

# Validation of the 24-hour physical activity recall in elderly adults

## Validação do recordatório de 24 horas para avaliação da atividade física em idosos

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**Abstract** – The objective of this study was to verify the validity of the 24-hour physical activity recall (R24AF) and to evaluate the number of days required to estimate weekly physical activity using the R24AF in elderly adults. A methodological validation study with a cross-sectional design was carried out. Thirty elderly adults used accelerometers (reference standard) and answered the R24AF by telephone for seven consecutive days. Data were analyzed using the following tests: Pearson's correlation to compare minutes of physical activity between methods; the McNemar test to verify agreement between methods regarding health-oriented physical activity recommendations ( $\geq 150$  min/week); graphical analysis using the Bland-Altman method; the t-test for dependent samples to detect differences in minutes of physical activity between methods; and the Kappa test to determine the number of days of R24AF use required to estimate weekly physical activity, with the seven days assessed by accelerometers serving as a reference. The correlation coefficient ranged from  $r=0.38$  ( $p=0.002$ ) to  $r=0.60$  ( $p<0.001$ ) when comparing minutes of physical activity between methods, according to intensity. At least four days of R24AF use were necessary to obtain an adequate estimate of weekly physical activity (Kappa=0.51,  $p=0.005$ ), and the estimated prevalence of active elderly was similar with four days' use of the R24AF and seven days' use of accelerometer. The R24AF proved valid for the evaluation of low and moderate physical activity in the elderly and requires at least four days of use (three week days plus one weekend day) to determine the pattern of weekly physical activity in the elderly.

**Key words:** Elderly; Motor activity; Validation studies.

**Resumo** – O objetivo do estudo foi verificar a validade do recordatório de 24 horas de atividade física (R24AF) e avaliar a quantidade de dias necessários para estimar a atividade física semanal por meio do R24AF em idosos. Participaram do estudo trinta idosos, os quais utilizaram acelerômetros e responderam os R24AF por telefone durante sete dias consecutivos. Para as análises de dados, utilizaram-se: correlação de Pearson (minutos de atividades físicas entre os métodos); teste de McNemar, para verificar a concordância entre os métodos para a recomendação de atividade física para a saúde ( $\geq 150$  min/sem); análise gráfica de Bland-Altman; teste t para amostras dependentes; e teste Kappa, para verificar a quantidade de dias necessários de aplicação do R24AF para a estimativa da atividade física semanal, tendo como referência os sete dias avaliados pelos acelerômetros. Obteve-se coeficiente de correlação de  $r=0,38$  ( $p=0,002$ ) a  $r=0,60$  ( $p<0,001$ ) na comparação dos minutos de atividades físicas entre os métodos de acordo com a intensidade. São necessários, pelo menos, quatro dias de aplicação para se obter uma estimativa adequada da atividade física semanal (Kappa=0,51;  $p=0,005$ ). E as estimativas de prevalência de idosos ativos foram similares quando se utilizou os quatro dias do R24AF na comparação com os sete dias do acelerômetro. Pode-se concluir que o R24AF foi válido para a avaliação da atividade física leve e moderada em idosos e são necessários, pelo menos, quatro dias de avaliação (três dias durante a semana e um dia no final de semana) para obter um padrão da atividade física semanal de idosos.

**Palavras-chave:** Atividade motora; Estudos de validação; Idoso.

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## INTRODUCTION

The literature has shown the positive effects, among elderly adults, of adopting an active lifestyle or engaging in physical activity programs and physical exercise to prevent and reduce the deleterious effects of aging<sup>1</sup>. The evidence of health benefits resulting from the practice of physical activity has been drawn mainly from analyses of moderate- and vigorous-intensity activities<sup>1</sup>. However, the attention of researchers has increasingly focused on the assessment of light-intensity activities, particularly given the role of this type of practice in people's daily lives, as well as the inactive profile and sedentary patterns of the population<sup>2,3</sup>. Recent studies involving elderly adults have shown that light-intensity physical activity can also promote health benefits<sup>4,5</sup>.

Several instruments that assess physical activity have been validated for use in the elderly population, e.g., the International Physical Activity Questionnaire (IPAQ) and the Baecke questionnaire<sup>6</sup>. These instruments tend to use a general estimate of moderate- or vigorous-intensity activities, assessed in different domains of leisure, transportation, occupational, or household activities<sup>7</sup>. Conversely, effective methods for assessing routine daily activities, particularly light-intensity activities, remain scarce. This scenario has prompted researchers worldwide to validate recall and diary-based methods of measuring physical activity in an effort to improve the quality of this type of assessment<sup>8-13</sup>. One important method is the 24-hour recall, which has been used to assess physical activity in North American adults since year 2000<sup>8,9</sup>. The instrument was based on the Seven day (7-d) Physical Activity Recall, first devised in the early 1980s in the United States<sup>14</sup>. Notwithstanding, there is a dearth of recall validation studies involving exclusively elderly populations, especially in developing countries.

Recently, a 24-hour physical activity recall (R24AF) was tested in Brazil, yielding satisfactory evidence of validity for use with adults<sup>15</sup>. Another type of recall was used in an epidemiological study with a representative sample of adults from the city of Niteroi<sup>16</sup>. Nevertheless, to the authors' knowledge, no previous similar studies have been conducted with elderly populations. Therefore, the objective of this study was to verify the validity of the R24AF and to determine the number of days required to estimate weekly physical activity using the R24AF in elderly adults.

## METHODS

A methodological validation study with a cross-sectional design was conducted. The elderly participants were randomly selected in multiples of three from the total registry of elderly (n=385) participants in the survey "Physical activity and its relationship with individual and environmental indicators in adults and elderly living in the district of Ermelino Matarazzo in the East zone of São Paulo City," which selected a representative sample of elderly living in the district in 2007<sup>17</sup>. Data collection for the study took place between June and August 2009.

Sample size was calculated based on the study by Kolbe-Alexander et al.<sup>18</sup>. In their study, the highest values of correlation ( $r=0.54$ ) were obtained by comparing physical activity measured by accelerometer for one week with physical activity estimated by questionnaire applied to South-African men. Assuming a correlation coefficient of 0.5,  $\alpha$  of 5%,  $\beta$  of 20% and 20% rate of losses and refusals, the ideal sample size was calculated at 30 elderly.

Exclusion criteria were: elderly presenting diseases or problems associated with changes in habitual physical activity, and mental problems preventing completion of the R24AF instrument without assistance.

Data collection was carried out by two students holding scientific initiation scholarships from the Bachelors course in Physical Activity Sciences of the University of São Paulo. Training was given (part theoretical, part practical) on the application of the instruments lasting five days (four hours per day) and overseen by the two lead researchers.

### Direct measurement of physical activity

The Actigraph model GT1M accelerometer is a validated instrument<sup>19</sup> and was employed in this study to take direct measurements of physical activity. The Actigraph is a biaxial activity monitor which measures acceleration in both vertical and horizontal directions. The device incorporates a microprocessor which digitizes and filters the acceleration signal, converts it into a numeric value (counts) and accrues this value as motion counts over a given time interval (epoch) set by the researcher. All the results are stored on the device and automatically transferred to software which computes the number of motions/activities per minute. The results from the accelerometers pool information on all the activities performed.

The elderly participants of the present study wore accelerometers for seven consecutive days, commencing use every morning upon waking and wearing the devices until the end of the day, removing them only for sleep and bathing. Participants received a telephone call every morning reminding them to use the accelerometers. After retrieval of the devices, the data from them were transferred to a computer using ActiLife version 1.0.53 software, which downloaded the data converting them into *.dat* and *.csv* format files. Following transfer, the resultant files were converted to *.xls* using the software application Windows Office Excel version 2007 to improve data visualization and trimming. To trim the data, spells of 30 consecutive minutes of activity lower than 25 counts were disregarded, since during these spells the individual was either performing sedentary activities or not using the device. In order for a day to be considered valid, at least 8 hours of activities of over 25 counts had to be performed. The present study used the following reference cut-off points: 1) for sedentary activities:  $<25$  counts; 2) for light-intensity activities:  $\geq 25$  and  $<1.041$  counts; and 3) for moderate- or vigorous-intensity activities:  $\geq 1.041$  counts. For moderate- or vigorous-intensity activities, the cut-off point proposed by Copeland et al.<sup>20</sup>, was adopted. However, to distinguish between light-intensity activities and sedentary behavior, the cut-off of 25 count was

adopted to better record routine daily activities and also due to a lack of consensus on this cut-off point<sup>8,20</sup>.

All elderly were given verbal instructions and a folder explaining how to use the accelerometers properly.

### Physical activity assessment by R24AF

The R24AF is innovative in the field of physical activity assessment and was devised with the aim of providing a detailed assessment of all the daily physical activities performed. The method is based on logging all the activities performed in the 24 hours prior to the interview, including sleep time, activities of personal hygiene, feeding, and transportation, occupational, household and leisure time activities as well as the practice of physical exercise and sports. For further details on the first validation with adults see the study by Ribeiro et al.<sup>15</sup>.

After the interview using the R24AF, all activities performed and their respective durations were keyed into a specific software application developed in 2005<sup>15</sup> which performs the calculation of the activities according to their classification based on the MET values from the compendium of physical activities of Ainsworth et al.<sup>21-23</sup>. All the physical activities in the compendium were input into the software, which can register up to seven separate recalls (seven days) for the same person<sup>15</sup>. The software is configured to consider sedentary activities as those with values of 0.9 to 1.5 MET, light-intensity physical activities as 1.6 to 2.9 MET, moderate as 3.0 to 5.9 MET and vigorous as values greater than or equal to 6.0 MET. The software then computes the values in minutes of light, moderate- and vigorous-intensity activities.

The elderly subjects in the present study were interviewed by telephone on a daily basis for seven consecutive days and interview times were set according to the first use of the accelerometers, commencing from the second day of use (after having used the accelerometer for 24 hours).

### Data analysis

For the collection of physical activity data, the instruments used different units of measurement (Accelerometer: counts; R24AF: MET values), although both were ultimately converted into minutes of physical activity according to intensity, allowing analysis and classification between the instruments.

All data were double keyed into an EpiData version 3.1 file and databases subsequently compared using the Validate module for detecting errors. Descriptive statistics were produced for the data, expressed in absolute and relative frequency (with their respective 95% confidence intervals – 95%CI) as mean and standard deviation (SD). The Kolmogorov-Smirnov test was used to test for normal distribution with the variables of minutes of light- and moderate-intensity physical activities obtained by the R24AF and by accelerometer. The percentage of elderly that met the weekly recommendations on the practice of physical activity according to the World

Health Organization guidelines was calculated<sup>24</sup>. For an individual to be considered to have met the recommendations, the weekly cut-off point of at least 150 minutes of moderate physical activity was used.

The average minutes spent on light, moderate and total (light + moderate intensities) physical activity were calculated for the seven days of assessment for both the R24AF and accelerometer, respectively, and the means of the two instruments were subsequently compared using Student's *t*-test for dependent samples. Pearson's correlation coefficient between the two measuring instruments was calculated for the following variables: a) minutes of moderate-intensity physical activity; b) minutes of light-intensity physical activity; c) minutes of total physical activity (light and moderate intensities). The coefficient was calculated for all seven days, for week days only, and for weekends only. The rate of Kappa concordance was calculated in order to determine the number of days of R24AF collection required to identify the practice of 150 minutes of moderate physical activity per week, with the seven days of accelerator data serving as a reference. Tests were performed with all possible combinations of days in order to obtain the best combination of week days for two, three, four, five and six-day assessments and the optimal combination was defined as that with the highest Kappa. The absolute concordance between the methods was analyzed using Bland-Altman<sup>25</sup> graphical analysis of the variable "minutes of moderate physical activity" for the best combination of four, five and six days. McNemar's test was applied in order to identify differences in estimated percentage of elderly that met the recommendations for the two methods. All statistical analyses were performed using the statistical package SPSS version 15.0 (SPSS Inc., USA) and a *p*-value of less than 0.05 was considered significant.

## Ethical aspects

The present study was approved by the Research Ethics Committee of the School of Physical Education and Sport of the University of São Paulo and by the Research Ethics Committee of the School of Public Health of the University of São Paulo. All study participants signed a free and informed consent form.

## RESULTS

A total of 31 elderly were interviewed, of which 30 completed all the assessments of the R24AF and the accelerometers. Participants were predominantly female (66.7%), had a mean age of 71.0 years (SD=5.8 years), were in the 70 to 79 years age bracket (53.3%), had concluded four to seven years of schooling (50.0%) and were widows (43.3%).

It should be stressed that none of the elderly performed vigorous physical activity, and the analyses therefore involved only light- and moderate-intensity physical activities.

The results of Pearson's correlation coefficients for the comparison between the assessment methods are given in Table 1. Acceptable correlation

values ( $r \geq 0.30$ ) were found between minutes spent on moderate-intensity physical activity over the seven days and on weekends, for minutes performing light-intensity physical activity, and total physical activity (light and moderate intensities).

Moderate-intensity activities recorded by the recalls was, on average, higher than by accelerometer, whereas the mean light-intensity physical activities recorded by the accelerometer was higher compared to recalls (Table 2).

**Table 1.** Pearson's correlation coefficient between minutes of physical activity estimated by R24AF and as measured by accelerometer for all seven days, five week days, and weekend days.

Intensity	All days		Week days		Weekend	
	r	p	r	p	r	P
Moderate	0.38	0.039	0.26	0.166	0.56	0.001
Light	0.54	0.002	0.55	0.002	0.43	0.018
Light + Moderate	0.60	<0.001	0.62	<0.001	0.53	0.003

**Table 2.** Mean and standard deviations of minutes of light- and moderate-intensity physical activity for all seven days assessed, by assessment method.

Variables	mean	SD	p*
Moderate-intensity physical activity (min/wk)			
Accelerometer**	235.0	180.3	0.014
R24AF**	473.6	541.4	
Mean difference	33.7	72.0	
Light-intensity physical activity (min/wk)			
Accelerometer**	2010.5	723.3	<0.001
R24AF**	1435.8	694.3	
Mean difference	82.1	97.6	
Light and moderate-intensity physical activity (min/wk)			
Accelerometer**	2245.5	797.2	0.030
R24AF**	1909.4	979.2	
Mean difference	47.7	115.4	

R24AF: 24-hour physical activity recall; \*p-value of Student's t-test for dependent samples; \*\*Seven days of use.

Regarding concordance of classification of physical activity level according to the World Health Organization standard, Table 3 depicts the results of the Kappa statistic between the instruments for the combinations of two, three, four, five and six days of assessment. The results show that, from four days of assessment forth, the best combination of days had moderate and significant concordance (Kappa= 0.51).

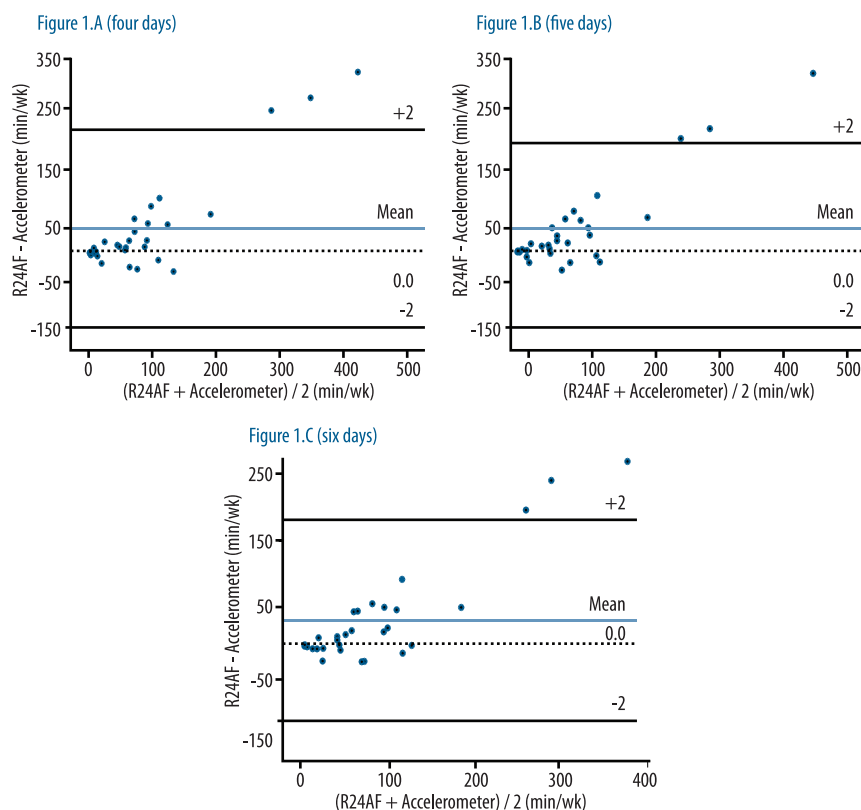
Figure 1 depicts Bland-Altman analysis plots showing results of differences in means and extreme limits of concordance with two standard deviations on comparison between data from accelerometer and best combinations of four to six days obtained with the R24AF, for moderate-intensity physical activities. The standard deviations were high and consequently concordance limits were large. However, an acceptable level of concordance was observed, since the majority of the data remained within acceptable

limits. The variables studied showed no apparent heteroscedasticity, given the differences between the instruments are not widely spread around the straight line. However, a tendency for overestimation (more data above zero) with the R24AF is evident compared to accelerometers. As the mean between the methods in minutes of moderate-intensity activity increases, there is a greater spread of data, indicating lower precision for higher values.

**Table 3.** Kappa concordance statistic to estimate weekly pattern of physical activity of elderly subjects according to number of days of R24AF use versus seven days of accelerometer use.

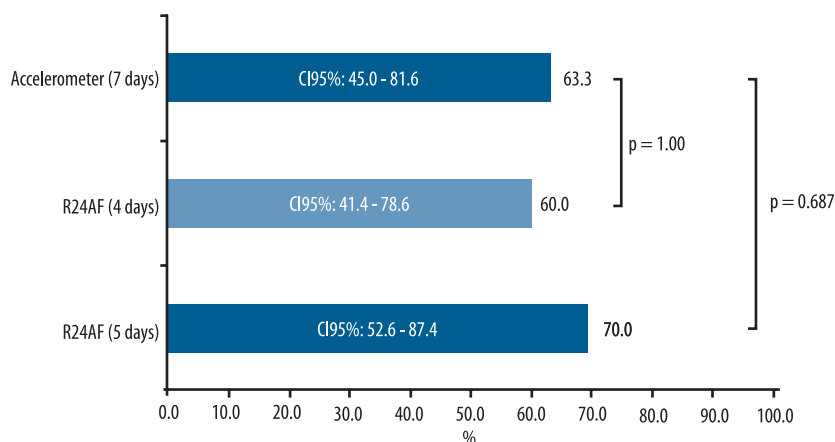
Number of days	Kappa*	p	Best combination of week days
Two	0.28	0.057	Wed + Sat
Three	0.36	0.034	Tue + Wed + Sat
Four	0.51	0.005	Tue + Thu + Fri + Sat
Five	0.55	0.002	Tue + Thu + Fri + Sat + Sun
Six	0.47	0.009	Tue + Wed + Thu + Fri + Sat + Sun
Seven	0.47	0.009	All days

\*Values of best combinations of days.



**Figure 1.** Bland-Altman plot for concordance between the instruments (accelerometer and R24AF) of best combination for four (A), five (B) and six (C) days of assessment of moderate-intensity activities.

With regard to classification of the level of physical activity according to World Health Organization standards, 60.0% of the elderly attained the recommendations by the R24AF when applied for four days while 63.3% attained the recommendations by accelerometer (Figure 2). It is noteworthy that none of the elderly reported practicing vigorous activities.



**Figure 2.** Percentage elderly practicing at least 150 minutes of moderate-intensity physical activity per week for seven days of accelerometer use compared with four and five best days of R24AF use. P= value of McNemar test.

## DISCUSSION

The R24AF proved valid for the evaluation of low- and moderate-intensity physical activity in elderly adults and requires at least four days of method application (including one weekend day) to determine the pattern of weekly physical activity.

The literature review carried out as part of this study found no investigations analyzing evidence of validity of physical activity recalls in exclusively elderly populations of developing countries. Ribeiro et al.<sup>15</sup> carried out a study in São Paulo involving an adult sample, whose objective was to evaluate the evidence of validity of the R24AF for assessing physical activity, with accelerators serving as a reference for comparison. In the cited study, the recall instrument was applied on two week days and on one weekend day, after use of the Biotrainer II accelerometer. The authors found correlation values of 0.38 in the comparison with total physical activity (combining light-, moderate- and vigorous-intensity activities) and of 0.47 for moderate- and vigorous-intensity activities.

The correlation coefficient results of the R24AF for elderly were acceptable<sup>26</sup> proving similar to validation studies of the 24-hour recall method used in North American adults, especially on the assessment of total physical activity<sup>8,9</sup>. This method assessed the previous day's activities by free interview, examining morning, afternoon and evening periods, focusing on light, moderate- and vigorous-intensity activities in the domains of leisure, occupational, transportation and household activities, including sleep time and sedentary activities, such as periods sitting down. Matthews et al.<sup>8</sup> studied 41 North American adults, assessing them during four different times of the year (i.e. over the four seasons). The correlation was performed based on the total 63 days of recall application with concomitant use of Actillum accelerometers, and the authors obtained a correlation coefficient of 0.57 between the mean values of daily minutes of light, moderate and vigorous activities obtained by both accelerometer and recalls. In another more recent study employing the same method,



Calabro et al.<sup>9</sup> assessed 20 North American adults and compared the recalls against two types of accelerometer: the *Intelligent Device for Energy Expenditure and Activity* (IDEEA), secured to the waist, and the *SenseWear Pro2*, attached to the arm. The participants used the monitors for 24 hours and the recalls were applied the following day in the laboratory setting. Total energy expenditure on light, moderate and vigorous activities, as well as minutes spent on moderate and vigorous activities, were estimated by recalls and compared against the accelerometers. The results showed correlation coefficients of 0.89 for estimated energy expenditure for light, moderate and vigorous activities on both accelerometers, of 0.57 compared with the IDEEA and of 0.66 compared with *SenseWear* for minutes spent on moderate and vigorous activities.

This study used application of recalls by telephone. Studies in the literature have shown no difference between telephone and in-person applications. The *7-d Physical Activity Recall* questionnaire was tested for validity in two versions, one by telephone and the other in-person, yielding intraclass correlation coefficients of 0.96<sup>27</sup>.

The results found in the present study indicate that the R24AF tends to underestimate light-intensity physical activity but overestimate moderate-intensity activity compared to accelerometers. This likely occurs because the participants, when reporting physical activities performed in the last 24 hours, may fail to report some lesser, brief light-intensity physical activities, whereas accelerometers measure all motions performed and therefore the instrument logs the vast majority of light-intensity physical activities with more accurate measurements of duration. Overestimation of the practice of moderate- to vigorous-intensity physical activities is a common finding for self-report based instruments, largely due to the fact that individuals tend to overestimate the duration of these activities given their perceived effort and also the disparity between relative intensity (reflecting effort perceived by the individual) and absolute intensity (normally employed by instruments)<sup>7</sup>.

The analyses performed by sufficiently active classification based on moderate-intensity activities showed adequate concordance on Bland-Altman analyses and on McNemar's test for the four or five best days. These findings corroborate the results of previous studies assessing differences in moderate- or vigorous-intensity exercises measured by accelerometer and recalls. The study by Matthews et al.<sup>8</sup> reported differences of 25 to 41 minutes while the study of Calabro et al.<sup>9</sup> found a mean difference of 20 minutes between the methods. In the present study, the mean difference for the four and five best days on moderate activities was 40 and 36 minutes, respectively (data not shown). In a validation studies of the *7d Physical Activity Recall*, Hayden-Wade et al.<sup>27</sup> found that 58% of North American adults and elderly attained the recommended level of 150 minutes of moderate- or vigorous-intensity physical activity, using accelerometer data as a reference, similar to the results of the present study.

In the present study, it is important to take into account that the report

of physical activities assessed by recall was based on the four domains of physical activity (leisure, transportation, household and occupational activities) and that previous validation studies have shown that recalls tend to record more activities than accelerometers<sup>8,9</sup>.

In addition, this study showed that at least four days of R24AF application are required, including at least one weekend day, to construct an adequate pattern of weekly physical activity of elderly. Notably, previous studies have adopted a minimum of three days' application of recalls to reach an estimate of weekly physical activity<sup>15,28,29</sup>.

Several limitations of present study should be highlighted. Firstly, the MET values on which the R24AF is based are estimates of activity intensity derived from studies conducted predominantly in adult populations<sup>21-23</sup> where no specific compendium for elderly is currently available. This factor may have negatively impacted comparisons with accelerometers. Another limitation involves the scarcity of studies determining the cut-off point of accelerometer counts for physical activity intensities (light, moderate and vigorous) for the elderly population, particularly in developing countries such as Brazil. Currently, there is no consensus on the use of some cut-off points, especially for differentiating light-intensity activities from sedentary behaviors<sup>20</sup>. Moreover, although this sample was sufficient for a validation study, the assessments could be extended to include larger samples of elderly to provide further external evidence confirming the validity of the method.

These preliminary results showed that the R24AF is viable and warrants a more in-depth qualitative assessment of light- and moderate-intensity activities practiced during leisure time, transportation, occupational, and household activities, presenting outcomes which may be employed either qualitatively or quantitatively for classifying levels of physical activity in elderly adults. Traditional questionnaires used in epidemiological surveys such as the IPAQ are known to be unsuitable to assess some key domains of physical activity in the elderly, e.g., household activities<sup>30</sup>. Further, the bulk of the questionnaires currently in use has been originally validated for assessing moderate- and vigorous-intensity activities, overlooking light-intensity activities. Thus, the R24AF can be considered an adequate option for applications where the objective is to carry out a more in-depth specific assessment of light- and moderate-intensity physical activities in elderly individuals.

The results showed that the R24AF is valid for the assessment of low- and moderate-intensity physical activity in elderly adults and that at least four days of assessment (three week days and one weekend day) are required to construct a pattern of weekly physical activity in elderly adults.

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