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Review Article

How can Physical Activity be Measured in Primary Health Care?

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Abstract

The purpose of this article was to review methods of physical activity (PA) measurement which could be used in primary health care. The CINAHL and MEDLINE databases were consulted for the years 1993 to 2014. Original articles that employed tools, questionnaires, and scales to assess physical activity in older adults and the elderly were included. The selected studies were required to provide information on the use, development, and psychometric properties of the tools. Due to the substantial number of existing PA questionnaires, only those validated in the Spanish population, or with a Spanish version validated in other populations, were analyzed.

The tools that could be useful in primary health care due to their ease in application and efficiency are the following. For an initial evaluation of patients prior to prescribing PA the Revised Physical Activity Readiness Questionnaire (rPAR-Q) is recommended. To assess routine levels of PA in patients the following questionnaires are suitable: Rapid Assessment of Physical Activity (RAPA), IPAQ (International Physical Activity Questionnaire), and the Spanish short version of the Minnesota Leisure Time Physical Activity Questionnaire (VREM). For patients prescribed walking, the pedometer is a practical tool to quantify PA. For patients prescribed a specific physical activity, the heart rate monitor is a functional device to ensure that PA is performed within safe and correct levels of intensity.

ABBREVIATIONS

PA: Physical Activity; MET: Metabolic Energy Turnover; HR: Heart Rate; HR Max: Maximum Heart Rate; ACSM: American College Of Sports Medicine; Rpar-Q: Revised Physical Activity Readiness Questionnaire; RAPA: Rapid Assessment Of Physical Activity; YPAS: Yale Physical Activity Survey; IPAQ: International Physical Activity Questionnaire; 7-Day PAR: Seven-Day Physical Activity Recall; CHAMPS: Community Healthy Activities Model Program For Seniors; LTPA: Minnesota Leisure Time Physical Activity Questionnaire; VREM: Spanish Short Version Of The Minnesota Leisure Time Physical Activity Questionnaire.

INTRODUCTION

Social change and progress have converted the general population into sedentary subjects [1]. A sedentary lifestyle, together with nutritional excesses, is a risk factor for many chronic diseases commonly found in developed countries [2].

A number of studies have demonstrated the beneficial effects of physical activity (PA) with respect to several diseases and cardiovascular risk factors. Within this context, PA is, therefore, an essential part of the preventive activities recommended for the general population. Due to their close relationship with patients, health professionals play a key role in this issue. The first step when prescribing PA is the evaluation of the patients' physical condition and level of activity they already practice. Once PA has been prescribed, it is of interest to both quantify and monitor the PA performed.

OBJECTIVES

The purpose of this article was to review PA measurement methods which could be used in primary health care. Their accessibility, ease in application, and efficiency were taken into account in the selection process.

METHODS

The review included original articles that used tools, questionnaires, and scales to assess PA in older adults and the elderly. The CINAHL and MEDLINE databases were consulted for the years 1993 to 2014. The selected studies were required to provide information on the use, development, and psychometric properties of the tools. Due to the substantial number of existing PA questionnaires, only those validated in the Spanish population, or with a Spanish version validated in other populations, were analyzed.

Measurable components of physical activity

PA is a difficult variable to measure, a number of components such as intensity, frequency, and length need to be taken into account.

Intensity is defined as the degree of effort required to perform a specific PA and is equal to necessary force employed. It is the most important variable and the most difficult to measure.

Absolute intensity is the energy expenditure resulting from PA performed during a certain amount of time. It is expressed as: oxygen consumption (VO_2, liters O_2/min), energy expenditure (Kcal·min-1 or kJ·min-1) or as a multiple of energy expenditure when resting, that is to say, the number of METs related to effort. One MET (Metabolic Energy Turnover) represents energy expenditure at rest. It is the amount of oxygen necessary for the maintenance of the organism's metabolic functions during 1 minute with the subject resting and seated. For each PA a determined number of METs is assigned (Ainsworth et al. compiled a Compendium of Physical Activities which, in the latest 2011version, quantifies the intensity of 821 activities in adults [3].

PA intensity can also be expressed in relative terms according to the maximum physical performance capacity of the study subject [4].

Intensity is generally defined as: light, moderate, or vigorous.

Frequency refers to the number of times PA is performed and is usually expressed in a specific time period (e.g. last week, last month, etc.). Frequency is also important to evaluate seasonal variability in PA patterns. Some studies have shown that, if energy expenditure is constant, the effect of PA on physical condition is the same whether the activity is carried out only once or various times [5, 6].

Length is defined as the number of minutes of PA. It can be performed continuously (one session) or intermittently, taking together in one day sessions of at least 10 minutes of duration [7]. Within certain limits, length and intensity of effort are inversely related. Comparable results have been obtained between a short session of high intensity and a long session of less intensity, as long as the total energy expenditure is similar. However, the drawback of high intensity PA is its association with greater cardiovascular risk and musculoskeletal lesions which can decrease adherence to training.

Evaluation of physical activity

Measurement methods of PA fall into two categories: objective and subjective.

Objective Methods: They are based on PA quantification through the response of certain biological or physiological variables to stimulus [8]. The most commonly used objective methods in primary health care are heart rate monitors, pedometers, and accelerometers. (Table 1) describes their advantages and disadvantages.

Heart rate measurement (heart rate monitor): Monitoring heart rate (HR) is the most popular and easiest method to evaluate physical exercise intensity. Due to the almost linear correlation between HRand intensityof efforts, the maximum heart rate (HRmax), defined as the maximum number of heart beats in one minute, is taken into consideration. The HR recommended to obtain positive effects on physical fitness is 55% - 90% HRmax. The most commonly employed method to estimate HRmax is the formula recommended by ACSM [9] for adults: HRmax = 220 – age, whilst Tanaka et al. provide the formula HRmax = 208 – (0.7 x age) for adults >40 years.

The heart rate monitor has many advantages: it is economical and can be worn innumerous situations, including under water, without interfering in the subject's lifestyle [10].

Pedometers: Small devices placed on the hip which register the number of steps (walking and running) in a given period of time.If the length of the subject's pace is included the distance completed can also be calculated. The advantages of pedometers include their being light, easy to use, economical, and collecting data over a long period of time [11]. However, some studies have shown that measurement errors can occur in people walking slowly or with short steps, and in obese subjects. Despite their limitations, pedometers have been shown to increase the level of PA in the general population because they establish visual objectives and offer a continuous feedback which may, additionally, increase motivation [12].

Individuals are considered sedentary when they take fewer than 5,000 steps per day and active with more than 10,000.

Table 1: Advantages and disadvantages of different objective physical activity measurements.

METHOD	ADVANTAGES	DISADVANTAGES
Heart rate measurement	. Requires minimum participation from the subject . Non-reactive, suitable for water sports . Economical . Suitable for all age groups	. Measures energy expenditure but does not record physical activity patterns . Heart rate frequency may be modified by situations not related to physical activity . Indirect calorimetry must be previously performed
Pedometer	. Non-reactive .Suitable for all age groups . Economical .Lightweight and easy to use	. Limited data storage capacity . Does not record intensity ofphysicalactivity. Does not register physical activity on the flat (cycling) or that carried out by the upper part of the body (carrying weight)
Accelerometer	. Non-reactive . Suitable for all age groups . Economical . Lightweight and easy to use . Large data storage capacity. Intensity can be measured	.Does not register physical activity on the flat (cycling) or that carried out by the upper part of the body (carrying weight). Cut-offs need to be defined.

Accelerometers: These devices measure movements performed on more than one plane. They are usually worn around the waist which nearest to the center of gravity and the closest place to where all body movement is made. They can also be placed on the wrist or ankle.

An accelerometer calculates energy expenditure by measuring the frequency, length, and intensity of PA [13].

Subjective methods

PA measurement by health professionals is usually carried out with questionnaires, interviews, and surveys all of which are inexpensive and easy to apply.

Subjective methods vary with respect to time periods evaluated, PA dimensions taken into consideration, and how the data is gathered and expressed.

Time of evaluation: techniques may evaluate PA over the previous week, during a typical week, during one year, or lifetime activity.

Dimensions of PA: Include work, leisure time, sports, house hold tasks, and transport.

Ways to gather information: personal interview and self-screening.

Ways to express information: results can be expressed as energy expenditure (kilocalories or METs), length (hours of PA), or grading on a predetermined scale.

In summary, questionnaires can measure the type of activity, frequency (average number of sessions per unit of time), length (minutes per session), and intensity (metabolic expenditure) in order to calculate energy expenditure as [14].

Energy expenditure = Frequency (days) x Length (minutes) x Intensity (METs)

Diaries / physical activity registers

Participants record in a diary from 1 to 7 days the activities they have been engaged in. The register may be a closed list of activities or an open one in which varying activities are recorded during the day [15].

The advantage of this technique is that it does not rely on the subject's memory as it involves a detailed written register and thus avoids observer bias. The main drawback with this form of data collection is the lack of control over the actual amount of effort performed by the participant. Moreover, because the diary is kept for only a short period of time, it may not reflect the participant's routine level of activity. In addition, it does not take seasonality into account. It is important to be aware that the diary may influence and alter the daily habits of the subject [16].

Questionnaires

Questionnaires, unlike diaries, do not rely on a great deal of effort from the patient. They are easy to answer and do not modify the regular routine of the interviewee. Whilst questionnaires are designed to permit the classification of individuals according to their PA there are some methodological problems. These include memory errors, subjective interpretations, uniform application of MET intensity regardless of how the activity was performed, and the desire to report what is socially accepted. All of which can affect response validity.

The psychometric properties of the questionnaires are: reliability, validity, and sensitivity to change.

Three criteria are employed to measure reliability: internal consistency, test-retest reliability, and inter-observer agreement. The first of these is the degree of congruence or correlation amongst different items in the same test as measured by Cronbach's alpha; the second refers to the degree to which, under unchanging conditions, the same results can be repeatedly obtained; and the third determines the degree to which two different observers obtain a similar result from applying the same tool. The two firstcriteria are usually calculated by the intra class coefficient correlation (ICC) or Pearson's chi square whilst inter-observer agreement is obtained with the kappa index. An acceptable level of reliability is when the coefficients are >0.70 [17,18].

Validity is the degree to which evidence and theory support interpretation of scores [17]. Three types of validity evidence are taken into account: content, criterion, and construct. Content validity is usually determined through a revision of the literature, patients' opinions, a panel of experts, and physicians' criteria. Criterion validity measures the relationship between an external variable, an index, or an indicator of the concept being evaluated and the instrument in question. A gold standard is generally employed for the comparison of new tools. Concurrent criterion validity exists when the correlation of the measurement with the gold standard is <0.70. Construct validity is demonstrated by measuring correlation with other measurements of the same construct (convergent validity) and exists when the correlations are >0.60 [19]. If differing constructs are correlated then the hypothesis should be considered *a priori* and at least 75% of the results should correspond to it [20].

Sensitivity to change refers to the capacity of a tool to measure changes in patients' health when they have undergone an intervention [17].The statistical estimation of effect, that is to say, the measurement of change in the state of health (which implies the identification of the difference between the score obtained before and after the intervention) must be calculated. At present, there is no consensus with respect to which statistical method should is employed [18].

The following PA questionnaires are discussed. Due to the substantial number of existing questionnaires, only those validated in the Spanish population, or with a Spanish version validated in other populations, are included [21].

The variable to be measured, the characteristics of the subjects for whom the questionnaire was developed or evaluated, its application (number of questions or items, type of activities, recall time, and length of administration), and psychometric properties were all taken into consideration (Table 2).

- **Questionnaires concerning physical activity contraindication:**

- **Revised Physical Activity Readiness Questionnaire (rPAR-Q):** A brief, 7-item, self-screening questionnaire

used before prescribing physical exercise for subjects interested in PA programs. It identifies any existing PA contraindications such as cardiovascular risk, pharmacological issues, and musculoskeletal problems [22].

- **Questionnaires concerning physical activity detection:** These kinds of questionnaires include only a few items. They measure the general level of PA and allow classification of people in either physically active or inactive categories. They prioritize effectiveness over accuracy and precision.
- **Rapid Assessment of Physical Activity (RAPA) [23]:** Designed to provide clinicians a rapid tool to assess patients' PA levels. It was validated in adults > 50 years using CHAMPS questionnaire as criterion. It is a 9-item, self-screening tool that evaluates strength, flexibility, and PA intensity and requires 2-5 minutes to complete.
- **Questionnaires concerning physical activity quantification:** Most of these questionnaires were originally designed for population studies. Their aim was to provide arapid, practical approximation of PA particularly with respect to daily practice.
- **Questionnaires concerning physical activity recall:** These questionnaires measure frequency, length, and type of PA for the duration of one day, one week, or one month and subjects are classified according to their level of PA intensity, ranging from low to vigorous.
- **Yale Physical Activity Survey (YPAS) [24]:** Evaluates regular specific activities related to domestic, exercise, and leisure time PA in seniors (>65 years old). The tool has two sections: 1) quantity of PA or exercise performed during a typical week in the previous month, and 2) activities carried out in the previous month. The interview takes approximately 20 minutes to complete.
- **IPAQ (International Physical Activity Questionnaire) [25]:** Measures the time spent walking and PA performed, ranging from moderate to vigorous intensity, over the seven days prior to the interview. It includes the PA performed for a minimum of 10 minutes in all domains including: work-related PA, domestic activities, transport-related PA, and leisure time PA. The IPAQ also measures the time a person sits. There is a short version (7 questions) which can be conducted via a telephone interview and a longer one (27 questions) for self-screening.
- **Seven-day Physical Activity Recall (7-day PAR) [26, 27]:** Are call of the activities performed over a seven day period, including work-related, leisure time, and domestic ones. Questions are related to time spent sleeping and carrying out PA (moderate, high, and very high). The interview takes around 20 minutes to complete.
- **CHAMPS Physical Activity questionnaire [28]:** CHAMPS (Community Healthy Activities Model Program for Seniors) was developed to assess interventions aimed at increasing PA levels in seniors. It evaluates weekly frequency and length of physical activities during a 4 week period. A non-validated Spanish version has been tested in Mexico and Peru. It is performed through an interview or self-screening and takes 20 minutes to complete.
- **Questionnaires concerning long-term physical activity:** These kinds of questionnaires include more than 20 items and provide information about the volume of PA engaged in during leisure or working time over the duration of one year or along a person's lifespan.
- **Minnesota Leisure Time Physical Activity Questionnaire (LTPA) [29]** evaluates leisure time (free time and domestic chores) PA quantity and quality during the previous year. The Spanish version has been validated in Spain for male and female subjects aged between 18 and 61 years old [30, 31]. The questionnaire has 67 items gathered in 8 dimensions and is completed through a 15-20 minute interview **The Spanish short version of the Minnesota Leisure Time Physical Activity Questionnaire (VREM)** [32], with only 6 items, was created in order to be used in primary care. Carried out by a personal interview, it takes approximately 5 minutes.
- **Modified Baecke Physical Activity Questionnaire [33-38]** adapted from the Baecke questionnaire for young adults, it is a specific version for subjects aged >60years. It is composed of 14 items regarding domestic, sport, and leisure time activities performed over the course of one year. It can be completed in 15 minutes with a personal interview.

DISCUSSION AND CONCLUSION

To summarize, due to their ease and efficiency the following tools could be useful in primary health care settings:

For an initial assessment of patients prior to prescribing PA the Revised Physical Activity Readiness Questionnaire (rPAR-Q) is recommended. It is a 7-item, self-screening questionnaire which can identify the risks before starting or increasing a PA program.

To evaluate routine levels of PA in patients

Rapid Assessment of Physical Activity (RAPA) classifies the subject in 2-5 minutes as physically active or inactive.

IPAQ (International Physical Activity Questionnaire) or the Spanish short version of the Minnesota Leisure Time Physical Activity Questionnaire (VREM) classifies the subjects in approximately 5 minutes into heavy, moderate, and light PA categories.

For patients who have been prescribed walking, the pedometer is a practical tool to quantify PA. It establishes tangible objectives and gives continuous feedback, which can be motivating.

Table 2: Psychometric properties of the questionnaires.

QUESTIONNAIRE	Reliability			Validity		Sensitivity to change
	Internal consistency	Test-retest reliability	Inter-observer agreement	Criteria	Construct	
Revised Physical Activity Readiness Questionnaire (rPAR-Q) [22]	-	-	k = 0,71	-	-	-
Rapid Assessment of Physical Activity (RAPA) [23]	-	-	Not applicable	Significant correlation with CHAMPS (p< 0,001)	81% sensitivity, 69% specificity. 77% positive predictive value, 75% negative predictive value	-
Yale Physical Activity Survey (YPAS) [34]	-	Total time r_s= 0.57 (p<0.0001) Weekly energy expenditure r_s= 0.58 (p<0.0001)	-	Correlation with accelerometer=>total week time , r_s= 0.44 (p<0.03) Weekly calorific expenditure r_s = 0.47 (p<0.02)	Correlation among the YPAS indices	Sensitive to change at 3 months after moderate intensity aerobic exercise intervention
IPAQ (International Physical Activity Questionnaire) [25]	-	r_s= 0,8-0,96	-	Correlation with accelerometer r_s= 0.33	Concurrent validity using two measurement formats in the same day , r = 0.67 Does not provide validity with respect to the measurement of light activity	-
Seven-day Physical Activity Recall (7-day PAR) [26, 35]	α= 0.77 [35]	ICC = 0.94-0.97 [26]	-	Correlation with DLW for moderate, intense, and very intense activity Correlation with n $VO_{2\ max\ f}$ light activities [36]	Correlation with accelerometer for all indices of activity The greatest correlation is for very intense activities r_s= 0.78	
CHAMPS Physical Activity questionnaire[28]	-	Moderate activity ICC = 0.67 All activities ICC= 0.66	-	-	It defines three groups in which PA is performed, p<0.001. It correlates with measurements of functional performance, calorific expenditure, and psychological well-being.	PA effect measures of the intervention and control groups divided at the standard deviation The effect measures for calorific expenditure were 0.38 and 0.42 (from low to moderate) The frequency measures were from 0.54 to 0.64 (moderate)).
Minnesota Leisure Time Physical Activity Questionnaire (LTPA) [30, 31]	-	-	-	Shows correlation with DLW for moderate and intense activity r_s= 0.50 and r_s=0,47 (p<0.05), and with $VO_{2\ max}$[36]	Correlation between total energy expenditure and age, r = -0.21 (p<0.05); heart rhythm at 3 minutes after exercise test r_s= -0.214 (p<0.05) High and moderate energy expenditure.	
Modified Baecke Physical Activity Questionnaire [37]	α= 0,.6 [38]	ICC= 0.96 [38]	-	-	Correlation with register of daily activity r_s= 0.78and r_s= 0.7 with a pedometer [37]	-

α: Cronbach's alpha; r_s: Spearman's correlation coefficient; ICC: intraclass correlation coefficient; K: Kappa index; DLW: doubly labeled water ; $VO_{2\ max}$: oxygen consumption

For patients who have been prescribed a specific physical activity, the heart rate monitor is a functional device to ensure that PA is performed within safe and adequate levels ofintensity.

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