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review article

Methods for assessing physical activity: a systematic review focused on older adults

Métodos de avaliação de atividade física: uma revisão sistemática focada em idosos

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Abstract – Among the large array of instruments for measuring physical activity (PA), the use of questionnaires, pedometers, and accelerometers with older adults is frequent. This study aimed to analyze the most widely adopted protocol for each instrument that is most commonly used to assess PA in older adults, and explore possible advantages and disadvantages of the methods used for these instruments. Thereby, we performed a search in databases and cross references of the articles selected. This procedure yielded in 16 studies being included. The in-depth analyzed studies demonstrate that questionnaires are usually applied either as an interview or self-administered, assessing the domains of leisure, sports, and household chores with a recall period of a typical week in the last month. Regarding pedometers and accelerometers, the length of time considered to be sufficient for data collection is five days. The devices are frequently used on the waist or hip with a belt or attached to clothing and removed only for water activities or during sleeping time. The use of either instrument should take into account the advantages and disadvantages that influence choosing one over the other, such as the number of participants to be evaluated, the time available for assessment, among others. The use of accelerometer along with PA questionnaire may yield more reliable and accurate measurements of PA level. In addition, it is recommended that, for older adults, questionnaires should be applied employing the interview format, in order to minimize possible misinterpretation of the questions.
Key words: Assessment; Older adults; Physical activity.

Resumo – *Dentre os diferentes instrumentos para medida da atividade física, o uso de questionários, pedômetros e acelerômetros na população idosa é algo bastante frequente. O objetivo do estudo foi analisar, dentre os instrumentos de medida da atividade mais utilizados em idosos, o protocolo mais adotado para cada instrumento e explorar possíveis vantagens e desvantagens dos métodos utilizados para o mesmo instrumento. Para tanto, efetuou-se uma busca em bases de dados, além de referências cruzadas dos artigos selecionados, dos quais foram selecionados 16 estudos. Os estudos analisados demonstram que questionários normalmente são aplicados em forma de entrevista ou autoadministrado, avaliando os domínios de lazer, esporte e atividades domésticas, com tempo de recordação de uma semana típica do último mês. Já em relação aos pedômetros e acelerômetros, 5 dias têm sido considerados suficientes para a coleta de dados. Os aparelhos são frequentemente utilizados na cintura ou quadril com uma cinta ou preso à roupa, e retirados apenas quando os idosos forem realizar atividades aquáticas ou dormir. A utilização de um ou outro instrumento deve levar em conta as vantagens e desvantagens que influenciarão na escolha do mesmo, como número de participantes a serem avaliados, tempo disponível para avaliação, entre outros. A utilização de acelerômetro juntamente com a aplicação de um questionário de AF pode ceder medidas mais confiáveis e precisas quanto ao nível de AF, porém recomenda-se que em idosos os questionários sejam realizados sob a forma de entrevista, a fim de minimizar possíveis erros de interpretação das questões.*
Palavras-chave: *Atividade física; Idosos; Avaliação.*

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INTRODUCTION

Despite the benefits of regular physical activity are well established in the literature, and the public health efforts to promote such practice within the population as a whole, physical inactivity remains a concern worldwide[1]. Analyzing physical inactivity among different age groups, the prevalence of physical inactivity is higher among older adults.

Parallel with the concern to promote and increase physical activity levels among the population, how to measure physical activity has drawn the attention of researchers. What would be the best method for assessing physical activity? In the literature it is possible to observe a large array of methods ranging from sophisticated methods that require highly specialized personnel and high cost, such as doubly labeled water, to questionnaires that are simple, practical, and inexpensive. Among the different instruments to measure physical activity, the use of questionnaires, pedometers, and accelerometers within the older population is quite common, most likely because of the possibility of evaluating a large number of participants.

Questionnaires are instruments normally used in epidemiological studies mainly for enabling the assessment of physical activity in a large sample size. In addition, questionnaires can be applied in different formats, such as interview, telephone, or self-administered. Furthermore, most of questionnaires are able to assess duration, intensity, frequency, and types of physical activity in the domains of household activities, leisure, sports/exercise, or occupation[2-4].

Pedometers are mechanical counters that record the number of steps in response to a vertical acceleration of the body[5]. These devices are lightweight, portable, and low cost, and are based on horizontal hip movement inherent in the swing phase of a step in humans[6,7].

Accelerometers are motion sensors that are sensitive to changes in acceleration of the body in one or all three axes and are able to provide a more direct measurement of the frequency, intensity, and duration of the movements related to the activity performed[8].

However, studies have presented different methods for the application of the same instrument. For example, Castro et al.[9] evaluated the level of physical activity in older adults using the short form of the International Physical Activity Questionnaire (IPAQ) as interview. Differently, Ferreira et al.[10] used the same questionnaire, but as self-administered. The same is observed for pedometers[11,12] and accelerometers[13,14]. However, the variation of the latter instruments is in the fastening position and days of the week used.

Given the foregoing, this study sought to examine the most widely adopted protocol for the instruments used the most for measuring physical activity of older adults (questionnaires, pedometers, and accelerometers) since the same instrument allows for different forms of application. In addition, this study aimed to explore possible advantages and disadvantages of the methods used for the same instrument.

The importance of a systematic review with these objectives is based on both the professional application as well as the orientation of future research for evaluating physical activity in older adults. Knowing the best protocol to be adopted with a given instrument can guarantee more reliable information.

METHODS

The methodological process of this study consisted of a systematic review of the literature based on a bibliographic search in the following databases: *Web of Science, SPORTDiscus, Biological Abstracts,* and *Medline*. The Boolean operators and keywords used were as follows: (*Assessment OR Evaluation OR Measurement*) *AND (Older Adults OR Older People OR Elderly) AND (Physical Activity) AND (Questionnaire OR Pedometer OR Accelerometer)*. In addition to the database search, a manual search was also employed using the reference list of the selected articles. The search for the articles was conducted in November 2011, and the selected articles should meet the following inclusion criteria: a) original articles reporting research with humans, b) studies describing the methods of application, use, and information regarding the data collected from the questionnaires, pedometers, and accelerometers, c) using older adults as sample, and d) being published in the last 5 years. First of all, the articles were selected by the title.

A total of 718 articles were identified. After the first screening, 661 articles were excluded whose titles were not related to the topic proposed or were repeated between databases. Subsequently, 41 articles were excluded based on methods that did not meet the inclusion criteria adopted for the study or were review articles. This procedure yielded in 16 articles being included and in-depth analyzed. Figure 1 illustrates the steps for selecting the articles.

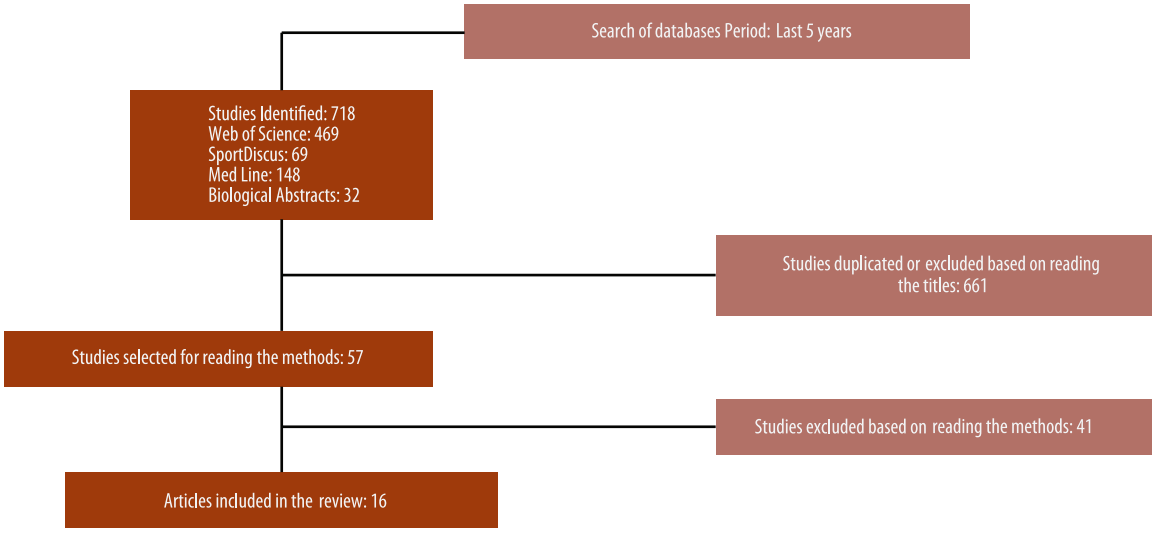

Figure 1. Steps for selecting the articles

RESULTS

The main information regarding methodological characteristics of the selected articles is summarized in the tables below and divided by type of instrument (Box 1, questionnaire; Box 2, pedometer and; Box 3, accelerometer).

Box 1. Methodological characteristics regarding the use of questionnaires in the studies selected.

Study	Questionnaire	Form	Domains	Recall period
Harris et al.[15]	17-item Zutphen Physical Activity Questionnaire	Self-administered	Leisure and sports	Usual activity during last week of month
Colbert et al.[16]	CHAMPS (Physical Activity Questionnaire for Older Adults)	Self-administered	Leisure, exercise, and daily activities	Typical week of last 4 weeks
	YPAS (Yale Physical Activity Survey)	Interview	Leisure, exercise, and household chores	Typical week of last month
	modPASE (modified version of the Physical Activity Scale for the Elderly)	Interview	Leisure, work, and household chores	Last 7 days
Banda et al.[17]	BRFSS (Behavioral Risk Factor Surveillance System)	Interview	Physical activities of moderate intensity for at least 10 minutes	Usual week
	PASS (Physical Activity Short Survey)	Self-administered	Physical activity of moderate and vigorous intensity	Last 7 days
	PALS (Physical Activity Long Survey)	Self-administered	Traditional aerobic activities and sports	Last 3 months
Moore et al.[18]	PASE (Physical Activity Scale for the Elderly)	Interview, Self-administered	Leisure, work, household chores	1 week
	CHAMPS (Physical Activity Questionnaire for Older Adults)	Interview, Self-administered	Leisure, exercises, and daily living activities	Typical week of last 4 weeks
	YPAS (Yale Physical Activity Survey)	Interview	Leisure, exercise, and household chores	Typical week of last month
	Modified Baecke Questionnaire for Older Adults	Interview	Leisure, sports, and household chores	Past year
Yasunaga et al.[19]	PAQ-EJ (Physical Activity Questionnaire for Elderly Japanese)	Self-administered	Personal transportation, exercises/sports, house chores, and work	Typical week of last month
Ewald, McEvoy and Attia[7]	PASE (Physical Activity Scale for the Elderly)	Phone or self-administered	Leisure, work, and household chores	Last 7 days
Gill et al.[20]	Phone-FITT (Brief Physical Activity Interview for Older Adults)	Telephone	Household chores, recreation, and structured activities	Typical week of last month

Box 2. Methodological characteristics regarding the use of pedometers in the studies selected.

Study	Type/Brand	Position	Days	Removal	Data considered
Harris et al.[15]	Yamax Digi-walker SW-200 (Yamax, Corp)	On the hip	7 days	Showering/ Swimming	<5 days excluded
Colbert et al.[16]	Pedometer with 7-d memory (NL-2000; New-Lifestyles, Inc. Lee´s Summit, MO)	Left side of waist using an elastic strap	7 days	-	Any day of less than 10h of usage was excluded
McMurdo et al.[21]	Omron HJ-113 piezoeletric pedometer (Omron Healthcare UK Ltd, Milton Keynes, UK)	One on the waist and another on the neck	-	-	-
Croteau et al.[22]	Yamax Digi-walker SW-200 electronic pedometer (Yamax Corporation, Tokyo, Japan)	Clipped to belt or clothing, and centered on the dominant foot	7 days	-	-
Togo et al.[23]	Electronic physical activity monitor (modified Kenz Lifecorder, Suzuken Co., Ltd., Nagoya, Aichi, Japan)	Attached to a belt at the waist, used uniformly on the left side of the subject's body.	-	Showering/ Changing clothes	-
Ewald, Mcevoy, and Attia[7]	Pedometer (Yamax DW200, Yamax, Tokyo, Japan)	Attached to clothing (each side), close to the anterior iliac spine	7 days	Changing clothes	-
Snyder, Colvin, and Gammack[24]	Accusplit Eagle 120XL pedometer (ACCUSPLIT, Livermore, CA)	Worn on the hip or belt	4 periods of 7 days	-	-
Bergman, Basset Jr., and Klein[25]	Yamax Digi-Walker SW-200 (DW; Yamax Corporation, Tokyo, Japan)	On belt or waistband at midline of right thigh	7 days	Showering	-
	StepWatch 3 Step Activity Monitor (SW3; Cyma Incorporated, Seattle, WA)	Attached above the lateral malleolus of the right leg	7 days	Showering/ When in bed	-

Box 3. Methodological characteristics regarding the use of accelerometers in the studies selected.

Trial	Brand	Type	Positioning	Days	Removal	Data considered
Harris et al.[15]	GT1M Actigraph (Manufacturing Technology Inc)	Uniaxial	On the hip, attached by a belt	7 days	Showering/ swimming	≥ 5 days
Copeland and Esliger[26]	Actigraph model 7164 accelerometer	Uniaxial	Two side by side, positioned on the right hip using an adjustable nylon belt	7 days	Bedtime	10h/day for at least 5 to 7 days
Colbert et al.[16]	GT1M uniaxial accelerometer (Actigraph, LLC, Pensacola, FL)	Uniaxial	Right side of waist using an elastic strap	7 days	-	Any day of <10h of usage was excluded
Banda et al.[17]	Actical accelerometer	Uniaxial	Attached to a neoprene belt that allowed easy and safe positioning of the device on the right hip	7 days	-	≥4 days of valid use with ≥12 h of time of valid use
Yasunaga et al.[19]	Electronic accelerometer (modified Kenz Lifecorder, Suzuken Co., Ltd., Nagoya, Aichi, Japan)		Attached to a belt on either left or right side of the body	1 month		<1.5 MET were excluded
McMurdo et al.[21]	RT3 (RT3 Accelerometry Research Tracker, Stayhealthy Inc., Monrovia, CA)	Triaxial	Device used on waistband	14 days	-	The first set of 24-hour data was discarded and days lost were excluded from the analysis
Koizumi et al.[27]	Kenz Lifecorder accelerometer (ACCEL; Suzuken Company, Nagoya, Japan)	Uniaxial	Able to use the device at waist level	7 days	-	Minimum of 5 days
Morie et al.[28]	Triaxial accelerometers (Actigraph, Pensacola, FL)	Triaxial	On an elastic belt on left or right hip	7 days	-	≥ 5 days
Gill et al.[20]	Actigraph GT1M monitor (Actigraph, LLC, Fort Walton Beach, FL)	Uniaxial	Attached to an elastic band on one side of subjects' body	7 days	Activity in water (showering) and at bedtime	≥ 5 days of valid data, of which at least one should be a day on a weekend.
Harris et al.[29]	GT1M Actigraph (Actigraph GT1M, Fl, USA)	Uniaxial	Worn around the hip on a belt	7 days	Showering/ Swimming	≥ 5 days

DISCUSSION

Considering the purpose of this study, which aimed to analyze the most adopted protocol of questionnaires, pedometers, and accelerometers, as well as to explore their advantages and disadvantages, the results found will be discussed by type of instrument.

Questionnaires

Among the indirect techniques for measuring physical activity level, questionnaires are characterized as being a descriptive survey instrument that aims to measure intensity, frequency, duration, and type of physical activity performed in different areas without manipulation of facts, phenomena, or behaviors of individuals. Questionnaires have been the most used method in large population studies due to low cost and practicality. In addition, less time is required for the application of questionnaires and most of them present good applicability, feasibility, and accuracy[2,4].

It was observed in the studies related to the use of questionnaires included in this review that questionnaires are often administered by interview or self-administered[16-19] with a recall period of a typical week in the last month[16-20]. The most assessed physical activity domains are leisure, sports, and household chores[25-29].

Age has a strong influence when measuring physical activity as for the accuracy of the information provided. That is because vision problems, interpretation of questions, and recall period of the physical activities performed in a certain period of time (requiring memory) could make self-administration difficult. A suggestion for questionnaires is their application using the interview format, in order to minimize errors commonly committed by older people who have difficulties measuring amount of days (normal/usual week), time (hours and minutes per day and week), and intensity (mild or moderate or vigorous) when performing physical activities. Questionnaires also exhibit low to moderate levels of validity when compared to more direct measuring instruments such as accelerometers, doubly labeled water, and others[30-32].

It is not possible to recommend one questionnaire over another since the choice of the questionnaire to be used should take into account the characteristics of the population/sample, because many times the population for which the questionnaire was designed does not present the same living conditions as the population being studied. Furthermore, the objectives of the study, sensitivity to typical physical activities, domains, and dimensions of physical activity to be measured, measurement of current *vs.* usual physical activity, unit of measurement in which the level of physical activity is expressed, as well as human resources and materials available, should also be taken into consideration[33].

Pedometers

The studies found with older adults: a) used protocols of seven days for

evaluation with pedometers[15,16,22,24,25]; b) as a general rule, the pedometer is attached to the hip or waist using an elastic strap or attached to clothing using a clip[16,22-25]; c) the instrument was removed only for sleeping, showering, and water activities[7,15,23,25].

The following main advantages of using pedometers could be mentioned: they have reduced size and cost, are not invasive, can be used in various contexts without interfering with daily life, and can be easily used in large groups. As for their disadvantages, pedometers are not sensitive to sedentary activities, isometric exercises, and activities involving the arms, and they are also not resistant to water[32]. Ainsworth et al.[34] and Hensley et al.[5] report that these devices tend to underestimate distances at low speeds and overestimate distances in walks and fast runs. Imprecise records can result from its location on the body as well as from the spring tension difference between the instruments. But, despite the lack of precision, these devices can differentiate changes in patterns of physical activity.

Accelerometers

The uniaxial accelerometer measures the body acceleration only on the vertical axis, whereas the triaxial detects acceleration on three axes (medial-lateral, anteroposterior, and vertical). Given that body movement is pluridirecional, several authors indicate that the most appropriate method for assessing physical activity and energy expenditure is to measure on three axes instead of performing an uniaxial measurement[35,36]. However, in the selected studies with older adults, the vast majority used uniaxial accelerometers[17,20,26,27,29], which may be partially explained by the cost of the uniaxial devices compared to the triaxial ones, but none of the studies justified their reason for using such model.

The minimum number of days required to collect data has important implications for conducting a study and its overall costs, and consequently the duration of the time of use to be considered. Researches require measurements of a sufficient number of days to reflect the average of a normal physical activity level[37]. Thus, the number of monitoring days will depend on the outcome of interest (i.e., routine physical activity, time spent doing an activity of moderate intensity, inactivity), though normally the data collected and validated for analysis is between three and seven days for the population in general[38].

In our analysis, the studies selected collected data for seven days, and the data collected below five days were excluded[19-21,28,29], which seems to indicate that data collected equal to or greater than five full days are the minimum amount to evaluate the physical activity level in the older adult population. Similar to the pedometers, the accelerometers are often attached to the hip or waist by a belt[20,21,26-28,] and are removed only for water activities and during sleeping time[26,29].

Regarding their advantages and disadvantages, accelerometers, just the same as pedometers, are small and have a low cost, but have an internal mechanism for counting steps that is more precise, capable of storing

data for longer periods of time, and also to quantify the acceleration of the movement. However, many activities such as cycling, swimming, and lifting weights, which do not involve vertical movement, are not well measured by this device[39].

Within this perspective, Reis et al.[40] reported that while we do not have an instrument that meets all the desired characteristics, the combination of different instruments such as motion sensors and questionnaires can provide more reliable and accurate data.

FINAL CONSIDERATIONS

The studies analyzed show that questionnaires are usually applied with older adults using the interview or self-administered format; however, it is recommended that questionnaires used with older adults be conducted in the form of interview in order to minimize possible misinterpretation of the questions. The domains to be assessed should be leisure, sports, and household chores, which are the ones most commonly done by older adults. The recall period is often a typical week in the last month. As for pedometers and accelerometers, they are frequently used over a period of seven days, and five days can already be considered sufficient for data collection. They are often attached to the waist or hip with a belt or attached to clothing and are removed only for water activities and during sleeping time.

Regarding the advantages and disadvantages in relation to using one of the instruments over the other, we should take into account a series of factors that will influence this choice, such as the number of participants to be evaluated, the time available for assessment, among others. Therefore, since there is an absence of instrument that meets all the advantages desired, if it is feasible, we recommend the use of accelerometers along with physical activity questionnaire for obtaining more reliable and accurate measurements on the level of physical activity.

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