VALIDITY AND RELIABILITY OF THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE AMONG MEXICAN ADULTS

by

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Abstract

**Background:** Because it is a strong determinant of chronic disease and mortality risk, physical activity is a health behaviour that is measured in most large health surveys. Questionnaires are the most commonly used method for measuring physical activity in health surveys. In the early 1990’s, an international physical activity questionnaire (IPAQ) was created to allow researchers from across the globe to employ the same questionnaire within their country. Several studies have been conducted on the IPAQ to determine whether the responses obtained are comparable when the questionnaire is administered on multiple occasions (reliability) and to determine the ability of the questionnaire to obtain the same physical activity result when compared to other direct measures, considered as “gold standard” (validity). However, none of these studies have been conducted in Mexico.

**Objective:** Examine: 1) the reliability of the IPAQ among Mexican adults by comparing minutes per week (min/wk) spent in moderate-to-vigorous physical activity (MVPA) from the IPAQ administered two times, 2) the validity of the IPAQ surveys by comparing IPAQ min/wk of MVPA to those obtained by the accelerometer.

**Methods:** 267 Mexican adults who worked in a factory in Mexico City participated. IPAQ was applied in a face-to-face interview during a first clinic visit. Participants received an accelerometer (motion sensor that measures and record physical activity) and wore it consecutively for the next 9 days. In a second visit, participants returned the accelerometer and completed a second IPAQ. The research team cleaned and analyzed the accelerometer data using standardized techniques. Results from the two IPAQ and the accelerometer were compared using the appropriate statistical tests.

**Results:** IPAQ1 and IPAQ2 measures of MVPA were significantly correlated to each other (r=0.55, p<0.01). The MVPA (min/week) measures from IPAQ1 and IPAQ2 were only modestly correlated with the accelerometer measures (r=0.26 and r=0.31, p<0.01). The percentage of the participants who were classified as inactive according to the World Health Organization physical activity guidelines was 18.0% in IPAQ1, 25.1% in IPAQ2, and 28.2% for the accelerometer.

**Conclusions:** IPAQ was modestly correlated to each other and it was lowly correlated to values obtained by the accelerometer. Since IPAQ has been used to obtain physical activity prevalence worldwide, caution should be taken when this instrument is used. Future research should be focused on the importance of including direct measures to measure physical activity levels within epidemiological surveys.
Co-Authorship

The presented thesis is the work of Catalina Medina in collaboration with her co-authors. The co-authors include her supervisor, Dr. Ian Janssen (Queen’s University), and Dr. Simón Barquera from the Mexican National Institute of Public Health.

The manuscript is presented according to the requirements for the journal Pan American Journal of Public Health. Catalina Medina was responsible for conducting a literature review to inform the research question and methodology, leading the design and organization of the study, collecting data in the field and training of the other research staff involved in data collection, entering and managing all of the data that were collected, completing all of the statistical analyses, interpreting the results, and writing the initial draft of the manuscript and all thesis chapters. Drs. Janssen and Barquera supported Catalina during all phases of the research. Dr. Janssen helped mostly with the study design, interpretation of the results, intellectual feedback, and provided extensive help with the writing. Dr. Barquera assisted primarily with the study design, population selection, the statistical analyses, and obtained the necessary funding for the research.
Acknowledgements

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I would like to thank Dr. Janssen; you were a very supportive and patient supervisor. I really appreciate the time you spent while reading my work. Thanks for teaching me to write in a scientific way, for pushing me to give my best and for helping me to get things done on time and aim for high standards. It was a great opportunity for me to work and learn from a renowned researcher.

I would also like to thank Dr. Barquera. You always challenged me to achieve my objectives. Thanks for believing in me, for the time you spent giving me advices, for guiding me, and finally, for being part of such a great group at INSP.

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My Mexican family during this process, Karla and Margarita: thank you. I will never forget the good times we spent together. Mago, you were my old sister, and friend. Thank you for being there every time, and for sharing part of your life with me in this process. Thanks to my family: Gabriel, Catalina and Gabito. You always have been a mainstay in my growing process. Nothing would be possible without your strong support. And to Daniel, who has been with me in this great journey, thank you for your patience and resilience.
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<th>Full Form</th>
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</thead>
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<tr>
<td>American College of Sport Medicine</td>
<td>ACSM</td>
</tr>
<tr>
<td>Centers for Disease Control and Prevention</td>
<td>CDC</td>
</tr>
<tr>
<td>International Physical Activity Questionnaire</td>
<td>IPAQ</td>
</tr>
<tr>
<td>Metabolic equivalent</td>
<td>MET</td>
</tr>
<tr>
<td>Mexican National Health and Nutrition Survey</td>
<td>ENSANUT</td>
</tr>
<tr>
<td>Mexican National Institute of Public Health</td>
<td>INSP</td>
</tr>
<tr>
<td>Mexican National Nutrition Survey</td>
<td>ENN</td>
</tr>
<tr>
<td>Moderate-to-vigorous physical activity</td>
<td>MVPA</td>
</tr>
<tr>
<td>Physical activity</td>
<td>PA</td>
</tr>
<tr>
<td>World Health Organization</td>
<td>WHO</td>
</tr>
</tbody>
</table>
Chapter 1
Introduction

1.1 General Overview

The World Health Organization (WHO) estimates that 31% of the world’s adult population is physically inactive as they do not engage in enough physical activity for health benefits.\(^1,2\) Moreover, in developing countries such as Mexico, almost 50% of the adults are classified as insufficiently active and this prevalence is rising.\(^1,2\) The emergence of obesity as a global public health issue has helped raise awareness of the physical inactivity crisis.\(^3,4\) In addition to obesity, physical inactivity is an established risk factor for premature mortality and several non-communicable diseases (e.g., coronary heart disease, stroke, some cancers, type 2 diabetes, osteoporosis, etc.).\(^3,5,6\)

Because of its importance to health, physical activity is routinely assessed in large-scale health surveys. Presently, several methods can be used to assess physical activity, including both objective methods (e.g., accelerometers, pedometers) and subjective methods (e.g., logs, questionnaires).\(^7,8\) Objective methods are not practical for use in large epidemiological studies due to cost and time limitations.\(^9,10\) Rather, in these larger studies physical activity questionnaires are typically used.\(^8,11\)

A recent literature review reported that 19 physical activity questionnaires have been routinely used to assess physical activity in adults.\(^12\) Many of these have been applied in large-scale population surveys. Because so many different questionnaires are used, historically it has been difficult to compare the physical activity data from one study to the next. Thus, it was difficult to compare physical activity levels across countries and to generate national and international actions. Therefore, an international task force created an international physical activity questionnaire (IPAQ).\(^13\) One of the main objectives of creating the IPAQ was to allow researchers to accurately assess physical activity levels within their
own study and to provide a common instrument that could be applied in different countries so that physical activity levels could be compared across different studies and countries.\textsuperscript{13}

The IPAQ was developed in 1996 as a questionnaire that could be used to assess physical activity levels of adults across a diverse range of countries and populations. The IPAQ instrument can be used to assess activities of different intensities and sedentary behaviours during work, transportation, and leisure-time. The IPAQ has been used for surveillance purposes in several countries.\textsuperscript{14-29}

The reliability and validity of the short form IPAQ has been tested in more than 12 countries.\textsuperscript{13-25, 27, 30, 31} The first validation study was a multi-national study conducted by Craig et al.\textsuperscript{13} Results from that study reported a pooled validity correlation of 0.30 (ranged from -0.12 to 0.57 in different countries) when IPAQ results where compared to those obtained objectively using accelerometers. The same study reported a pooled reliability score of 0.76 (ranged from 0.25 to 0.88 in different countries) when comparing the results from two IPAQ surveys conducted 7 days apart. These validity and reliability values have been obtained in more than 12 countries, including those countries with similar geographic areas than Mexico (e.g. Southern California, which is heavily populated with Mexican-Americans; Guatemala, which is similar to the poorer areas of Mexico; and Brazil, which is a Latin American country with a similar income level as Mexico).\textsuperscript{13} However, there is no published evidence that reports on the validity and/or reliability of the IPAQ and other physical activity questionnaires within Mexican adults.

The 2012 Mexican Health and Nutrition Survey (ENSANUT) used the IPAQ to assess physical activity among adults.\textsuperscript{32} The ENSANUT is the only national survey in Mexico that measures physical activity. As part of the 2012 ENSANUT reporting process that is required by the federal government, the reliability and validity of the survey instruments, including the IPAQ, must be documented.
The research conducted for this thesis was conducted in collaboration with the Mexican National Institute of Public Health (INSP), the group responsible for conducting the ENSANUT. The overall goal of the thesis research was to determine whether the IPAQ is an appropriate instrument to assess moderate-to-vigorous physical activity levels within Mexican adults. The specific objectives are outlined below.

1.2 Thesis Objectives

Objective one: To examine the test-retest reliability of the physical activity measures obtained in the IPAQ within a sample of Mexican adults.

Objective two: To determine the validity of the IPAQ physical activity measures within a sample of Mexican adults by comparing IPAQ results to those obtained objectively using accelerometers.

1.3 Thesis Organization

This thesis is presented in a manuscript-based format. This thesis includes a literature review (chapter 2) that examines the reliability and validity of physical activity questionnaires, with a special emphasis placed on the IPAQ. This is followed by a manuscript that describes the thesis research that examined the validity and reliability of the IPAQ among Mexican adults (chapter three). The fourth chapter includes a summary of the findings and an expanded discussion. The thesis also contains three appendices that provide additional details and information on some of the methods used in the research.
1.4 References


Chapter 2

Literature Review

2.1 Overview

The focus of this chapter is on the evidence in regard to the test-retest reliability and validity of commonly used physical activity questionnaires in adult populations, with a particular emphasis placed on the International Physical Activity Questionnaire (IPAQ). To set the context for the thesis work, the literature review also provides a brief overview of the public health significance of physical activity and of the Mexican Health and Nutrition Survey (ENSANUT). The ENSANUT is the only national survey that is used to monitor health behaviours within the Mexican population.

2.2 Key Definitions

*Physical Activity* refers to “any body movements produced by the skeletal muscles that results in an increased energy expenditure”.¹ A *Metabolic Equivalent* (MET) is “a unit that estimates energy expenditure (oxygen consumption) of physical activity”.¹ According to the energy expended, activities can be of a light, moderate, or vigorous intensity. Light activities have a MET of ≤ 2.9, moderate activities range from 3.0 to 5.9 METs, and vigorous activities are those with MET values ≥ 6.² This thesis will focus on moderate-to-vigorous physical activity (MVPA). The total MVPA per week that an individual accumulates can be used to classify them as being either *physically active* (e.g., accumulates enough MVPA for health benefits) or *physically inactive* (e.g., does not accumulate enough MVPA for health benefits). For the purpose of this thesis, and in accordance with the recommendations of the World Health Organization (WHO), a minimum of 150 minutes per week of moderate physical
activity, or 75 minutes per week of vigorous physical activity, or an equivalent combination of the two intensities will be used to define someone as being physically active.\(^3\)

When discussing the *reliability* of a physical activity questionnaire, I will be referring to whether the responses to the questionnaire are consistent when the questionnaire is administered on multiple occasions.\(^4,5\) When discussing the *validity* of a physical activity questionnaire, I will be referring to the extent to which the results from the questionnaire give the same result when compared to an objective measure.\(^4,5\)

*Accelerometers* are the most commonly used objective measure to validate physical activity questionnaires. Accelerometers can be used to collect and record the intensity of movement and physical activity in free-living conditions over an extended period of time such as 7 consecutive days. The instrument converts the accelerations caused by movements into an electric signal, which is stored as a physical activity count over a predefined interval, such as every minute. Accelerometers are portable (about 3 cm X 3 cm X 1.5 cm) and are typically worn on the right hip attached to either a belt or clip. Data storage capabilities allow researchers to store minute-by-minute physical activity data for more than 7 consecutive days. Finally, in order to identify participants meeting the WHO organization guidelines based on IPAQ and the accelerometer I will be referring to sensitivity and specificity. *Sensitivity* refers to the ability of the IPAQ to correctly identify the percentage of active, moderately active, and inactive individuals, based on the accelerometer values. *Specificity* refers to the ability of the IPAQ to correctly identify the percentage of non-active, non-moderately active and non-inactive individuals.
2.3 Public Health Importance of Physical Activity

According to the WHO, 31% of the global population is physically inactive. Physical inactivity is responsible for more than 5 million deaths per year around the world and is one of the leading modifiable risk factors for non-communicable disease. A recent article published by Lee et al. reported that 6-10% of the non-communicable disease mortality is attributed to physical inactivity and that inactivity causes 6% of all coronary heart disease cases and 7% of all type 2 diabetes cases.

Physical inactivity affects both developed and developing countries. In Mexico, it is estimated that physical inactivity is the seventh leading risk factor for mortality. Moreover, in 2006 approximately 12% of Mexicans were classified within the lowest physical activity category according to the IPAQ cut-points (<600 METs/week).

National level studies that monitor physical activity are important for a variety of reasons. First and foremost, they provide information on the physical activity level of the population, how these levels change over time, and high-risk groups for inactivity (e.g., women, the poor, the elderly). The findings from these surveys can also be used to link physical inactivity to the health outcomes that are measured simultaneously (e.g., obesity, hypertension, etc.), they can stimulate physical activity research, and they can be used to help generate guidelines and recommendations aimed at increasing physical activity across different settings.

2.4 Overview of the Mexican Health and Nutrition Survey

The Mexican Health and Nutrition Survey (ENSANUT) was developed to estimate the prevalence and trends of a comprehensive set of health and nutrition conditions and behaviours within the Mexican population. This repeated cross-sectional survey is collected every 6 years; the last was completed in early 2012 and included a
representative sample of approximately 89,000 Mexicans (12,000 children <5 years, 13,000 children 5-9 years, 20,000 adolescents 10-19 years, and 43,000 adults ≥ 20 years).

The 2006 ENSANUT used an adaptation of the IPAQ to evaluate physical activity patterns in adults aged 20 and older.\textsuperscript{10} The short form version of the IPAQ was selected to be used in the 2012 ENSANUT to maintain consistency with some of the physical activity questionnaire items that were used in the 2006 cycle of the ENSANUT.\textsuperscript{13} Furthermore, as discussed in subsequent sections of this chapter, the short form IPAQ was already available in Spanish, was developed and tested for use in adults aged 15 to 69 years, had been used for surveillance purposes in several other countries, and was currently extensively used in the physical activity research community. In addition, validity and reliability studies had been conducted in other middle-income countries\textsuperscript{14, 15} and other Spanish speaking countries.\textsuperscript{14} Therefore, the short version of the IPAQ was used in the 2012 ENSANUT in a subsample of 1 out of 3 selected participants aged 15 to 69 years. More details on the IPAQ are provided in section 2.5.1 of this chapter.

A special effort is being placed by the Mexican National Institute of Public Health (INSP), the institute responsible for conducting the ENSANUT, and the Mexican government on reviewing, testing and validating the questionnaires and other measurement instruments that are being used in the 2012 ENSANUT. The group that I am collaborating with at the INSP, the Center of Nutrition and Health, was responsible for selecting the physical activity questions used in the 2012 ENSANUT and for conducting the necessary reliability and validity work. For the physical activity component of the 2012 ENSANUT, no previously validated instruments within the Mexican population were available and therefore, to meet the requirements of the
Mexican government who funds the survey, the validity and reliability of the IPAQ need to be assessed within the Mexican population.

2.5 Overview of Physical Activity Measurement

Physical activity levels can be assessed using a variety of objective and subjective methods. Commonly used objective methods include heart rate monitors and motion sensors. Commonly used subjective methods include log/diaries and questionnaires.

Heart rate is a physiological parameter that can be used to assess the response of an individual to a certain duration and intensity of physical activity. Heart rate has a linear relationship to oxygen consumption and energy expenditure. Heart rate can be measured using a transmitting chest elastic band and a receiver watch. Heart rate monitors are low cost and accessible instruments that can assess physical activity from 15 second to 1-minute intervals. However, there are some factors that affect the way heart rate measures physical activity patterns including high ambient temperature and humidity, stress and the size of the muscle mass, which can increase the heart rate values without affecting VO\textsubscript{2} outcomes.

Motion sensors are mechanical or electronic instruments that can measure habitual physical activity by movement or acceleration. These instruments are typically attached to the hip using an elastic belt. Pedometers or step counters are mechanical monitors that measure body movement in one direction. Pedometers were developed to monitor specifically walking behaviours. Pedometers have been used in large-scale studies due to their low cost and unobtrusive size. However, several limitations make it difficult to use pedometers to assess physical activity. Pedometers do not make distinctions between physical activity intensities; they do not typically
store information on the time of movement (e.g., total step counts but no indication of when steps were taken), and they cannot detect certain activities such as upper body activities. In addition, because there are so many different pedometer manufacturers and brands, it is difficult to compare the physical activity levels from one study to the next.16

Accelerometers are motion devices that can measure physical activity by acceleration in a time interval.20 They have substituted pedometers in mostly large-scale and validation studies.21, 22 Accelerometers are normally attached to the upper body by an elastic belt; however, some authors have used them in either the wrist or ankle position.20 Their high storage capacity, small and unobtrusive size and the ability to make distinctions between intensity and duration of physical activity are the most important advantages.16, 20 Among their main limitations include the inability to assess certain activities such as carrying heavy objects, high-speed running, and swimming. In addition, their variety within axis, brands and cut-points to denote different intensity levels make it difficult to compare findings across studies.16, 20, 23

Logs/diaries are instruments that provide a daily physical activity record.5, 24 Logs/diaries are designed to capture detailed types, intensity and patterns of physical activity.5, 24 Logs/diaries are normally collected over a short periods of time (1 to 7 days) and an advantage of logs/diaries over other self-reported measures is that they minimize recall bias.5, 24 Logs/diaries are rarely used in large-scale population surveys due to the high cost and time involved in training and managing the data that is recorded.5 In addition, the effort involved to answer these instruments may cause people to overestimate or overreact while reporting habitual physical activity.5, 24

Questionnaires are the most commonly used instruments for measuring physical activity in large-scale population studies due to the low cost and easy to collect. There
are 19 commonly used physical activity questionnaires in large-scale surveys. The use of different physical activity questionnaires in the literature has hampered the comparability of physical activity patterns in different studies and countries. To address this issue, an international physical activity questionnaire (IPAQ) was created. This questionnaire has allowed researchers to monitor national prevalence of physical activity and to make comparisons across countries.

2.5.1 The International Physical Activity Questionnaire

The International Physical Activity Questionnaire (IPAQ) was developed in the 1990’s by an international group of experts, with support from the WHO and the Centers for Disease Control and Prevention (CDC), to estimate physical activity patterns of populations from different countries and socio-cultural contexts. Short and long form versions of the IPAQ were designed. Both versions can be either self-administered or answered by an in-person or telephone interview.

The short form IPAQ consists of nine items that estimate the number of sessions and the average time spent in bouts of MVPA lasting at least 10 minutes. It takes approximately 8-10 minutes for a participant to complete the short form IPAQ. The long form IPAQ consists of 31 items that collects information related to household and yard work activities, occupational activity, self-powered transport, leisure time and sedentary activities. It takes approximately 15 minutes for a participant to complete the long form IPAQ. The recall period for both versions is the previous 7 days. Although both IPAQ versions have acceptable valid and reliable results, the IPAQ committee has suggested the short IPAQ be used to compare national and international prevalence because the short time spent for its application and because it can capture total physical activity. For this and other reasons (e.g., shorter time to complete the
short form version), which I have previously explained in great detail in a report written to the INSP, the short form IPAQ was selected to be used into the 2012 ENSANUT.  

In addition to the questionnaire itself, a standardized data reduction and cleaning protocol was developed for the IPAQ. This protocol can be used to clean the questionnaire data (e.g., handle missing data, truncation rules for extreme values), standardize the questionnaire responses to create useable physical activity variables (e.g., minutes per week of total, moderate, and vigorous physical activity), and to place participants into different physical activity groups based on adherence to global physical activity guidelines.

2.6 Reliability of Physical Activity Questionnaires

The reliability of a questionnaire reflects the capacity of a tool to obtain the same result in consecutive measurements. The time interval required for the retest should be short enough to ensure physical activity pattern comparisons and long enough to avoid seasonal bias. 1-day to 12-months are the most common time intervals. The recall period of the questionnaire indicates the time interval to be used. Generally, when physical activity is measured during the past or usual week, a 1- to 8-day retest interval is used. The questionnaire time interval has a direct effect on the test-retest correlation value. For example, a correlation of 0.72 was found between repeated physical activity measures when the Harvard College Alumni physical activity questionnaire was administered at 1 month intervals; this correlation value decreased to 0.34 when the questionnaire was asked 8 months apart.

The reliability of a physical activity questionnaire tends to be higher when more vigorous physical activities are assessed. Sallis et al. found a higher correlation value within vigorous physical activity compared to moderate physical activity in a
sample of 53 Caucasian men and women. The same results was found by Brown et al.\textsuperscript{33} who evaluated the reliability of 4 different questionnaires in a sample of approximately 150 male and female Australians.

Gender is another confounding variable that has a direct effect on the test-retest correlation values. For example: Brown et al.\textsuperscript{33} reported that correlations were lower in women, especially for high intensity activities. Moreover, Sallis et al.\textsuperscript{30} found that test-retest correlation values were higher in women than in men for light intensity activities, but higher in men than in women for high intensity activities.

2.6.1. Reliability of physical activity questionnaires within Mexicans

There is limited evidence on the test-retest reliability of physical activity questionnaires within the Mexican population. The only published study evaluating the test-retest reliability is of the 3-day self-reported questionnaire (Bouchard) completed 4 weeks apart in a sample of 30 Mexicans aged 20-60 years. This study found a correlation of 0.70 for the physical activity energy expenditure estimates produced by the two questionnaires.\textsuperscript{34}

2.6.2 Reliability of the IPAQ

The reliability of the short form IPAQ has been examined in several countries and in different languages, as summarized in Table 1 (see page 18). Most of the 11 studies presented in this table administered the IPAQ on two occasions separated by 7-days and included both men and women in the study. The sample sizes ranged from 19 to 257 participants. The ages of the participants included in these studies ranged from 15 to 75 years. Participants from 15 different countries were included in these 11 studies; however, none of these studies included a Mexican sample.
All of the 11 previously published studies described that the level of MVPA reported in the first and second IPAQ assessments were correlated (0.53-0.86); however, there was a modest correlation of 0.59 between the studies.\textsuperscript{15, 33, 35-40} Countries that obtained a reliability correlation \( \geq 0.8 \) include Greece, the United States, China, the United Kingdom, Netherlands, and urban areas of Guatemala. Countries where the correlation values were \( \leq 0.4 \) are the rural areas of Guatemala and South Africa.

There was no apparent trend suggesting that the sample size of the study influenced the test-retest correlation coefficient values. Even though the age range was wide, the correlation values were not affected by age differences across the studies. Three studies reported correlation values stratified by sex. In general, the results were similar in men and women and somewhat inconsistent.\textsuperscript{36, 40}

Finally, eight studies reported the correlation values stratified by physical activity intensity. Test-retest correlations between walking, moderate and vigorous activities were quite different. Specifically, the general pattern of findings indicates that the correlations were lowest for moderate intensity activities and higher for walking and vigorous intensity activities.\textsuperscript{15, 33, 36-39, 41, 42}
Table 1. Summary of previous studies examining the reliability of the IPAQ

<table>
<thead>
<tr>
<th>Author and year</th>
<th>N</th>
<th>Age (y)</th>
<th>Gender</th>
<th># of times survey administered</th>
<th>Key results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craig et al. (2003)</td>
<td>1974</td>
<td>18 to 65</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.76 for total physical activity</td>
</tr>
<tr>
<td>Papathanasiou et al. (2009)</td>
<td>218</td>
<td>19 to 29</td>
<td>Both</td>
<td>3</td>
<td>Correlations of 0.81 for total physical activity and 0.93 for vigorous</td>
</tr>
<tr>
<td>Oyeyemi et al. (2011)</td>
<td>102</td>
<td>20 to 65</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.61 for MVPA, 0.73 for vigorous, and 0.33 for moderate</td>
</tr>
<tr>
<td>Kolbe-Alexander et al. (2006)</td>
<td>122</td>
<td>62 to 70</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.60 in women and 0.54 in men for total physical activity</td>
</tr>
<tr>
<td>Brown et al. (2004)</td>
<td>194</td>
<td>18 to 75</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.68 for MVPA, 0.52 for vigorous, and 0.41 for moderate</td>
</tr>
<tr>
<td>Cust el at. (2009)</td>
<td>177</td>
<td>50 to 65</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.53 for MVPA in high confidence group and 0.33 in low confidence group</td>
</tr>
<tr>
<td>Deng et al. (2007)</td>
<td>224</td>
<td>51 to 82</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.84 for MVPA, 0.83 for vigorous, and 0.81 for moderate</td>
</tr>
<tr>
<td>Macfarlane et al. (2007)</td>
<td>49</td>
<td>15 to 33</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.79 for MVPA, 0.75 for vigorous, and 0.31 for moderate</td>
</tr>
<tr>
<td>Mäder et al. (2006)</td>
<td>178</td>
<td>15 to 75</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.54 for total physical activity, 0.43 for vigorous, and 0.50 for moderate</td>
</tr>
<tr>
<td>Dinger et al. (2006)</td>
<td>111</td>
<td>18 to 30</td>
<td>Both</td>
<td>2</td>
<td>Correlation of 0.86 for total physical activity, 0.89 for vigorous, and 0.71 for moderate</td>
</tr>
<tr>
<td>Kurtze et al. (2008)</td>
<td>109</td>
<td>20 to 39</td>
<td>Men</td>
<td>2</td>
<td>Inter-class correlation of 0.62 for vigorous, and 0.30 for moderate</td>
</tr>
</tbody>
</table>

In terms of overall assessment of the reliability of the IPAQ, the average correlation value for MVPA for the studies summarized in Table 1 was 0.59. When examining the rural areas alone, the average correlation value was 0.80 and when examining the urban areas alone the average correlation value was 0.28. Some explanations about the variability of the correlation value could be related to people from urban areas being more educated and may have more experience in completing surveys. Moreover, translation issues, extrapolation and cultural factors could also be related to the way people understand and answer the questionnaire. This literature review included countries with similar sociodemographic characteristics as Mexico,
however, currently there is no published evidence examining the test-retest correlation of the IPAQ in Mexican adults.

Finally, the reliability of the IPAQ to assess moderate physical activity was generally lower than for walking and vigorous physical activity. This result is consistent with previous studies.\textsuperscript{15, 33, 36, 41} This may be explained by the fact that people have less difficulty reporting more structured or planned physical activity such as walking and organized sports, which generally involve a higher amount of physical activity intensity.

\section*{2.7 Validity of Physical Activity Questionnaires}

Validity is the degree to which an instrument obtains the same results when compared to another instrument.\textsuperscript{4, 5} This thesis focuses specifically on \textit{concurrent validity} or “the extent to which an instrument measures what it is intended to measure”.\textsuperscript{18, 43} In this case, the direct measures are not considered “gold standard”.\textsuperscript{4, 18, 44} Measures include observation, records, diaries/logs, self-report, questionnaires, surveys, heart rate, motion sensors, double labeled water and calorimetry.\textsuperscript{18} \textit{Criterion validity} is part of the convergent validity, and refers to “the extent to which the output of an instrument (e.g., questionnaire) measures the same exposure of interest, which is generally more valid”.\textsuperscript{14, 18} Since there is not an available “gold standard” method to obtain criterion validity, concurrent validity is the most used kind of validity within studies.\textsuperscript{4, 44, 45}

Prior to the 1990’s, newly developed physical activity questionnaires used to be validated against other physical activity questionnaires.\textsuperscript{44} However, as the technology has advanced, pedometers and accelerometers have become the most used instruments to test the validity of physical activity questionnaires.\textsuperscript{5, 46}
Several physical activity questionnaires have been validated against accelerometer and pedometer measures. The time frame and duration of the accelerometer measures typically depends on the time frame of MVPA assessed by the questionnaire. For example, physical activity questionnaires that assess activity over a 7-day period are typically validated against accelerometers data obtained over the same time period.\textsuperscript{46} Pearson correlation is normally the statistical measure of choice within these validity studies. In addition, sensitivity and specificity has been used to measure the validity of the categorical data provided by the questionnaires (e.g., adherence to physical activity guidelines).

In general, the results from physical activity questionnaires and accelerometers are only modestly correlated. In a systematic review conducted by van Poppel et al.\textsuperscript{28} a pooled correlation value of 0.31 for both total and MVPA was reported. The modest correlation could potentially be explained by 1) the possibility that either the questionnaire and/or the accelerometer are not measuring one or more dimension of physical activity, 2) a systematic error within-person occurred when people over or under estimate their physical activity every time the questionnaire is asked, 3) a variation in the physical activity classification due to the lack of distinction between each physical activity category, 4) a misinterpretation of the questions that led to measurement error in surveys and/or the inability to correctly recall all activities performed when completing the surveys, 5) a misinterpretation of the question due to cultural or sociodemographic differences and/or the lack of ability to understand or answer the questionnaire due to education issues, and/or 6) a social desirability bias that led individuals to answer what is socially acceptable, in this case, to overestimate their physical activity.\textsuperscript{12, 24, 47}
Questionnaire measures of moderate intensity physical activity are more poorly correlated to accelerometers of the same intensity than are questionnaire measures of vigorous intensity activities.\textsuperscript{13, 48} For example, Rauh et al.\textsuperscript{49} reported a correlation of 0.34 for vigorous physical activity vs. a correlation of 0.13 for moderate activity when the Godin questionnaire was used. Moreover, Jacobs et al.\textsuperscript{48} found a correlation of 0.26 for vigorous activities and 0.19 for moderate activities when compared values from the seven recall questionnaire to accelerometers measures. One explanation for this is that moderate physical activities are more difficult to report than structured sport or vigorous physical activities. In other words, moderate activities are normally accumulated during the day in a non-constant way, whereas vigorous activities are more stable, therefore easier to recall.\textsuperscript{24, 27}

Most of the studies present correlation values adjusted either by age, gender or both. Few studies show age or gender stratifications. When stratification is reported, the correlations between questionnaire and accelerometer measures tend to be higher in men than in women.\textsuperscript{13, 48, 50, 51} For example, Richardson et al.\textsuperscript{52} reported a correlation of 0.58 for total activity in men compared to 0.20 in women when physical activity results obtained by the Minnesota questionnaire and Caltrac accelerometers. One explanation of this could be that moderate physical activities are more common in women than in men.

\textit{2.7.1 Validity of physical activity questionnaires within Mexicans}

To the best of my knowledge, there is no published evidence on the validity of physical activity questionnaires within Mexican adults.
2.7.2 Validity of the IPAQ

2.7.2.1 IPAQ vs. accelerometers

Ten published studies have investigated the validity of the short form IPAQ by comparing the IPAQ self-reported physical activity measures to those obtained objectively by accelerometer. A summary of these studies, none of which were conducted within Mexico, is shown in Table 2 (page 24). Most of the studies assessed physical activity with accelerometers over one week, the same time frame assessed by the IPAQ. The sample size ranged from 12 to 1270, and the age of the participants studied ranged from 15 to 82 years. All the studies included both men and women.

The available evidence shows that the short form IPAQ has an average correlation of 0.30 for MVPA scores when compare to objective instruments.\textsuperscript{35, 37, 38, 40, 42, 53-55} This correlation value does not seem to be related to the sample size. However, the validity of the IPAQ varies across countries. Craig et al.\textsuperscript{14} evaluated the validity of the IPAQ in participants from 12 countries. A pooled correlation of 0.30 was obtained between accelerometer measures and IPAQ measures of total physical activity. The correlations were noticeably lower ($r < 0.13$) than the pooled results in participants from Brazil, Sweden, Australia and Southern California. This result could be related to sociocultural factors and/or translation issues that affect the way the questionnaire is answered.

International recommendations have suggested that accumulating 150 minutes of moderate physical activity or 75 minutes of vigorous physical activity in at least 10 minutes bouts are sufficient to obtain health benefits.\textsuperscript{3} Following this recommendation, IPAQ was designed to capture physical activities in at least 10 minute bouts and recently some studies have addressed the point to include a 10-minute interval within validation studies when IPAQ is used. For example, Wolin et al.\textsuperscript{55} showed a significant
correlation of 0.26 for the MVPA measures when based on 10-minute bouts and 0.36 when based on all MVPA (e.g., sporadic and bouted MVPA) in 250 African Americans who wore Actical accelerometer for 6 days.

Finally, six studies classified the prevalence of physical activity according to the WHO guidelines. All of these reported that a higher percentage of participants met the guidelines based on the IPAQ than on the accelerometer measures.\textsuperscript{14, 37, 42, 55, 56}
<table>
<thead>
<tr>
<th>Author and year</th>
<th>N</th>
<th>Age (y)</th>
<th>Gender</th>
<th>Accelerometer Method</th>
<th>Correlation between IPAQ and Accelerometer</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Craig et al. (2003)</td>
<td>781</td>
<td>18 to 65</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.30$ for total activity</td>
<td>82% of the participants meet 150 min/week based on both instruments</td>
</tr>
<tr>
<td>Macfarlane et al. (2007)</td>
<td>49</td>
<td>15 to 55</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.09$ for total activity</td>
<td>76% of the participants meet 150 min/week based on accelerometer and 94% based on IPAQ</td>
</tr>
<tr>
<td>Macfarlane et al. (2006)</td>
<td>49</td>
<td>15 to 55</td>
<td>Both</td>
<td>R3D accelerometer</td>
<td>$r = 0.17$ for total activity</td>
<td>82% of the participants meet 150 min/week based on the RT3 and 94% based on IPAQ</td>
</tr>
<tr>
<td>Ekelund et al. (2006)</td>
<td>185</td>
<td>20 to 69</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.34$ for total activity</td>
<td>A sensitivity value of 45% and a specificity value of 77% from IPAQ, using MTI as a gold standard</td>
</tr>
<tr>
<td>Mäder et al. (2006)</td>
<td>35</td>
<td>15 to 75</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.39$ for total activity</td>
<td>80% of the participants were classified as active based on the IPAQ.</td>
</tr>
<tr>
<td>Dinger et al. (2006)</td>
<td>123</td>
<td>18 to 30</td>
<td>Both</td>
<td>CSA accelerometer</td>
<td>$r = 0.22$ for total activity accumulated in bouts of at least 10-minutes</td>
<td>_</td>
</tr>
<tr>
<td>Wolin et al. (2008)</td>
<td>250</td>
<td>24 to 70</td>
<td>Both</td>
<td>Actical accelerometer</td>
<td>$r = 0.36$ for total physical activity and 0.26 based on bouted (10+ minutes) activity</td>
<td>89% of the participants meet CDC/ACSM recommendations based on 1-min interval, and 25% based on 10-min interval</td>
</tr>
<tr>
<td>Lee et al. (2011)</td>
<td>1270</td>
<td>15 to 82</td>
<td>Both</td>
<td>GT1M accelerometer</td>
<td>$r = 0.11$ for MVPA</td>
<td>81.3% of participants meet guidelines based on IPAQ and 79.6% based on accelerometer</td>
</tr>
<tr>
<td>Kolbe-Alexander et al. (2006)</td>
<td>122</td>
<td>62 to 70</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.05$ in women and 0.43 in men for vigorous, -0.09 in women and 0.31 in men for moderate</td>
<td>_</td>
</tr>
<tr>
<td>Cust et al. (2009)</td>
<td>177</td>
<td>50 to 65</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.27$ in low confidence group and 0.30 in high confidence for total physical activity</td>
<td>_</td>
</tr>
<tr>
<td>Timperio et al. (2004)</td>
<td>510</td>
<td>18 to 75</td>
<td>Both</td>
<td>MTI accelerometer</td>
<td>$r = 0.14$ when daily log was used and 0.29 when daily log was not used</td>
<td>(log group) 89.5% of the participants were classified as sufficiently active based on the survey and 78.9% based on the accelerometer (no log group) 86.3% of the participants were classified as sufficiently active based on the survey and 74.7% based on the accelerometer.</td>
</tr>
</tbody>
</table>
2.7.2.2 IPAQ vs. pedometers

Pedometers have been validated against objective measures such as accelerometers. Studies reported a pooled correlation of 0.86 when comparing pedometer counts to accelerometer physical activity measures and 0.68 when comparing pedometer counts to doubly labeled water measures of total energy expenditure.\textsuperscript{18, 19}

Three published studies have investigated the validity of the short form IPAQ by comparing the IPAQ self-reported physical activity measures to those obtained by pedometer. A summary of these studies is shown in Table 3. The first one was evaluated by Macfarlane et al.\textsuperscript{42} who examined the validity of the short form IPAQ in 49 subjects from China who wore a pedometer for 7 consecutive days. They found a significant correlation of 0.30 for total physical activity. Another study conducted by Deng et al.\textsuperscript{39} evaluated the validity of the short form IPAQ in 224 older Chinese adults who wore a pedometer for 7 consecutive days. They found a significant correlation of 0.33 for MVPA and 0.51 for walking scores, and non-significant correlation of -0.09 for vigorous scores, and 0.05 for moderate. Finally, De Cocker et al.\textsuperscript{58} evaluated the validity of the short form IPAQ in a sample of 310 Belgium adults who wore a pedometer for 7 consecutive days. They found a significant correlation of 0.28 for total physical activity, 0.15 for walking, 0.33 for moderate and 0.20 for vigorous.

\begin{table}[h]
\centering
\caption{Summary of research related to validity of the IPAQ based on pedometer measures}
\begin{tabular}{llllll}
\hline
Author and year & N & Age (y) & Gender & Method & Correlation Between IPAQ and Pedometer \\
\hline
Macfarlane et al. (2006) \textsuperscript{42} & 49 & 15 to 55 & Both & Yamax SW-200 Pedometer & \(r= 0.30\) for total physical activity \\
Deng et al. (2007) \textsuperscript{39} & 224 & 51 to 82 & Both & Yamax SW-200 Pedometer & \(r= 0.33\) for total physical activity \\
De Cocker et al. (2008) \textsuperscript{58} & 310 & 38.7 & Both & Yamax SW-200 Pedometer & \(r= 0.28\) for total physical activity \\
\hline
\end{tabular}
\end{table}
The average correlation value between questionnaire and objective measures of physical activity (Table 2 and 3) covered in this thesis was 0.30. As previously discussed on page 19, this low r may be explained by a number of factors such as recall, cultural and education bias, the lack of distinction between physical activity intensities, and a social desirability bias.\textsuperscript{12, 45, 47}

A close inspection of the data in Tables 2 and 3 suggests that the correlation values varied considerably from country to country. Among the countries that obtained a correlation value <0.20 were Australia, China, Sweden and Brazil. Some of the authors of these studies postulated that the low correlation values they observed were related to the inability of the accelerometers to measure some of the more common physical activity in that country, such as bicycling, which is a common mode of transportation and physical activity in China. In addition, translation issues and cultural factors may affect the way the questionnaire is answered.\textsuperscript{14} This justifies the need to conduct a similar study in Mexico given the absence of validity research done in that country.

2.8 Summary

According to the WHO, 31.1% of the global population is considered inactive, and this prevalence is rising.\textsuperscript{8, 59} Because physical inactivity is a highly prevalent condition that is associated with numerous chronic diseases, it is a commonly measured behaviour in epidemiological research.\textsuperscript{60-62} Questionnaires are easy and low cost instruments used to assess physical activity within large-scale population surveys, and the IPAQ is a commonly used physical activity questionnaire.\textsuperscript{5}

Several studies have examined the validity and reliability of different physical activity questionnaires, including the IPAQ. The available evidence demonstrates that
the reliability is in the acceptable range, with test-retest correlations between repeated questionnaire responses of around 0.60.\textsuperscript{14, 15, 33, 35-42} The validity results are not as encouraging as the correlation between questionnaire measures and those obtained objectively are in the 0.30.\textsuperscript{14, 35, 37-42, 54-57}

The validity and reliability of physical activity questionnaires have been obtained in different countries. Results from these studies demonstrate that either the validity or reliability value can differ from country to country. Translation issues, cultural factors and education levels are the most common problems suggested by the authors. These correlation values have been obtained in countries with similar sociodemographic areas than Mexico; however, the Mexican population has its own distinct culture and geography, and these findings may not apply to Mexico.

2.9 References


3. Organización Mundial de la Salud. Recomendaciones mundiales sobre actividad física para la salud2010:

   \url{http://whqlibdoc.who.int/publications/2010/9789243599977_spa.pdf}


Chapter 3
VALIDITY AND RELIABILITY OF THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE AMONG MEXICAN ADULTS
ABSTRACT

Objective. The purpose of this study was to determine the test-retest reliability and validity of the Spanish version of the short form International Physical Activity Questionnaire (IPAQ) within Mexican adults.

Methods. Two hundred and sixty seven participants (aged 19-68 years, 48% female) who worked in a variety of occupations at a factory within Mexico City wore an Actical accelerometer for nine consecutive days and answered the Spanish version of the short form IPAQ on two occasions (IPAQ1 and IPAQ2, separated by 9 days). The relation and differences between moderate-to-vigorous physical activity (MVPA) measures obtained from IPAQ1, IPAQ2, and the accelerometer were determined using correlations, linear regression, and paired t tests.

Results. IPAQ1 and IPAQ2 measures of MVPA were significantly correlated to each other (r=0.55, p<0.01). However, MVPA was 44 ± 408 min/week lower in IPAQ1 than in IPAQ2, although this difference did not reach statistical significance (p=0.08). The MVPA (min/week) measures from IPAQ1 and IPAQ2 were only modestly correlated with the accelerometer measures (r=0.26 and r=0.31, p<0.01) and by comparison to accelerometer measures, MVPA values were higher when based on IPAQ1 (174 ± 357 min/week, p<0.01) and IPAQ2 (135 ± 360 min/week, p<0.01). The percentage of participants who were classified as physically inactive according to the World Health Organization guidelines was 18.0% in IPAQ1, 25.1% in IPAQ2, and 28.2% based on the accelerometer.

Conclusions. Similar to what has been observed in other populations, the short form IPAQ has a modest reliability and poor validity to assess MVPA in Mexican adults.

Keywords. Physical activity, Measurement, Self-report, Accelerometer, Mexico
INTRODUCTION

Physical inactivity is an important public health issue and is the seventh most prevalent risk factor for cardiovascular disease globally.\textsuperscript{1,2} In addition to cardiovascular disease, physical inactivity is a leading risk factor for premature mortality, type 2 diabetes, osteoporosis, and certain types of cancer.\textsuperscript{3,4} According to the World Health Organization (WHO), in developing countries such as Mexico, almost half of the adult population does not accumulate enough physical activity for health benefits.\textsuperscript{2,5}

Because of its importance to chronic disease prevention, physical activity is a key behavioural risk factor that is measured in most general health surveys.\textsuperscript{3,6,7} Questionnaires are the most practical and economically feasible tool researchers can use to measure physical activity in large population based studies\textsuperscript{8-11} and there are several physical activity questionnaires available.\textsuperscript{9,12-15} One of the most commonly used ones is the International Physical Activity Questionnaire (IPAQ), which was developed in 1996 as an instrument that could be used in adults across a diverse range of countries and populations.\textsuperscript{16} The IPAQ can be used to assess activities of different intensities and sedentary behaviours during work, transportation, and leisure-time.

Currently, the IPAQ is used for surveillance purposes in several countries.\textsuperscript{16-18} The reliability and validity of the short form IPAQ has been tested in more than 12 countries.\textsuperscript{16-25} Across these countries the pooled correlation of repeated MVPA measures obtained by the IPAQ is 0.76 and the pooled correlation between MVPA measures obtained by the IPAQ and accelerometer is 0.30.\textsuperscript{16}

The reliability and validity of the IPAQ and other physical activity questionnaires for Mexico remains unknown. The validity and reliability of the IPAQ has been obtained for geographic areas that are similar to Mexico such as southern California (which falls on Mexico’s northwest border and is heavily populated with Mexican-
The results of these studies indicate a poor validity (e.g., $r < 0.13$ when compared to accelerometer) and a modest reliability (e.g., $r \geq 0.25$ between multiple IPAQ surveys). This result could be related to education issues and/or sociocultural factors that affect the way poorer people answer the questions. In addition, there could be translation issues and there is the possibility that either the questionnaire and/or the accelerometer are not measuring one or more dimension of physical activity that is important for such populations. Nonetheless, the Mexican population has its own distinct culture and geography, and these findings may not apply to Mexico. Therefore, the purpose of this study was to determine the test-retest reliability and validity of the IPAQ within Mexican adults.

**METHODS**

**Participants.** Data was collected on 272 Mexican men and women aged 18-69 years. All participants worked at the same factory within Mexico City. Full and part time employees from a variety of occupational types participated (e.g., executives, administrative assistants, factory workers, janitorial staff, security guards). Potential participants were excluded if they had a severe physical disability or a medical condition that would not allow them to engage in physical activity. All participants provided their informed consent prior to participating. The National Public Health Institute Ethics Review Board of Mexico approved the study.

**Procedures.** Participants visited a clinic within the factory on two occasions. During the first visit, trained staff collected anthropometric data. Weight and height was measured to the nearest 0.1 kg and 0.1 cm, and the body mass index (BMI) was
calculated as kg/m$^2$. Waist circumference was measuring using a fiberglass tape to the nearest 0.1 cm at the midpoint between the iliac crest and the lower rib.

During the first clinic visit two already trained interviewers completed, in a face-to-face interview, the short form version of the Spanish IPAQ and verified if participants were accurately reporting time and duration of physical activity. The compendium of activities was used as a supporting file for classifying physical activity intensities. After the interview, participants received an Actical® accelerometer (Mini Mitter Company, Bend, OR, USA). They were instructed on accelerometer placement and asked to wear it, using an elastic belt, at all times (except when in water) for the following 9 days. They were also given a daily log to track when the accelerometer was removed, and an illustrated instruction pamphlet on how to wear the accelerometer with frequently asked questions and support contacts. Accelerometers were initialized to start recording at midnight. Nine days after their initial clinic visit, participants returned the accelerometers to the clinic, and at that point a second IPAQ was administered.

**IPAQ.** The IPAQ was developed by an international group of experts to estimate physical activity patterns of populations from different countries and socio-cultural contexts. In addition, this questionnaire was already translated into Spanish and has previously been used in other Latin American populations. The short form IPAQ contains 9 items that can estimate the time spent in MVPA in bouts of at least 10 minutes over the past 7 days. In this study the IPAQ was administered in face-to-face interviews in both clinic visits. It took approximately 8-10 minutes to complete each IPAQ.

The IPAQ questionnaire data was cleaned in accordance with the IPAQ protocol such that: 1) physical activity duration data collected in hours was converted into minutes, 2) results reported as a weekly frequency were converted into an average daily
time, and 3) “do not know”, “refused” or “missing data” for duration or frequency were removed from the analysis. Truncation was performed for all daily duration values exceeding 180 minutes. Based on the reported time spent in moderate (including walking) and vigorous intensity physical activity weighted by two, participants were categorized as being active (≥300 min/wk), moderately active (150-299 min/wk), or inactive (<150 min/wk) according to the World Health Organization (WHO) physical activity guidelines.28

**Actical Accelerometer.** The Actical® is an omni-directional sensor that measures physical activity by acceleration in multiple directions in the range of 0.35-3.5 Hz. The activity counts are summarized over one minute periods of time or “epochs”. After the accelerometer data were collected, they were downloaded and inspected using the manufacturer’s software (Actical V2.12, Mini Mitter Co. Bend, OR). The accelerometer data were then cleaned and managed using the Personal Activity and Location Measurement System (PALMS) program and SPSS version 20 software (IBM SPSS statistics, IBM Corporation, Somers, NY). All periods of 60 or more consecutive minutes with zero epoch counts were removed prior to calculating wear time for a given day.29 A valid wear day was defined as at least 10 hours of wear time.30 Only 12% of the days collected in the entire sample did not meet the 10-hour wear time criteria, and these days were removed from the dataset. 262 of the 267 participants (98%) had at least 4 valid wear days, and 227 had at least 7 valid wear days (85%).

Established cut-points were used for each epoch (minute of physical activity data) to determine if the participant was engaged in moderate intensity (3.0 to 5.9 METs, 1535 to 3961 accelerometer counts) or vigorous intensity (≥ 6 METs, ≥ 3962 accelerometer counts) activity.30 Because the IPAQ assessed MVPA accumulated in bouts of at least 10 minutes, all moderate and vigorous intensity minutes that occurred
in bouts of at least 10 consecutive minutes of MVPA (with allowance of 2 minutes per each 10 minutes below the 1535 epoch cut-point), was summed for each valid day and averaged to determined weekly moderate, vigorous, and MVPA values. As with the IPAQ data, participants were subsequently categorized as being active, moderately active, or inactive according to the WHO physical activity guidelines.28

**Statistical Analysis**

Simple descriptive statistics (means, interquartile ranges, 95% confidence intervals) were used to describe the sample. Skewness and kurtosis were used to test normality and variables that were not normally distributed were logarithmically transformed prior to subsequent analyses. *For the reliability analyses*, mean differences in physical activity between IPAQ1 and IPAQ2 were examined using paired t tests. Intraclass correlation coefficients were used to determine the correlation between the IPAQ1 and IPAQ2 measures. *For the validity analyses*, paired t tests were used to compare the means of the IPAQ and accelerometer measures. Pearson correlation coefficients were used to assess the strength of the relationship between the IPAQ and accelerometer measures and multiple linear regression analyses were used to assess the association between them after adjusting for sex, age, and body mass index. The intercepts and slopes of the regression lines and their associated 95% confidence intervals were examined to see if the values were different from 0 and 1, respectively. Finally, the sensitivity and specificity of adhering to the WHO physical activity guidelines based on IPAQ1 and IPAQ2, with accelerometer measures as the gold standard, was calculated. Sensitivity refers to the ability of the IPAQ to correctly identify the percentage of active, moderately active, and inactive individuals, based on the accelerometer values. Specificity refers to the ability of the IPAQ to correctly
identify the percentage of non-active, non-moderately active and non-inactive individuals.

RESULTS

Descriptive Characteristics

Characteristics of the sample are presented in Table 4. Of the 272 participants, 267 answered the IPAQ on both occasions and 262 had valid accelerometry data. The mean ± SD age was 36.7 ± 10 years (range = 19 to 68 years old) and 138 (51.7%) were men. The mean (SD) body mass index was 26.9 ± 4.1 kg/m²; 46.6% were classified as overweight (18.5-24.9 kg/m²) and 19.7% were obese (≥30 kg/m²).

Table 4. Participant Characteristics, Mexico City 2011

<table>
<thead>
<tr>
<th></th>
<th>Total (N = 267)</th>
<th>Men (N = 138)</th>
<th>Women (N = 129)</th>
<th>≤40 years (N = 172)</th>
<th>&gt;40 years (N = 95)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>36.7 (10)</td>
<td>36.4 (10)</td>
<td>37.2 (10)</td>
<td>30.6 (6)</td>
<td>47.9 (6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>70.9 (13.2)</td>
<td>76.1 (12.0)</td>
<td>64.8 (11.5)</td>
<td>69.7 (13.2)</td>
<td>73.1 (12.8)</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.62 (0.1)</td>
<td>1.68 (0.1)</td>
<td>1.55 (0.1)</td>
<td>1.63 (0.09)</td>
<td>1.60 (0.1)</td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>26.9 (4.1)</td>
<td>27.1 (3.6)</td>
<td>26.9 (4.6)</td>
<td>26.1 (3.8)</td>
<td>28.4 (4.3)</td>
</tr>
<tr>
<td>Waist circumference (cm)</td>
<td>89.6 (10.9)</td>
<td>92.7 (9.7)</td>
<td>86.4 (11.3)</td>
<td>86.9 (10.2)</td>
<td>94.4 (10.6)</td>
</tr>
</tbody>
</table>

Data presented as mean (standard deviation)

Reliability

The mean and median minutes per week for the physical activity variables are presented in Table 5. On average, participants reported a higher MVPA in IPAQ1 (402 ± 369 min/week) than IPAQ2 (359 ± 359 min/week), although this difference did not reach statistical significance (p = 0.08). The mean difference between IPAQ1 and
IPAQ2 MVPA measures was 44 ± 408 min/week, with an interquartile range of -100 to 170 min/week (Table 6). The differences between IPAQ1 and IPAQ2 measures were more pronounced in women than men (64 ± 376 vs. 24 ± 438 min/week) and in ≤40 year olds than >40 year olds (57 ± 423 vs. 20 ± 379 min/week).
Table 5. Mean and median moderate, vigorous, and moderate-to-vigorous physical activity levels (minutes per week) for IPAQ and Actical accelerometer, Mexico City 2011

<table>
<thead>
<tr>
<th></th>
<th>IPAQ1</th>
<th>IPAQ2</th>
<th>Accelerometer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Median (IQR)</td>
<td>Mean (SD)</td>
</tr>
<tr>
<td>Moderate</td>
<td>311 (326)</td>
<td>210 (90,420)</td>
<td>323 (340)</td>
</tr>
<tr>
<td>Vigorous</td>
<td>91 (162)</td>
<td>30 (0,120)</td>
<td>118 (154)</td>
</tr>
<tr>
<td>MVPA</td>
<td>402 (369)</td>
<td>300 (150,510)</td>
<td>441 (385)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IPAQ2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>286 (310)</td>
<td>190 (90,330)</td>
<td>312 (356)</td>
</tr>
<tr>
<td>Vigorous</td>
<td>73 (152)</td>
<td>10 (0,80)</td>
<td>104 (187)</td>
</tr>
<tr>
<td>MVPA</td>
<td>359 (359)</td>
<td>250 (120,430)</td>
<td>416 (423)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerometer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>197 (112)</td>
<td>178 (114,257)</td>
<td>224 (120)</td>
</tr>
<tr>
<td>Vigorous</td>
<td>28 (50)</td>
<td>11 (1,32)</td>
<td>40 (64)</td>
</tr>
<tr>
<td>MVPA</td>
<td>226 (140)</td>
<td>197 (126,287)</td>
<td>264 (157)</td>
</tr>
<tr>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>


Table 6. Mean and median moderate, vigorous and moderate-to-vigorous physical activity differences (minutes per week) between IPAQ1, IPAQ2 and accelerometer, Mexico City 2011

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
<th>≤40 years</th>
<th>&gt;40 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median</td>
<td>Mean</td>
<td>Median</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>(SD)</td>
<td>(IQR)</td>
<td>(SD)</td>
<td>(IQR)</td>
<td>(SD)</td>
</tr>
<tr>
<td><strong>IPAQ1 vs. IPAQ2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PA</td>
<td>25 (376)</td>
<td>10 (105,150)</td>
<td>11 (400)</td>
<td>3 (-120,146)</td>
<td>41 (348)</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>18 (168)</td>
<td>0 (0,60)</td>
<td>14 (183)</td>
<td>13 (-23,75)</td>
<td>23 (151)</td>
</tr>
<tr>
<td>MVPA</td>
<td>44 (408)</td>
<td>20 (-100,170)</td>
<td>24 (438)</td>
<td>20 (-100,181)</td>
<td>64 (376)</td>
</tr>
<tr>
<td><strong>IPAQ1 vs. Accelerometer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PA</td>
<td>110 (312)</td>
<td>21 (-98,213)</td>
<td>90 (308)</td>
<td>-1 (-112,177)</td>
<td>131 (316)</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>64 (158)</td>
<td>6 (-6,88)</td>
<td>79 (154)</td>
<td>40 (-5,112)</td>
<td>47 (161)</td>
</tr>
<tr>
<td>MVPA</td>
<td>174 (357)</td>
<td>93 (-59,281)</td>
<td>170 (362)</td>
<td>78 (-61,272)</td>
<td>178 (354)</td>
</tr>
<tr>
<td><strong>IPAQ2 vs. Accelerometer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PA</td>
<td>90 (309)</td>
<td>6 (-103,174)</td>
<td>90 (356)</td>
<td>-22 (-117,163)</td>
<td>89 (252)</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>45 (151)</td>
<td>0 (-11,60)</td>
<td>65 (191)</td>
<td>9 (-14,79)</td>
<td>24 (88)</td>
</tr>
<tr>
<td>MVPA</td>
<td>135 (360)</td>
<td>37 (-99,112)</td>
<td>156 (433)</td>
<td>30 (-108,207)</td>
<td>113 (261)</td>
</tr>
</tbody>
</table>

Data presented as mean (standard deviation) and median (interquartile range) differences in minutes per week of physical activity

IPAQ = international physical activity questionnaire; MVPA = moderate-to-vigorous physical activity
Table 7 provides the intraclass correlation coefficients for the MVPA data obtained from the two IPAQ surveys. Independent of physical activity intensity, gender, and age the IPAQ1 physical activity measures were significantly (p<0.01) related to the IPAQ2 physical activity measures with r values ranging from 0.31 to 0.57.

<table>
<thead>
<tr>
<th></th>
<th>Total</th>
<th>Men</th>
<th>Women</th>
<th>≤40 years</th>
<th>&gt;40 years</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IPAQ1 vs. IPAQ2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PA</td>
<td>0.49</td>
<td>0.39</td>
<td>0.56</td>
<td>0.46</td>
<td>0.54</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>0.50</td>
<td>0.31</td>
<td>0.56</td>
<td>0.48</td>
<td>0.48</td>
</tr>
<tr>
<td>MVPA</td>
<td>0.55</td>
<td>0.48</td>
<td>0.57</td>
<td>0.56</td>
<td>0.54</td>
</tr>
<tr>
<td><strong>IPAQ1 vs. Accelerometer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PA</td>
<td>0.25</td>
<td>0.30</td>
<td>0.22</td>
<td>0.25</td>
<td>0.29</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>0.24</td>
<td>0.11 NS</td>
<td>0.15 NS</td>
<td>0.28</td>
<td>0.13 NS</td>
</tr>
<tr>
<td>MVPA</td>
<td>0.26</td>
<td>0.27</td>
<td>0.21</td>
<td>0.25</td>
<td>0.27</td>
</tr>
<tr>
<td><strong>IPAQ2 vs. Accelerometer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate PA</td>
<td>0.26</td>
<td>0.21</td>
<td>0.26</td>
<td>0.27</td>
<td>0.26</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>0.34</td>
<td>0.27</td>
<td>0.25</td>
<td>0.37</td>
<td>0.25</td>
</tr>
<tr>
<td>MVPA</td>
<td>0.31</td>
<td>0.22</td>
<td>0.32</td>
<td>0.33</td>
<td>0.27</td>
</tr>
</tbody>
</table>

All correlation values were statistically significant (p<0.05) unless noted by NS (not significant).

The distribution of participants across the three physical activity groups was different in IPAQ1 and IPAQ2 (p<0.01), with fewer men and women being categorized into the more active categories in IPAQ2 (Table 8). Based on IPAQ1, 18.0% were inactive, 24.0% were moderately active, and 58.1% were active. The corresponding values for IPAQ2 were 25.1%, 26.2%, and 48.7%, respectively.
Table 8. Classification into three physical activity categories and sensitivity and specificity of the IPAQ to identify inactivity, moderately active, and active participants, Mexico City 2011

<table>
<thead>
<tr>
<th></th>
<th>Prevalence, %</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inactive</td>
<td>Moderately</td>
<td>Active</td>
</tr>
<tr>
<td>IPAQ1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.0</td>
<td>24.0</td>
<td>58.1</td>
</tr>
<tr>
<td>IPAQ2</td>
<td>25.1</td>
<td>26.2</td>
<td>48.7</td>
</tr>
<tr>
<td>Accel.</td>
<td>28.2</td>
<td>42.4</td>
<td>29.4</td>
</tr>
</tbody>
</table>
Validity

By comparison to the accelerometer measures, the MVPA values were 174 ± 357 min/week higher based on IPAQ1 and 135 ± 360 min/week higher based on IPAQ2 (p<0.01). These differences are further described in Table 6 according to physical activity intensity, gender, and age.

Within the total sample, the correlation between the accelerometer and questionnaire measures of MVPA were r=0.26 for IPAQ1 and r=0.31 for IPAQ2. Similar correlations were observed within men and women and within those ≤40 years and >40 years (Table 7).

In multiple regression analysis, IPAQ1 and IPAQ2 MVPA measures were associated with the accelerometer measures after controlling for age, gender, and body mass index. As shown in Figure 1, when IPAQ1 and IPAQ2 values of MVPA were used to predict accelerometer measures, the intercept of the regression line was greater than zero (intercept =1.38 to 1.14, p<0.01) and the slope was less than one (slope = 0.49 to 0.53, p<0.01). This indicates that participants with low MVPA levels over-reported their MVPA in IPAQ1 and IPAQ2 relative to the accelerometer measures, with the level of over-reporting diminishing as MVPA levels increased such that the regression line and line of identity crossed at 323 min/week for IPAQ1 and 295 min/week for IPAQ2.

Figure 1. Differences between IPAQ1, 2 and accelerometer (10-minute bout) for the total sample
The distribution of participants across the three physical activity groups was different when based on IPAQ and accelerometer measures (p<0.01), with fewer participants being categorized into the more active categories with the accelerometer measures (Table 8). Based on the accelerometer, 28.2% of the participants were inactive as compared to 18.0% for IPAQ1 and 25.1% for IPAQ2. The sensitivity of IPAQ1 to capture active, moderately active and inactive individuals was 70.1%, 23.4% and 18.9%. The corresponding specificity values were 47.0%, 75.4%, and 82.4%. Table 5 provides the sensitivity and specificity values for IPAQ2.

DISCUSSION

The purpose of this study was to determine the test-retest reliability and validity of the short form IPAQ among Mexican adults. Key findings are that MVPA measures obtained from two IPAQ surveys are only modestly correlated (r=0.55), and the values obtained from the second survey tended to be lower than those obtained from the first survey. Moreover, IPAQ measures of MVPA were poorly correlated (r=0.26 to 0.31) and considerably higher (402 ± 369 to 359 ± 359 minutes/week) than those obtained by accelerometer. The specificity to correctly classify people as inactive was acceptable (>70%), whereas the sensitivity was low (<30%).

Our observation that the MVPA values reported on two IPAQ surveys administered approximately one week apart are only modestly correlated (r=0.55) is consistent with observations made by other authors who studied participants from a variety of settings and countries. This result could be explained by the true differences in the MVPA levels from week to week, overestimation of the true MVPA due to an incorrect perception of activity, misinterpretation of the questions that led to measurement error in both IPAQ
surveys, and/or the inability to correctly recall all activities performed when completing the surveys.

The amount of MVPA reported in IPAQ2 was 12% lower than what was reported in IPAQ1, and the prevalence of those in the active group decreased from 58.1% to 48.7%. Others have reported similar findings. It is possible that participants learning about MVPA when completing IPAQ1, and subsequently were more aware of and better able to report their MVPA for IPAQ2. These results suggest that caution should be used when classifying physical activity based on a single IPAQ, as is common practice in most large health surveys.

Although statistically significant, the correlations between the IPAQ and accelerometer MVPA measures were poor ($r \sim 0.30$). This result is consistent with the correlation ($r = 0.31$) reported by Craig et al. based on their IPAQ validity study conducted in 2721 adults from 12 countries. In addition to being poorly correlated to the objective measures, the IPAQ MVPA measures were considerably higher (78% for IPAQ1, 59% for IPAQ2) than the accelerometer MVPA measures. This finding supports the well-documented observation that the IPAQ and other physical activity questionnaires overestimate physical activity. Reasons that can explain these results include that people over perceive and subsequently over report their MVPA, a social desirability bias, and the fact that accelerometers do not fully capture aspects of physical activity that are not step based and that involve upper body movements. Indeed, carrying extra weight was one of the main activities performed within the factory that our study participants worked in, and this type of activity could not have been accurately captured by the accelerometers.

The findings from this study have important implications for the way that the prevalence of physical activity is being measured and reported on within the Mexican population. The recently completed Mexican National Health and Nutrition Survey (ENSANUT 2012) used the IPAQ to estimate physical activity levels. The IPAQ was
administered on one occasion in face-to-face interviews to 11,228 adult participants.

According to ENSANUT 2012 results, 70.7% of Mexican where classified as being active, compared to 29.4% obtained in this study using an accelerometer. Our findings suggest that ENSANUT 2012 participants would have over-reported their physical activity levels and that the true prevalence of physical activity in Mexican adults is likely far less than that estimated in ENSANUT 2012.

The modest reliability correlation value and poor validity correlation value found in our study suggest that there is considerable misclassification of participants into physical activity categories in the ENSANUT 2012 and other Mexican studies that rely on questionnaire measures of physical activity. The implication that this misclassification has on the reported prevalence of physical activity/inactivity prevalence is obvious. This misclassification would also impact the ability to detect associations between physical activity with its determinants (e.g., gender, age, environment) and outcomes (e.g., obesity, hypertension). Specifically, misclassification of physical activity would lead to underreported associations (e.g., reported prevalence ratios are weaker than true prevalence ratios).

A key limitation of this study relates to the fact that the sample was chosen by convenience. Because the sample were all employed, they were likely healthier than the general population in Mexico, many of who are unemployed or unable to work because of existing health problems. A second limitation relates to the use of the accelerometers as the “gold standard” measures of MVPA for the validity comparisons. While objective, accelerometer are not a perfect measure of MVPA as they do not adequately capture some activities (e.g., pushing or pulling objects, carrying extra weight, water based activities). Moreover, the accelerometer cut-points used to categorize physical activity intensities may be population specific and not appropriate for Mexicans.
In conclusion, within the Mexican population the IPAQ has modest test-retest reliability and a poor validity. Future studies within Mexico should consider employing objective measures of physical activity. Other countries, such as Canada \textsuperscript{47} and the United States \textsuperscript{48}, have successfully used accelerometers in some of their national health measures surveys, and the feasibility of employing such technology in the ENSANUT should be examined.

\textbf{Acknowledgments}

We would like to thank Grupo Medix for their support in the data collection phase of this study. This work was carried out with support from CAMBIO –Canada and Mexico Battling Childhood Obesity- which is funded by the Global Health Research Initiative (GHRI), a collaborative research funding partnership of the Canadian Institutes of Health Research, The Canadian International Development Agency, Health Canada, the International Development Research Centre and the Public Health Agency of Canada. Ian Janssen was supported by a tier 2 Canada Research Chair.

\textbf{Competing interests}

The authors declare that they have no competing interests.

\textbf{REFERENCES}


Chapter 4

General Discussion and Conclusions

4.1 Summary of key findings

The present thesis examined the validity and reliability study of the short form IPAQ in a sample of Mexican adults. Key findings are that: 1) The correlation between IPAQ MVPA measures obtained 9 days apart was 0.55, and 2) MVPA measured obtained by the IPAQ were poorly correlated (r=0.31) to those obtained simultaneously using an Actical accelerometer. In addition, the IPAQ overestimates MVPA by 59% when compared to the objective accelerometer measurement.

4.2 Strengths of thesis research

The utilization of an objective measurement of physical activity during 7 complete days using Actical accelerometers as a standard to evaluate the Spanish IPAQ short validity is one of the main strengths of the present study. While there is extensive available information related to the reliability and validity of physical activity instruments among developed countries,\(^1,2\) such information is not available for Latin American countries such as Mexico. This study therefore provides important data for Mexico and specifically around the validity of the IPAQ physical activity data that has been used in the 2012 ENSANUT.

Another strength relates to the use of Actical accelerometer. The accelerations output from this device has demonstrated a high correlation (r=0.80-0.90) when compared to energy expenditure measurements obtained in closely controlled laboratory environments.\(^3\) Moreover, the small and unobtrusive size of this device allowed participants to maintain a good adherence rate. Specifically, I only needed to exclude 1.8% of the participants and from the analysis due to incomplete and invalid accelerometer data. Most other studies in the
literature typically report losing about 20% of their sample because of incomplete or invalid accelerometer data.  

The sample was reasonably large and quite heterogeneous as it included both sexes, a wide age range (19-69 years old), and people from an assortment of occupations (from intense to sedentary occupations). Most previous studies examining the validity and reliability of the IPAQ are based on small and homogeneous samples and have not reported age and sex correlation values. The sample size of the present study was calculated based on the main results reported by Craig et al.  

4.3 Limitation of thesis

A key limitation of the proposed thesis is that the population participating in the study was chosen by convenience. Because they were all employed, they were likely healthier and of a higher socioeconomic status than the general population. Therefore, these results may not be generalizable to the Mexican adult population.

A second limitation is related to the test-retest reliability where a higher correlation value was observed between the accelerometer and the retest IPAQ (IPAQ2). In other words, I observed that people had a difficult time accurately identifying physical activity intensities during the interview for IPAQ1; and this appeared to be largely corrected in the interview for IPAQ2.

Another limitation of the study relates to the use of the accelerometers that objectively assess physical activity. Although accelerometers, such as Actical, have been validated in an adult age group, they have some disadvantages while measuring physical activity. Primarily, they do not adequately capture certain types of movement (e.g., pushing or pulling objects, carrying extra weight) and all exercise (e.g., bicycling, water-based activities).
Finally, the prediction equation and cut-points used to categorize physical activity intensities are no standardized for the Actical and other accelerometers devices. In addition, the cut points used within the study were based on Canadian population, which is normally healthier and younger that the general population and somewhat different than the average Mexican. This can make it difficult to compare the findings across studies and can influence the volume of physical activity detected in any study.

4.4 Implications and Contributions of Thesis Research

The findings generated from this work have important implications for physical activity research in Mexico. As previously explained, Mexico is using the short form IPAQ to measure the prevalence of physical inactivity in the population based on the 2012 Mexican National Health and Nutrition survey (ENSANUT). The National Institute of Public Health, the group responsible for conducting this national health survey, is giving special attention to the validity and reliability of the questionnaire items used in the 2012 ENSANUT. The findings from this thesis are being used to inform the physical activity component of the validity and reliability work.

Results from this study demonstrated that a different prevalence of physical inactivity would be obtained depending on whether a single or multiple IPAQs or an accelerometer is used. Since only a single IPAQ was used within ENSANUT (e.g., akin to IPAQ1 in my thesis research), it is likely that the prevalence of adults meeting the physical activity guidelines are over reported based on the 2012 ENSANUT. In addition, the physical activity misclassification generated by the IPAQ could impact the ability of researchers using the ENSANUT data to link physical activity data with any determinants or outcomes of physical inactivity.
Finally, results generated by this thesis will allow Mexican researchers to develop an adjusting equation to account for differences between self-reported physical activity and the true value reported by the accelerometer. This equation will allow researchers to correct the over-reporting of MVPA by the IPAQ. The correction strategy has been applied successfully in other papers.8

4.5 Directions and Future Research

The existing research into the physical activity component in Mexico is mainly limited. The majority of the studies included in this literature review are focuses on several countries but Mexico. Physical activity research within Mexican population still needs work and there are several gaps that need to be addressed.

A special effort has been placed to include the same instrument to measure physical activity trends worldwide. Therefore, future research in Mexico should include the use of the same instrument to obtain physical activity prevalence trends. In addition, researchers should also consider including, within the following national surveys, the use of objective measurements such as accelerometers and pedometers to obtain a better estimation of the physical activity levels in the studying population. Strategy that has been applied in other countries.9, 10

Physical activity research in Mexico should also examine the validity and reliability of a physical activity instrument in the population to be studied. Questionnaires are the most cost effective instruments to measure physical activity levels. Almost all of these instruments have been included into the national surveys. These instruments have been validated against different objective methods including accelerometers and pedometers. However, these instruments generally produce a physical activity misclassification that needs to be understood.
Finally, Mexican research should also cover other physical activity areas that have not been studied. Researchers within Mexico should consider studying the personal and environmental determinants and the consequences (e.g., economic consequences) of the physical activity that are affecting whether or not an individual is physically active or inactive. In addition, the set of studies should be healthful to obtain local and national physical activity guidelines and to create policies to increase physical activity levels within Mexicans.

4.6 Summary of MSc Research Experience

This study allowed the candidate to gain considerable research experience. The candidate performed two extensive literature reviews. The first was based on physical activity questionnaires suitable for large-scale surveys, and that literature review informed the selection of the IPAQ for the 2012 ENSANUT and has been published as a research report at the INSP. The second literature review was focused on the validity and reliability of the short form IPAQ, which is summarized in this thesis. In addition, the candidate developed an instruction/manual (see Appendix D) that was used within the present study and within ENSANUT 2012 that research staff used when administering the IPAQ. Furthermore, the candidate trained interviewers, from both the present study and ENSANUT 2012, on how to apply the IPAQ with a special focus on the differences between moderate and vigorous physical activities. The candidate designed the questionnaires and instruments, conducted primary data collection, and contributed to the design of the present study and the physical activity component of the 2012 ENSANUT. Furthermore, the candidate conducted all of the statistical analysis for this study and the physical activity analyses for the 2012 ENSANUT. Finally, the candidate disseminated her findings through two poster presentations at international scientific meetings, preparation of the physical activity findings for the national
and regional 2012 ENSANUT reports, and preparation of this thesis document and the scientific papers that will be submitted for publication.

4.7 Conclusions

The study of physical inactivity within epidemiological surveys is important. Physical inactivity is a risk factor that is directly associated with several non-communicable diseases. The WHO estimates that 31% of the adult population in the world is physically inactive, and this percentage is rising.

Physical activity questionnaires are the most commonly used instrument within large-scale studies. In this study, the validity and reliability of the IPAQ within Mexican adults was examined. The key findings were that the IPAQ had a modest reliability but a poor validity. Future research in Mexico should consider using objective physical activity measures.

4.8 References


Appendix “A” Short form version of the Spanish IPAQ questionnaire

IPAQ TELEFÓNICO CORTO ÚLTIMOS 7 DÍAS

LEA: Ahora le voy a preguntar acerca del tiempo que Ud. ha estado físicamente activo(a) en los últimos 7 días. Por favor responda cada pregunta a la manera en que Ud. se considera una persona activa. Planea acerca de las actividades que Ud. hace en su trabajo, como parte de sus oficios en su casa, jardín o terreno que tenga alrededor de su vivienda, para ir de un sitio a otro, y en su tiempo libre de desempeño, para ejercicio, deporte o recreación.

LEA: Ahora, piense acerca de todas las actividades físicas que requieren un esfuerzo físico fuerte que Ud. hizo en los últimos 7 días. Actividades físicas vigorosas son las que hacen respirar y latir el corazón mucho más fuerte que lo normal y pueden incluir el levantamiento de objetos pesados, escalar, nadar, subir bicicleta o pasear rápido en bicicleta. No incluya caminar. Planea acerca de las actividades que Ud. hizo por lo menos 10 minutos continuos.

1. Durante los últimos 7 días, ¿Cuántos días hizo Usted actividades físicas vigorosas?
   a. Días por semana: ________________
   b. No sabe, no está seguro(a): ________________
   9. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades físicas que Ud. hace por lo menos 10 minutos continuos]

2. ¿Cuánto tiempo en total usualmente se toma realizar actividades físicas vigorosas en los días que las realizó?
   a. HORAS por día: ________________
   b. MINUTOS por día: ________________
   c. No sabe, no está seguro(a): ________________
   999. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades físicas que Ud. hace por lo menos 10 minutos continuos]

3. Durante los últimos 7 días, ¿cuántos días hizo Usted actividades físicas moderadas?
   a. Días por semana: ________________
   b. No sabe, no está seguro(a): ________________
   9. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades físicas que Ud. hace por lo menos 10 minutos continuos]

4. ¿Cuánto tiempo en total usualmente se dedicó a uno de esos días que hizo actividades físicas moderadas?
   a. HORAS por día: ________________
   b. MINUTOS por día: ________________
   c. No sabe, no está seguro(a): ________________
   999. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades físicas que Ud. hace por lo menos 10 minutos continuos]

5. ¿Durante los últimos 7 días, cuántos días caminó Usted por lo menos 10 minutos seguidos?
   a. Días por semana: ________________
   b. No sabe, no está seguro(a): ________________
   9. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades que Ud. da por lo menos 10 minutos seguidos]

6. ¿Cuánto tiempo en total pasó generalmente caminado en uno de esos días?
   a. HORAS por día: ________________
   b. MINUTOS por día: ________________
   c. No sabe, no está seguro(a): ________________
   999. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades que Ud. da por lo menos 10 minutos seguidos]

7. ¿Cuánto tiempo en total pasó generalmente caminado en la semana?
   a. HORAS por semana: ________________
   b. MINUTOS por semana: ________________
   c. No sabe, no está seguro(a): ________________
   999. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades que Ud. da por lo menos 10 minutos seguidos]

LEA: Ahora piense acerca del tiempo que Ud. pasó sentado(a) en la semana durante los últimos 7 días. Incluye el tiempo en el trabajo, en la casa, estudiando y durante el tiempo de desempeño. Esto puede incluir tiempo que pasó sentado(a) en un escritorio, viendo televisión, bebiendo, sentado(a) o acostado(a) viendo televisión.

8. Durante los últimos 7 días, ¿Cuánto tiempo en total pasó sentado(a) durante un día en la semana?
   a. HORAS por día: ________________
   b. MINUTOS por día: ________________
   c. No sabe, no está seguro(a): ________________
   999. Refusa contestar

[Claroificación por parte del entrevistador: Hable solamente en actividades que Ud. da por lo menos 10 minutos seguidos]

9. Refusa contestar

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Appendix “B” Daily log and illustrated instruction pamphlet

EMERGENCIA CON EL ACCELERÓMETRO

¿Qué hacer en caso de que se mueva el acelerómetro?
Colocarlo en la posición que indica la instrucción.
¿Qué hacer en caso de que accidentalmente se moje el acelerómetro?

NO IMPORTA, únicamente se debe de reportar cuando esté a consumir.
¿Si se me moja el cinturón que sostiene mi acelerómetro, puedo cambiarlo por otro?
No es conveniente, pero recuerde que el acelerómetro tiene que permanecer todo el tiempo con usted, así que si le es muy molesto permanecer con el cinturón mojado puesto, avíseme por otro, sólo por esa ocasión.
¿Si se me rompe el cinturón?
Favor de recortarse inmediatamente al personal de la clínica.
¿Si no me puse el acelerómetro por cualquier razón?
Anótelo en las observaciones de mi carnet y reportarlo al asesor. Especificar las razones que no lo tuve puesto.
¿Si soy una persona que realiza actividad física y sudo mucho, siempre viendo a me mojar mi ropa, por ende el cinturón siempre acaba mojado?
Tratar de usar el acelerómetro en el reporte del short, pantalón corto o ropa.
¿Si se estropea o me interrumpo el acelerómetro?
Reportarse inmediatamente con el personal de la clínica.

Carnet de Asistencia

“Evaluación de actividad física en adultos mexicanos de la Ciudad de México”

Nombre ________________________________

Número de acelerómetro ____________________________

RECUERDE TRAER ESTA TARJETA EN CADA VISITA A LA CLÍNICA

INSTITUTO NACIONAL DE SALUD PÚBLICA

Av. Universidad 361, Colonia Santa María Ahuacatlán, 62560 Toluca, Edo. de México

Tel: (777) 322-017

USO DEL ACCELERÓMETRO

1. El acelerómetro se coloca por DEBAJO de la ropa, de lado.
2. DERECHO de la cadera, encima del NUEVO ropa.
3. DEBAJO del omóplato, como lo muestra la figura
4. El acelerómetro PERMANECERÁ puesto toda la noche.
5. El acelerómetro se retira ÚNICAMENTE cuando se realizan actividades acuáticas como: nadar (mar, ríos), jacuzzi, natación, etc.

PRÓXIMA VISITA LA CLÍNICA:

Fecha ____________________________

HOIB ____________________________ am pm

CALENDARIO DE ACCELERÓMETROS

COLOCACIÓN DEL ACCELERÓMETRO

Fecha ____________________________

RETIRO DEL ACCELERÓMETRO

Fecha ____________________________

HOIB ____________________________ am pm

OBSERVACIONES

DÍA 1. FECHA: ____________________________

DÍA 2. FECHA: ____________________________

DÍA 3. FECHA: ____________________________

DÍA 4. FECHA: ____________________________

DÍA 5. FECHA: ____________________________

DÍA 6. FECHA: ____________________________

DÍA 7. FECHA: ____________________________
Appendix “C” Consent Form

INSTITUTO NACIONAL DE SALUD PÚBLICA

Carta de Consentimiento Informado para Participar en el Estudio de Investigación:

Retractividad de vida y calidad de vida en México: Adultos

Confidencialidad y valores del ConsentimientoIPAQ modificada en individuos mexicanos

G R A N T  D E  C O N S E N S U M I E N T O  P A R A  A D U L T O S (de 18 a 65 años de edad)

Estimado(a)/a señor(a):

Este correo tiene el propósito de informar sobre el estudio a invitado a participar en esta importante investigación. Antes de que tome una decisión, es importante que entienda por qué se está realizando la investigación, lo que se va a investigar, así como los posibles beneficios, riesgos o molestias que podría ocasionarle el participar. Por favor tome el tiempo que requiera para leer detalladamente la siguiente información.

Intrínseca/Objetivos:
El Instituto Nacional de Salud Pública está realizando un proyecto de investigación en el cual se le está invitiada a participar.

El objetivo del estudio es evaluar la utilidad de un cuestionario para medición de actividad física como una medida más exacta para monitorear actividad física diaria y estimar si las personas en un condición siguen las recomendaciones establecidas de actividad física para una vida saludable.

El estudio (Actividad Física) es un instrumento que mida la intensidad de sus actividades durante el día y la noche.

Preparativios:
Si Ud. acepta participar, deberá acudir a la clínica médica de su lugar de trabajo 2 veces en total durante su jornada laboral, por un tiempo mínimo de 30 minutos en cada visita.

En la primera visita recibirá algunos condicionantes para conocer su composición corporal. Para ello medirán su altura con una regla estilizada y su presión arterial con un termómetro. Luego tomarán sus medidas mediante una escala de actividad física. Durante el estudio, se le proporcionarán señales en forma de una actividad física diaria y la realización de actividades diarias. En todos los casos se llevará un registro de actividad física durante el día y la noche. Es importante que los datos sean precisos y que se registren las actividades realizadas correctamente. En caso de no cumplir con estos requisitos, se podrá cancelar su participación en el estudio.

Beneficios:
El estudio está diseñado para proporcionar información valiosa acerca de su salud y bienestar. Participar en el estudio puede ayudar a mejorar su comprensión de su salud y ayudar a identificar posibles problemas de salud. A través del estudio, se proveerá a los participantes con la información necesaria para tomar decisiones informadas sobre su salud y bienestar.

Confidencialidad:
Las informaciones proporcionadas en este estudio se mantendrán confidenciales y no se utilizan para fines comerciales. La información personal proporcionada se utilizará únicamente para fines de investigación y no será divulgada a terceros sin su consentimiento previo.

Riesgos y Compensación:
No existen riesgos físicos o emocionales asociados con participar en el estudio. No existen compensaciones monetarias para los participantes.

Participación Voluntaria/Destino: La participación en este estudio está absolutamente voluntaria. Usted está en plena libertad de decidir si participa o no. Si decide participar, la información será utilizada únicamente para fines de investigación.

Nombre(s) del participante(s):

Nombres/Des/cédula/Telefono/Correo electrónico:

Nombre Completo del Testigo 1:

Fecha de nacimiento/Relación con el participante:

Nombre Completo del Testigo 2:

Fecha de nacimiento/Relación con el participante:

Nombre de la persona que obtiene el consentimiento:

Fecha de nacimiento/Relación con el participante:

Comisión de Ética

Autor: Instituto Nacional de Salud Pública

Fecha: 2023

Versión: Aprobada

Complements: C: 00089

Firma del docente de la sección de ética:

Copias selladas en archivo
Appendix “D” Manual/Instruction for the IPAQ

ACTIVIDAD FÍSICA PARA PERSONAS DE 15 A 69 AÑOS

La sección de actividad física forma parte del cuestionario individual de hogar, y se aplica a personas de 15 a 69 años.

OBJETIVO

El cuestionario de actividad física tiene el propósito de cuantificar los días, las horas y los minutos que dedican las personas entre 15 a 69 años a actividades vigorosas, moderadas, y estar sentado. La mayoría de las preguntas buscan conocer la frecuencia, intensidad y tiempo de la práctica de actividad física, habitual y en los siete días previos a la aplicación del cuestionario.

Este cuestionario está basado en un cuestionario validado que se ha utilizado internacionalmente, por lo que es muy importante aplicarlo tal y como está presentado, para hacer comparables sus resultados con los de otros estudios en donde se ha utilizado.

DEFINICIONES

Actividades físicas aeróbicas, también conocidas como actividades de resistencia, son aquellas actividades en las que los grandes grupos musculares se mueven de una forma rítmica durante un periodo prolongado de tiempo. Estas actividades mejoran la capacidad cardiorespiratoria. Ejemplo: correr, nadar, andar en bicicleta.

Actividades físicas vigorosas, son las que hacen que el individuo se agite y respire con más dificultad de lo normal. En la escala del 1 al 10, las actividades vigorosas se encuentran entre 7 ó 8 del esfuerzo físico personal. Ejemplo: correr a buen paso, andar en bicicleta rápidamente, nadar constantemente, cargar cosas pesadas, cavar, trabajo agrícola como cosechar, etc.

Actividades físicas moderadas, son aquéllas que hacen que se agite un poquito más de lo normal. En la escala del 1 al 10, las actividades moderadas se encuentran entre 5 ó 6 del esfuerzo físico personal. Ejemplo: cargar cosas ligeras, ir a un paseo en bicicleta, bailar, trotar ligeramente, etc.

DESCRIPCIÓN DE LA SECCIÓN

El formato de las preguntas de esta sección es muy similar al de las secciones pasadas. Este cuestionario comprende las preguntas No. 1 a 4. Se hace referencia a las actividades realizadas en los últimos 7 días (vigorosas, moderadas, caminando, sentado). El objetivo final es conocer el tiempo en horas y minutos dedicado a cada forma de actividad por día. Se pregunta en primer lugar ¿cuántos días a la semana se realiza, considerando un tiempo

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mínimo de al menos 10 minutos continuos por día (actividades vigorosas, moderadas y caminando). La última pregunta de los apartados de actividades vigorosas, moderadas, y caminando pregunta las horas y minutos realizados por SEMANA (Esta última pregunta solo se realizará cuando la persona entrevistada no puede contestar las preguntas “a” de estos apartados, porque la cantidad de tiempo varía de día a día)

Para toda esta sección las opciones de respuesta “No realiza esa actividad” corresponden al código 00, “No responde” al código 88, “No sabe” al código 99.

Esta sección está conformada por:

I. Recuadros

   El primer recuadro contiene las preguntas de la entrevista.
   El segundo recuadro incluye las categorías de respuesta con sus códigos respectivos.
   El tercer recuadro incluye los espacios para codificación y los pases entre preguntas.

II. Indicaciones introductorias

   El entrevistador deberá leer (tal cual está escrito en el cuestionario) el párrafo introductorio para cada actividad, ejemplo:

   Actividad Física Moderada
   Ahora piense en todas las actividades que requieran de un esfuerzo físico moderado que pudo haber realizado durante los últimos 7 días. Las actividades moderadas hacen que usted se agite un poquito más de lo normal y estas actividades pueden ser: bailar, cargar cosas ligeras de un lugar a otro, ir en bicicleta a un paseo regular, tocar la batería, realizar diversas labores caseras al mismo tiempo, alimentar animales, jugar voleibol, un trote ligero, etc. No incluya caminar. Piense solamente en esas actividades que usted hizo por lo menos 10 minutos continuos.

III. Indicaciones por pregunta

Actividades Vigorosas

2. El adulto indicará, durante los últimos 7 días, ¿Cuántos días realizó alguna actividad que requiera de un esfuerzo vigoroso? Se considerará que realizó esta actividad si la hizo por lo menos 10 minutos continuos durante ese día. La respuesta se expresa en días por semana (rango del 00 al 07). Si la persona no realiza alguna actividad vigorosa, no responde o no sabe, pasa a la pregunta 3 (es decir, ya no se pregunta más sobre actividad física vigorosa).

Nota: Antes de registrar el número de días, se recomienda preguntar qué actividades vigorosas se realizaron ya que muchas veces, el entrevistado hace referencia a actividades que en este cuestionario NO se clasifican como actividades vigorosas y por lo tanto no serán tomadas en cuenta en esta pregunta.

2a. La persona indicará, Generalmente ¿Cuánto tiempo en total le tomó realizar actividades físicas vigorosas en los días que las realizó? (los marcados en la pregunta previa 2). La idea de esta pregunta es que la persona pueda dar un tiempo promedio, del
o los mismos días que reportó y que dedicó a actividades físicas vigorosas por lo menos 10 minutos. La respuesta se expresa en horas y minutos por DÍA (rango de 00:00 a 16:00 horas/minutos). Si la persona conoce el tiempo promedio en horas o minutos, pasar a la pregunta 3.

Nota: Se recomienda desglosar el tiempo referido a aquellas actividades como natación, correr, gimnasio, de forma tal, que únicamente se anote el tiempo REAL dedicado a AF VIGOROSA (ejemplo: Juan Robles dijo que corrió 1 hr, sin embargo, al preguntarle más detalladamente se encontró que inició caminando 5 minutos, trotando 10 minutos, siguió corriendo 30 minutos y terminó caminando otros 15 minutos; por lo tanto únicamente se toman en cuenta 30 minutos de AF VIGOROSA y el tiempo restante se anota en la clasificación que corresponda).

2b. Esta pregunta se realizará si la persona entrevistada no conoce el tiempo promedio en horas y minutos (pregunta 2a), por que la cantidad de tiempo varía de día a día. La persona indicará el tiempo total que realizó actividades físicas vigorosas en los últimos 7 días. La respuesta a esta pregunta debe ser la suma de las horas y minutos en que realizó actividades vigorosas en los últimos 7 días (una SEMANA), por lo menos 10 minutos por actividad (rango de 00:00 a 112:00 horas/minutos). (ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador” para mayor aclaración).

Actividades Moderadas

3. El adulto indicará, durante los últimos 7 días, ¿Cuántos días realizó alguna actividad que requiera de un esfuerzo moderado? Se considerará que realizó esta actividad si la hizo por lo menos 10 minutos continuos durante ese día. La respuesta se expresa en días por semana (rango del 00 al 07). En esta pregunta NO se incluye CAMINAR. Si la persona no realiza alguna actividad moderada, no responde o no sabe, pasa a la pregunta 4 (es decir, ya no se pregunta más sobre actividad física moderada).

Nota: Antes de registrar el número de días, se recomienda preguntar qué actividades moderadas se realizaron ya que muchas veces, el entrevistado hace referencia a actividades que en este cuestionario NO se clasifican como actividades moderadas y por lo tanto no serán tomadas en cuenta en ésta pregunta.

3a. La persona indicará, Generalmente ¿Cuánto tiempo en total le tomó realizar actividades físicas moderadas en los días que las realizó? (los marcados en la pregunta previa 3). La idea de esta pregunta es que la persona pueda dar un tiempo promedio, del o los mismos días que reportó y que dedicó a actividades físicas moderadas por lo menos 10 minutos. La respuesta se expresa en horas y minutos por DÍA (rango de 00:00 a 16:00 horas/minutos). Si la persona conoce el tiempo promedio en horas o minutos, pasar a la pregunta 4.

Nota: Anotar actividades complementarias a actividades de otras secciones que hagan referencia a AF MODERADA por periodos mayores a 10 minutos. Retomando el ejemplo de Juan Robles, 10 minutos de trote se considera una actividad física moderada.
3b. Esta pregunta se realizara si la persona entrevistada no conoce el tiempo promedio en horas o minutos (pregunta 3a). La persona indicará el tiempo total que realizó actividades físicas moderadas en los últimos 7 días. La respuesta a esta pregunta debe ser la suma de las horas y minutos en que realizó actividades moderadas en los últimos 7 días (una SEMANA), por lo menos 10 minutos por actividad (rango de 00:00 a 112:00 horas/minutos). (ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador” para mayor aclaración).

**Caminando**

4. El adulto indicará, durante los últimos 7 días, ¿Cuántos días caminó? Se considerará que realizó ésta actividad si la hizo por lo menos 10 minutos continuos durante ese día. La respuesta se expresa en días por semana (rango del 00 al 07). Si la persona no caminó, no responde o no sabe, pasa a la pregunta 5 (es decir, ya no se pregunta más sobre caminar).

Nota: A los encuestados que den respuestas como: “siempre”, “diario” o “todos”, hacer énfasis que se pregunta por NUMERO de días. Recordar que se pregunta por los 7 días de la semana.

4a. La persona indicará, Generalmente ¿Cuánto tiempo en total caminó? (los marcados en la pregunta previa 4). La idea de ésta pregunta es que la persona pueda dar un tiempo promedio, del día que reportó y que dedicó a caminar por lo menos 10 minutos. La respuesta se expresa en horas y minutos por DÍA (rango de 00:00 a 16:00 horas/minutos). Si la persona conoce el tiempo promedio en horas o minutos, pasar a la pregunta 5.

Nota: Hacer énfasis en que se pregunta por “tiempos de caminata ≥10 minutos”, en caso de que una persona tenga varias caminatas al día, se irán sumando únicamente los periodos cuya duración haya sido ≥10 minutos.

4b. Esta pregunta se realizará si la persona entrevistada no conoce el tiempo promedio en horas o minutos (pregunta 4a). La persona indicará el tiempo total que caminó en los últimos 7 días. La respuesta a esta pregunta debe ser la suma de las horas y minutos en que caminó en los últimos 7 días (una SEMANA), por lo menos 10 minutos por actividad (rango de 00:00 a 112:00 horas/minutos). (ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador” para mayor aclaración).

**Sentado(a)**

5. La persona indicará, ¿Cuántas horas y minutos estuvo sentado en promedio durante un día? Debe incluirse el tiempo que pasó sentado(a) en el trabajo, en la casa, estudiando o durante el tiempo de descanso. Puede ser sentado(a) en un escritorio, visitando amistades, leyendo, sentado(a) o acostado(a) viendo el televisor. La respuesta se expresa en horas y minutos por DÍA (rango de 00:00 a 16:00 horas/minutos). Si la persona conoce el tiempo promedio en horas o minutos, pasar a la pregunta 6.
Nota: En ésta pregunta también se incluye el tiempo sentado en trayectos de transporte en caso de: a) que la persona se haya trasladado en vehículo propio, b) que la persona se haya trasladado en taxi o combi, c) que la persona se haya trasladado en transporte público y SIEMPRE o durante TODO su recorrido le haya tocado sentado (ejemplo: cuando la persona toma el pesero, micro, etc., en una base). Tomar en cuenta únicamente tiempo DENTRO del vehículo de motor en que estuvo SENTADO.

5a. Esta pregunta se realizará si la persona entrevistada no conoce el tiempo promedio en horas o minutos (pregunta 5). La persona indicará el tiempo total que estuvo sentada el miércoles pasado. La respuesta se expresa en horas y minutos por DÍA (miércoles) (rango de 00:00 a 16:00 horas/minutos). (ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador” para mayor aclaración).

IV. Instrucciones para el entrevistador

a) Para actividades vigorosas, moderadas, caminando, y sentado(a)

En UNO de esos días

Se está buscando obtener el tiempo que la persona realiza actividad física vigorosa, moderada, caminando, y sentado(a) en UNO de los 7 días de la semana. Por lo que el entrevistador deberá enfatizar esta premisa en el momento de encuestar. Para recordar éste énfasis, UNO de esos días de la semana estará subrayado de la siguiente manera:

¿Cuál es la cantidad total de TIEMPO que usted pasó en tren, autobús, automóvil, tranvía, metro o colectivo en UNO de esos días de la semana?

b) Para actividades vigorosas, moderadas y caminado

Últimos 7 días y por lo menos 10 minutos continuos

Se está buscando obtener respuestas de actividad física realizada los últimos 7 días, por lo menos 10 minutos contínuos. Por lo que el entrevistador deberá enfatizar estas dos premisas en el momento de encuestar. Para recordar éste énfasis, tanto últimos 7 días como por lo menos 10 minutos continuos estarán subrayados en el cuestionario, ejemplo:

Ahora piense en el tiempo que ha caminado durante los últimos 7 días. Esto incluye caminar en el trabajo, en la casa, trasladándose de un lugar a otro y/o cualquier otra caminata que usted haya hecho meramente por recreación, deporte, ejercicio o placer. Piense solamente en esas actividades que usted hizo por lo menos 10 minutos continuos.

Recuadros aclaratorios para el entrevistador
El entrevistador encontrará un recuadro aclaratorio con la siguiente leyenda:

*Nota para el entrevistador*: Si la persona entrevistada no puede contestar porque la cantidad de tiempo varía día a día, o incluye tiempo dedicado en diferentes trabajos, pregunte:

El encuestador pasará a la opción b si:
1) El tiempo de la actividad varía día con día.
2) La persona hace más de una actividad por día, de la misma o diferente intensidad.
3) Combinación del punto 1 y 2.

 Esto se puede explicar detalladamente con los siguientes ejemplos:

1. Si la persona en UNO de los últimos 7 días de la semana, realiza por lo menos 10 minutos de UNA actividad, pero los tiempos varían día a día. Se pregunta la opción b. Ejemplo:

   Imaginemos que Patricia machaca grano en metate diariamente. Los lunes 2 horas, martes 1 hora, miércoles 1 hora, jueves 3 horas, viernes 1 hora, sábado y domingo no lo hace.

   Si hiciéramos la pregunta: Generalmente ¿Cuánto tiempo en total le tomó realizar actividad(es) física(s) moderada(s) en UNO de esos días? Patricia no podría contestar acertadamente porque el tiempo que dedica día a día es muy diferente. Por lo que se deberá preguntar de forma en que incluya el tiempo por semana de la siguiente manera: ¿Cuánto tiempo dedicó usted en los últimos 7 días a hacer actividad(es) física(s) moderada(s)? En este caso y por tratarse de actividad moderada, se sumará; lunes 2 hora + martes 1 hora + miércoles 1 hora + jueves 3 horas + viernes 1 hora = total 8 horas por semana.

2. Si la persona en UNO de los 7 días de la semana, realiza por lo menos 10 minutos de MAS de UNA actividad de la misma o de diferente intensidad y tiempos diferentes de UNA o MAS de UNA actividad. Se pregunta la opción b. Ejemplo:

   Imaginemos que Raúl realiza las siguientes actividades en una semana generalmente. Los lunes hace natación por 2 horas, martes carrera por 3 horas, miércoles bicicleta por 2 horas, jueves bicicleta y natación por 2 horas, viernes bicicleta y carrera por 4 horas, sábados descansa y domingos carrera y natación por 4 horas. Como notamos, la cantidad de tiempo, horas y actividad física varía día con día.

   Si hiciéramos la pregunta: Generalmente ¿Cuánto tiempo en total le tomó realizar actividad(es) física(s) vigorosa(s) en UNO de esos días? Raúl no podría responder acertadamente debido a que el tiempo que dedica día con día, así como las actividades son muy variadas. Por lo que para esta pregunta se deberá preguntar de forma en que incluya el tiempo por semana de la siguiente manera: ¿Cuánto tiempo dedicó usted en los últimos 7 días a hacer actividad(es) física(s) vigorosa(s)? En este caso y por tratarse de actividades vigorosas, se haría la suma de dichas actividades; lunes 2 horas + martes 3 horas + miércoles 2 horas + jueves 2 horas + viernes 4 horas + domingos 4 horas = total 17 horas por semana.
* Nota: El ejemplo 1 podría aplicar para caminar y sentado(a).

c) Para actividades moderadas

Debido a que las actividades moderadas incluye caminar, muchos de nosotros solemos incluir caminar en el apartado de actividades moderadas, sin embargo, debido a que este cuestionario tiene un apartado especial para CAMINANDO, nosotros NO incluiremos CAMINAR como ACTIVIDAD MODERADA. Por lo que el entrevistador deberá enfatizar estas premisas en el momento de encuestar. Para recordar éste énfasis, No incluya caminar estará subrayada en el cuestionario de la siguiente manera:

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Actividad Física Moderada
Ahora piense en todas las actividades que requieran de un esfuerzo físico moderado que pudo haber realizado durante los últimos 7 días. Las actividades moderadas hacen que usted se agite un poquito más de lo normal y estas actividades pueden ser: bailar, cargar cosas ligeras de un lugar a otro, ir en bicicleta a un paso regular, tocar la batería, realizar diversas labores caseras al mismo tiempo, alimentar animales, jugar voleibol, un trote liger, etc. No incluya caminar. Piense solamente en esas actividades que usted hizo por lo menos 10 minutos continuos.
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* Nota: Existen actividades moderadas que incluyen caminar, pero con la diferencia de que es caminar haciendo otra cosa, generalmente cargando objetos o empujándolos. Éstas sí se incluirán en este apartado.

V. Pases importantes

a) Actividades vigorosas

1. Si en la pregunta 2 la persona responde “No realiza alguna actividad vigorosa (00)”, "No responde (88)”, ”No sabe (99)” PASA a la pregunta 3. En esta misma pregunta (2) si la persona responde “imposibilidad para moverse o caminar (55)” se dará por terminado todo el cuestionario de actividad física.

2. En la pregunta 2a, si la persona sabe “cuánto tiempo en total le tomo realizar actividad(es) física(s) vigorosa(s) en UNO de esos días” PASA a la pregunta 3.

3. Si la persona no sabe o no responde o si la cantidad de tiempo varía día a día, o incluye tiempo dedicado en diferentes trabajos, continuar a la pregunta 2b. (Ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador”)

b) Actividades moderadas

1. En la pregunta 3, si la persona no pudo contestar, no sabe o no realiza actividad física moderada PASA a la pregunta 4.

2. En la pregunta 3a, si la persona sabe “cuánto tiempo en total le tomo realizar actividad(es) física(s) moderada(s) en UNO de esos días” PASA a la pregunta 4.
3. Si la persona no sabe o no responde o si la cantidad de tiempo varía día a día, o incluye tiempo dedicado en diferentes trabajo continuar a la pregunta 3b. (Ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador”)

c) Caminando

1. En la pregunta 4, si la persona no pudo contestar, no sabe o no caminó, PASA a la pregunta 5.

2. En la pregunta 4a, si la persona sabe “cuánto tiempo en total le tomo caminar en UNO de esos días” PASA a la pregunta 5.

3. Si la persona no sabe o no responde o si la cantidad de tiempo varía día a día, o incluye tiempo dedicado en diferentes trabajo continuar a la pregunta 4b. (Ver Descripción de la sección, apartado III, inciso b, “Recuadros aclaratorios para el entrevistador”)
Appendix E “Accelerometers cleaning process”

Actical data collection using Personal Activity and Location Measurement System (PALMS) system

Overview:
1. Contact PALMS system personnel
2. Get a user name and a password
3. Register your project
4. Export CSV files
5. Select PALMS cleaning protocol
6. Analyze Actical files

1. Getting started: Contact PALMS system personnel to get a user name and a password by consulting their main web page, available at: https://ucsd-palms-project.wikispaces.com/

Once you get a user name and a password, access to the follow web page: https://palms.ucsd.edu:8443/PALMS/ to get started (diagram 1).

Diagram 1: PALMS web page to get access.

Register the name and characteristics of your project, indicating the starting and ending date and some other details including study group and time zone.

Diagram 2: Study characteristics registration
Once the study is registered, the program will ask you to select the devices that will be used. In this case, the Actical accelerometer was selected. In addition, the option GPS device will be selected; even though the study is not using this function. The program will also ask you for the calculation you will be using. For Actical analysis, PALMS system recommends to use GPS, Activity, HR – Process and Merge (R3) and Daily Summary V2.0.1 (beta).

**Diagram 3:** Devices and calculation specifications.

The following step will be to upload participants file. PALMS system asks you to upload each file in either CSV or crude Actical file. On the top of the web page, “participants button” should be selected, and then every file must be uploaded individually or by group. PALMS program will ask you to select the file status as “inactive, active, completed, or test”. When the file is completely uploaded, active option should be chosen.
Diagram 4: Participants uploading

Diagram 5: Dataset overview

When participants data is uploaded, dataset will present every file specifying number of participant, device, data imported, starting date, ending date, number or samples, status, and actions.

Calculations that are already selected will be available in the “calculation option”. “GPS, Activity, HR – Process and Merge (R3) option” will be the first option to be selected. This option will allow to indicate devices data cleaning and cut-points.
Diagram 6: Calculations selection

“GPS, Activity, HR – Process and Merge (R3) option” will allow to select devices cut points. In this case, accelerometer option will be the only one that must be filled. Other options such as GPS, heart rate, EE estimate, merge options must remain empty.

Diagram 7: Devices cut point selection

Accelerometer option will allow to select accelerometer cut points to be used in the analysis. It will include accelerometer calculations, not wearing time, bouts detection, sedentary bout detection, and activity classification cutoff values. Cut point selection will depend on the study purposes.
Once the accelerometer cut point is selected. Start calculation button must be selected. The program will spend 20 to 40 minutes calculating the dataset. When the dataset calculation is ready, results can be viewed on the “Results option”

Diagram 9: Dataset calculation viewing
The next part of the analysis consists on selecting “Daily Summary V2.0.1 (beta) calculation” available within the “Calculation option”. This option will allow to merge dataset calculations already obtained in the step explained before “GPS, Activity, HR – Process and Merge (R3)”.

**Diagram 10**: Daily Summary V2.0.1 (beta) calculation

Once the analysis is complete, it will be available for download within “Results option”, and be ready for another analysis.