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# ASSESSING THE VALIDITY AND RELIABILITY OF THE PORTUGUESE VERSION OF THE OCCUPATIONAL SITTING AND PHYSICAL ACTIVITY QUESTIONNAIRE (OSPAQ) IN WORKERS OF A POLYTECHNIC INSTITUTE.

Ana Elisabete Cardoso da Silva

**Orientador:** Professora Doutora Joana Santos …………………………………………………..………..(ESS, P.Porto)
**Coorientador:** Professor Doutor Mário Vaz…………………………………………………………….…..(FEUP, U.P.)
**Arguente:** Professora Doutora Carolina Vila-Chã ……………………………………………………….…………….(IPG)
**Presidente do Júri:** Professor Doutor João Baptista…………………………………………………………...(FEUP, U.P.)

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**Faculdade de Engenharia da Universidade do Porto**

Rua Dr. Roberto Frias, s/n 4200-465 Porto PORTUGAL

**VoIP/SIP:** feup@fe.up.pt **ISN:** 3599*654

**Telefone:** +351 22 508 14 00 **Fax:** +351 22 508 14 40

**URL:** http://www.fe.up.pt **Correio Electrónico:** feup@fe.up.pt

# DESTAQUES

1. 47 participantes (100% mulheres), concordaram em preencher o questionário em 2 ocasiões (taxa de resposta de 88,68%);
2. Para os 7 dias de medição, o tempo médio gasto em atividades sedentárias foi mais prevalente (688,9 ±588,3 minutos por semana);
3. Para os dias de trabalho, os resultados para o tempo médio gasto em atividades sedentárias foi de 557,7 ± 570,6 min/semana, sendo inferior ao tempo médio gasto em atividades sedentárias no fim de semana, que foi de 1129,6 ± 417,1 minutos
4. Todas as medições com o OSPAQ indicaram uma fraca confiabilidade, como demonstrado pelos coeficientes de correlação de intraclasse para os minutos despendidos em atividades sedentárias (0,29), leves (0,11), moderadas (0,27) e vigorosas (0,06);
5. Os resultados obtidos para os minutos gastos em atividades sedentárias, leves ou vigorosas indicaram uma associação fraca (<0,3) e para as atividades moderadas, uma associação baixa (0,3-0,49).

# HIGHLIGHTS

1. 47 participants (100% women), agreed to complete the questionnaire on two occasions (response rate of 88.68%);
2. For the 7 days of measurement, the mean time spent on sedentary activities was more prevalent (688.9 ± 588.3 minutes per week);
3. For the working days, the results for sedentary activities had a mean duration of 557.7 ± 570.6 minutes, and were inferior than the non-working days, were the mean duration spent on sedentary activities were 1129.6 ± 417.1 minutes;
4. All measures obtained with the OSPAQ indicated poor reliability, as reflected by the ICCs for minutes spent in sedentary (0.29), light (0.11), moderate (0.27) and vigorous (0.06) activities.
5. The obtained results for minutes spent in sedentary, light or vigorous activities over the course of the measurements indicated a weak association (<0.3). For the time spent in light activities the measurements indicated a low association (0.3-0.49).

# RESUMO

Atualmente, os adultos despendem grande parte das suas horas de vigília no local de trabalho e, para trabalhos desenvolvidos num ambiente de escritório, a maioria dessas horas são gastas na posição sentada, o que pode ser prejudicial para a saúde. Há uma diversidade de estudos que demonstram que muito tempo gasto na posição sentada geram uma diversidade de riscos à saúde, independentemente do nível de atividade física. Assim, é necessário avaliar o impacto que o comportamento sedentário exerce sobre os indivíduos, especialmente, nos trabalhadores do setor educacional. O principal objetivo deste estudo foi efetuar uma avaliação das diferenças entre os diferentes tipos de atividade ocupacional nos dias úteis e comparar com o fim de semana e determinar a confiabilidade e validade da versão portuguesa do "*Occupational Sitting Physical Activity Questionnaire*" (OSPAQ) em trabalhadores do Instituto Politécnico da Guarda. O OSPAQ foi utilizado para medir o nível de atividade física e atividade sedentária, reportado pelos participantes. De modo a medir objetivamente o comportamento sedentário, utilizou-se o acelerómetro durante 7 dias de medição (dias úteis e fins-de-semana). No total, cerca de 53 indivíduos foram convidados (100% mulheres), com idades entre os 26 e 63 anos (média ± DP, 50,7 ± 8,7 anos), a preencher o questionário em duas ocasiões (taxa de resposta de 88,68%) e incluídos no presente estudo. Durante os 7 dias de medição, o tempo médio gasto em atividades sedentárias foi superior (688,9 ± 588,3 minutos por semana). Também, o resultado médio obtido para as atividades moderadas (16,2 ± 28,5 minutos por semana) não cumpriram as diretrizes definidas pela Organização Mundial de Saúde. Em relação aos dias úteis, as atividades sedentárias tiveram uma duração média de 557,7 ± 570,6 minutos e, para os fins de semana a duração média foi de 1129,6 ± 417,1 minutos. Comparando os resultados, pode-se concluir que os resultados obtidos para os fins-de-semana são superiores aos dias úteis. Estes resultados são esperados, uma vez que ser sedentário no trabalho está associado a um comportamento mais sedentário fora do trabalho (Saidj et al., 2015). Todas as medidas obtidas com o OSPAQ indicaram baixa confiabilidade, conforme refletido pelo coeficiente de correlação de intraclasse para os minutos gastos em atividades sedentárias (0,29), leve (0,11), moderada (0,27) e vigorosa (0,06). Para além disso, o teste *t* para amostras emparelhadas demonstrou diferenças estatisticamente significativas entre a ocasião 1 e 2 nos domínios de atividades sedentárias, leves ou vigorosas. A confiabilidade, avaliada pelo teste-reteste, refletiu que há uma variação na aplicação do OSPAQ na mesma amostra. Os resultados obtidos para os minutos gastos em atividades sedentárias, leves ou vigorosas ao longo das medidas indicaram uma associação fraca (<0,3). Para o tempo gasto em atividades leves, as medidas indicaram baixa associação (0,3-0,49). Os gráficos de *Bland & Altman* mostraram níveis baixos de concordância entre os métodos. Um motivo que poderia justificar a existência de diferenças significativas entre a ocasião 1 e a ocasião 2 nos domínios sedentário, leve, moderado e vigoroso é o fato de a presente amostra ser composta por professores (N = 10; 21,28%). Nesta profissão, é muito difícil manter a vida pessoal e profissional separadas. Assim, muitas vezes, para concluir suas as tarefas, é necessário trabalhar longas horas que invadiram o tempo pessoal (Day, Stobart, Sammons, & Kington, 2006). Embora o trabalho sedentário esteja associado a muitos efeitos adversos à saúde, nos últimos anos, surgiram várias alternativas no posto de trabalho tradicional. Estas alternativas foram criadas com o objetivo de reduzir o tempo gasto em comportamento sedentário, proporcionando recursos para posturas estáticas reduzidas e maior variabilidade dos músculos e articulações.

**Palavras-chave**: OSPAQ, atividade física, tempo sedentário, validade, confiabilidade

## ABSTRACT

Nowadays, adults spend a large part of their waking hours at the workplace and for many office-based occupations, the majority of these hour are spent sitting, what can be really harmful and detrimental to health. There is a diversity of studies that demonstrate that much time spent seated infers a risk for health impairments irrespective of the level of physical activity. Thus, it is necessary to evaluate the impact that sedentary behaviour has on individuals, specially, in workers in the education sector. The main purpose of this study was to evaluate the differences of occupational activity types between working days and non-working days and determine the reliability and criterion validity of the Portuguese version of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) in workers of a Polytechnic Institute. The OSPAQ was used to measure the self-reported physical activity level and sedentary behaviour. In order to objectively measure the sedentary behaviour, the accelerometer was used for 7 days (working days and non-working days). In total, 53 individuals were invited to participate in this study. About 47 participants (100% women), aged between 26 and 63 years (mean ± SD, 50.7 ± 8.7 years), agreed to complete the questionnaire on two occasions (response rate of 88.68%) were included in the present study. For the 7 days of measurement, the mean time spent on sedentary activities was more prevalent (688.9 ± 588.3 minutes per week). Also, the mean result obtained for the moderate activities (16.2 ± 28.5 minutes per week) don't fulfil the guideline defined by the World Health Organization. Regarding the **working days**, the sedentary activities had a mean duration of 557.7 ± 570.6 minutes, and for the **non-working days**, the mean duration spent on sedentary activities were 1129.6 ± 417.1 minutes. Comparing the results, it can be concluded that the obtained results on the non-working days are greater than the working days. This results are expected, since being sedentary at work is associated with more sedentary behaviour outside of work (Saidj et al., 2015). All measures obtained with the OSPAQ indicated poor reliability, as reflected by the ICCs for minutes spent in sedentary (0.29), light (0.11), moderate (0.27) and vigorous (0.06) activities. Also, the paired t-test showed statistically significant differences between occasion 1 and occasion 2 across sedentary, light, moderate and vigorous domains. The test-retest reliability, in this case reflected that there is a variation in the application of the OSPAQ on the same sample. The obtained results for minutes spent in sedentary, light or vigorous activities over the course of the measurements indicated a weak association (<0.3). For the time spent in light activities, the measurements indicated a low association (0.3-0.49). Bland & Altman plots showed mixed levels of agreement for mixed levels of agreement between methods. One reason that could justify the existence of significant differences between occasion 1 and occasion 2 across sedentary, light, moderate and vigorous domains is the fact that our sample is composed of teachers (N = 10; 21.28%). In this profession, it is very hard to keep the personal and professional lives separate. Thus, many times, to complete their tasks, it is necessary to work long hours which encroached onto personal time (Day et al., 2006). Although sedentary work is associated with many adverse health outcomes, in the last few years, several alternatives have emerged from the traditional workstation. These alternatives were created with the aim to reduce the time spent in sedentary behaviour providing affordances for reduced static postures and more variability of the muscles and joints.

**Keywords**: OSPAQ, physical activity, sedentary time, validity, reliability

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# LIST OF ACRONYMS

- *r* – PEARSON'S CORRELATION COEFFICIENT;
- BD – BIPOLAR DISORDER;
- BVP – BLOOD VOLUME PULSE;
- CI – CONFIDENCE INTERVAL;
- CVD – CARDIOVASCULAR DISEASE;
- DSE – DISPLAY SCEEN EQUIPMENT;
- DSE – DISPLAY SCREEN EQUIPMENT;
- ECG – ELECTROCARDIOGRAPHY;
- H. – HOURS;
- HR – HEART RATE;
- ICC – INTRACLASS CORRELATION COEFFICIENT;
- IMUS – IERTIAL MEASUREMENT UNITS;
- IPAQ – INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE;
- LBP – LOW BACK PAIN;
- LTPA – LEISURE TIME PHYSICAL ACTIVITY;
- MEMS – MICRO-ELECTRO-MECHANICAL-SYSTEMS;
- MET – METABOLIC EQUIVALENT EXPENDIRURE;
- MIN. – MINUTES;
- OR – ODDS RATIO;
- OSPAQ – OCCUPATIONAL SITTING AND PHYSICAL ACTIVITY QUESTIONNAIRE;
- PA – PHYSICAL ACTIVITY;
- PAST – PAST-DAY ADULTS' SEDENTARY TIME;
- PDR – PREVIOUS DAY RECALL;
- RADI – RAPID ASSESSMENT DISUSE INDEX;
- SB – SEDENTARY BEHAVIOUR;
- SBQ – SEDENTARY BEHAVIOUR QUESTIONNAIRE;
- SDT – SELF-DETERMINATION THEORY;
- SEMG – SURFACE ELETROMIOGRAPHY;
- TPB – THEORY OF PLANNED BEHAVIOUR;
- WHO – WORLD HEALTH ORGANIZATION;

# PART 1

# 1 INTRODUCTION

Adults spend a large part of their waking hours at the workplace and for many office-based occupations, the majority of these hour are spent sitting, what can be really harmful and detrimental to health (Owen, Sparling, Healy, Dunstan, & Matthews, 2010). Sedentary behaviour can be defined as any waking behaviour characterized by an energy expenditure smaller or equivalent to 1.5 Metabolic equivalent of task (METs), while in a sitting, reclining or lying posture (Owen, Leslie, Salmon, & Fotheringham, 2000; Pate, O'Neill, & Lobelo, 2008).

According to the 2018 Eurobarometer survey of sport and physical activity[1], nearly half of Europeans never exercise or play sport, and the proportion has increase gradually in recent years. In Portugal, 1,089 people were interviewed to evaluate the frequency of exercise or playing sport. It was concluded that 68% of the Portuguese population considers that they never exercise or play sport. Only 5% the Portuguese population considers engaging regularly in other physical activities such as cycling from one place to another, dancing or other, while 64% admits that they never do that. In relation to the time spent sitting on an usual day that included the time spent on a desk, visiting friends, studying or watching television, 23% of the Portuguese population considers that spends from 2h30min or less, while 39% admits that they spend from 2h31min to 5h30min, and also, 24% considers that they spent approximately from 5h31min to 8h30min, while 10% spends more than 8h31min per day and only 3% doesn't know the time spent in this position.

These facts can have an explanation, because nowadays people are usually confronted with a modern and industrialized society that spends more time engaged in sedentary behaviours in the main domains of living, like working when using a computer or sitting on a desk, travelling or driving a car, and also, during leisure as when watching television (Chau, van der Ploeg, Merom, Chey, & Bauman, 2012; Church et al., 2011; Ng & Popkin, 2012). The prolonged sedentary behaviour is prevalent across many professions and it has been found to be very detrimental to health. Thus, it is crucial to create well planned strategies focused on preventing and reducing the sedentary behaviour, to reduce this type of exposure (Wang, Wu, Lange, Fadhil, & Reiterer, 2018).

There is a diversity of studies that demonstrate that much time spent seated infers a risk for health impairments irrespective of the level of physical activity. Sedentary work has been associated with several adverse outcomes, such as an increased risk of cardiovascular disease, obesity, depression, type 2 diabetes, musculoskeletal disorders and premature mortality (Eisenberg, Chen, Ye, & Louis, 2015; Ford, Kohl, Mokdad, & Ajani, 2012; Uffelen et al., 2010; Zemp, Fliesser, Wippert, Taylor, & Lorenzetti, 2016).

[1] https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/82432 (Accessed in: 12/12/2018)

Thus, it is necessary to evaluate the impact that the sedentary behaviour has on individuals, specially, in workers in the education sector. There are several methods to perform an assessment of sedentary behaviour (SB), such as, questionnaires available for evaluation of sedentary behaviour, although it is necessary to determine the most valid and reliable questions for targeting key modes of sedentary behaviour (SB). In this category of methods, can be included the **Occupational Sitting and Physical Activity Questionnaire (OSPAQ)** used to assess the physical activity level and sedentary behaviour. The OSPAQ is an instrument developed to record the proportion of work time spent sitting, walking, standing, and doing heavy labour, as well as the total length of time worked in the past five working days (Kennedy, Boreham, Murphy, Young, & Mutrie, 2007). This instrument was developed from the MONICA (Multinational Monitoring of trends and determinants in cardiovascular disease) Optional Study of Physical Activity and the Behavioural Risk Factor Surveillance[2] (Roeykens et al., 1998). Also, to perform a more complete evaluation, it is possible to use accelerometers. These instruments are capable of assessing and recording the magnitude and the movements generated by the body. By being placed next to the body, these sensors can measure the acceleration of the body segments, converting the received signal by electrical transductors. Most accelerometers created to measure the physical activity, generate an output of arbitrary representations of acceleration known as counts (Sasaki, Samara, Gonçalves, & John, 2016). These sensors present many advantages, for example, they are quite small, with low battery consumption, and can easily be integrated with other sensors. Therefore, they are generally unobtrusive to wear and very practicable to use in the field. However, the method for calculating counts differs between accelerometers due to the lack of an industrial standard for transformation of raw acceleration data (Strath et al., 2013).

The main objective of this study is to evaluate the differences of occupational activity types between working days and non-working days and determine the reliability and criterion validity of the Portuguese version of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) in workers of the Polytechnic Institute of Guarda.

Although sedentary work is associated with many adverse health outcomes, in the last few years several alternatives have emerged from the traditional workstation. These alternatives were created with the aim to reduce the time spent in sedentary behaviour providing affordances for reduced static postures and more variability of the muscles and joints. These alternative workstations, such as sit-stand workstations, cycling workstations and treadmill workstations are designed with the goal to reduce sedentary behaviour and mitigate the associated health outcomes (Davis, Kotowski, Sharma, Herrmann, & Krishnan, 2009; Hedge & Ray, 2004; Nerhood & Thompson, 1994).

[2]https://www.cdc.gov/brfss/about/about_brfss.htm (assessed in: 09/04/2019)

## 1.1 Sedentary behaviour

**Sedentary behaviour** comes from the Latin word *sedere* ("to sit"), which is the term used to designate those behaviours for which energy expenditure is low including prolonged sitting or lounging time in transit, at work, at home, and in leisure time (Tremblay, Colley, Saunders, Healy, & Owen, 2010).

So, it can be defined as any waking behaviour characterized by an energy expenditure smaller or equivalent to 1.5 Metabolic equivalent of task (METs), while in a sitting, reclining or lying posture (Owen et al., 2000; Pate, O'Neill, et al., 2008). Following this definition, sedentary behaviour includes tasks or movements performed sitting or lying down, if just energy requirements are low (Holtermann et al., 2017).

### 1.1.1 Health consequences of sedentary behaviour

There is a diversity of studies that demonstrate that much time spent in sedentary activities infers a risk for health impairments irrespective of the level of physical activity. The main consequences that can occur when workers are exposed to workplaces that are characterized by having a lack of physical activity are: low back pain (LBP); mental health problems (e.g. anxiety and depression, bipolar disorder, schizophrenia); cardiometabolic diseases and cancer (Holtermann et al., 2017).

#### 1.1.1.1 Lumbar posture, muscular activity and low back pain (LBP)

A study conducted by Mörl & Bradl (2013) with the aim to measure the posture and preform a surface electromyography (sEMG) of the lumbar spine during the office work, for a more complete understanding of the lumbar spine within such conditions. It was concluded that most of the time spent in office work was sedentary (82%). Only 5% of the measured time was undertaken in erect body position (standing or walking). The sEMG of the lumbar muscles under investigation was task dependent. A strong relation to lumbar spine posture was found within each task. The more the lumbar spine was flexed, the less there was activation of lumbar muscles and because of this very low muscular activity, the load is transmitted by passive structures like ligaments and intervertebral discs. Due to the viscoelasticity of passive structures and low activation of lumbar muscles, the lumbar spine may incline into de-conditioning. This may be a reason for low back pain (LBP).

Chronic low back pain is the most common form of low back pain and numerous psychosocial and physical aspects could be responsible for its development as well as the progression to a chronic condition. So, it is no surprise that the prolonged static sitting is also thought to be associated with an increased risk of developing musculoskeletal disorders in the back, neck, shoulders, arms and legs. Subjects with LBP or perceived lumbar discomfort have been reported to adopt a more static sitting behaviour with less frequent micro-movements and infrequent but large shifts in posture

(Sullivan, Keeffe, Sullivan, & Sullivan, 2012; Telfer, Spence, & Solomonidis, 2009; Vergara & Page, 2002).

A pilot study developed by Zemp, Fliesser, Wippert, Taylor, & Lorenzetti (2016) analysed the influence of back pain on sitting behaviour in the office environment by using a textile pressure mat (64-sensor-matrix) placed on the seat pan was used to identify the adopted sitting positions and the application of two standardised questionnaires to assess short and long-term back pain in order to divide the subjects into two groups (with and without back pain).

It has been shown that breaks in sitting time, regular changes between different sitting positions, as well as changing from a sitting to a standing working position all have a positive effect on the human body (Healy et al., 2008; Healy, Matthews, Dunstan, Winkler, & Owen, 2011). However, office workers can only use a few sitting positions as it is very difficult to control our sitting position during concentrated working. To solve this situation and increase awareness, sitting behaviour monitoring and feedback devices can be used, which could detect and prevent discomfort and musculoskeletal disorders at an earlier time point (Haller et al., 2011). Musculoskeletal disorders and especially LBP are multifactorial in nature and therefore the whole biopsychosocial spectrum needs to be considered to ensure thorough analysis and treatment (Keeffe et al., 2013).

### 1.1.1.2 Sedentary behaviour and mental health

#### *1.1.1.2.1 Anxiety and depression*

Anxiety is a disease characterized by a persistent and excessive worry, that can cause an amount of distress, capable to constrain the ability to carry out the normal daily activities (Smith, Hamer, & Gardner, 2018).

One study conducted by Allen, Walter, & Swann (2019), determined the magnitude of the association between sedentary behaviour and anxiety. This review included the analysis of 13 observational studies, that verified that sedentary behaviour was associated with an increased risk of anxiety for non-adjusted effect sizes (k=7, OR=1.33 [95% CI: 1.14,1.55]) and effect sizes adjusted for sociodemographic and health-related factors (k = 11, OR = 1.48 [95% CI: 1.25, 1.75]). The regression models showed that effect sizes were not moderated by age or gender. However, there was some evidence of moderation by study quality and measurement of sedentary behaviour and anxiety. Measures of sitting time showed larger associations than measures of screen time, and measures of anxiety symptoms showed larger associations than measures of anxiety disorders. Thus, this research provided evidences that sedentary behaviour has a small positive association with anxiety, after controlling for sociodemographic and other health-related factors.

Depression is another serious medical illness that negatively affects how you feel, the way you think and how you act, and can cause a persistent feeling of sadness and loss of interest (Smith et al., 2018).

A study by Arredondo et al. (2013) was conducted to examine and determine the association between depression severity and sedentary behaviour, weight status, and social integration, and moderating role of socio-demographic characteristics, and social integration, and perceived social mobility on the association between depression and sedentary behaviours. This study included an evaluation of three hundred and ninety-seven adults were recruited using multistage sampling methods and consented to complete a one-time interview and measurement of height and weight. The mean age was 43.4 ± 16.9, and 47% were obese. The findings suggested that depression was positively correlated with sedentary behaviours, such as sedentary individuals who were older or reported a social lower status, were at highest risk for depression.

Also, Stubbs et al. (2018), studied the relationship between sedentary behaviour and depression in 42,469 individuals (50.1% female, mean 43.8 years). The results obtained concluded that the people with depression spent 25.6 (95% CI 8.5–42.7) more daily minutes in sedentary behaviour (SB) than non-depressed participants. This discrepancy was most notable in adults aged ≥ 65 years (35.6 min more in those with depression). Adjusting this data for socio-demographics and country, depression was associated with a 1.94 (95% CI 1.31–2.85) times higher odds for high SB (i.e., ≥ 8 h/day). The largest proportion of the SB-depression relationship was explained by mobility limitations (49.9%), followed by impairments in sleep/energy (43.4%), pain/discomfort (31.1%), anxiety (30.0%), disability (25.6%), cognition (16.1%), and problems with vision (11.0%). Thus, people with depression are at increased risk of engaging in high levels of SB.

It is not uncommon to a person suffer for anxiety or depression or both. Nearly one-half of those diagnosed with depression are also diagnosed with an anxiety disorder. It is therefore difficult to disentangle whether sedentary behaviour is associated with anxiety, depression, or both mental disorders (Smith et al., 2018).

### *1.1.1.2.2 Bipolar Disorder*

Bipolar disorder, also known as manic-depressive illness, is a brain disorder that is characterized by affective instability and cognitive deficits, and causes unusual shifts in mood, energy, activity levels, and the ability to carry out day-to-day tasks (DelBello, Adler, Cerullo, Fleck, & Strakowski, 2009).

Vancampfort et al. (2016), conducted a meta-analysis to investigate physical activity (PA) and sedentary behaviours (SB) levels and its predictors in bipolar disorder (BD). The present review included six studies were eligible including 279 (129 male participants) people with BD (mean age=43.9 years; range: 32.0–51.5 years). The trim and fill analysis demonstrated people with BD spent in total 210.1 min (95%CI=146.3–273.9 min) per day being physically active and 613.3 min (95%CI=389.9–836.6 min) during waking hours being sedentary. No significant difference in total PA per day was observed between people with BD and controls (g=−0.62, 95% CI=−1.55 to 0.31, I2=88.5%, n BD =82, n controls =86). Objective measures of PA recorded significantly lower levels (P=0.03) compared to self-report PA. Meta-regression demonstrated that older age and a higher body mass index predicted lower PA levels. Thus, adults with BD engage in high levels of sedentary behaviour during waking hours.

#### *1.1.1.2.3 Schizophrenia*

Schizophrenia is a severe, chronic psychiatric illness characterized by delusions and hallucinations, negative symptoms, and cognitive dysfunction that frequently leads to a lifetime of impairment and disability. This illness appears to be caused by complicated interactions between heritable genetic risk factors and a range of environmental exposures (Volk & Lewis, 2015).

A study conducted by Stubbs, Williams, Gaughran, & Craig (2016), preformed a meta-analysis to investigate sedentary behaviour (SB) levels and predictors in people with psychosis. This study included thirteen studies, including 2033 people with psychosis (mean age 41.3 years (range 25.1–60), 63.2% male participants (range 35–89%), body mass index equal to 28.7 (range 25.9–32.1). The trim and fill analysis demonstrated people with psychosis spent 660.8 min (95% CI 523.2-798.4, participants = 2033) or 11.0 h (95% CI 8.72–13.3) per day being sedentary. Objective measures of SB recorded significantly higher levels ($p < 0.001$) of SB (12.6 h per day, 95% CI 8.97–16.2, studies = 7, participants = 254) compared to self-report SB (6.85 h per day, 95% CI 4.75–8.96, studies = 6, participants = 1779). People with psychosis engaged in significantly more SB than controls ($g = 1.13$, 95% CI 0.496–1.77, $P < 0.001$, n psychosis = 216, n controls = 159) equating to a mean difference of 2.80 (95% CI 1.47–4.1) hours per day. Multivariate meta-regression confirmed that objective measurement of SB predicted higher levels of sedentariness. Thus, it was concluded that people with psychosis engage in very high levels of sedentary behaviour in their waking day.

### 1.1.1.3 Sedentary behaviour and cardiometabolic diseases

Ahmad, Shanmugasegaram, Walker, & Prince (2017) conducted a systematic review to determine whether sedentary time was associated with cardiometabolic diseases and their risk factors among South Asian adults. Results identified a trend whereby greater sedentary time was associated with an increased risk for diabetes, and several other cardiometabolic risk factors among South Asian adults

A study executed by Su et al. (2017) aimed to longitudinally explore independent association of physical activity and sedentary behaviours with body weight. The research included 15 050 adults who have complete demographic and dietary data, leisure time physical activity (LTPA) and sedentary behaviour evaluations, anthropometric measurements from longitudinal data of China Health and Nutrition Survey 2004–2011. As results, it was obtained that the overweight and obesity prevalence in men and women progressively increased from 2011 to 2014, while the energy expenditure (MET-h/week from leisure time physical activity (LPTA) declined. It was also noticed that the time spent (h perday) spent in sedentary behaviours increased in men and women over 7 years. Also, LTPA (MET-h/week) was linked with weight gain for moderate ($\beta = 0.43$, 95%

confidence interval (CI): 0.16–0.60, ρ<0.01) and low (β = 0.52, 95% CI: 0.23–0.81, ρ<0.01) versus high LTPA in men; weight was increased by 0.7 kg (95% CI: 0.44–0.93, ρ<0.001) and 0.4 kg (95% CI: 0.12–0.68, ρ<0.01) among men and women without LTPA, respectively, compared with those with high LTPA.

Sedentary behaviour was associated with weight gain in men (β = 0.45, 95% CI: 0.14–0.76, ρ<0.01) and in women (β = 0.29, 95% CI: 0.11–0.49, ρ<0.05) for high versus low level. Moreover, overweight and obesity risk in men with low LTPA or without LTPA was 1.88 (95% CI: 1.15–2.51, ρ<0.05) and 2.01 (95% CI: 1.41–3.03, ρ<0.001) times higher than those with high LTPA, respectively. Odds of overweight and obesity were increased to 1.63 (95% CI: 1.29–2.21, ρ<0.01) times in women with low LTPA and 1.69 (95% CI: 1.37–2.27, ρ<0.001) times in women without LTPA compared with those with high LTPA. High level sedentary behaviour was associated with 19% (OR = 1.19, 95% CI: 1.04–1.35, ρ<0.05) greater odds of overweight and obesity against low level in men. Thus, LTPA and sedentary behaviours are independently and longitudinally associated with overweight and obesity, especially in men (Su et al., 2017).

#### 1.1.1.4 Sedentary behaviour and the risk of cancer

Europe contains 9% of the world population but it has a 25% share of the global cancer disease (Ferlay et al., 2015). According to the study of Ferlay et al. (2018), in Portugal, the most common leading types of cancer in terms of new cases is prostate cancer in males and breast cancer in females. And the leading types of cancers that affects the Portuguese population and causes more deaths is lung cancer in males, and colorectum cancer in females.

The lifestyle factors of sedentary behaviour are being studied for their association with the appearance of cancer. It was already proved that sedentary behaviour is positively and independently associated with an increased risk of more than ten types of cancer, including colorectal cancer (and advanced adenomas), endometrial cancers, and breast cancer (Kerr, Anderson, & Lippman, 2017).

According to Schmid & Leitzman (2014), 43 observational studies including a total of 68936 cancer cases were analysed. The results comparing the highest and the lowest levels of sedentary time, the relative risks (RRs) for colon cancer were 1.54 (95% confidence interval [CI] = 1.19 to 1.98) for TV viewing time, 1.24 (95% CI = 1.09 to 1.41) for occupational sitting time, and 1.24 (95% CI = 1.03 to 1.50) for total sitting time. For endometrial cancer, the relative risks were 1.66 (95% CI = 1.21 to 2.28) for TV viewing time and 1.32 (95% CI = 1.08 to 1.61) for total sitting time. A positive association with overall sedentary behaviour was also noted for lung cancer (RR = 1.21; 95% CI = 1.03 to 1.43). Sedentary behaviour was unrelated to cancers of the breast, rectum, ovaries, prostate, stomach, esophagus, testes, renal cell, and non-Hodgkin lymphoma.

### 1.1.2 Sedentary behaviour – characteristics and what should be assessed?

The concept of sedentary behaviour is distinct from the lack of physical activity, it is more exactly related to the time spent during sitting as distinct from too little exercise. If we consider an individual that can be sufficiently active according to the physical activity guidelines but still can spend prolonged time sitting in front of the TV, it is concluded that the generic term sedentary behaviour identifies a class of behaviours characterized primarily by sitting, with associated low levels of metabolic energy expenditure. Also, there some emerging evidences suggesting a distinct underlying physiology of prolonged sitting time related to the inactivation of lipoprotein lipase and subsequent deleterious impacts on lipid metabolism.

The energy expenditure was classified in the **Table 1** (Ainsworth et al., 2011; D W Dunstan et al., 2010; Pate, Neill, & Lobelo, 2008).

Table 1 - Levels of activity.

| Level of Activity | MET | Examples of Activities |
|---|---|---|
| Minimal | 1.0 to 1.5 | lying down, sitting still and standing still |
| Light | 1.5 to 3.0 | sitting and standing performing tasks with the upper body, and slow walking |
| Moderate | 3.0 to 6.0 | normal walking, carrying light loads |
| Vigorous | ≥ 6.0 | fast walking, running and cycling |

MET – Metabolic equivalent task.

There is an amount of various assessment procedures and indicators of physical activity and sedentarism. The **Table 2** executed by Tremblay (2010), demonstrates the following:

Table 2 - Potential assessments procedures and indicators of physical activity and sedentarism.

| Assessment Methods | PA Measure | |
|---|---|---|
| | Assessment Procedure | Example indicators |
| Direct (objective) | Direct observation; | Minutes of PA, types of PA; |
| | Portable indirect calorimetry; | Energy expenditure, $VO_2$; |
| | Doubly labelled water; | Energy expenditure; |
| | Accelerometery; | Minutes above threshold; |
| | Pedometry; | Steps per day; |
| | Heart rate monitoring; | Minutes above threshold; |
| | Respiration rate. | Minutes above threshold. |
| Reported (subjective) | PA questionnaire or interview; | Energy expenditure, minutes of PA; |
| | PA activity diary; | Energy expenditure, minutes of PA; |
| | PA log; | Frequency of PA, types of PA; |
| | Exercise equipment usage recall; | Frequency, duration, intensity; |
| | Active transportation recall; | Type, frequency, duration, distance; |
| | Stairs climbed recall. | Floors per day. |
| Global | Occupational classification | MET value, energy expenditure |
| | PA comparison to peers | Rating (e.g. higher, same, lower) |
| | Connectedness with nature | Outdoor time. |
| | **SB Measure** | |
| **Assessment Methods** | **Assessment Procedure** | **Example indicators** |
| Direct (objective) | Direct observation; | Minutes of SB, types of SB |
| | Portable indirect calorimetry; | Minutes at resting metabolic rate |
| | Doubly labelled water; | Energy expenditure |
| | Accelerometery; | Minutes below thresholds |
| | Pedometry; | Steps per day |
| | Heart rate monitoring; | Minutes below threshold or at rest |
| | Respiration rate. | Minutes below threshold or at rest |
| Reported (subjective) | SB questionnaire or interview; | Minutes of SB, chair time, screen time |
| | SB activity diary; | Minutes of SB, chair time, screen time |

| Assessment Methods | PA Measure | |
|---|---|---|
| | Assessment Procedure | Example indicators |
| | SB log;<br>Labour-saving usage recall;<br>Automobile usage recall;<br>Elevator and escalator recall. | Frequency of SB, types of SB<br>Frequency, duration<br>Frequency, duration, distance, car time<br>Floors per day, frequency of use. |
| Global | Occupational classification<br>SB comparison to peers<br>Household cocooning | Chair time, screen time, car time;<br>Rating (e.g. higher, same, lower)<br>Indoor time, screen time. |

Analysing the data from the Table 1, it is concluded that there is a small difference between sitting and standing posture. Therefore, carrying out a study only assessing the energy expenditure is not enough to provide reliable information about the gross body posture. Assessing sedentary behaviour also requires measurement of body posture, like using wearables to assess a multitude of body positions, as per their anatomical location (Ainsworth et al., 2011; Foutaine, Johann, Skalko, & Liguori, 2016; Gibbs, Kowalsky, Perdomo, Grier, & Jakicic, 2017).

Thus, to perform a complete assessment of sedentary behaviour requires assessment of the two different components in its definition: energy expenditure and body posture. To measure the characteristics of this variable, it is important to consider the daily duration of sedentary behaviour for considering the health effects of sedentary behaviour and for assessing the need for interventions aimed at reducing it. It is also important information on the domain in which the sedentary behaviour takes place, like work, leisure or transportation is often collected via self-reported diary entries (Holtermann et al., 2017).

To evaluate the health consequences of sedentary work, it is important to consider the time patterns, because the time spent in continuous prolonged bouts of sedentary behaviour may be more detrimental to health than the same duration spent in shorter bouts (Carson et al., 2014; Gupta, Heiden, Mathiassen, & Holtermann, 2016; Healy et al., 2008). It is also important to consider the durations of sedentary periods as well as the periods of non-sedentary behaviour (Hallman et al., 2016; Straker et al., 2014). The time spent on this type of activity has bens well studied, documented and proved to have significant effects on health, which along with the body posture and behaviour during periods of occupational non-sedentary behaviour may modify the health effects of sedentariness (Bauman & Craig, 2005; Danquah et al., 2017; Warburton, Charlesworth, Ivey, Nettlefold, & Bredin, 2010).

Concluding, wearables capable of monitoring not only the total duration and the time pattern of sedentary behaviour, but also the duration and pattern of other postures and movements, and of energy expenditures above 1.5 METs, can be relevant when assessing the need for interventions aimed at reducing sedentary behaviour, as well as their effects on health (Holtermann et al., 2017).

### 1.1.3 Sedentary Behaviour Questionnaires

There are numerous of questionnaires available for evaluation of sedentary behaviour, but it is necessary to to determine the most valid and reliable questions for targeting key modes of sedentary behaviour (SB). The self-report tools are capable to provide information about mode and domains of SB, but little is known about their validity, which is, the degree to which the questionnaire measures what it claims to measure, and reliability, which is the degree to which a questionnaire can produce consistent and reproducible results (Atkin et al., 2012; Carson et al., 2016).

In the **Table 3** is presented a list of the most widely used English-language questionnaires for measuring sedentary behaviour in individuals. There is also presented a brief description of each instrument.

Table 3 - List of the most widely used questionnaires for measuring SB in adults.

| Questionnaires | Author | Description |
|---|---|---|
| Bouchard Physical Activity Questionnaire | Bouchard et al., (1983) | Widely used diary in which participants can report physical activity for each 15 min interval over three days. Activities are rated on a scale of Likert from on a scale of 1 to 9 (1 = sedentary activity, 9 = intense manual work or high intensity sports) to yield a total energy expenditure score; however, the diary is burdensome, particularly for individuals with cognitive dysfunction (Sylvia, Bernstein, Hubbard, Keating, & Anderson, 2014). |
| Previous-Day recall of active and sedentary behaviours | Matthews et al., (2013) | "*Previous day recalls (PDR) offer several advantages over questionnaire-based estimates of usual activity and sedentary behaviour. First, they allow respondents to rely on episodic memory to generate reports about time spent in specific activity-related behaviours, rather than use of estimation strategies and long-term averaging. Thus, the information reported on the PDR may be more accurate. Second, PDRs capture more detailed information about different types of activities, offer a unique opportunity to assess body posture (i.e., sitting vs. standing), as well as information about behavioural context (e.g., location and purpose) not available from other measures. Hence, PDRs may be particularly valuable for studies interested in posture-based estimates of sedentary behaviour, or that require information about where and why physically active and sedentary behaviours occur*" (Matthews et al., 2013). |
| International Physical Activity Questionnaire (IPAQ)[3] | IPAQ group[4] | This instrument covers four domains of physical activity: work-related, transportation, housework/gardening and leisure-time activity. The questionnaire also includes questions about time spent sitting as an indicator of sedentary behaviour. In each of the four domains the number of days per week and time per day spent in both moderate and vigorous activity are recorded. At work, during transportation and in leisure time, walking time is also included (Hagstromer, Sjostorm, & Oja, 2006). |
| Marshall Sitting Questionnaire | Questionnaire adapted from Miller & Brown, (2004) | The main objective of this questionnaire is to assess the time spent sitting on weekdays and weekend days: 1) traveling to and from places, 2) at work, 3) watching television, 4) using a computer at home, and 5) for leisure, not including television (Marshall, Miller, Burton, & Brown, 2010). |
| SIT-Q | Validation study conducted by Lynch et al., (2014) | The SIT-Q[5] is a measure of habitual sedentary behaviors across occupation, transportation, household and leisure-time domains. It was designed for use in population cohort studies and is administered as a written questionnaire. |
| SIT-Q 7-d | Validation study conducted by Wijndaele et al., (2014) | It is expanded version of SIT-Q, using a 7-day reference frame. |

[3] https://sites.google.com/site/theipaq/ (Assessed in: 31/07/2019)
[4] https://sites.google.com/site/theipaq/ (Assessed in: 31/07/2019)
[5] https://www.sedentarybehaviour.org/sedentary-behaviour-questionnaires/ (Assessed in:31/07/2019)

| Questionnaires | Author | Description |
|---|---|---|
| Bouchard Physical Activity Questionnaire | Bouchard et al., (1983) | Widely used diary in which participants can report physical activity for each 15 min interval over three days. Activities are rated on a scale of Likert from on a scale of 1 to 9 (1 = sedentary activity, 9 = intense manual work or high intensity sports) to yield a total energy expenditure score; however, the diary is burdensome, particularly for individuals with cognitive dysfunction (Sylvia, Bernstein, Hubbard, Keating, & Anderson, 2014). |
| The Sedentary Behaviour Questionnaire (SBQ) | Validation study conducted by Rosenberg et al., (2010) | *"The SBQ was designed to assess the amount of time spent doing 9 behaviors (watching television, playing computer/video games, sitting while listening to music, sitting and talking on the phone, doing paperwork or office work, sitting and reading, playing a musical instrument, doing arts and crafts, sitting and driving/riding in a car, bus, or train). The 9 items were completed separately for weekdays and weekend days.* (Rosenberg et al., 2010)*"* |
| Rapid Assessment Disuse Index (RADI) | Validation study conducted by Shuval et al., (2014) | It is a tool that can quantify and track the sedentary time and low levels of daily lifestyle physical activity among primary care patients[6]. |
| Past-day Adults' Sedentary Time (PAST) | Validation study conducted by Clark et al., (2013) | It's a 7-item questionnaire that asks questions about sedentary behaviours on the previous day[7]. |
| LASA Sedentary Behaviour Questionnaire | Validation study conducted by Visser & Koster (2013) | A 10-item questionnaire that asks about weekday and weekend day sedentary behaviour. |
| Occupational Sitting and Physical Activity Questionnaire (OSPAQ) | Validation study conducted by Chau, Ploeg, Dunn, Kurko, & Bauman, (2012) | It's an instrument developed to record the proportion of work time spent sitting, walking, standing, and doing heavy labour, as well as the total length of time worked in the past five working days (Kennedy et al., 2007). |

The usual SB pattern can be assessed objectively by using accelerometers and inclinometers, but these methods are often too time or resource intensive for inclusion in population-level health surveys and studies. Also, these objective methodologies are unable to distinguish between different domains, such as, occupational/school, transportation, leisure, domestic; and modes of SB, for example, TV, computer use, reading, car driving. This is an important detail, given the fact that some modes of SB appear to be more consistently associated with indicators of poor health than others.

A study conducted by Prince, LeBlanc, Colley, & Saunders (2017) aimed to summarize the available self-report tools for assessing the most common modes of SB including TV viewing, computer use, total screen time, reading, sedentary transportation, and total SB in national and international population surveillance surveys; and, to identify the most valid and reliable questions/questionnaires for assessing total and individual modalities of SB. This review identified

[6] https://www.sedentarybehaviour.org/sedentary-behaviour-questionnaires/ (Assessed in:01/08/2019)
[7] https://www.sedentarybehaviour.org/sedentary-behaviour-questionnaires/ (Assessed in:01/08/2019)

a total of 16 pediatric and 18 adult national/international surveys assessing SB, and few have gone on psychometric testing. Fourteen pediatric and 35 adult questionnaires with psychometric information were included. While reliability was generally good to excellent for questions targeting key modes of SB, validity was poor to moderate, and reported much less frequently. The most valid and reliable questions targeting specific modes of SB were combined to create a single questionnaire targeting key modes of SB. The obtained results highlighted the importance of including SB questions in survey modules that are adaptable, able to assess various modes of SB, and that exhibit adequate reliability and validity.

### 1.1.4 How to select the best wearable to perform an occupational sedentary health assessment?

The wearables have a wide range of technical specifications to ensure that data collection does not bother the worker and is as accurate as possible so, they must be intended to be worn throughout the day (some even at night) the sensors are most often covered by skin-friendly, synthetic materials and enclosed in small cases and often integrated in synthetic or textile bands. Depending on the type of sensor included in the wearable, it assesses and provides output parameters of general physical activity and inactivity (e.g. number of steps, activity intensity, rest), energy expenditure, posture and body movements. Depending on the technical specifications of the wearable, data can be recorded in time resolutions from milliseconds to minutes (Holtermann et al., 2017).

#### 1.1.4.1 Postural and kinematic assessment

In this category, the most popular sensor capable to capture the human movements is the accelerometer. It can measure accelerations on three orthogonal spatial axes and can assess static spatial body segment orientation based on gravity, as well as movements, as derived from the dynamic changes in acceleration. To preform assessment of body segment orientation, low pass filtering of the acceleration signal from a 3-axis accelerometer and deriving the angles for each axis with respect to the gravitational acceleration vector allows it to be used as an inclinometer, which can provide assessments of relatively invariant postures (Chastin & Granat, 2010; Godfrey, Conway, Meagher, & ÓLaighin, 2008; Hansson, Asterland, Holmer, & Skerfving, 2001; Skotte, Korshøj, Kristiansen, Hanisch, & Holtermann, 2014).

Accelerometers present a list of many advantages, for example, they are quite small, with low battery consumption, and can easily be integrated with other sensors. Therefore, they are generally unobtrusive to wear and very practicable to use in the field. However, the method for calculating counts differs between accelerometers due to the lack of an industrial standard for transformation of raw acceleration data (Strath et al., 2013).

The accelerometers are instruments capable of measuring the magnitude and the total volume of movements generated by the body. By being put next to the body, these equipment's can measure the acceleration of the segments that it is close, converting the received signal by electrical transductors. Most accelerometers created to measure the physical activity, generate an output of arbitrary representations of acceleration known as counts. This unit is not physiologically meaningful, but it has been used to determine the energy expenditure trough statistical modelling in different age groups (Sasaki et al., 2016).

Each sample is summed over an 'epoch' and the output of the accelerometer is given in 'counts'. **Counts** are a result of summing post-filtered accelerometer values (raw data at 30 Hz) and are directly related to the magnitude of acceleration. The derivation of counts involves the following procedure (Sasaki et al., 2016):

1. **Digital Rectification** – process of transforming negative acceleration signals (e.g., those opposite to the direction of gravity) into equivalent positive signals;
2. **Proprietary filtering** – involves several filters for various purposes. The use of bandwidth filters to remove frequencies and acceleration values outside the normal range for human movement is common among possible filters that can be employed in the pre-processing of data. The filtered data is then classified into different levels of acceleration where each level is equivalent to a certain proportion of g/count.

**Epochs** are specified time intervals for which counts are summed over the data analysis. Generally, in studies that classify the activity intensity as sedentary, light, moderate, or vigorous, are used cutoff points for 60-s epochs (Sasaki et al., 2016).

For more accurate 3-dimentional kinematic field assessments of body segment orientations and movements, inertial measurement units (IMUs) is an equipment that consist of 3-axis accelerometers, 3-axis gyroscopes and 3-axis magnetic field sensors (magnetometers) are required. By integrating information from these complementary sensor types, the limitation of each individual sensor type is compensated for, allowing multisensory fusion algorithms to precisely assess 3-dimentional orientations and movements (Faber, Chang, Kingma, Dennerlein, & van Dieën, 2016; Roetenberg, Slycke, & Veltink, 2007). However, it is important to consider the magnetic field disturbances in the work place when applying a magnetometer (Kok, Hol, & Sch, 2012).

#### 1.1.4.2 Cardiorespiratory assessment

A linear relationship is known between cardiorespiratory stress and energy expenditure, and therefore with activity intensity (Strath et al., 2000). So, the heart rate (HR) can be assessed and used to estimate energy expenditure, which complements the data of accelerometers, leading to an increased accuracy for assessing physical activity and sedentary behaviour. Different principles are available for assessing HR, with electrical (electrocardiography, ECG) and optical (photoplethysmography, PPG; blood volume pulse, BVP) sensor technologies being the most commonly used (Alian & Shelley, 2014).

#### 1.1.4.3 Categorization of wearables

The **Table 4** summarizes the existing wearable categories, their characteristics and the position of the equipment on the body (Holtermann et al., 2017).

Table 4 - Categories and characteristics of wearables.

| Category | Examples of wearable | Characteristics |
|---|---|---|
| **1** | Accelerometer | • can provide data on the general level of physical activity;<br>• the accuracy and possible transformation of data to specific information on sedentary behaviour and physical activity depend on the placement of the sensors (Trost, Mciver, & Pate, 2005);<br>• can collect data in the wristband or hip (data interpreted as overall physical activity of the whole body) or in the leg (which provides the possibility to differentiate between body postures like sitting, standing, walking, and cycling). |
| **2** | Few independently positioned accelerometers and physiological sensors | • can obtain more accurate information of physical activity, energy expenditure, body postures and movements than with Category 1 wearables;<br>• adhered to the skin;<br>• build into textiles. |
| **3** | Multiple sensor systems developed to simultaneously assess physical activity, body segment orientations and movements, as well as energy expenditure in the field with accuracy similar to that obtained under laboratory conditions | • more expensive than Category 1 and 2 wearables;<br>• primarily developed for research purpose;<br>• attachment on different body parts. |

## 1.2 Physical Activity

The World Health Organization (WHO), defines **physical activity** as any bodily movement produced by skeletal muscles that requires energy expenditure – including activities undertaken while working, playing, carrying out household chores, travelling, and engaging in recreational pursuits. The term "physical activity" should not be confused with "exercise", which is a subcategory of physical activity that is planned, structured, repetitive, and aims to improve or maintain one or more components of physical fitness. Beyond exercise, any other physical activity that is done during leisure time, for transport to get to and from places, or as part of a person’s work, has a health benefit. Further, both moderate- and vigorous-intensity physical activity improve health (WHO, 2018).

Physical activity is affected by individual characteristics (demographics, household and lifestyle characteristics, preferences, culture, genetic factors/biological dimensions, time allocation); built environment (land use patterns, the transportation system, and design features); social environment (societal values and preferences, public policies, economic/market factors). Whether an individual is physically active depends on demographic characteristics such as gender, age, and ethnic background, and on socioeconomic characteristics such as education and income level. It also depends on at least three other factors, the latter two of which are external to the individual: (a) attitudes, preferences, motivations, and skills related to the behaviour; (b) opportunities or constraints that make the behaviour easier or more difficult to perform; and (c) incentives or disincentives that encourage or discourage the desired behaviour relative to competing activities (Institute of Medicine of the National Academies, 2004).

Although the benefits of regular physical activity are well known, most of the population avoids meeting the recommended level of activity. Physical activity interventions can be effective in improving well-being across office-based workplace settings (Abdin, Welch, Byron-Daniel, & Meyrick, 2018). However, the behaviour change is a difficult process, when we want to increase physical activity at the workplace. It is particularly challenging because there are many barriers that impede physical activity and many influences that promote sedentary behaviour. Therefore, health professionals must go beyond a traditional prescription model to influence change (Chambliss, 2015).

### 1.2.1 Characteristics of physical activity

Physical activity can be characterized in four dimensions (Klipstein-Grobusch, Montoye, Kemper, Saris, & Washburn, 1997):

- Frequency of the activity (F), usually measured in times per week;
- Intensity (I) which the activity is executed;
- Time (T), which is the duration of the activity/exercise;
- Type of activity (T).

There are some authors that consider other dimension, which it refers to the circumstances in which the activity is carried out (Klipstein-Grobusch et al., 1997). According to Shephard (1994), physical activity can have several aspects or purposes, namely: utilitarian (considering the work activities and household chores); free time ( activities of recreational level) and physical education (activities of educational character).

Physical activity can be expressed in watts, in terms of quantity of work, time or period of activity (minutes, hours), unities of movements or from numerical result obtained through the answers to a questionnaire (Klipstein-Grobusch et al., 1997).

The stimulus provided by physical activity that acts on the individual will affect directly over the processes of adaptation over the organism, provoking different effects depending on the quantitative factors (work activity, tasks, physical education and leisure activities) (Sánchez, 2001).

### 1.2.2 Physical activity programmes at the workplace

The World Health Organization (2010) defines a healthy workplace as "*one in which workers and managers collaborate to use a continual improvement process to protect and promote the health, safety and well-being of all workers and the sustainability of the workplace*."

Nowadays, companies that are interested and committed in protecting and ensuring the health and safety of workers are among the most successful and competitive, and also enjoy better employee retention rates. In this way, there's a necessity to create a consistent pattern of how the conditions for a healthy workplace can be created. Some factors that the employees need to consider are the following (World Health Organization, 2010; Wyatt, Brand, Ashby-Pepper, Abraham, & Fleming, 2015):

- The costs of prevention *versus* the resultant costs from accidents;
- The financial consequences of legal breaches of safety and health laws;
- The health of workers as an important patrimony of the company.

The adherence to these principles avoids incapacities for work, minimization of the costs related to health and the costs associated with high turnover and training of new workers, increasing long-term productivity as the quality of products and services (World Health Organization, 2010).

With the increase of the employees' physical activity, a healthier workforce is developed, and it is noticed an increase in employees' activity, and a employees' risk of developing costly and debilitating chronic diseases (Baicker, Cutler, & Song, 2010; Naydeck, Pearson, Ozminkowski, Day, & Goetzel, 2004). Thus, with the application of this type of programmes, it is verified an increase in the workers productivity, a reduce in absenteeism, and increase morale. Workers who are physically active have lower healthcare costs, require less sick leave, and are more productive at work (Goetzel & Ozminkowski, 2008; Mills, Kessler, Cooper, & Sullivan, 2007).

In Portugal, the national programme to the promotion of physical activity, is a project that aims to promote the sensibilization, the physical literacy and the and the readiness of the entire population for the practice of regular physical activity and sedentary time reduction. Other objective of this program is to promote the generalization of assessment, counselling and referral of physical activity in primary health care institutions. Also, it is important to encourage environments that promote physical activity in the areas of leisure, work, schools, universities, transport and health services and to promote epidemiological surveillance and research and promote and disseminate good practices in the field of promotion of physical activity (Teixeira et al., 2017).

The FitWork project is a programme that focuses to develop to improve European employees' well-being, by implementing physical activity programs in companies, which are specifically designed to comply with the tasks carried out by workers at their workplace[8].

The general objective of the project is to promote physical activity at work, awareness workers and health and safety professionals of the importance of health-enhancing physical activity attending to the job demands. More specifically, this programme pretends to define specific exercises considering musculoskeletal risks of people at work and design a physical activity programme to reduce musculoskeletal injury risks. Also, it introduces motivational aspects with the application of this programme and helps to define good practices to develop physical activity programs at work, and to disseminate these good practices with the aim of researching as many professionals as possible[9].

#### 1.2.2.1 Active workstations

An active workstation is a type of workplace intervention that enables people to incorporate physical activity into a sedentary task and can include different types of activity such as walking on a treadmill, pedalling a stationary bicycle, using an elliptical trainer, or simply standing at a height-adjustable desk. These workstations allow people to incorporate physical activity into normally sedentary desk tasks (Tine Torbeyns, Bailey, Bos, & Meeusen, 2014). A regular level of physical activity at the workplace has many benefits, at the human organism level, especially in the prevention of obesity (Ilacqua, Emerenziani, Guidetti, & Baldari, 2019), heart disease (Goenka & Lee, 2017), diabetes (Siomos, Andreoni, Buchholz, & Dickins, 2017), improvement in mental health (Conti & Ramos, 2018), prevention of cancer (Thune & Furberg, 2001) and premature death (Crespo et al., 2002).

A study conducted by Ojo, Bailey, Chater, & Hewson (2018), performed a systematic review that pretended to examine the effect of active workstations on workplace productivity and performance. The study concluded that sit-stand desks had no detrimental effect on performance, however, some studies with treadmill and cycling workstations identified potential decreases in performance. Most studies evaluated productivity and work performance during single-session trials with the evidence suggesting that sit-stand workstations have no detrimental effect on these outcomes.

Koren, Pišot, & Šimunič (2016), analysed simultaneous work and exercise for non-sedentary office workers. The authors have monitored oxygen uptake, heart rate, sweating stains area, self-perceived effort, typing test time with typing error count and cognitive performance during 30 min of exercise with no cycling or cycling at 40 and 80 W. Compared baseline, it was found an increased physiological responses at 40 and 80 W, which corresponds to moderate physical activity (PA). Typing time significantly increased by 7.3% (p = 0.002) in C40W and also by 8.9% (p =

[8]http://fitwork.eu/files/FITWORK_folleto.pdf (accessed in 04/12/2018)
[9]http://fitwork.eu/project/ (accessed in 04/12/2018)

0.011) in C80W. Typing error count and cognitive performance were unchanged. Thus, moderate intensity exercise performed on cycling workstation during simulated office tasks increases working task execution time with, it has moderate effect size; however, it does not increase the error rate. Participants confirmed that such a working design is suitable for achieving the minimum standards for daily PA during work hours.

There are many devices that can be introduced to reduce sedentary behaviour and increase physical activity at the workplace. The most used equipment's in these types of interventions are: a treadmill, a desk bike, an under desk elliptical trainer, or a height-adjustable desk.

A treadmill workstation is a desk that is adapted in a way that the users can walk on a treadmill, while working. Treadmill desks are intended to reduce the amount of time spent sitting in today's otherwise sedentary office (MacEwen, MacDonald, & Burr, 2015). Some of the benefits to use this type of intervention are: this equipment provides a reduced impact, more exactly, running on a treadmill reduces more impact on the feet than running on the street or other outdoor surfaces. The other benefit is that the operator can control between a light workout and an intense workout. The next big boost that one might get from running on a treadmill is that it can really help the brain function better, be healthier, making the worker feel much happier. The reason for this is because running and aerobic exercises like biking trigger the brain to release increased amounts of endorphins. Endorphins are the chemical compounds in your brain which make the person feel happiness. Therefore, running on a treadmill at the workplace can directly contribute to the relief of depression and anxiety. Moreover, using a treadmill can reduce the risk of heart disease, diabetes, and joint related health problems.

Desk bikes are equipment's that allow people to pedal, while performing other tasks at their workstations. Cycling is a form of physical activity that effectively taxes the cardiorespiratory and metabolic functions of the whole body in a wide range of intensities and thus lends to many potential health benefits (Oja et al., 2011).

An under desk elliptical trainer[10] is made of high-quality pedal exercisers and ellipticals which are suitable in offices to keep everyone fit while working. One of the benefits is that allows the worker to exercise while working at a desk, watching television, reading a book, etc. Also, the under desk elliptical works by a gliding movement. And, there is continuous movement with no impact on the knees. Furthermore, the muscles exercised include the glutes, quadriceps, hamstrings, and calves.

A height-adjustable desk allows workers to easily change postures from sitting to standing height throughout the day which can positively impact physical health. With this type of intervention, it's possible to the worker to adjust the desk, instead of trying to adapt a diverse workforce to one or two fixed desk configurations. This adaptability allows users to work using their bodies' optimal "Neutral Posture" – which is the work posture where your body is at its strongest and most

[10] https://fitnessreporting.com/best-under-desk-elliptical-review/ (Assessed in: 03/02/2019)

efficient. Also, the worker has the possibility to variate positions between sitting position and standing position (Tew, Posso, Arundel, & McDaid, 2015).

In order to improve the adherence of the workers to these types of interventions and provoke the behaviour change in these individuals, we must consider the implementation of some strategies, to guarantee the full adherence to our intervention.

Heinrich et al. (2018), Proença et al. (2018), Schellewald et al. (2018a) and Torbeyns et al. (2016) designed interventions that included the implementation of bike desks in the office to reduce sedentary time.

To improve the adherence to their interventions, these authors used an amount of strategies to increase the success of the results. According to Torbeyns et al. (2016), the strategy used to enhance and motivate the participation of the workers was to perform an information session about their intervention, where the intervention was explained and the participants had the chance to contact with the equipment that would be used an had the possibility to use it. Also, the same author applied an interview designed specifically to the study and contained questions about how experienced the cycling during work, if they would continue when having the opportunity, how many hours they would find ideal, if they experienced any positive or negative effects of the cycling on e.g. attention, motivation, productivity, fatigue, energy level, health. As a result, most of the participants were positive about the intervention, more exactly, one third of the participants experienced a positive effect on work-related parameters, like attention and work performance and two thirds of the workers considered that the active workstation positively influenced their motivation during work. Furthermore, about half of the participants felt more energetic, more self-confident and perceived a positive effect on their health and lifestyle. Also, the relationships with other colleagues were positively influenced for two thirds of the participants.

The implementation of this type of strategy was positively accepted by the workers, especially, in increasing the level of physical activity in the workplace. Also in this case, the relationship with the other colleagues provided support and positive reinforcement, improving the adherence of the participants, triggering the change of behaviours to the practice of physical activity in the workplace.

Heinrich et al. (2018) assessed the behavioural regulations for using a dynamic office workstation, by a self-constructed item that where grounded in self-determination theory. The self-determination theory[11] (SDT) is a theory of motivation that is concerned with supporting our natural or intrinsic tendencies to behave in effective and healthy ways (i.e. practice exercise). In SDT the different types of motivation are distinguished based on the different reasons or goals that give rise to an action. The intrinsic motivation pertains to engage in a physical activity because of the inherent pleasures and satisfactions in provides. In contrast, extrinsic motivation characterizes activities that are performed in order to obtain some separable outcome, whether that is a tangible

[11] http://selfdeterminationtheory.org/ (Assessed in: 31/01/2019)

reward, an avoidance of a punishment, or the attainment of recognition, or approval. It can be concluded that this method was indicated to examine the various motivations people have for engaging in intended behaviours, that in this case, was to use the active workstation (Ryan & Deci, 2000).

Schellewald et al. (2018a) also did an information session, like Torbeyns et al. (2016) did, but he also integrated a scale that was modified to be feasible for a high number of multiple repeated measurements. The version included five dimensions, two of which represent motivational state (self-confidence, willingness to perform), three of which represent stress state (recovery, calm, mood). To avoid a tendency to the middle a six-point answering scale without a mean value was assessed. The results of using this type of scale, showed a large intra- and interindividual differences. One disadvantage of the use of this scale is that the results were already quite high before the introduction of the desk bike, what could indicate that the workplace has a good environment, or indicate that the people that participated in the intervention were already had the motivation to participate in the intervention. So, the investigator does not know if their intervention to promote the physical activity in the workplace was well succeeded.

The authors Proença et al. (2018), evaluated the acceptability of the equipment used in the intervention that was developed according with the Theory of Planned Behaviour (TPB), to better understand participants’ beliefs and expectations predictive of their potential to use the pedal desk under the workplace conditions. The TPB predicts an individual's intention to engage in a behaviour at a specific time and place. It posits that individual behaviour is driven by behaviour intentions, where behaviour intentions are a function of three determinants: an individual’s attitude toward behaviour, subjective norms, and perceived behavioural control (Ajzen, 1985). The results were similar to other studies that evaluated the acceptability and found that the workers are positive and accept the under desk pedalling devices and the deskbikes (Carr, Walaska, & Marcus, 2012; Straker, Levine, & Campbell, 2009). The use of such instrument is good to understand the motivation of the workers to perform this intervention, however it is unclear to know if the participants will use these devices in the long-term.

Ben-ner et al. (2014), Bergman et al. (2018), Bouchard et al. (2016) e Tudor-Locke et al. (2014) used a treadmill workstation at an office workstation to reduce the sedentary behaviour and increase the physical activity and the well-being of the workers.

To increase the adherence of the workers, Bergman et al. (2018), sended an e-mail about the health risks of sedentary behaviours and reminders to use the treadmill as much as possible. Although the investigators did not consider to ask the workers the efficacy of implementing this measure, the fact of sending this type of e-mails helps as a reminder to use more the workstation and to keep the participants connected to the intervention. The health communications have the power to inform and influence individual and community decisions that enhance health, leading to, an increase knowledge and awareness of a health issue, influence perceptions, beliefs and attitudes.

Also, it can prompt the action, debunk myths and misconceptions and show the benefit of behaviour change (Arkin et al., n.d.).

Tudor-Locke et al. (2014), tracked the adherence of the participants by using an online post-session survey. Also, behavioural support was provided to promote participants' adherence to scheduled sessions on a daily basis. Participants who failed to report a session were systematically contacted within 24 h to determine whether they completed their session or merely failed to report it. Specifically, if the session scheduled for the previous day was missed, an e-mail was sent supporting the participant to make their subsequent day's scheduled session. Phone calls were placed to the participant if two consecutive days of treadmill desk sessions were missed to query about reasons for missing and to assist the participant with problem solving any issues that were identified as potential barriers to use. Participants who had recurring adherence issues received additional attention, including on-site visits to the corporate campus. Also, each participant received a gift voucher of 25 $ for attending each of the scheduled assessments.

In this case, the fact of the investigators tracked all the participants is a great way to enhance the participation and have better results. The incentives are extremely effective in a way to align the employee's actions toward a common goal. In this case, the incentive provides a higher performance gains than non-monetary, tangible incentives (gifts, travel) (Condly & Clark, 2003)

The authors Ben-ner et al. (2014), assessed the adherence of the workers by an online survey, that according to the authors, the analysis identifies the effects of treadmill workstation and experience with them on the basis of within, such as, person changes in physical activity and work performance of walkers. This strategy was also used by Bouchard et al. (2016), who assessed the interests and expectations of the workers, by applying three questionnaires to capture participants' interests, expectations and intentions to use treadmill workstations. Although this strategy seems prominent, there is no discussion of the authors about the results of this strategy to improve the adherence of the workers to active workstations. The author also used a pedometer as a potential motivator for the participants to use more the treadmill.

Carr et al. (2016), like Bouchard et al. (2016), gave the participants an iPod with a pedalling tracker, that helped the participants to see their evolution.  By doing that, it is possible to investigate how motivated participants were to engage in a treadmill workstation protocol and the likelihood of work-related behaviour change. He also compensated the participants with 40 $ to participate in their intervention, like Tudor-Locke et al. (2014).

In conclusion, to know whether an individual is physically active depends on demographic characteristics such as gender, age, and ethnic background, and on socioeconomic characteristics such as education and income level. It also depends on at least three other factors, the latter two of which are external to the individual: (a) attitudes, preferences, motivations, and skills related to the behaviour; (b) opportunities or constraints that make the behaviour easier or more difficult to perform; and (c) incentives or disincentives that encourage or discourage the desired behaviour relative to competing activities (Institute of Medicine of the National Academies, 2004).

Thus, to be sure about achieving the desirable effects, that is achieve a behavioural change in the workplace, to increase the physical activity in the workplace, it might be of interest to increase participation through e.g. motivational text messages and financial rewards. Other factor that can contribute to the great adherence to any intervention is the fact that each worker should have their personal desk, which could be an extra stimulating factor for using it more often, as they would not lose time due to changing workstations.

## 1.3 Work with display screen equipment's (DSE)

The computer is an important tool in enterprises, due to their functionality and benefits for the process and organization of the companies, so it is particularly natural to observe a gradual increase in the jobs that require the usage of display screen equipment's[12] (DSE). Due to this massive utilization, it is crucial to follow the minimum requirements of safety and health in relation to the use of an DSE at the workplace, identify the main hazards/risks factors which workers are exposed and to evaluate these risks.

The Decree-law n.º 349/93 transposes the Directive n.º 90/270/CEE stablishes the minimum safety and health requirements focused to working with Display Screen Equipment's (DSE). According to the Portuguese legislation[13] the employer must:

- Evaluate the existing health and safety conditions in the different workplaces, namely the those related to the risks to the vision, physical affections and mental health;
- Consider, basing in the previous evaluation, measures to eliminate or minimize those risks;
- Inform the workers about all the themes related to the health and safety of their workplace;
- Stablish periodic breaks from the usage of DSE;
- Ensure the medical vigilance of workers, before they take the job and when they present symptoms of visual perturbance, ensuring medical examination.

The main consequences[14] of using the DSE are presented in the **Table 5**.

Table 5 - Consequences of the utilization of DSE.

| | |
|---|---|
| **Visual System** | Eye irritation |
| | Indisposed for noise and vibrations |
| | Irritability or depression |
| | Headache |
| | Eye pain |
| | Red eyes |
| | Dry or watery eyes |

[12] https://www.ugt.pt/downloadcomunicados?comunicado=2710&file=7fe2ad2698df3a4893023a3dbe3e2be4fe31c2c6 (assessed in :09/04/2019)
[13] https://data.dre.pt/eli/dec-lei/349/1993/10/01/p/dre/pt/html (Assessed in:09/04/2019)
[14] https://www.ugt.pt/downloadcomunicados?comunicado=2710&file=7fe2ad2698df3a4893023a3dbe3e2be4fe31c2c6 (assessed in :09/04/2019)

| | |
|---|---|
| | Blurry or double vision |
| | Increased sensitivity to light |
| | Difficulty concentrating |
| | Physical and muscular fatigue |
| **Musculoskeletal System** | Discomfort and tiredness in the cervical, dorsal and lumbar areas |
| | Musculoskeletal disorders in the hands and pulses |

The analysis of this type of workplace should be executed having in thought the equipment (e.g.: screen, keypad, emitted radiation, the working table, and the chair); the workplace environment, natural and artificial illumination and, finally, the organization of work.

# 2 MATERIALS AND METHODS

## 2.1 General objective

The main purpose of this study is to evaluate the differences of occupational activity types between working days and non-working days and determine the reliability and criterion validity of the Portuguese version of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) in workers of the Polytechnic Institute of Guarda.

### 2.1.1 Specific objectives

To respond to the main objective of this work, there were defined a group of specific objectives to respond to the main goal of this work:

1. Characterize the physical activity of the participants during working time and leisure times;
2. Compare the participants responses in occasion 1 and occasion 2 and determine the Interclass Correlation Coefficient (ICC);
3. Evaluate the criterion validity, by determine the Pearson's (r) correlation coefficient;
4. Determine the Bland-Altman plots in order to describe the agreement between two quantitative measures, by constructing limits of agreement.

## 2.2 Methods

### 2.2.1 Procedure

Participants were recruited from the Polytechnic Institute of Guarda. The individuals of the sample were required to have a full-time on an office-based role and aged ≥ 18 years. All participants that agreed to participate in the study, received an informed consent. Also, all the participants provided the demographic information including age, gender, country of birth, and anthropometrics (height and weight) that was collected from each participant by a questionnaire, developed by the School of Health, Polytechnic of Porto. It was also applied to all participants of this study, the Portuguese version of the Questionnaire of Health State SF-12, developed by Pais Ribeiro (2005).

A random sample was selected, and the participants were invited to wear an accelerometer on the waist for seven consecutive days, on working days and leisure time days and complete the Portuguese version of OSPAQ in two occasions.

The time spent in sedentary, light, moderate, and vigorous activity was objectively measured using the ActiGraph wGT3X-BT. The collected data from the accelerometer was downloaded and analysed by the software ActiLife[15] v6.13.4, which is an actigraphy data analysis software platform**.** This software combines a powerful processing engine with an extensive selection of customer-driven features, analysis tools, and data management options to support a broad range of research objectives. To perform the data analysis and processing, this software has a robust screening and analysis toolkit allows to process and score collected data using a comprehensive selection of independently developed and validated algorithms.

In order to evaluate the differences between the working days and the non-working days, the following parameters were evaluated: mean duration of sedentary bouts, mean duration of sedentary breaks, mean duration of moderate to vigorous activities (MVPA) and mean steps counts. To analyze these parameters, it is necessary to define the concepts. A **sedentary bout** is defined as a "*period of time in continuous sedentary time where the activity intensity fell into the sedentary range with no interruption*" (Honda et al., 2016). To the measurement of this parameter (no minimum duration required and no tolerance allowed), and for each participant, the mean sedentary bout duration using data from all adherent days was computed for the primary measure of sedentary accumulation patterns. MVPA is defined as all the activities of ≥ 3 METs. A **sedentary break** is defined as a as a non-sedentary bout in between two sedentary bouts (Mark S Tremblay et al., 2017). A moderate to vigorous activity (**MVPA**) bout was defined as a period of time in continuous activities where the activity intensity was ≥ 3 METs (Honda et al., 2016).

### 2.2.2 Evaluation

#### 2.2.2.1 Questionnaires

There are several measuring instruments that can be used in this type of studies, but the questionnaires are considered a good option because they not only are a widely used instrument and well accepted by the individuals, and also constitute a cheaper method that make possible to obtain intended results in the population of the study (Wendel-Vos, Schuit, Saris, & Kromhout, 2003).

The **Occupational Sitting and Physical Activity Questionnaire (OSPAQ)**, presented in the Annex I, is a subjective method, used to measure the physical activity level and sedentary behaviour. The OSPAQ is an instrument developed to record the proportion of work time spent sitting, walking, standing, and doing heavy labour, as well as the total length of time worked in the past five working days (Kennedy et al., 2007). This instrument was developed from the

[15] https://www.actigraphcorp.com/actilife/ (assessed in: 24/07/2019)

MONICA Optional Study of Physical Activity and the Behavioural Risk Factor Surveillance[16] (Roeykens et al., 1998).

The sociodemographic data questionnaire is an instrument developed by the School of Health of Porto, created to characterize the population from the study. Characteristics such as: age, gender, nationality, education, current job, number of working hours, working schedules, and other questions were assessed with the application of this questionnaire. The questionnaire is presented on the Annex II.

### 2.2.2.2 Accelerometer

The ActiGraph[17] wGT3X-BT monitor device, presented in Figure 1, is light weighted device (19 grams), compact (3.3 * 4.6 * 1.5 cm) and contains a rechargeable lithium battery that should be fully charged before initialization and deployment to subjects. It uses a tri-axial accelerometer to collect motion data on 3 axes: vertical (Y), horizontal right-left (X) and horizontal front-back axis (Z) with a dynamic range of +/- 8G. Acceleration data are sampled by a 12 bit analog to digital converter at user specified rates ranging from 30 Hz to 100 Hz and stored in a raw, non-filtered/accumulated format in the units of gravity (G's). The collected data is stored directly into a non-volatile flash memory.

**Figure 1** - Actigraph wGT3X-BT

Each sample is summed over an 'epoch' and the output of the Actigraph is given in 'counts'. The counts obtained in a given time period are linearly related to the intensity of the subject's physical activity (PA) during this period (Santos-lozano et al., 2013).

The sampling rate is the predetermined frequency that accelerometers are configured to collect data. The standard unit for sampling is the Hertz, which is the number of times per second that the accelerometer will measure motion. Raw acceleration data collected between 30 and 100 Hz are usually presented in multiple g-force. While recent studies have developed methods to process raw data, most of the validated methods employ counts to estimate PA intensity (Sasaki et al., 2016).

[16] https://www.cdc.gov/brfss/about/about_brfss.htm (assessed in: 09/04/2019)
[17] https://s3.amazonaws.com/actigraphcorp.com/wp-content/uploads/2019/02/04090339/ActiGraph_wGT3X-BT_UserGuide_02012019_Revision2_FINAL.pdf (assessed in :09/04/2019)

The accelerometer activity counts were recorded in 5-seconds epochs and aggregated into 1-min epochs, which were then used to compute time spent in the different activity intensities, i.e., sedentary (<100 counts per minute), light (100–1951 counts per minute), moderate (1952–5724 counts per minute), and vigorous (>5725 counts per minute), based on Freedson (1998) cut points for light-, moderate-, and hard-intensity levels. The wear time was validated by including the periods of consecutive strings of zero-count epochs lasting 60 minutes or longer.

##### *2.2.2.2.1 Calibration and error sources*

The ActiGraph's[18] activity monitors employ the use of solid-state accelerometer circuitry and digital filtering. The incorporation of these technologies improves the reliability and repeatability beyond its predecessor. Thus, there is no need to calibrate periodically the accelerometer, once each unit is calibrated as part of ActiGraph, LLC's standard manufacturing process and this calibration holds through the life of the product. The accelerometer has swapped out the piezoelectric beam for a highly accurate and stable solid state Micro-Electro-Mechanical Systems (MEMS) that undergoes a precise batch manufacturing process to ensure an unprecedented level of repeatability. The initial tolerance specification on sensitivity only varies by + 10%. Additionally, this sensitivity drifts with temperature by only 0.01%/ºC (or 0.9% across the entire operating range) thus making it a negligible component of error. The other primary contributor to error was the hardware-based filter.

### 2.2.2.3 Statistical Analysis

To perform the statistical analysis of the recorded data by the OSPAQ and the sociodemographic data, it was used the software IBM SPSS Statistics 24. In order to conduct the demographic data analysis of the sample, the sociodemographic data questionnaire was applied, and determined the percentage of individuals that belonged to each category of each question.

In relation to the OSPAQ questionnaire, the self-reported activity data was calculated by multiplying the percentage of the activity spend in each domain (sitting, walking, standing, perform heavy labour) from the OSPAQ by the number of hours worked in the last 7 days. This result was then converted into minutes (Chau, Ploeg, et al., 2012).

Once one of the objectives of this work was to evaluate the reliability and criterion validity of the Portuguese version of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) and compare with data collected by accelerometers, it is crucial to define the concepts of reliability and validity. In order to apply any measurement instruments or assessment tools for research or clinical applications, their reliability must be stablished (Koo & Li, 2016). **Reliability** is defined as the as "*the extent to which measurements can be replicated"* (Daly & Bourke, 2000). In other words, it means that the tool gives consistent results when administered by different people

[18] https://s3.amazonaws.com/actigraphcorp.com/wp-content/uploads/2018/03/11163734/calibration.pdf (assessed in: 09/04/2019)

(interrater reliability) or at different time points (test-retest reliability) (Sainani, 2017). **Validity** determines whether the research truly measures that which it was intended to measure or how truthful the research results are (Golafshani, 2003). The criterion validity[19] measures how well one measure predicts an outcome for another measure. A test has this type of validity if it is useful for predicting performance or behavior in another situation (past, present, or future).

The test-retest reliability, which reflects the variation in measurements taken by an instrument on the same subject under the same conditions. It is generally indicative of reliability in situations when raters are not involved or rater effect is neglectable, such as self-report survey instrument (Koo & Li, 2016). The test-retest of the Portuguese version of the OSPAQ was executed by comparing participants' responses from time 1 and time 2 using the Intraclass Correlation Coefficient (ICC) via a two-way mixed model based on absolute agreement for each domain (Jancey, Tye, Mcgann, Blackford, & Lee, 2014). The two-way mixed model is used when the selected raters are the only raters of interest. With this model, the results only represent the reliability of the specific raters involved in the reliability experiment. They cannot be generalized to other raters even if those raters have similar characteristics as the selected raters in the reliability experiment. As a result, 2-way mixed-effects model is less commonly used in interrater reliability analysis (Koo & Li, 2016)

The Intraclass Correlation Coefficient (ICC) was firstly introduced by Fisher (1955) and nowadays is used in conservative care medicine to evaluate interrater, test-retest, and intrarater reliability, and it is calculated by mean squares (i.e., estimates of the population variances based on the variability among a given set of measures) obtained through analysis of variance. This evaluation is fundamental to clinical assessment, because without them, there is no confidence in our measurements, nor it is impossible to explain any rational conclusions from our measurements (Koo & Li, 2016). The ICC was interpreted as indicated in the **Table 6.**

Table 6 - Interpretation of the ICC values (Based on Chau, Ploeg, et al., (2012).

| Interpretation | ICC |
|---|---|
| **Poor repeatability** | < 0.4 |
| **Fair to good repeatability** | 0.4-0.75 |
| **Excellent repeatability** | > 0.75 |

It was also conducted a paired sample t-test ascertain the apparent differences between occasion 1 (test) and occasion 2 (retest) for self-reported physical activity. The paired-sample t-test is a procedure used to determine whether the mean difference between two sets of observations is zero. In a paired sample *t*-test, each subject or entity is measured twice, resulting in *pairs* of observations[20].

In this case, the criterion validity was indicated by the Pearson's (*r*) correlation coefficient, and the strength of correlation was interpreted with the values from **Table 7**. Evidently, the correlation

[19] https://www.statisticshowto.datasciencecentral.com/criterion-validity/ (Assessed in: 25/07/2019)
[20] https://www.statisticssolutions.com/manova-analysis-paired-sample-t-test/ (Assessed in:01/09/2019)

will quantify the degree to which two variables are related (Giavarina, 2015). This type of correlation[21] shows the linear relationship between two sets of data.

Table 7 - Interpretation of the Pearson's (*r*) correlation coefficient values.

| Interpretation | Pearson's correlation coefficient (*r*) |
|---|---|
| **Weak** | <0.3 |
| **Low** | 0.30-0.49 |
| **Moderate** | 0.50-0.69 |
| **Strong** | 0.70-0.89 |
| **Very strong** | >0.90 |

It was also used Bland-Altman plots, in order to assess if the differences between self-reported and measured data were strongly associated with mean values. This plot was introduced to describe the agreement between two quantitative measures, by constructing limits of agreement. These statistical limits are calculated by using the mean and the standard deviation (*s*) of the differences between two measurements. To check the assumptions of normality of differences and other characteristics, they used a graphical approach. Bland & Altman recommended that 95% of the data points should lie within ± 2s of the mean difference (Giavarina, 2015). Thus, for each variable, the plot represents discrepancies between self-reported and measured values against the mean of self-reported values. The limits of agreement were computed as the mean difference ± 1.96 standard deviations, showing the range of discrepancies for 95% of the participants.

[21] https://www.statisticshowto.datasciencecentral.com/probability-and-statistics/correlation-coefficient-formula/ (Assessed in: 25/07/2019)

# PART 2

# 3 RESULTS AND DISCUSSION

## 3.1 Participants Characteristics

In total, 53 individuals were invited to participate in this study. About 47 participants (100% women), aged between 26 and 63 years (mean ± SD, 50.7 ± 8.7 years), agreed to complete the questionnaire on two occasions (response rate of 88.68%) and were invited to participate in the present study. The **Table 8** presents the demographic characteristics of the participants. Most of the participants were university educated (55.3%).

Table 8 - Participant Characteristics.

| **Characteristic** | | **Total (n=47) N (%)** |
|---|---|---|
| **Gender** | Female | 47 (100) |
| | Male | 0 (0) |
| **Age** | Mean | 50.7 |
| | SD | 8.7 |
| | Min. | 26 |
| | Max. | 63 |
| **Education level** | Basic education (4º grade) | 2 (4.3) |
| | Basic education (9º grade) | 4 (8.5) |
| | High school (12º year) | 15 (31.9) |
| | Graduation | 15 (31.9) |
| | Master's degree | 5 (10.6) |
| | PhD | 6 (12.8) |

About 50 of the participants (94.3%) agreed to wear an accelerometer on the waist and wore the accelerometer for an average of 7.6 ± 0.5 days. The average accelerometer wear time for each day was 15.6 hours (937.5 ± 441.3 mins). Relatively to the working days, the average wear time for each day was 15.1 hours (903.7 ± 454.9 mins) which was 15.7% lower than the 17.4 hours wear time for nonwork days (1046 ± 372 mins).

## 3.2 Comparison of sedentary and physical activity

The obtained results for the sedentary behaviour and physical activity measures in the 7 days of measurement, work and non-workdays and all occupational activity types of the sample included is this study are presented in **Table 9**.

Table 9 - Comparison of sedentary behaviours in the study group.

| **Sedentary behaviour rates from 7-d study (n=50)** | | **Sample Group** | | | |
|---|---|---|---|---|---|
| | | **Min.** | **Max.** | **Mean** | **SD** |
| **Occupational Activity Type** | **Sedentary** | 0.0 | 1440.0 | 688.9 | 588.3 |
| | **Light** | 0.0 | 330.0 | 56.6 | 78.9 |

| Sedentary behaviour rates from 7-d study (n=50) | | Sample Group | | | |
|---|---|---|---|---|---|
| | | Min. | Max. | Mean | SD |
| | Moderate | 0.0 | 129.0 | 16.2 | 28.5 |
| | Vigorous | 0.0 | 55.0 | 1.2 | 6.6 |
| Sedentary Bouts | | 10.0 | 1036.0 | 44.1 | 130.2 |
| Sedentary Breaks | | 0.0 | 1440.0 | 350.5 | 536.6 |
| MVPA | | 0.0 | 115.0 | 15.2 | 26.6 |
| Steps Counts | | 0.0 | 19812.0 | 6652.7 | 4668.1 |
| Steps per minute | | 0.0 | 50.6 | 7.8 | 5.9 |
| **Sedentary behaviour rates from working days (n=50)** | | **Sample Group** | | | |
| | | **Min.** | **Max.** | **Mean** | **SD** |
| Occupational Activity Type | Sedentary | 0.0 | 1440.0 | 557.7 | 570.6 |
| | Light | 0.0 | 330.0 | 48.7 | 73.7 |
| | Moderate | 0.0 | 112.0 | 13.2 | 25.9 |
| | Vigorous | 0.0 | 55.0 | 1.2 | 0.9 |
| Sedentary Breaks | | 0.0 | 1440.0 | 252.8 | 458.2 |
| MVPA | | 0.0 | 94.0 | 13.6 | 24.4 |
| Steps Counts | | 0.0 | 17438.0 | 6314.1 | 4657.2 |
| Steps per minute | | 0.0 | 50.6 | 7.6 | 6.2 |
| **Sedentary behaviour rates from non-working days (n=50)** | | **Sample Group** | | | |
| | | **Min.** | **Max.** | **Mean** | **SD** |
| Occupational Activity Type | Sedentary | 0.0 | 1440.0 | 1129.6 | 417.1 |
| | Light | 0.0 | 281.0 | 119.0 | 93.7 |
| | Moderate | 0.0 | 129.0 | 27.2 | 35.7 |
| | Vigorous | 0.0 | 4.0 | 0.89 | 1.4 |
| Sedentary Breaks | | 0.0 | 1440.0 | 1210.7 | 373.0 |
| MVPA | | 0.0 | 37.9 | 22.2 | 37.9 |
| Steps Counts | | 0.0 | 19812.00 | 7723.0 | 4565.5 |
| Steps per minute | | 0.0 | 23.5 | 8.5 | 4.9 |

N = number of participants, Max.= maximal value, Min. = minimal value, SD = standard deviation.

Relatively to the occupational activity type, during the **7 days of measurement**, the mean time spent on sedentary activities were (mean ± SD) 688.9 ± 588.3 minutes, 56.6 ± 78.9 minutes were spent doing light activities, 16.2 ± 28.5 minutes performing moderate activities and 1.2 ± 6.6 minutes spent in vigorous activities. It was verified that the majority of time is spent while performing light or moderate activities, is not concordant with the World Health Organization Global Strategy on Diet, Physical Activity and Health, that consider that adults (age between 18-64 years) should do: "*at least 150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity* *throughout the week or an equivalent combination of moderate- and vigorous-intensity activity"*[22], which in this case isn't fulfilled by the individuals.

Regarding the **working days**, the sedentary activities had a mean duration of 557.7 ± 570.6 minutes, while the light activities had a mean duration of 48.7 ± 73.7 minutes, the moderate activities had a mean duration of 13.2 ± 25.9 and the vigorous activities had a mean duration of 1.2 ± 0.9 minutes. During the **non-working days**, the mean duration spent on different activities evaluated were 1129.6 ± 417.1 minutes on sedentary activities, 119.0 ± 93.7 minutes performing light activities, 27.2 ± 35.7 minutes doing moderate activities and 0.89 ± 1.4 minutes performing vigorous activities. Comparing the results, it can be concluded that the obtained results on the non-working days are greater than the working days. These results are expected, since being sedentary at work is associated with more sedentary behaviour outside of work (Saidj et al., 2015).

For the **sedentary bouts**, the mean values were 44.1 ± 130.2 minutes for the 7 days of measurement. There isn't to our knowledge a recommended value to discuss properly this parameter, although, it can be noticed that there is a high variation on the obtained results, as seen for the obtained standard deviation of the result. The maximal value obtained for this parameter was 1036.0 minutes, which is 17.27 hours per 7 days of measurement.

The mean duration of the **sedentary breaks** were 350.5 ± 536.6 minutes for the 7 days of measurement, 252.8 ± 458.2 minutes for working days, a little bit lower than the 1210.7 ± 373.0 minutes for non-working days.

Relatively to the moderate to vigorous physical activity (**MVPA**), the mean values were 15.2 ± 26.6 minutes for the 7 days of measurement, 13.6 ± 24.4 minutes for the working days and 22.2 ± 37.9 minutes for the non-working days. Physical activity guidelines state that adults should engage in at least 150 min a week of moderate-to-vigorous physical activity (MVPA) to obtain health benefit (Knox, Musson, & Adams, 2015). Comparing the guideline results with the obtained results, it is concluded that the obtained results are much lower than the recommended values.

The mean values for the steps per minute were 7.8 ± 5.9 steps per minute for the 7 days of measurement, 7.6 ± 6.2 steps per minute for the working days and 8.5 ± 1.9 steps per minute for the non-working days.

Sedentary time has shown to be determinant of several health outcomes but also the fact that the sedentary time (ST) is accumulated may be relevant as well. So, patterns of sedentary time expressed by sedentary breaks (interruptions of periods of sitting), the length of sedentary bouts (uninterrupted periods of ST) and the mean duration of a sedentary bout are relevant to consider in analysis (Dunstan et al., 2012; Healy et al., 2008; Velde et al., 2017).

Giurgiu et al. (2019) mentioned, the exposure to sedentary time (15-minute intervals prior to each e-diary assessment) and sedentary bouts (30-minute intervals of uninterrupted sedentary

[22] https://www.who.int/dietphysicalactivity/factsheet_adults/en/ (Assessed in:26/08/2019)

behaviour) influenced negatively the following mood dimensions: valence and energetic arousal. In particular, the more participants were sedentary in their everyday life, the less they felt well and energized. Thus, sedentary behaviour can be seen as a general risk factor because it impacts both somatic and mental health. Most importantly, physical activity and sedentary behaviour showed independent effects on mood dimensions.

Bellettiere et al. (2019) considers, a higher bout duration indicates more prolonged accumulation patterns, whereas lower bout durations indicate interrupted patterns. One study performed by Honda et al. (2016) aimed to examine the associations between time spent in prolonged and non-prolonged sedentary bouts and the development of metabolic syndrome. A total of 430 office workers (58 women), without metabolic syndrome were followed by annual checkups until 2014. The sedentary time was assessed using a tri-axial accelerometer, during 10 consecutive days. Time spent in total, prolonged (accumulated ≥ 30 min) and non-prolonged sedentary bouts (accumulated < 30 min) was calculated. During the follow-up checkups, 83 participants developed metabolic syndrome. After performing an adjustment for age, sex, education, smoking, and family income, positive associations were observed between time spent in prolonged sedentary bouts and the development of metabolic syndrome. After proceeding additional adjustments for moderate-to-vigorous physical activity, those in the three highest quartiles of time spent in prolonged sedentary bouts showed higher risk of metabolic syndrome compared to the lowest quartile group, with adjusted hazard ratios (95 % confidence intervals) of 2.72 (1.30 – 5.73), 2.42 (1.11 – 5.50), and 2.85 (1.31 – 6.18), respectively. Concluding that sedentary behaviour accumulated in a prolonged manner was associated with an increased risk of metabolic syndrome.

Bellettiere et al. (2019) evaluated the average daily sedentary time an mean sedentary bout duration, and concluded that the longer *versus* shorter mean sedentary bout duration was associated with higher risks for cardiovascular disease (CVD) (HR, 1.54; 95% CI, 1.27-2.02; P trend=0.003). Also, the dose-response associations of sedentary time and bout duration with CVD were linear (ρ nonlinear >0.05, each). Thus, both high sedentary time and long mean bout durations were associated in a dose-response manner with increased CVD risk in older women, which suggests that efforts to reduce CVD burden might benefit from addressing either or both components of sedentary behavior.

Analyzing the presented results, it can be concluded that reducing the time spent in prolonged sedentary bouts may be beneficial for the prevention of some health consequences, such as the metabolic syndrome (Honda et al., 2016). However, it is important to consider that there is no guideline that refers a recommended value for this parameter, so this analysis is performed in order to protect the health and safety of the individuals of this sample. Although it is considered that there still exists a very weak epidemiological evidence base to support the inclusion of ’sedentary breaks’ in guidelines, reliance on self-reported sitting measures, and misinterpretation of data whereby methodologically inconsistent associations are claimed to be strong evidence. In conclusion, public health guidance requires a consistent evidence based but this is lacking for SB. The development of quantitative SB guidance, using an underdeveloped evidence base, is still premature (Stamatakis et al., 2019).

It is necessary to intervene in the sedentary behaviour and promote the physical activity at the workplace. A study conducted by Aghdam, Sahranavard, Jahangiry, Asghari Jafarabadi, & Koushaa (2018) aimed at reducing the sitting time and promoting physical activity (PA) among females with sedentary behaviours through providing social support. Participants in both intervention and control groups reported a significant increase in their PA at work that was in favor of the intervention group (at baseline: 112 versus 153 metabolic equivalent of task (MET)-minute/week; after intervention: 399 versus 154 MET-minute/week) ($P < 0.05$). Considerable differences between the intervention and control groups were observed in terms of siting time (at baseline: 25.8 versus 25 hour/ week; after intervention: 19.3 versus 24.3 hour/week). The reduction was significantly higher in the intervention group (6 hour/week) than the control group (0.8 hour/week). Thus, the findings indicated that providing a social support in schools for female teachers may improve several domains of PA and aggravate mental and physical workplace-related problems.

Other workplace intervention that can improve the physical activity, is the implementation of active workstations, in order to incorporate physical activity into a sedentary task and can include different types of activity such as walking on a treadmill, pedalling a stationary bicycle, using an elliptical trainer, or simply standing at a height-adjustable desk. These workstations allow people to incorporate physical activity into normally sedentary desk tasks (Torbeyns et al., 2014). A regular level of physical activity at the workplace has many benefits, at the human organism level, especially in the prevention of obesity (Ilacqua et al., 2019), heart disease (Goenka & Lee, 2017), diabetes (Siomos et al., 2017), improvement in mental health (Conti & Ramos, 2018), prevention of cancer (Thune & Furberg, 2001) and premature death (Crespo et al., 2002).

It is important to consider that an individual being physically active depends on demographic characteristics such as gender, age, and ethnic background, and on socioeconomic characteristics such as education and income level. It also depends on at least three other factors, the latter two of which are external to the individual: (a) attitudes, preferences, motivations, and skills related to the behaviour; (b) opportunities or constraints that make the behaviour easier or more difficult to perform; and (c) incentives or disincentives that encourage or discourage the desired behaviour relative to competing activities (Institute of Medicine of the National Academies, 2004).

Thus, to be sure about achieving the desirable effects, that is achieve a behavioural change in the workplace, to increase the physical activity in the workplace, it might be of interest to increase participation through e.g. motivational text messages and financial rewards. Other factor that can contribute to the great adherence to any intervention is the fact that each worker should have their personal desk, which could be an extra stimulating factor for using it more often, as they would not lose time due to changing workstations.

## 3.3 Reliability and criterion validity of the Portuguese version of OSPAQ

The **Table 10** shows the comparison of responses administered at 7-day interval. On average, in occasion 1, the participants reported that they engaged on sedentary activities on 1620 minutes in the last 7 days, when in occasion 2, the individuals considered to spend approximately 596 minutes per week on sedentary activities.

In relation to the reported values for the moderate activities, in occasion 1, the participants considered that they spent approximately 437 minutes in the last 7 days. In occasion 2, the average reported that they spent an average of 407 minutes per week in moderate activities. For the vigorous activities, the individuals reported a mean duration of 72 minutes in occasion 1, while in occasion 2, they reported a mean duration of 155 minutes per week. Comparing the results, with the World Health Organization Global Strategy on Diet, Physical Activity and Health, that refer at least"*150 minutes of moderate-intensity aerobic physical activity throughout the week or do at least 75 minutes of vigorous-intensity aerobic physical activity throughout the week or an equivalent combination of moderate- and vigorous-intensity activity"*[23], it is concluded for both domains, the reported values for moderate activities are fulfilled, while for vigorous activities, in occasion 1, the participants reported less 3 minutes than the expected value.

All measures obtained with the OSPAQ indicated poor reliability, as reflected by the ICCs for minutes spent in sedentary (0.29), light (0.11), moderate (0.27) and vigorous (0.06) activities. Also, the paired t-test showed statistically significant differences between occasion 1 and occasion 2 across sedentary, light, moderate and vigorous domains. The test-retest reliability, in this case reflected that there is a variation in the application of the OSPAQ on the same sample.

Table 10 - OSPAQ measures administered at 7-day interval during workday.

| Domain | | Occasion 1 | | | | Occasion 2 | | | | Paired t-test | | | ICC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Mean** | **SD** | **Max.** | **Min.** | **Mean** | **SD** | **Max.** | **Min.** | **Mean Difference** | **t** | **ρ** | **(95% CI)** |
| **Sedentary** | (min per week) | 1619.5 | 1602.3 | 10710.0 | 0.0 | 902.921 | 574.9 | 2241.2 | 0.0 | 595.5 | 2.268 | 0.029 | 0.29 (-0.34,0.63) |
| **Light** | | 798.6 | 1480.3 | 9103.5 | 52.5 | 433.9 | 391.2 | 1680.0 | 0.0 | 453.4 | 1.762 | 0.086 | 0.11 (-0.69,0.54) |
| **Moderate** | | 436.9 | 595.3 | 2880.0 | 0.0 | 403.6 | 253.2 | 1080.0 | 0.0 | 64.7 | 0.636 | 0.529 | 0.27 (-0.39,0.62) |
| **Vigorous** | | 72.41 | 128.5 | 535.5 | 0.0 | 69.3 | 154.8 | 720.0 | 0.0 | 7.8 | 0.239 | 0.813 | 0.06 (-0.785,0.51) |

The Pearson (*r*) correlation coefficients between the self-reported activities and the accelerometer measured values are presented in the **Table 11**, for the waist.

Table 11 - Criterion validity of OSPAQ when compared to accelerometer.

| Domain | OSPAQ + Accelerometer | |
|---|---|---|
| | Waist | |
| | ***r*** **(95% CI)** | **ρ** |
| **Sedentary** | - 0.096 | 0.582 |

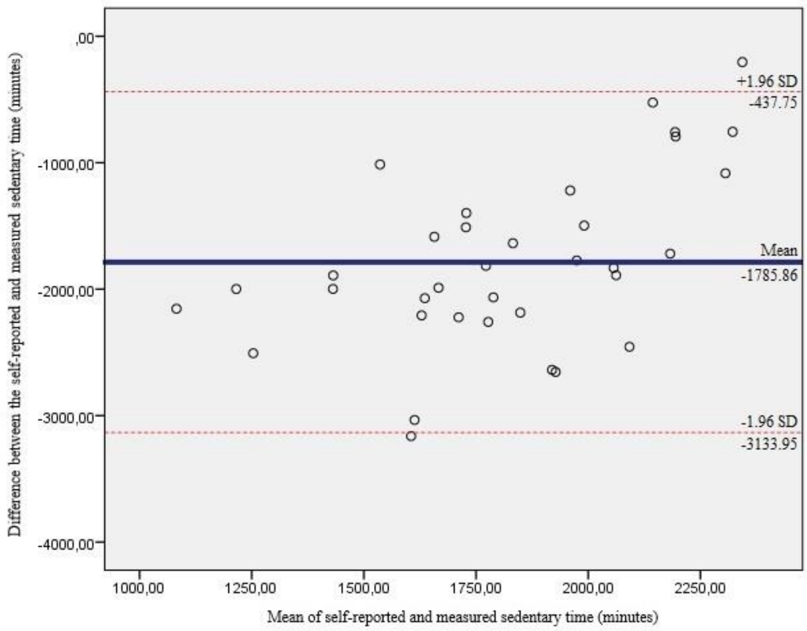
[23] https://www.who.int/dietphysicalactivity/factsheet_adults/en/ (Assessed in:26/08/2019)

| Domain | OSPAQ + Accelerometer | |
|---|---|---|
| | Waist | |
| | *r* (95% CI) | ρ |
| **Light** | 0.124 | 0.477 |
| **Moderate** | -0.315 | 0.066 |
| **Vigorous** | -0.091 | 0.605 |

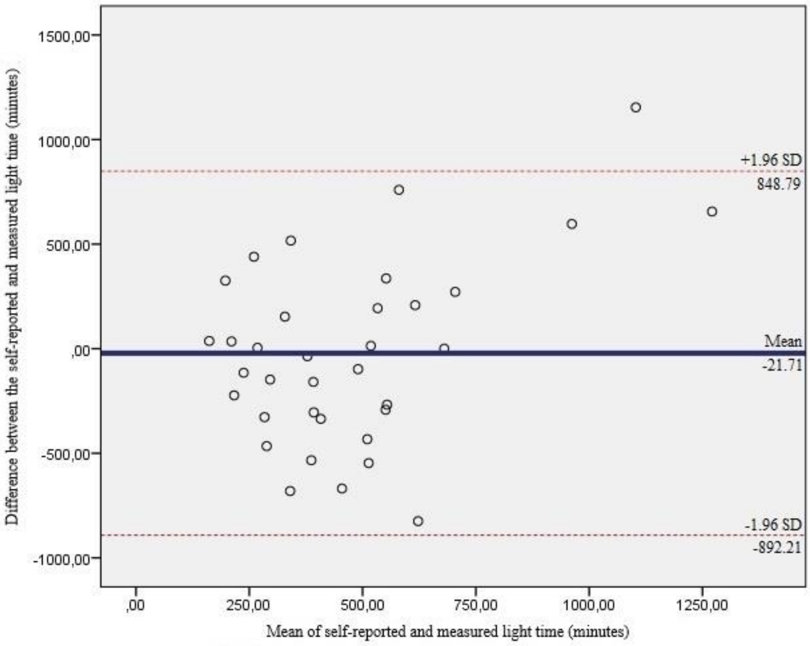
The obtained results for minutes spent in sedentary, light or vigorous activities over the course of the measurements indicated a weak association. For the time spent in light activities the measurements indicated a low association. Thus, the statistical relationship or association between this data is either weak or low, and has a negative correlation for sedentary, moderate or vigorous and a positive correlation for light activities.

The **Figure 3** illustrates the Bland-Altman plots for sedentary activities (1A), light activities (1B), moderate activities (1C), and vigorous activities (1D). The horizontal lines in each plot represent the mean discrepancy (solid blue line) and 95% limits of agreement (red dashed light).

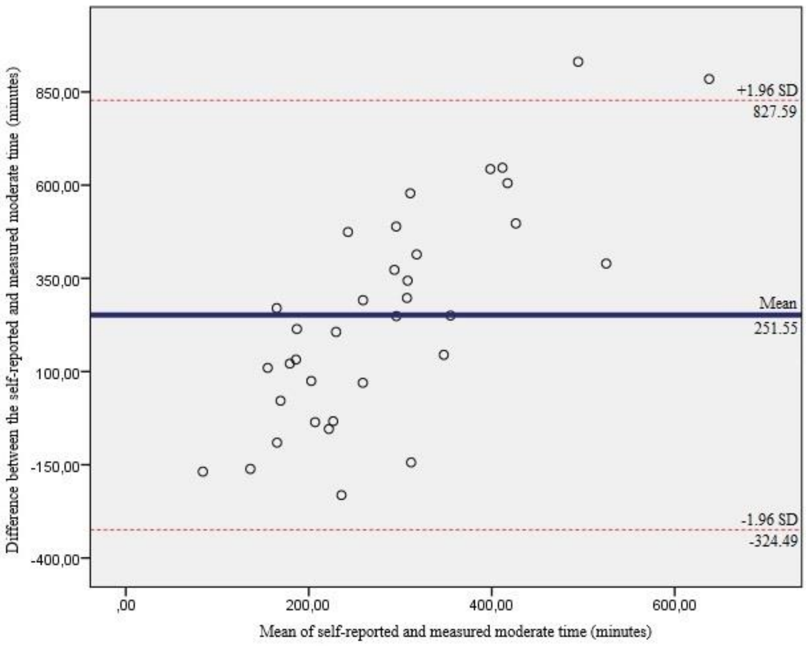
**1A**



**1B**


Difference between the self-reported and measured light time (minutes)
Mean of self-reported and measured light time (minutes)
+1.96 SD
848.79
Mean
-21.71
-1.96 SD
-892.21

**1C**


Difference between the self-reported and measured moderate time (minutes)
Mean of self-reported and measured moderate time (minutes)
+1.96 SD
827.59
Mean
251.55
-1.96 SD
-324.49

**1D**

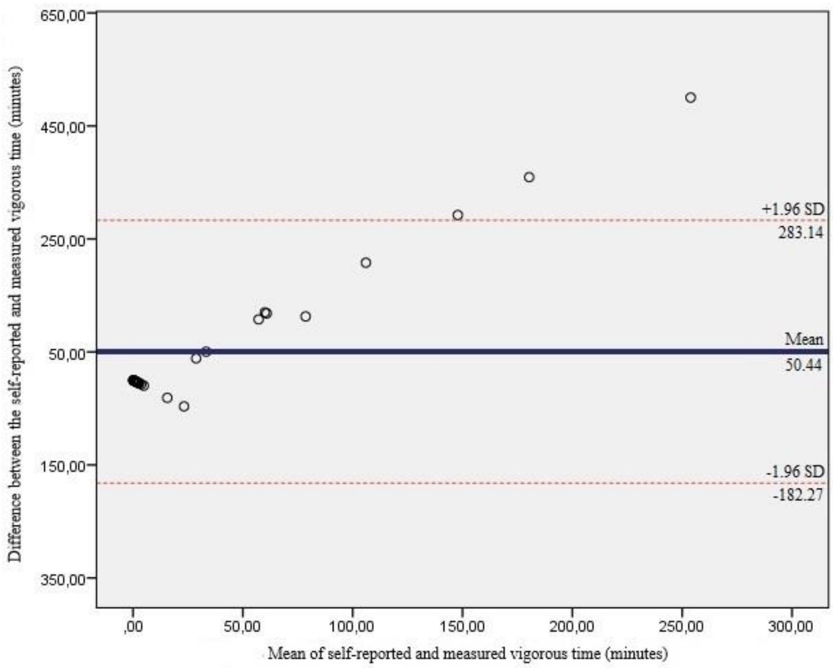



**Figure 2** - Bland-Altman plots of discrepancy between self-reported and measured sedentary activity (1A), light activity (1B), moderate activity (1C) and vigorous activity (1D) versus the mean of self-reported and measured data

This study investigated the OSPAQ questionnaire in terms of sitting, standing and walking time in workers of the Polytechnic Institute of Guarda. Overall, the self-reported data collected with the OSPAQ over-estimated the level of activity of sedentary behaviour when compared to accelerometer derived data. There are other studies, such as Clark et al. (2011), who obtained an over-report of sitting time by 0.45h and a low correlation between objectively measured and self-assessed sitting time during working hours.

One reason than could explain this observed over-report is the fact that there may be social desirability bias (where undesirable activities are underestimated) or recall bias (activities are systematically forgotten) (Jefferis et al., 2016).

In this scenario, the obtained results demonstrated that this self-report instrument may not be acceptable for measuring sedentary and physical activity behaviours in the workplace, as evident from the weak test-retest reliability with low observed ICCs for the four domains.

The accelerometer was objectively used to assess the criterion validity of this instrument. Although the comparison of the accelerometer measurements with the self-reported data is an excellent method to evaluate the criterion validity, the obtained results suggested that, for this case, the combination of the accelerometer with self-reported data had a weak association (van Poppel, Chinapaw, Mokkink, van Mechelen, & Terwee, 2010). Some discrepancies between self-reported measures and accelerometers can occur, as accelerometers could not register all the upper body movements (e.g. swimming and cycling) (Cleland et al., 2014).

The obtained Bland & Altman plots illustrate wide levels of agreement between methods (accelerometer measurements and OSPAQ), which indicate a low level of agreement between methods (Curry & Thompson, 2015). The limits of agreement for the sedentary time revealed that the sample may have over-reported or under-reported the sedentary time by as much as ± 1348 minutes per week (approximately 22 hours). The Bland-Altman plots for the light activity indicated that the individual differences could vary by as much as ± 870 minutes per week (approximately 15 hours), while for moderate activities this variation occurred between ± 576 minutes per week (approximately 9.6 hours). For the vigorous activities, the Bland-Altman plot showed the least amount of variation, with limits of agreement between ± 233 minutes per week (approximately 3.9 hours). Overall, these results could point to a possible discrepancy in the way that the OSPAQ and the participants conceptualize the domain of each domain of activity differently. A more extensive exploration of how the OSPAQ defines and the participants conceptualize each domains of activities, should be performed in order to improve the validity of this instrument (Curry & Thompson, 2015).

A study performed by Jancey et al. (2014) also evaluated the reliability and criterion validity of the OSPAQ in office-based workers. The methodology used was the same as this study and, as a result, the ICCs for minutes spent sitting (0.66), standing (0.83) and walking (0.77) showed moderate to strong test-retest reliability. No significant differences were found between the repeated measurements taken seven days apart. Correlations with the accelerometer readings were moderate. The Bland-Altman plots showed moderate agreement for standing time and walking time but systematic variation for sedentary time. Comparing both results, it can be concluded that one reason that could justify the existence of significant differences between occasion 1 and occasion 2 across sedentary, light, moderate and vigorous domains is the fact that our sample is composed of teachers (N = 10; 21.28%). In this profession, it is very hard to keep the personal and professional lives separate. Thus, many times, to complete their tasks, it is necessary to work long hours which encroached onto personal time (Day et al., 2006). Thus, the differences in types of employment may account for differences in sedentary time by background. Thus, workplace sitting significantly contributes toward the accumulation of daily sedentariness. For example, on workdays, individuals with sedentary jobs walk and stand less, and accumulate more sedentary time than during their leisure time (Merchant et al., 2015).

In other study conducted by Brito et al. (2012), aimed at assessing the physical activity among teachers, it was possible to notice that the prevalence of low, moderate and high levels of physical activity was 46.3%, 42.7% and 11%, respectively. Low physical activity was more prevalent among those aged 31 to 42 years (19.5%) and less prevalent among those aged 55 to 66 (5.7%). Moderate and high levels of physical activity were less prevalent among older teachers. Thus, in this case, the prevalence of low physical activity was high.

The accelerometers are instruments capable of measuring the magnitude and the total volume of movements generated by the body and present many advantages, for example, they are quite small, have low battery consumption, and can easily be integrated with other sensors. Therefore, they are generally unobtrusive to wear and very practicable to use in the field (Strath et al., 2013). In addition, they are generally considered to be one of the best methods for providing evidence regarding the validity of questionnaires that measure physical activity. The existence of variations that may occur can be explained due to the activity categories of accelerometer data compared with those of the self-reported data not being exact. Other factor that can contribute to the existence of any variation, is the fact that the accelerometer inclination sensors might not be sufficiently sensitive, or the accelerometer is not correctly putted, or with people movements is possible that the accelerometer can suffer a dislocation in his position, what could influence the results of the measurements (Grant, Ryan, Tigbe, & Granat, 2006; van Poppel et al., 2010).

It is also important to mention that this study used a convenience sample of volunteers and that the sample of participants were not randomly recruited from the institution, so, the selection bias cannot be ruled out, especially since the majority of participants were university educated and female.

# 4 CONCLUSIONS AND FUTURE PERSPECTIVES

## 4.1 Conclusion

The present study aimed to evaluate the differences of occupational activity types between working days and non-working days and determine the reliability and criterion validity of the Portuguese version of the Occupational Sitting and Physical Activity Questionnaire (OSPAQ) in workers of the Polytechnic Institute of Guarda.

Comparing the results relatively to the working days with the non-working days, it can be concluded that the obtained results on the non-working days are greater than the working days. Although this results are expected, since being sedentary at work is associated with more sedentary behaviour outside of work (Saidj et al., 2015). For the analysis of the reliability and criterion validity of the Portuguese version of the OSPAQ, the results showed that that this self-report instrument may not be acceptable for measuring sedentary and physical activity behaviours in the workplace, as evident from the weak test-retest reliability with low observed ICCs for the four domains. Also, the obtained Bland & Altman plots illustrate mixed levels of agreement between methods (accelerometer measurements and OSPAQ). One reason that could justify the existence of significant differences between occasion 1 and occasion 2 across sedentary, light, moderate and vigorous domains is the fact that our sample is composed of teachers (N = 10; 21.28%). In this profession, it is very hard to keep the personal and professional lives separate. Thus, many times, to complete their tasks, it is necessary to work long hours which encroached onto personal time (Day et al., 2006)

Given the observed high prevalence of mean time spent in sedentary behaviour, a rising need exists to address this challenge with sustainable interventions. Breaking up sedentary behaviour appears to be a promising strategy to prevent the negative effects on human health. Therefore, intervention for reducing workers' sedentary behaviours are needed, in order to improve the general health.

## 4.2 Strengths, limitations and Future perspectives

One strength of this study is the use of a previously field-validated objective measurement method to evaluate the sedentary behaviour (Jancey et al., 2014). Other strength to this study is the fact that, with the registration and analysis of epochs as short as 5 seconds, it is possible to detect interruptions in sitting time shorter than 1 min, what could have difficulted interpretation of the results.

A primary limitation for the execution of this study was the fact that the only possible location to collect data from the accelerometer was the waist. In order to possible to compare the best location to collect data, it would be interesting to collect data simultaneously in more than one location in the same individual.

Also, the study sample was relatively small, and is not representative for the Portuguese population. Therefore, these findings cannot be generalized to a wider sample. Thus it is necessary a larger validation study is necessary to provide data on comparability of accelerometer and OSPAQ questionnaire.

It is necessary to achieve scientific progress in this field and create interventions to improve physical activity in order to fulfil the guidelines and improve workers health. Thus, as a future perspective, this questionnaire can be applied with a physical activity intervention, in order to serve as a complement to prof that the intervention was well succeeded.

Although this study wasn’t enough to prove reliability and criterion validity of the Portuguese version of the OSPAQ, it is important to mention that it was only considered a specific context (workers of a polytechnic institute) and a specific sample (only women). Perhaps it would be better to apply this methodology to a bigger and heterogeneous sample of individuals.

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# 6 ANNEX

## 6.1 Annex I – OSPAQ Questionnaire

***Occupational Sitting and Physical Activity Questionnaire* (OSPAQ)**

1. Quantas horas trabalhou nos últimos 7 dias?____________horas

2. Durante os últimos 7 dias, quantos dias foi trabalhar?______________dias

Para responder à questão 3, considere o exemplo que se segue:

A Joana é uma trabalhadora de escritório. O seu dia de trabalho envolve trabalhar ao computador na sua secretária, atender o telefone, preencher documentos, tirar fotocópias e andar um pouco pelo escritório. Considerando os últimos 7 dias, a Joana descreveria um dia típico de trabalho como:

| | |
|---|---|
| Estar sentado (incluindo conduzir) | 90% |
| Estar em pé | 5% |
| A caminhar | 5% |
| Trabalho pesado ou tarefas fisicamente exigentes | 0% |
| Total | 100% |

3. Como é que descreveria o seu dia típico de trabalho nos últimos 7 dias? (isto inclui apenas o seu dia de trabalho típico, e não viagens de ida e volta para trabalho ou o que fez no seu tempo de lazer)

| | |
|---|---|
| Estar sentado (incluindo conduzir) | _____% |
| Estar em pé | _____% |
| A caminhar | _____% |
| Trabalho pesado ou tarefas fisicamente exigentes | _____% |
| Total | _____% |

Deve garantir que o total é 100%

## 6.2 Annex II – Sociodemographic data questionnaire

***Questionários***

O presente questionário é **anónimo e confidencial** e destina-se a caracterizar o nivel de atividade física durante um dia típico de trabalho.

Não existem respostas certas ou erradas, pelo que a sua **opinião sincera** é muito importante.

Muito obrigada pela Sua Colaboração.

DADOS SÓCIO-DEMOGRÁFICOS

(a preencher pelo(a) trabalhador)

1. Idade: ___________

2. Género (assinale com um X):

Feminino □ Masculino □

2.1. Se respondeu feminino, encontra-se grávida? Sim □ Não □

3. Nacionalidade: ______________________

4. Escolaridade: ______________________

5. Categoria profissional: ______________________

6. Há quanto tempo trabalha nesta empresa? ______________________

7. Nº horas de trabalho semanal: ______________________

8. Qual o seu horário de trabalho? ______________________

9. Trabalha por turnos? Sim □ Não □