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CONCURRENT AND CRITERION VALIDITY OF THE 7 DAY-PAR IN SPANISH ADOLESCENTS

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ABSTRACT

This study analyses the validity of the self-report questionnaire Seven Day Physical Activity Recall (7 Day-PAR) in Spanish adolescents. For this purpose, we analysed the relations of 7 Day-PAR data with accelerometer data (concurrent validity) and with the aerobic physical fitness and body fat percentage of the sample (criterion validity). The study was carried out with a sample of 123 Spanish adolescents (M = 14.85, SD = .87). Physical activity (PA) was measured by the 7 Day-PAR and the Actigraph GT3X accelerometer. Aerobic fitness was estimated by the 20-m shuttle run test. Body fat percentage was measured using a bioelectrical impedance scale (Oregon Scientific GR101). The results revealed that the 7 Day-PAR showed acceptable validity for the measurement of very hard PA and low validity for hard PA, but it showed a problem in the measurement of moderate PA. It seems that young people find it difficult to report their moderate PA time properly, because it tends to be more sporadic, non-planned, and therefore less memorable and quantifiable than high-intensity activities. This article concludes with some suggestions to improve the validity of the 7 Day-PAR and the measurement of moderate PA.

Key Words: physical activity, health behaviour, questionnaire, accelerometer

VALIDEZ CONCURRENTE Y DE CRITERIO DEL 7 DAY-PAR EN ADOLESCENTES ESPAÑOLES

RESUMEN

Este estudio analiza la validez del cuestionario de autoinforme Seven Day Physical Activity Recall (7 Day-PAR) en adolescentes españoles. Para ello, se analizó la relación de los datos del 7 Day-PAR con los datos procedentes de acelerómetros (validez concurrente) y los datos de condición física aeróbica y porcentaje de grasa de la muestra (validez de criterio). El estudio se llevó a cabo con una muestra de 123 adolescentes españoles (M = 14.85, DT = .87). La actividad física (AF) se midió con el 7 Day-PAR y el acelerómetro Actigraph GT3X. La condición física aeróbica se estimó con la prueba Course Navette. El porcentaje de grasa se midió con la báscula de bioimpedancia eléctrica Oregon Scientific GR101. Los resultados indicaron que el 7 Day-PAR mostró una validez aceptable para la medida de la AF muy fuerte y baja validez para la medida de la AF fuerte, pero se observó un problema de validez en la medida de la AF moderada. Parece que los adolescentes encuentran dificultades para detallar adecuadamente su AF moderada, porque tiende a ser más esporádica y menos planeada, resultándoles más difícil de recordar y cuantificar que las actividades de alta intensidad. Este artículo concluye con algunas sugerencias para mejorar la validez del 7 Day-PAR y la medida de la AF moderada.

Palabras clave: actividad física, conducta saludable, cuestionario, acelerómetro

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INTRODUCTION

There is much scientific evidence of the benefits of physical activity (PA) for health and the prevention of diseases such as obesity, type II diabetes, or cardiovascular disease (Bouchard, Blair, & Haskell, 2007). The lack of PA is particularly worrisome in youth because the stages of childhood and adolescence are essential to acquire and consolidate healthy and active lifetime habits (Telama et al., 2014; Welk, Eisenmann, & Dollman, 2006). Accordingly, different studies show that many children and adolescents in Spain and other developed countries habitually participate in insufficient PA (Aznar et al., 2011; Guthold, Cowan, Autenrieth, Kann, & Riley, 2010; Martín-Matillas et al., 2011; Riddoch et al., 2004). Hence, the promotion of PA among young people has become a priority public health goal (Welk et al., 2006).

Studies that identify the factors influencing young people's PA participation, as well as studies focused on the assessment of interventions for the promotion of PA, represent an important step towards the promotion of active and healthy lifestyles in this population (Sallis & Owen, 1999). However, without adequate measures of PA, it is impossible to establish rigorous and useful scientific knowledge, and validity of the measurement instruments of PA is therefore essential (Welk, Corbin, & Dale, 2000).

Measuring a person's PA in real and natural conditions is extremely complicated, especially in children and adolescents (Ortega, Ruiz, & Castillo, 2013). There are many ways to measure PA, among which are noteworthy the so-called objective methods, such as accelerometers, and the subjective methods, such as questionnaires (Ortega et al., 2013). Accelerometers involve both high costs and application time, but they can be very useful for studies with samples that are not very large or to validate other measurement techniques (Welk et al., 2000). Questionnaires represent an appropriate method to measure PA in studies with large samples of population, when other resources are unavailable, or when assessment time is scarce, despite the fact that their validity is lower (Martínez-Gómez et al., 2009; Welk et al., 2000).

At the international level, one of the most extensively used questionnaires to measure PA is the 7 Day Physical Activity Recall (7 Day-PAR), which has been shown to have acceptable validity in adolescents and adults when compared with the results of direct observation or cardiac frequency monitors (Sallis, 1997). Other validity studies have compared the results of the 7 Day-PAR with those from diverse accelerometers. The study of Sloane, Snyder, Demark-Wahnefried, Lobach, and Kraus (2009), with a sample of adult survivors recently diagnosed with breast and prostate cancer, found moderate correlations between minutes per week of moderate-vigorous PA measured with the RT3 triaxial accelerometer and minutes of moderate-hard-very hard PA measured with the 7 Day-PAR (initial test, .54; year 1, .24; year 2, .53, $p < .01$

in all cases). However, Crocker, Holowachuk, and Kowalski (2001) found no significant correlation between the *counts* (unit of measure, see method) recorded with the triaxial Tritrac-R3D accelerometer and energy expenditure measured with the 7 Day-PAR in children (M = 11, SD = 1.4 years).

These data seem to indicate that the validity of the 7 Day-PAR may be affected by the age of the participants who complete the questionnaire, the measurement instrument of PA being compared, and the PA-related variables among which the comparison is established. In this regard, we have found no studies comparing the results of the 7 Day-PAR with those of an accelerometer in a sample of adolescents, nor have we found any study comparing the 7 Day-PAR with the triaxial Actigraph GT3X accelerometer, one of the most widely accepted and used by the scientific community in recent years (Hänggi, Phillips, & Rowlands, 2013). Likewise, in the reviewed literature, we have not identified any study analysing whether the validity of the 7 Day-PAR differs as a function of the different levels of PA measured (light, moderate, hard, very hard) when comparing the results of this questionnaire with an accelerometer.

The validity of the 7 Day-PAR could also be analysed by comparing the PA results of this instrument and other more valid instruments (for example, the Actigraph GT3X accelerometer) with certain variables that are logically related to PA (criterion validity). Diverse studies indicate that moderate and vigorous PA is related to lower percentages of body fat in children and adolescents (Ekelund et al., 2004; Wittmeier, Mollard, & Kriellaars, 2007), although other studies only found this relationship with vigorous PA (Butte, Puyau, Adolph, Vohra, & Zakeri, 2007; Dencker et al., 2006; Gutin, Yin, Humphries, & Barbeau, 2005; Moliner-Urdiales et al., 2009; Ness et al., 2007). Moreover, daily PA is related to greater aerobic fitness, although the relationships found in several studies are low or moderate (Dencker & Andersen, 2011; Kristensen et al., 2010).

In view of these previous results, the aim of this study was to analyse the validity of the 7 Day-PAR questionnaire in adolescents, comparing its results with those of the ActiGraph GT3X accelerometer (concurrent validity) and with the level of aerobic fitness and the percentage of body fat of the sample (criterion validity).

METHOD

Participants

Participants in the study were 123 students (73 girls and 50 boys), from 3rd and 4th grade of Compulsory Secondary Education, aged between 13 and 17 years (M = 14.85, SD = .87) and coming from three schools located in the province of Alicante (Spain).

Measures

Level of physical activity measured objectively. ActiGraph GT3X accelerometers were used to measure the accelerations on all three anatomical body planes (sagital, frontal, and cross-sectional), providing movement data to the magnitude vector resulting from the accelerations on all three axes. The data from the accelerations were filtered by the accelerometer and stored in its memory in *counts* (unit of measurement) and in 60-second *epochs*. In order to consider as valid a participant's data, the following inclusion criteria were taken into account: presenting 4 or more measurement days and a minimum of 10 hours recording per day (Riddoch et al., 2004). The recording intervals equal to or higher than 60 consecutive minutes of 0 counts, including bands with less than 2 consecutive minutes with values equal to or lower than 100 counts, were considered intervals in which the participants were not wearing the accelerometer and were therefore excluded from analysis (Pfitzner et al., 2013).

To calculate the time (in minutes) of the different intensities of PA, the cut-points established for youths by Evenson, Cattellier, Gill, Ondrak, and McMurray (2008) were used, taking into account the validation of Trost, Loprinzi, Moore, and Pfeifer (2011): sedentary 0-100 counts per minute (< 1.5 METs), light 101-2295 counts per minute (≥1.5 and < 4 METs), moderate 2296-4011 counts per minute (≥ 4 and < 6 METs), and vigorous ≥ 4012 counts per minute (≥ 6 METs).

Levels of self-reported physical activity. To measure the levels of daily self-reported PA, we used the 7 Day-PAR questionnaire (Sallis, 1997; Sallis et al., 1985) in its Spanish version (Grandes et al., 2009). This questionnaire is used to recall the PA carried out during the past week. Participants must indicate the minutes dedicated every day of the week to PA, distinguishing the different intensities: moderate (“activities that feel like walking at a normal pace”, 4 METs), hard (“activities that are not as intense or hard as running, but requiring more effort than moderate activity”, 6 METs), and very hard (“activities that feel like running”, 10 METs). The questionnaire also collects information about the participants' daily hours of sleep (1 MET). The questionnaire protocol allowed us to calculate the total minutes of daily light activity (1.5 METs) by subtracting the time dedicated to sleeping and to moderate, hard, and very hard PA from the total minutes of the day.

Aerobic fitness. In order to assess the adolescents' aerobic fitness, the multistage 20-meter shuttle run test was used (Léger, Mercier, Gadoury, & Lambert, 1988). For this purpose, teachers from the three schools were instructed to perform the test with the same protocol. The test consists of running back and forth on a 20-meter course, while listening to an audiotape with different stages that mark the rhythm of the participant's movement with a sound signal, accelerating progressively. At the end of the test, the number of intervals performed is counted.

Percentage of body fat. The Oregon Scientific GR101 bioimpedance scale was used to measure body fat.

Procedure

Authorization for this study was requested from the Department of Education of the Valencian Community, the schools, and the parents of the participants, who signed an informed consent form. The study was approved by the Research Ethics Committee of the Miguel Hernández University of Elche. Participation in this study was voluntary. To perform all the measures, the students were informed of the goal and procedure of the study. The measures were performed in two sessions. In the first session, the students were instructed on how to use the accelerometers during the week. In order to record students' activity for seven consecutive days, the accelerometers were placed on the right side, between the waist and the hip, and held in place with an elastic belt. Students were requested to put on the accelerometer every day upon waking up, only removing it to sleep, shower, or to perform other activities that could damage the device, for example, swimming. In this session, we measured their percentage of body fat with the bioimpedance scale in a special room, separated from the other students. One week later, the accelerometers were collected and the 7 Day-PAR questionnaire was administered to the students. Subsequently, they performed the multistage 20-meter shuttle run test.

Data analysis

Descriptive statistics of all the variables of interest were calculated, providing the mean and standard deviation of the number of intervals carried out in the multistage 20-meter shuttle run test, the percentage of body fat, and the daily minutes of PA performed at different intensities, obtained with the questionnaire and the accelerometer. Next, to compare the measures of the questionnaire and the accelerometer and to analyse criterion validity, we performed bivariate correlational analysis of all the variables of the study, as well as linear regression analysis. In the linear regression analysis, the dependent variables were aerobic fitness and percentage of body fat, and the independent variables were the types of PA measured with the accelerometer and the questionnaire. Data from the accelerometer were analysed with the Actilife 6.7.1 software. The remaining analyses were performed with the SPSS 19 statistical package.

RESULTS

Descriptive statistics and correlational analysis

Table 1 shows the variation in the mean of daily minutes of PA performed at a certain intensity, depending on whether it was measured with the questionnaire or the accelerometer. Regarding the correlational analysis, Table 1 shows that sedentary activity measured with the accelerometer correlated negatively with the rest of the PA intensities measured with the accelerometer. This pattern of correlations also occurred between light PA and the remaining PA intensities measured with the questionnaire.

TABLE 1
Descriptive Statistics and Bivariate Correlations.

Variables	*M* *(min/day)*	*SD* *(min/day)*	1	2	3	4	5	6	7	8	9	10
1. Sedentary (Accel.)	549.53	81.60	-	-.39**	-.42**	-.29**	.18*	-.14	-.01	-.11	-.14	-.01
2. Light (Accel.)	230.53	45.80		-	.09	.25**	-.22*	.16	.10	.07	.02	.10
3. Moderate (Accel.)	29.80	14.23			-	.41**	-.37**	.25**	.17	.16	.23*	-.10
4. Vigorous (Accel.)	10.18	10.10				-	-.31**	-.05	.18*	.38**	.49**	-.37**
5. Light (Quest.)	1381.24	38.93					-	-.62**	-.33**	-.56**	-.19*	.06
6. Moderate (Quest.)	22.00	29.26						-	-.06	-.14	-.17	.25**
7. Hard (Quest.)	13.38	16.53							-	-.07	.07	-.06
8. Very hard (Quest.)	15.56	27.14								-	.42**	-.31**
9. Aerobic fitness	5.58	2.73									-	-.68**
10. Body Fat	26.13	10.83										-

Note. Accel = Accelerometer; Quest. = Questionnaire.
***p < .01. *p < .05.*

Light and moderate PA were positively related to vigorous PA, all of them measured with the accelerometer. This was not the case with the questionnaire measures, because moderate, hard, and very hard PA were negatively related, although not significantly.

With regard to the correlations between the accelerometer and the questionnaire, we found that accelerometer-measured sedentary activity correlated positively with light PA on the questionnaire (r = .18). However, light PA on the accelerometer correlated negatively with light PA on the questionnaire (r = -.22). Moderate and vigorous PA on the accelerometer also correlated negatively with light PA on the questionnaire (r = -.37 and r = -.31, respectively). Nevertheless, a positive relation was found between moderate PA on the accelerometer and moderate PA on the questionnaire (r = .25), and between vigorous PA on the accelerometer and hard and very hard PA on the questionnaire (r = .18 and r = .38, respectively).

Analysing the correlations among the different PA intensities and the criterion variables, aerobic fitness was positively related to moderate PA (r = .23) and vigorous PA (r = .49) measured with the accelerometer, and with very hard PA (r = .42) measured with the questionnaire, and negatively related to light PA measured with the questionnaire (r = -.19). The negative correlation found between moderate PA on the questionnaire and aerobic fitness was noteworthy, although this value was nonsignificant.

Percentage of body fat correlated negatively with vigorous PA on the accelerometer (r = .-37) and with very hard PA on the questionnaire (r = .-31). However, the positive and significant correlation between the percentage of body fat and moderate PA measured on the questionnaire (r = .25) was surprising. Lastly, we observed a negative and high correlation between aerobic fitness and the percentage of body fat (r = -.68).

Linear regression analysis

For the two criterion variables, aerobic fitness and percentage of body fat, various regression analyses were performed, including the types of PA measured with the accelerometer in a first model; in a second model, the types of PA measured with the questionnaire; and in a third model, the types of PA measured with either method that showed higher prediction power in the first two models. In the regression analysis, we did not contemplate the variable light PA measured with the questionnaire because it was obtained from the other PA variables (subtracting all the types of PA and the time dedicated to sleep from the total minutes per day), and altered the results of the analysis.

Table 2 shows that vigorous PA measured with the accelerometer positively predicted aerobic fitness in the first model (β = .51), whereas very hard PA measured with the questionnaire predicted it in the second model (β = .41). Upon introducing both variables in the third analysis, a higher regression weight was found in the measure of the accelerometer than in that of the questionnaire (β = .39 vs. β = .27). Table 3 shows that, in the first model, light PA measured with the accelerometer positively predicted the percentage of body fat (β = .19), whereas vigorous PA with accelerometer predicted it negatively (β = -.45). In the second model, body fat percentage was positively predicted by moderate PA on the questionnaire (β = .20) and negatively by very hard PA (β = -.29). In the last model, vigorous PA measured with the accelerometer had a higher regression weight than very hard PA on the questionnaire (β = -.30 vs. β = -.20).

TABLE 2
Linear Regression Analysis of Aerobic Fitness according to the Intensity of Physical Activity.

Variables	*F*	R^2 Adj.	β	*t*
	10.33**	.23		
Sedentary (Accel.)			-.04	-.44
Light (Accel.)			-.12	-1.47
Moderate (Accel.)			.01	.08
Vigorous (Accel.)			.51	5.71**
	9.62**	.17		
Moderate (Quest.)			-.10	-1.23
Hard (Quest.)			.08	1.05
Very hard (Quest.)			.41	4.92**
	26.62**	.30		
Vigorous (Accel.)			.39	4.77**
Very hard (Quest.)			.27	3.28**

Note. Accel = Accelerometer; Quest. = Questionnaire.
***p < .01. *p < .05.*

TABLE 3
Linear Regression Analysis of the Percentage of Body Fat according to the Intensity of Physical Activity.

Variables	*F*	R^2 Adj.	β	*t*
	6.67**	.16		
Sedentary (Accel.)			-.05	-.49
Light (Accel.)			.19	2.07*
Moderate (Accel.)			.04	.45
Vigorous (Accel.)			-.45	-4.82**
	6.80**	.12		
Moderate (Quest.)			.20	2.41*
Hard (Quest.)			-.07	-.80
Very hard (Quest.)			-.29	-3.33**
	12.55**	.16		
Vigorous (Accel.)			-.30	-3.31**
Very hard (Quest.)			-.20	-2.21*

Note. Accel = Accelerometer; Quest. = Questionnaire.
***p < .01. *p < .05.*

DISCUSSION

The aim of this study was to analyse the validity of the 7 Day-PAR questionnaire. For this purpose, we compared the results of this questionnaire with those of the ActiGraph GT3X accelerometer (concurrent validity). We also studied the relation between PA measured with both instruments and the level of aerobic fitness and body fat percentage of the sample (criterion validity).

The relations found among the different types of PA as a function of their intensity measured with the 7 Day-PAR and the ActiGraph GT3X accelerometer were not very high. In fact, recent studies have shown that, in general, the correspondence between measures from objective and subjective measurement methods of PA is not high (Celis-Morales et al., 2012; Medina, Barquera, & Janssen, 2013; Slootmaker, Schuit, Chinapaw, Seidel, & van Mechelen, 2009). Different explanations have been offered to clarify this issue. The study carried out by Sloomatker et al. (2009), with a sample of Dutch adolescents and adults, showed that age and educational level affect the match of both types of measures. These authors found that adults presented a better match than adolescents, and that adolescents with a higher educational level presented a better match than those with lower educational levels. It should not be forgotten that our study was carried out with a sample of adolescents, and this may explain why no powerful relations were found between some of the PA categories measured with the two instruments.

Although the relation between the measures from the 7 Day-PAR and the ActiGraph GT3X accelerometer were not very high, the relations found between the two measurement methods, and between their results and the criterion variables (body fat percentage and aerobic fitness) lead to the discussion of some interesting aspects concerning the validity of the 7 Day-PAR.

Light activity measured with the questionnaire and sedentary activity measured with the accelerometer

Light PA on the questionnaire (equivalent to sedentary activities) correlated negatively with the remaining PA measured with the questionnaire. This pattern of correlations was also observed between sedentary activity on the accelerometer and the different types of PA also measured with the accelerometer. Light PA on the questionnaire (equivalent to sedentary activities) also correlated negatively with light, moderate, and vigorous PA on the accelerometer. All these correlations are logical, indicating that the more sedentary activity one performs, the less PA one does.

It is also logical for light activity on the questionnaire to correlate negatively with aerobic fitness and positively with its equivalent (sedentary activity) measured with the accelerometer, although this correlation was low, raising doubts about the validity of the 7 Day-PAR for this type of activity.

Moderate activity measured with the questionnaire and with the accelerometer

Moderate PA on the questionnaire and on the accelerometer correlated positively. Nevertheless, a validity problem was detected with the 7 Day-PAR in the measure of moderate PA, which correlated positively with the percentage of body fat. This contradicts the results of prior studies indicating that participation in moderate and/or vigorous PA is related to lower body fat (Ekelund et al., 2004; Wittmeier et al., 2007). In addition, moderate PA on the accelerometer had a positive relation with aerobic fitness, which is consistent with the literature (Dencker & Andersen, 2011; Kristensen et al., 2010).

The arguments of Riddoch et al. (2004) may serve to understand the problems involved in the measure of moderate PA. These authors indicate that the levels of moderate PA measured with self-reports are lower than those measured with the accelerometer, which is consistent with our results. The explanation of these authors for this discrepancy is that moderate PA tends to be sporadic and unplanned, so it is more difficult to identify, recall, quantify, and detail in self-reports.

Hard and very hard activity measured with the questionnaire and vigorous activity measured with the accelerometer

Hard and very hard PA on the questionnaire correlated positively with vigorous PA on the accelerometer. The correlation index between very hard PA on the questionnaire and vigorous PA on the accelerometer was the highest found between two equivalent types of PA on both instruments. This indicates higher validity of the 7 Day-PAR for the measure of high intensity PA. In turn, it is consistent with the results of another study carried out with Spanish adolescents that found clearly higher correlations for vigorous PA in comparison with moderate PA when comparing the results of various questionnaires with those of an accelerometer (Martínez-Gómez et al., 2009).

Moreover, both very hard PA on the questionnaire and vigorous PA on the accelerometer correlated positively with aerobic fitness and negatively with body fat percentage, maintaining the prediction effects in the regressions. These results were expected, in accordance with prior studies of aerobic fitness (Dencker & Andersen, 2011; Kristensen et al., 2010) and body fat percentage (Butte et al., 2007; Dencker et al., 2006; Gutin et al., 2005; Moliner-Urdiales et al., 2009; Ness et al., 2007). Nevertheless, we note that the predictor effect was higher for vigorous PA on the accelerometer, as expected from a more valid instrument to measure PA.

Other studies have shown that the highest levels of PA, measured both by questionnaire and accelerometer, are good predictors of the percentage of body fat and of other health-related factors (Celis-Morales et al., 2012). These results show the appropriateness of using subjective methods like the 7 Day-PAR to measure high intensity PA, due to its economy and ease of use. This evidence also underlines the need to promote this type of PA (very hard, vigorous) because of its clear relation with health.

Relation between the different levels of PA using the same instrument

Moderate, hard, and very hard PA measured with the questionnaire were not related, but vigorous PA on the accelerometer was positively related to light and moderate PA on the accelerometer. This result may be due to the fact that the people who completed the 7 Day-PAR had to differentiate and delimit the time dedicated to each type of PA, whereas in real life, different types of PA are intermingled. In addition, identifying and compiling the exact time dedicated to each type of PA is a difficult task. Therefore, it seems that the 7 Day-PAR, like any subjective method, presents some limitations to measure PA in temporal bands in which the intensity of the exercise varies constantly. The accelerometer does not present this limitation, as it provides objective and direct measures of PA.

CONCLUSIONS AND LIMITATIONS

In view of the results of this study, the validity of the 7 Day-PAR could be considered acceptable for very hard PA, but low for hard and light PA. A problem of validity was detected for moderate PA. Perhaps the validity of this questionnaire could be improved for moderate PA if more examples of activities that represent this intensity were specified in the protocol (Sallis, 1997). It would also be interesting to warn the informers that moderate PA will probably be intermingled with higher intensity activities within the same session, and these intervals should be specified. Another alternative to improve the measure of moderate PA would be to modify the questionnaire protocol (Sallis, 1997) so that informers could indicate fragments of activity of less than 10 minutes (moderate, hard or very hard PA).

A limitation of this validation study was that the PA categories of the 7 Day-PAR and the Actigraph GT3X accelerometer were not exactly equivalent. The structure and design of the 7 Day-PAR are very interesting to facilitate recall. Nevertheless, the questionnaire could be improved if the terms of the different types of PA it measures, as well as their corresponding intensities, were updated to coincide with those currently used in accelerometry.

Other limitations of this study were the following. The accelerometer data were stored in 60-second *epochs*. Shorter *epochs* would have offered more rigorous measures of sedentary activity and PA. In recent years, studies have used *epochs* of 60, 15, and 5 seconds, but current literature recommends the use of 1-second *epochs* (Calahorro-Cañada et al., 2015). Another limitation was the use of cut-points validated for vertical-axis acceleration (Evenson et al., 2008), whereas our accelerometers stored data from the magnitude vector of the 3-axis acceleration. However, the lack of agreement in the scientific community concerning the appropriate cut-points to measure the different intensities of PA in children and adolescents should be remarked (Calahorro-Cañada et al., 2015). This fact, together with the constant technological and methodological evolution of accelerometry, hinders the election of the most appropriate cut-points, depending on the accelerometer model, the age of the sample and the categories of PA which are of interest in each study. Moreover, several studies with children and adolescents have pointed out that vertical-axis data and magnitude vector data of the Actigraph GT3X accelerometer predict energy expenditure in a similar way (Hänggi et al., 2013; Jimmy, Seiler, & Mäder, 2013). This evidence could justify the cut-points used in this study. In fact, some validation studies with children and adolescents suggest cut-points for the magnitude vector of the Actigraph GT3X accelerometer which are quite similar to the cut-points of this study. For instance, Hänggi et al. (2013) established the cut-point for sedentary activity at < 3 count per second (< 180 counts per minute); Santos-Lozano et al. (2013) established the cut-point for moderate PA at 2114 counts per minute; and Jimmy et al. (2013) established the cut-point for vigorous PA at 381 counts per 5 seconds (4572 counts per minute). The differences between these cut-points and the ones used in this study are no larger than the differences that can be found between the cut-points proposed for the magnitude vector of the Actigraph GT3X accelerometer in diverse validation studies (Hänggi et al., 2013; Jimmy et al., 2013; Santos-Lozano et al., 2013). As Calahorro-Cañada et al. (2015) suggest, the scientific community should come to an agreement to specify common cut-point criteria.

Although this issue is beyond the scope of this study, future studies should review the validity of the accelerometer to measure light PA, and analyse the relation between this variable and diverse health-related factors. In our study, light PA on the accelerometer was related to a higher percentage of body fat in the regression model. This result seems incongruous, especially when considering that light PA on the accelerometer had a negative relation with sedentary activity on the accelerometer and a positive relation with vigorous PA on the accelerometer.

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