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A practical guidance for assessments of sedentary behavior at work: A PEROSH initiative☆

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ABSTRACT

Sedentary behavior is defined as sitting or lying with low energy expenditure. Humans in industrialized societies spend an increasing amount of time in sedentary behaviors every day. This has been associated with detrimental health outcomes. Despite a growing interest in the health effects of sedentary behavior at work, associations remain unclear, plausibly due to poor and diverse methods for assessing sedentary behavior. Thus, good practice guidance for researchers and practitioners on how to assess occupational sedentary behavior are needed.

The aim of this paper is to provide a practical guidance for practitioners and researchers on how to assess occupational sedentary behavior.

Ambulatory systems for use in field applications (wearables) are a promising approach for sedentary behavior assessment. Many different small-size consumer wearables, with long battery life and high data storage capacity are commercially available today. However, no stand-alone commercial system is able to assess sedentary behavior in accordance with its definition. The present paper offers decision support for practitioners and researchers in selecting wearables and data collection strategies for their purpose of study on sedentary behavior.

Valid and reliable assessment of occupational sedentary behavior is currently not easy. Several aspects need to be considered in the decision process on how to assess sedentary behavior. There is a need for development of a cheap and easily useable wearable for assessment of occupational sedentary behavior by researchers and practitioners.

1. Background

Sedentary behavior is defined as sitting or lying with low energy

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expenditure (SBRN, 2012). People in modern industrialized societies spend more and more time engaged in sedentary behaviors during the main domains of living, like working (e.g. when using computers), travelling (e.g. when driving a car) and during leisure (e.g. when watching television) (Chau et al., 2012; Church et al., 2011; Ng and Popkin, 2012; Aadahl et al., 2013).

Prospective studies have demonstrated a positive association between self-reported time spent sitting and chronic disease and all-cause mortality (Dunstan et al., 2010; Ford et al., 2010; Hu et al., 2001; Katzmarzyk et al., 2009; Patel et al., 2010; Schmid et al., 2015; Stamatakis et al., 2011; Warren et al., 2010; Wijndaele et al., 2011). A meta-analysis including nearly 600,000 adults showed a dose-response relationship between self-reported daily total sitting and all-cause mortality, with a 2% increase in all-cause mortality per hour spent sitting per day (Chau et al., 2013). Importantly, several studies have found such associations even after adjusting for the extent of moderate or vigorous physical activity (Hancox et al., 2004; Honda et al., 2014; Hu et al., 2003; Katzmarzyk et al., 2009; Raynor et al., 2006; Thorp et al., 2011). This indicates that much time spent seated infers a risk for health impairments irrespective of the level of physical activity.

A systematic review devoted to detrimental health effects of occupational sitting found limited evidence for an independent association with musculoskeletal pain, some forms of cancers, cardiovascular diseases, obesity indicators, diabetes and mortality (van Uffelen et al., 2010). One systematic review on predictors for neck and shoulder pain reported limited evidence for a positive association between occupational sitting and non-specific neck pain (McLean et al., 2010), while insufficient evidence was found by two other systematic reviews (da Costa and Vieira, 2010; Mayer et al., 2012). For different cancer types, meta-analyses have reported varying associations with self-reported occupational sitting time (Schmid and Leitzmann, 2014; Zhou et al., 2015). Prospective studies on self-reported occupational sitting and obesity also present mixed evidence. One found that BMI decreased with less occupational sitting for women, but not for men (Eriksen et al., 2015), while no association between occupational sitting and BMI was found in two other studies (Pinto Pereira and Power, 2013; Pulsford et al., 2013). Studies also find conflicting results concerning associations between self-reported occupational sitting and mortality (Chau et al., 2013; Pulsford et al., 2015; Stamatakis et al., 2013; van der Ploeg et al., 2015). Thus, it is not clear if spending large amounts of time in sedentary behavior at work is an independent risk factor for health impairments. Moreover, dose-response relationships and, hence, threshold values for occupational sedentary behavior with respect to health outcomes remain to be established.

A likely main reason for the conflicting results on associations between occupational sedentary behavior and health is that the available research is almost exclusively based on self-reported sitting time measured by questionnaires. The strength of questionnaires is their low cost and low burden of effort, both for the participant and for the researcher. Thus, it is feasible to use questionnaires to collect information from large populations. However, self-reported sedentary time at work has been shown to be both biased and imprecise (Gupta et al., 2016b; Koch et al., 2016; Kwak et al., 2011; Lagersted-Olsen et al., 2014), and is therefore generally regarded to have severe limitations when used in studies of occupational sedentary behavior.

Visual observation, either on-site or videotaped is another method for assessing sedentary behavior. Observational methods are still a common approach among researchers and practitioners for assessing body postures at work (Mathiassen et al., 2013) and have shown attractive properties in being valid and reasonably reliable when trained observers rate postures of large body parts (Takala et al., 2010). However, observations are generally time consuming and expensive per unit of working time observed (Trask et al., 2013, 2014, 2012), and they are therefore only feasible with relatively short assessment periods and limited population sizes. Observation-based methods are also associated with considerable uncertainty due to observers differing in ratings (Denis et al., 2000; Rezagholi et al., 2012). Visual observations at the workplace can also be challenging due to the logistic burden associated with data collection and ethical aspects (e.g. observing work with patients). Observations may also modify the behavior of the observed worker (observational bias).

Because of the imprecision and bias of self-reports, and the costs, limited feasibility and methodological uncertainty of observations, it is generally recommended to use objective technical instruments for assessing physical exposures such as sedentary behavior (Burdorf and van der Beek, 1999; Wells et al., 1997). Technical instruments are believed to be both valid and associated with minor error in use (Hansson et al., 2001). A wide variety of ambulatory, direct technical assessment systems for use in the field (wearables) are already commercially available. Available wearables utilize technologies such as accelerometry, pedometry, heart rate monitoring and indirect calorimetry (Tremblay et al., 2010). The on-going development of these technologies has led to miniaturization and greatly diminished costs, increasing the feasibility of assessing sedentary behavior objectively on larger populations in real-life settings, with minimal disturbance for the participants. However, despite the greatly increasing accessibility to commercially available wearables for assessing sedentary behavior, accompanied by an increasing use of wearables among researchers and practitioners, no current practical guidance is available on how to properly assess sedentary work using wearables. Therefore, the Partnership for European Research in Occupational Safety and Health (PEROSH, http://www.perosh.eu/) gathered a group of scientists from several European research institutions with the aim of developing a practically useful guidance for researchers and practitioners on how to assess occupational sedentary behavior. The initiative focused on wearables. Thus, laboratory-based or stationary systems, e. g. optoelectronic systems, which are not feasible for data collection in real and dynamic work environments, were not included.

1.1. *Definition of sedentary behavior —what should be assessed?*

Any assessment of some exposure needs to be based on a clear definition of that exposure. A current limitation in sedentary behavior research is the ambiguity among descriptions of "sedentary behavior" in the available literature. For example, a major dictionary describes sedentary as "doing or requiring much sitting" or "characterized by a lack of physical activity" (Merriam-Webster, 2016). Thus, a vague description may lead to divergences among both researchers and practitioners of how to assess and understand "sedentary behavior".

A strict definition for sedentary behavior has therefore been proposed by a network of experts in the field; "*any waking behavior characterized by an energy expenditure* $\leq$ *1.5 METs while in a sitting or reclining posture*" (SBRN, 2012; Straker et al., 2016). Following this definition, sedentary behavior includes tasks or movements performed sitting or lying down, if just energy requirements are low. Thus, a complete assessment of sedentary behavior requires assessment of the two different components in its definition: *energy expenditure* and *body posture.*

Assessments of energy expenditure have mainly addressed physical activities (Ainsworth et al., 2011). Energy expenditure can be described in terms of the energy requirements during human motion relative to those when the body is at rest, measured in