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Original Paper

A Summary and Critical Evaluation of Two Methods of Measuring PA and SB

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Abstract

This paper evaluates two methods for measuring physical activity (PA) and sedentary behavior (SB): the Omron pedometer (objective) and the International Physical Activity Questionnaire-Short Form (IPAQ-SF, subjective). The pedometer offers portability and accuracy in step counting but risks reactivity and data manipulation. The IPAQ-SF is cost-effective for large samples but suffers from recall bias and overestimation of activity levels. Recommendations include combining tools to mitigate limitations and extending trial durations to reduce reactivity. Both methods, despite flaws, remain valuable for health-related assessments when contextually applied.

Keywords

Physical activity measurement, Sedentary behavior assessment, Method comparison

Introduction

Sedentary behaviour (SB) is defined as being in a sitting, lying and leaning position while awake and expending ≤1.5 METs of energy (Tremblay et al, 2017). Sedentary behaviour has increased as a result of lifestyle changes. SB is a major risk factor for non-communicable diseases such as type 2 diabetes (T2D), cardiovascular disease (CVD) and cancer, and the risk of death from disease increases with increased sedentary time (Patterson et al., 2018). According to the WHO (2020), physical activity (PA) is defined as "any bodily movement produced by skeletal muscles that involves energy expenditure.", and regular physical activity can have a beneficial effect on health outcomes such as the cardiovascular system. Therefore, for these reasons, the measurement of PA and SB is key in relation to the promotion of physical activity for health. Although PA and SB are multifaceted and there are many ways to measure them, each with relative strengths and limitations. I have experienced a variety of methods in measuring and assessing PA as well as SB. This essay will discuss a selection of tests for one PA and one SB. It will also critically consider the strengths and limitations of these methods in the context of my own experience and provide ideas and suggestions for future practical research.

Measurement method

There are several methods for measuring PA and SB, common methods are subjective reports (questionnaires and diaries), objective device wear (pedometers, accelerometers, heart rate monitors) or observational methods. In this essay a pedometer (Omron pedometer) was chosen to measure PA and a questionnaire (IPAQ) to measure SB.

PA — pedometer(OP)

The pedometer accumulates the number of steps taken by the subject throughout the day and is a common instrument used in testing due to its convenience and compactness. One of the most commonly used pedometers is the OP. The OMRON HJ-720ITC pedometer, for example, has two single-axis piezoelectric accelerometers oriented at 90 degrees to each other to calculate the number of steps taken by the subject when the OP is horizontal or vertical. It also automatically stores the day's data in memory and resets it to zero at midnight. The pedometer was worn continuously (either on a belt or in a trouser or shirt pocket) for the duration of the trial, with the subject living a normal life, removing the pedometer at bedtime and wearing it upon awakening. At the end of the experiment, the data from the pedometer is transferred to a computer and then analysed by data analysis software such as SPSS. Baseline and daily step counts (mean ± SD) were calculated during the analysis. For individual participants, the number of steps per time period per day can be graphed to analyse the subject's dynamic PA levels. In order to measure adherence, it is also possible to quantify the participants' daily wear time. (Rider, Bassett, Thompson, Steeves, & Raynor, 2014).

SB — Questionnaire (IPAQ-SF)

The International Physical Activity Questionnaire (IPAQ) is a questionnaire that was designed in 1998 based on international standards particularly for physical activity assessment and backed by trial data from 12 nations. There are several surveys that evaluate sedentary behaviour (Craig et al., 2003). There are two variants of the IPAQ: a long form (IPAQ-LF) with 31 questions and a short form (IPAQ) with 7 questions (IPAQ-SF). While the IPAQ-SF records the four states of high intensity exercise, moderate intensity exercise, walking and sitting. Craig (2003) recommends the use of the "last seven days recall" for the study. The subjects were instructed to recollect their level of activity during the previous seven days and fill in the blanks as they deemed suitable. Data can be collected to obtain total weekly physical activity and sedentary behaviour and can be converted to metabolic equivalent minutes per week (MET-min/week) using SPSS to provide descriptive statistics and test for normality based on the mean ± standard deviation (SD) of the quantitative variables, or the formula. The data can be used to classify subjects into active and inactive groups (Romero-Blanco et al., 2020).

There have also been a number of trials using the pedometer alongside the IPAQ-SF. Ahmad et al. (2018) used SPSS to recode the data, create a two-by-two cross tabulation. From there, the extent to which physical activity levels are categorised when using the pedometer and IPAQ-SF at the same time is tested for consistency. It is also possible to derive is whether there is a difference between the dichotomous dependent variables of the two by using the McNemar test.

Strengths and weaknesses

It is believed that the instruments chosen for measuring the assessment of subjects' PA and SB will generally be expected to be appropriate and valid. When selecting an instrument, the experimenter will generally weigh up the choice in terms of validity, reliability and feasibility (Kelly, Fitzsimons, & Baker, 2016). Also, the cost of the test is something that the experimenter will need to consider, including the size of the sample, the budget for the tool and other factors. Researchers can select a measurement instrument that is better appropriate for the experiment by evaluating the benefits and drawbacks of the two measurement tools (Omron Pedometer and IPAQ-SF).

Omron pedometer

Firstly, one of the most obvious advantages of the Omron pedometer is that it is small, light and portable, and does not interfere with the subject's normal activities of life. During the time I wore the pedometer, it was clipped around my waist and did not interfere with my normal daily activities. Running or other activities requiring a wider spectrum of physical activity were unaffected, nor did I notice a noticeable sensation of weight. This is probably a good test experience for the subject, as there is no additional physical burden. Running or other activities requiring a wider spectrum of physical activity were unaffected, nor did I notice a noticeable sensation of weight. Thirdly, in the case of the OMRON pedometer (model HJ-720ITC), there is no single fixed position in which to wear it that would affect accuracy. During the time I was wearing the pedometer, there was a situation where the pedometer would not clip around my waist for the day's wear; the fact that the pedometer worked properly in a non-waist position was a plus in this case. Zhu and Lee (2010) asked subjects to wear the pedometer in ten different positions on the body and concluded that the OMRON pedometer could be worn on a flat surface when walking on When walking on flat ground, it can be worn on the waist, in a pocket and hung around the neck. But the pedometer placed in the front side pocket of the trousers was not as accurate as the other positions. The pedometer has also been proven to be suitable for use on treadmills and for walking on surfaces of all speeds.

To follow, the Omron pedometer is also highly accurate in non-laboratory environments. Five researchers, including Silcott (2011), further assessed the accuracy of the Omron HJ-720ITC pedometer under free-living circumstances. The results showed that the free-living conditions did not demonstrate a high level of accuracy consistent with that in the laboratory, and that the position in which the pedometer was worn affected the data collected by the pedometer. Accuracy was greater in the pocket, particularly for obese adults, maybe because body composition had little bearing on where the pedometer was placed in the pocket (BMI). The implication maybe that the pocket is able to hold the pedometer in place and prevent the tilt angle from exceeding 30 degrees. However, despite this underestimation, the high accuracy of the Omron pedometer during the test (laboratory environment and free living environment) is undeniable. Furthermore, the Lee, Williams, Brown, & Laurson (2015) trial similarly reported that the Omron pedometer provides valid and reliable pedometer data in both laboratory and free-living environments. The validity of the Omron pedometer can also be confirmed. A test on preschool children concluded that the effectiveness of pedometers can be confirmed (De Craemer et al., 2015). In this group analysis, the research also revealed a little difference between pedometers and accelerometers. As a result, in the context of group investigations, the lower cost of pedometers (relative to accelerometers) is also advantageous. According to Huang et al. (2016), the Omron pedometer has no accuracy errors when walking on level ground and between stairs, which would similarly support its validity.

However, the Omron pedometer still has its flaws. First off, although its compactness is one of its strengths, there can be instances where you forget to wear it because it is small. During my use, I would go out and then forget that I needed to wear the pedometer, resulting in not taking continuous measurements or not wearing it enough days. Also, due to its small size, I frequently worry that I may drop it while I'm out and about and am feeling a little anxious. Another argument is that prejudice may still exist even when objectivity lowers the likelihood of bias. Where I can see the numbers on the pedometer screen, I will always be aware of them and will deliberately shake the pedometer to increase the number of steps, which can lead to inaccurate entry of pedometer data and bias in the results. In addition, as the test was conducted in class with the pedometer, I would go out for a walk or walk for a longer period of time with the pedometer on to achieve a higher step count than others. This could result in different PA behaviours throughout the test and biassed findings. This phenomenon is known as "reactivity".

According to Scott's study on the responsiveness of adolescents when wearing pedometers, the results were reported to show a responsiveness in which step counts spiked at the beginning and then dropped and calmed down in the latter days, regardless of whether the pedometer was sealed or not. The experiment also included a questionnaire, which indicated that subjects tampered with data and performed more PA during the trial (Scott, Morgan, lotinkoff, Trost & Lubans, 2014). Furthermore, a study by Clemes & Deans (2012) similarly demonstrated that reactivity occurs. The report showed that the number of steps taken with the pedometer unsealed was significantly higher than the number of steps taken with the pedometer sealed and lasted for a week. Here is another disadvantage, the pedometer can only be used for physical activity on the ground, when I go swimming I cannot wear the pedometer. This means that the pedometer cannot detect the physical activity level of people who are particularly active. Also, during my usage, non-walking actions like leg shaking may cause a rise in steps, although this may does not significantly affect the results.

IPAQ-SF

Based on a comparison of all the questionnaires I have completed myself, perhaps the biggest advantage of the IPAQ-SF for the subjects is that there are only seven questions, which reduces the recall burden on the subjects. Secondly, in terms of cost, it is less expensive than other instrumental questionnaires and can be used for large sample studies, reducing the pressure on the researcher's budget. The reliability of the IPAQ-SF is also demonstrated by the fact that the questionnaire has been validated in 12 countries, as mentioned above (Craig et al., 2003). Furthermore, its reliability can be demonstrated according to van Poppel et al. (2010) and it is one of the most widely used questionnaires.

However, because the IPAQ-SF is subjective, its validity appears to be in doubt. Research on the validity of the IPAQ-SF has been conducted from an early stage, and a systematic review has shown that the validity of the IPAQ-SF varies considerably between countries, and these conflicting findings suggest that researchers in large international studies need to be more cautious in their use of the questionnaire (Poppel et al., 2010). Then Lee et al. (2011) reviewed 23studies and showed that the IPAQ-SF has a lower than acceptable correlation compared to objective measures and overestimates physical activity (by 84% on average). There have also been studies on the validity of the IPAQ-SF in recent years and it was found that Criterion validity was rather low and there was a risk of bias in the analysis (Meh, Sorić, & Sember, 2021). When I actually fill out the questionnaire, I also modify the real data to make the data look better. For other subjects, when they learned that SB was bad behaviour, they also appeared to modify the data. And it was a memory burden to write down the exact time of SB in seven days. If subjects want to fill in the exact time, they need to keep track of my activity time at all times, which is very cumbersome.

Recommendations

In future studies, researchers could reduce reactivity by extending the duration of the trial as appropriate, Clemes & Deans (2012) showed that reactivity seemed to last for a week when wearing a pedometer, perhaps increasing the duration to two weeks or more would give data more in line with actual free living. However, extending the duration of the trial may not be applicable to adolescents, as Scott et al.'s (2014) study suggests that some adolescents have an unsupportive attitude towards wearing pedometers, with over half feeling embarrassed and not wanting to wear them. Perhaps in the future some rewards could be adopted during the trial to reduce this negative attitude. Also, the pedometer could be sealed during testing to reduce reactivity. Although the pedometer is not a good test tool for people who do specific exercises, it is a good test tool for older people and for people who do walking interventions. In addition, if the IPAQ-SF is used in a trial for SB testing, a pedometer or accelerometer can be used in conjunction with the test for the purpose of reducing the risk of bias. Finally, investigators may be able to improve the quality of the assessment through more standardised reporting.

Conclusion

In conclusion, the measurement of PA and SB is an important part of assessment and intervention in the health field and there are many ways in which it can be measured while ensuring the safety of the subjects. This essay describes two methods of measuring PA and SB, their advantages and limitations, and suggestions for future research. These advantages seem to help researchers to make more appropriate trial designs and reduce the risk of bias. Although both approaches have disadvantages, they appear to be mitigated by practical experimental improvements, and their practical advantages allow experimenters to accept these minor flaws. However, researchers can select different measurement tools for different experiments, not just pedometers and IPAQ, and it is certain that in the future more complex behaviours can be analysed and more people can be helped by these measurement tools. And, as the field of physical activity health develops, different measurement methods can help develop more effective interventions to improve health.

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