y SW200Yamax Digi-Walker) se compararon mediante coeficientes de correlación intraclase (CCI).
Resultados: En el test de laboratorio, los valores de correlación fueron buenos en los pasos realizados a baja intensidad (CCI = 0.85-0.80). La menor diferencia de mediana fue para el tiempo sentado (1,5 segundos). En condiciones habituales, el tiempo sentado (CCI = 0.99) y los pasos (CCI = 0.92) mostraron valores de correlación excelentes, con una diferencia de 0,5 minutos y 18 pasos.
Conclusiones: W@W-App proporciona medidas válidas para la monitorización de patrones sedentarios en el trabajo; aspecto clave para modificar el sedentarismo en las oficinas.

Introduction

High volumes of occupational sitting have been associated with an increased risk of cardiovascular disease, type 2 diabetes[1] and musculoskeletal disorders.[2] Thus, reducing sedentary behaviour in office-based work environments has become an occupational behavioural risk that needs to be addressed.[3]

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Figure 1. W@W-App pouch.

Introducing smartphone applications (Apps) can support technology-based behaviour change; contributing to maximize the effectiveness of workplace-based programs to reduce occupational sitting.[4] Smartphones are not only a normal part of daily life–used by more than 3.6 billion individuals world wide[5] but Apps enable users to measure and self-monitor health behaviours in real time. This contributes to recognising sitting time patterns and increasing awareness,[4] key issues for successfully engaging in “occupational sitting reduction” programs.[6]

App measurements for physical activity have mainly focused on step counts and moderate-to-vigorous physical activity (MVPA) rather than sedentary behaviour.[7,8] Such Apps gather information from the native sensors of smartphones (Accupedo, Runtastic, Moves, PacerWorks or Tayutau)[7] or from external consumer-based physical activity tracking devices, mainly located on the wrist or waist area (e.g. Fitbit, NickFuelBand or JawboneUp).[8] While the validity of Apps for step counts and MVPA has been reported as moderate to good, validity for sitting time measures is less clear.[4] App measurements–especially for postural classification–vary considerably based on the device location (hip, waist, wrist or upper arm);[9] with current Apps finding it difficult to offer valid measurements for sitting and standing.[10]

Based on the need to identify occupational sedentary patterns in real life conditions within workplace health promotion programs–a key determinant for changing sedentary behaviour–[6] this study aimed to assess the validity of the Walk@Work-App (W@W-App) for measuring occupational sitting time and stepping on Spanish office employeesí own personal smartphones.

Methods

A convenience sample of Spanish office administrative workers from the University of Vic-Central University of Catalonia, was recruited (April 2015) via Inclusion criteria were: having a smartphone with a hardware Android version >4.0, and being able to get up from a chair, perform moderate intensity walking and use the stairs. The study was approved by the University’s institutional review board and volunteers signed a written informed consent.

Participants used their own smartphones with the W@W-App installed, placed in a pouch attached at the right belt side (W@W-App pouch) (Figure 1). The pouch was developed to locate the smartphone sensors in participants’ mid-to-front point of the thigh (near the centre of mass), the best position to avoid postural measurement errors for sitting time, (and to replicate positioning of the criterion measure ActivPAL3TM). The W@W-App assessed time spent sitting and ambulatory activity in steps. The net external forces acting on the smartphones were detected by the mobile phone accelerometer (X, Y, and Z axes), which was configured using SENSOR_DELAY_GAME at a 25-27 Hz rate. The forward acceleration signals registered step counts. For sitting time a 30-degree tilt was applied to the X and Y-axes.

Seventeen participants undertook the one hour prescribed protocol (10 women; 26 ± 3 years): 1) self-paced walking (5 minutes); 2) brisk walking (5 minutes); 3) ascending and descending eight sets of stairs; 4) 5 minutes of active working tasks (moving around the office reading a document, going down stairs to the photocopier and delivering a message to a colleague); 5) sitting down

Table 1
Mean differences between smartphone measures and the criterion measures (ActivPAL3TM for sitting time and a SW200 Yamax Digi-Walker for step counts).

	Mean criterion devices	Mean W@W-App	Mean difference (95%CI)	MAE	ICC (95%CI)
Protocol 1: Prescribed protocol (n = 17)					
Walking at self-pace; steps (5 min)	523 ± 33.3	539 ± 21.1	-16.8 (-28.9 to -4.6)	17.9	0.85 (0.51 to 0.95)
Walking faster; steps (5 min)	539 ± 12.4	616 ± 69.7	-21.5 (-69.2 to 26.2)	51.5	0.20 (-2.20 to 0.80)
Going up stairs; steps (4 floors)	94 ± 6.4	68 ± 31.9	26.1 (10.0 to 42.3)	27.4	0.13 (-1.40 to 0.69)
Going down stairs; steps (4 floors)	100 ± 5.3	44 ± 31.4	56.0 (39.3 to 72.7)	57.1	-
Active working tasks; steps (5 min)	471 ± 61.0	438 ± 55.7	13.1 (9.1 to 17.0)	37.5	0.80 (0.47 to 0.93)
Sitting; seconds (5 min)	300 ± 0.0	302 ± 2.0	1.5 (-2.5 to 0.4)	1.5	-
Stand up and down 14 times while sitting; seconds sitting (10 min)	583 ± 8.4	570 ± 5.7	6.3 (22.2 to 10.4)	13.2	0.67 (0.03 to 0.89)
Protocol 2: Free living protocol (n = 7)					
Walking (steps)	538 ± 195.2	520 ± 250.4	18.4 (-94.2 to 131.0)	-	0.92 (0.54 to 0.97)
Sitting (min)	96.1 ± 11.8	95.6 ± 12.6	0.5 (-1.3 to 2.2)	-	0.99 (0.97 to 0.99)

95%CI: 95% confidence interval; ICC: intra-class correlation; MAE: mean absolute error.

(5 minutes); and 6) standing up and down from the chair (14 times). One month later participants were invited to participate in two hours of continuous monitoring of a normal working day, and seven women completed the free-living protocol. For criterion measures during the prescribed and free-living protocol, participants used an inclinometer ActivPAL3TM on the left hip to detect sitting events lasting more than three seconds, and a SW200 Yamax Digi-Walker pedometer placed on the left hip to measure step counts.

Validity of the W@W-App was analyzed by measuring agreement, intra-class correlation coefficients (ICC) and mean differences of sitting time against the inclinometer ActivPAL3TM, while step counts against the SW200 Yamax Digi-Walker pedometer. The absolute mean error (MAE) was calculated for the laboratory protocol.

Results

Table 1 shows mean (SD) data for the W@W-App and criterion measures (ActivPAL3TM and SW200 Yamax Digi-Walker), as well as their mean differences and ICCs.

During the prescribed protocol, the smallest mean difference between devices in sitting time was identified when participants spent 5 minutes sitting without transitions (1.5 seconds; MAE = 1.5). In contrast, the largest mean difference was found for sitting with transitions (6.3 seconds; MAE = 13.2). For stepping, the largest differences between the W@W-App and the pedometer were found for descending stairs and brisk walking (56 and −21 steps; MAE = 57.1 and 51.5, respectively). The smallest differences were found for self-paced walking and active working tasks (−16 and 13 steps; MAE = 17.9 and 37.5, respectively), with good agreement between the W@W-App and the pedometer (ICC = 0.85 and 0.80, respectively). During free-living conditions, the mean difference between the W@W-App, the pedometer and the ActivPAL3TM was 18 steps and 30 seconds of sitting respectively. For both sitting and self-paced walking, the W@W-App showed excellent levels of agreement (ICC = 0.99 and 0.92, respectively) compared with criterion measures.

Discussion

This study evaluated the validity of the W@W-App for measuring sitting time and stepping at work. Given the growing evidence on the risks associated with excessive sitting, having a low-cost self-monitoring tool that accurately measures occupational sitting and activity patterns in real time is important for maximizing effectiveness in workplace interventions. The W@W-App demonstrated accurate measures for desk-based sitting time, especially in prolonged periods of sitting, and while moving around performing work tasks.

Existing laboratory-based and free-living validation studies to measure sedentary patterns using Apps have found similar results; with the highest accuracy shown for sitting time and for ambulatory activities, but not for MVPA.[11,12] However, smartphones were provided by the researchers to control measurement reliability;[11,12] in contrast, the W@W-App was installed onto participants' own smartphones to assess validity in a real-world, ecological setting.

Furthermore, sedentary patterns in previous studies were mostly assessed by using accelerometer sensors positioned at the wrist or waist,[7] or by use of different in-built smartphone sensors supplemented by an online learning activity classification method to allow normal use of the smartphone.[8] Several usability problems were identified from these processes such as perceived high cost of the wearables and low accuracy of data measurements[9,10] due to the different location of smartphone devices at work, where employees kept devices in handbags or on the desk. For this reason, the W@W-App pouch allowed participants to use their own smartphones (e.g. texting, calling or internet searching) while also monitoring sedentary patterns during working hours. Although employees perceived that using the pouch at work was a feasible option, further investigation needs to explore the usability of the W@W-App pouch in "occupational sitting reduction" interventions.

The main limitations of this study are the small sample size and that the W@W-App only operates with the Android smartphone platform. The majority of participants were women, what is a common fact on health promotion interventions when participants are recruited voluntary.[13] Ongoing studies should incorporate a wider array of new phones and models to compare levels of agreement in larger and longer studies in free-living conditions.

Despite these limiting factors, this is one of the few studies evaluating the validity of an App for measuring sedentary patterns using participants' own smartphones sensors under real-life conditions. The current study provides occupational health practitioners with a low-cost tool (W@W-App) to accurately monitor prolonged sitting and self-paced walking during working hours in office-based workers; amplifying the impact workplace health promotion interventions might have on reducing occupational sitting.

Editor in charge

Cristina Linares Gil.

Transparency declaration

The corresponding author on behalf of the other authors guarantee the accuracy, transparency and honesty of the data and information contained in the study, that no relevant information has been omitted and that all discrepancies between authors have been adequately resolved and described.

What is known about the topic?

Sitting for long periods without interruptions have been associated with many chronic diseases. Thus, reducing sedentary behaviour in desk-based jobs has become a behavioural risk to be addressed within workplace health promotion programs. Smartphone sensors have the potential to identify sedentary patterns and influence behaviour change. However, measurement accuracy remains unclear.

What does this study add to the literature?

The current study provides occupational health practitioners with a valid low-cost tool (W@W-App) that monitors activity and sedentary patterns in real time in office-based workers. This is a key issue to effectively modify occupational sitting time in employees whose work time is dominated by sedentary tasks.

Authorship contributions

J. Bort-Roig, A. Puig-Ribera and R.S. Contreras conceived the study, and J. McKenna and N.D. Gilson oversaw its conduct. All authors participated in the design of the study. J. Bort-Roig and E. Chirveches-Pérez led data collection with support from A. Puig-Ribera. J. Bort-Roig and J.C. Martori analysed de data and interpreted the results. J. Bort-Roig drafted the manuscript, and all authors edited and revised the manuscript, and approved the final manuscript.

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Conflicts of interest

None.

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