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Physical Activity Patterns in Adults Who Are Blind as Assessed by Accelerometry

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The main purpose of our study was to quantify, by using accelerometry, daily physical activity (PA) in adults with visual impairments. Sixty-three adults (34.9% women) who are blind (18–65 years) wore an accelerometer for at least 3 days (minimum of 10 hr per day), including 1 weekend day. Nineteen participants (~30%) reached the recommendation of 30 min per day of PA, when counting every minute of moderate or greater intensity. No one achieved that goal when considering bouts of at least 10 min. No differences were found between genders in PA measures. Chronological age, age of blindness onset, and body mass index were not associated with PA. We conclude that adults who are blind have low levels of PA and are considerably less active compared with the general population. Health promotion strategies should be implemented to increase daily PA for people with visual impairments.

Keywords: visual impairment; physical activity; accelerometry; disability; adults

The regular practice of physical activity is associated with several health benefits and a reduction in risk of all-cause mortality (Garber et al., 2011; Warburton, Nicol, & Bredin, 2006). Physical activity, especially if performed at a moderate to vigorous intensity, decreases the risk of developing coronary heart disease, stroke, type 2 diabetes, and some forms of cancer (Garber et al., 2011; Pate et al., 1995; U.S. Department of Health and Human Services, Office of Disease Prevention and

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Health Promotion, Physical Activity Guidelines Advisory Committee, 2008). There is also important evidence that physical activity has a significant impact on several psychological parameters (such as information processing speed, attention capacity, and executive-control processes) and is associated with a lower risk of cognitive decline and dementia (Colcombe & Kramer, 2003; Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001; Marmeleira, Godinho, & Fernandes, 2009).

The World Health Organization's global strategy on diet, physical activity, and health advocates for a greater focus on national monitoring and surveillance of patterns of physical activity and on the identification of specific high-risk groups and measures to respond to their needs (World Health Assembly, 2004). This would aid in identifying groups to target with more efficient physical activity promotion strategies, including policy formulation, planning physical activity promotion interventions, and accurate evaluation of such physical activity promotion actions (Hagströmer, Oja, & Sjostrom, 2007; Kirchner, 2006; U.S. Department of Health and Human Services, Office of the Surgeon General, 2005).

The number of people of all ages who have visual impairments worldwide is estimated to be 285 million, of whom 39 million are blind (Pascolini & Mariotti, 2012). In Portugal, according to the last available census, people who have at least one type of a disability represented 6.1% of total resident population, nearly 40% of whom have a sensory disability (auditory and visual; Gonçalves, 2003). Unfortunately, little is known about the physical activity behavior of people with visual impairments, because they are typically not included in large-scale population studies. In Portugal, a recent study used accelerometry to evaluate physical activity in a representative sample of the country's population, but people who are blind were not included (Baptista et al., 2012).

Some research that focused on the physical fitness of children and adolescents with visual impairment (both blindness and low vision) has shown that they engage in insufficient physical activity and have low scores on measures of physical fitness (Hopkins, Gaeta, Thomas, & Hill, 1987; Kobberling, 1991; Longmuir & Bar-Or, 2000). Conversely, it has been shown that young people with visual impairment who engage in regular physical activity improve their fitness and exhibit levels of fitness comparable with those of individuals without visual impairments (Houwen, Hartman, & Visscher, 2010; Lieberman, Byrne, Mattern, Watt, & Fernandez-Vivo, 2010; Ponchillia, Powell, Felski, & Nicklawski, 1992; Williams, 1996).

There have been reports that individuals with a later onset of blindness and greater visual acuity have greater physical fitness (Skaggs & Hopper, 1996) and that a high degree of visual disability might be associated with reduced physical activity (Hopkins et al., 1987). In a more recent study by Holbrook, Caputo, Perry, Fuller, and Morgan (2009), the authors examined the influence of visual impairment severity and the age of visual impairment onset and found that these factors did not influence physical activity participation in a U.S. sample of adults who are blind.

To implement public health policies for promoting physical activity, it is necessary to understand the actual physical activity level of the target population. Unfortunately, few studies have assessed the adherence of people with visual impairments to recommendations for physical activity. In this context, we examined habitual physical activity, as assessed by accelerometry, in Portuguese adults who are blind. In addition, we investigated whether factors such as gender, chronological age, age of blindness onset, and body mass index are associated with physical activity in adults who are blind.

Method

Participants

The inclusion criteria consisted of being 18–65 years of age, being legally blind, living independently in the community, being a member of the Associação dos Cegos e Amblíopes de Portugal (ACAPO; the main Portuguese association for people with a visual impairment), having a phone number registered in the ACAPO database, and living in the Lisbon area.

In Portugal, a person is considered legally blind (Decree Law 49331/69 of October 28, 1969) if corrected central visual acuity is 20/200 (6/60 m; 0.1 decimal) or less in the better eye or if the angle of corrected field of vision is less than 20° (e.g., tunnel vision). Information on the level of visual impairment was first obtained from the records maintained by the ACAPO association and subsequently confirmed directly with the participants, who were also asked about the age of blindness onset.

According to the ACAPO records, there were 204 age-eligible persons. Twenty-seven had no telephone number, which left 177 potential participants. For 6 months, approximately 8 adults were contacted by phone every week by ACAPO technicians. All participants were informed about the study and invited to participate. From the initial group of 177 potential participants, 77 were not contactable by phone (i.e., invalid phone number or unreachable after 2 attempts), 30 declined to participate, and 3 had moved out of the Lisbon area, which left 67 volunteers (37.9% of those meeting the inclusion criteria and 67.0% of those contacted). Sufficient data were collected on 63 volunteers (24 and 39 with congenital and acquired blindness, respectively), because 4 volunteers did not meet the accelerometer wear-time criteria (described in the data collection section below). There was no significant difference in the proportions of men and women among volunteers, persons who refused to participate, or uncontactable persons. Persons who refused to participate tended to be older (53.6 ± 11.2 years) than volunteers (47.6 ± 11.4 years) and uncontactable persons (48.0 ± 12.9 years). The characteristics of the participants are listed in Table 1. None of the participants reported physical limitations in mobility. Eleven participants were engaged in some form of exercise and sport.

All participants were informed about the objectives of the study and gave their informed consent to participate. The study was approved by the University of Évora ethics committee and was conducted in accordance with the World Medical Association's Declaration of Helsinki on human studies (World Medical Association, 1997).

Table 1 Descriptive Characteristics of the Participants

Characteristic	Men (*n* = 41)	Women (*n* = 22)	All (*N* = 63)
Age (years)	49.3 (10.8)	44.7 (12.0)	47.7 (11.3)
Height (cm)	170.1 (5.9)*	155.2 (6.7)	164.9 (9.5)
Weight (kg)	77.2 (13.6)*	68.4 (14.2)	74.2 (14.3)
BMI (kg/m^2)	26.7 (4.4)	27.8 (5.4)	27.1 (4.8)

Notes. * Significant differences between genders ($p < .05$). The data are presented as mean (standard deviation). BMI = body mass index.

Instruments

Habitual physical activity was assessed by accelerometry (model GT1M; ActiGraph, Fort Walton Beach, FL). The GT1M (3.8 × 3.7 × 1.8 cm; 27 g) measures the acceleration of normal human movements, ignoring high frequency vibrations associated with mechanical equipment. It stores physical activity information in user determined epoch lengths. Data are downloaded using ActiGraph software and stored in a computer database. ActiGraph accelerometer measurements have been used previously in physical activity research with people with visual impairments (Cervantes, & Porretta, 2013; Willis, Jefferys, Vitale, & Ramulu, 2012) and have been shown to be valid and reliable for quantifying physical activity in adults without visual impairments (Pate, Pratt, Blair, Haskell, Macera, Bouchard et al., 1995; Silva, Mota, Esliger, & Welk, 2010).

Participants' height was measured without shoes with a wall-mounted tape measure to the nearest centimeter. After participants removed heavy clothing, their weight was measured to the nearest 0.5 kg with a Seca balance scale (Seca Vogel & Halke, Hamburg, Germany).

Data Collection

One of the researchers met each of the participants at his or her home or work at a mutually convenient time. Participants were instructed to use the accelerometer during waking hours for 7 consecutive days, except during water activities. The device was securely attached on the right hip, near the iliac crest. The accelerometers were activated on the first day at 6:00 a.m., and a decision was made to record data in 15-s epochs to enable comparison of the results of this study with those of Baptista et al. (2012). The accelerometer activation and data download were performed using the software Actilife Lifestyle (Version 3.2). Processing was done with the program MAHUffe (Version 1.9.0.3; http://www.mrc-epid.cam.ac.uk/research/resources/materials-transfer-disclaimer/physical-activity-downloads/) from the original downloaded files from the accelerometer (*.dat).

The data inclusion criteria were the same as in the study of Baptista et al. (2012) to allow for meaningful comparisons with previous results on the physical activity prevalence of the general Portuguese population. Therefore, the study included the results from participants with at least 3 valid days (including 1 weekend day) and a minimum wear time of 10 hr per day. Periods of at least 60 consecutive min of zero intensity counts were considered nonwear time.

Physical activity variables evaluated by accelerometry included minutes per day spent in different intensities of activity, minutes per day spent in 10-min bouts of moderate or greater intensity physical activity, mean time (minutes per day) of total physical activity (light, moderate, and vigorous), mean intensity of physical activity (counts per minute), and number of steps per day.

The time spent at different levels of physical activity was calculated using the following criteria: sedentary: < 100 counts per min; light: 100–2019 counts per min; moderate: 2,020–5,998 counts per min (corresponding to 3–5.9 METs); vigorous: ≥ 5,999 counts per min (corresponding to ≥ 6 metabolic equivalent of tasks, or METs; Baptista et al., 2012; Troiano, Berrigan, Dodd, Masse, Tilert, & McDowell, 2008). To examine adherence to physical activity recommendations for public health, we considered the accumulation of at least 30 min of moderate to vigorous physical activity (MVPA) per day (Pate et al., 1995; World Health Assembly, 2004). We also computed bouts of 10 min or more of MVPA, which were defined as 10 or more consecutive min above the respective cutoff value, with allowance of 1 min in every 5 min below the threshold (Baptista et al., 2012). This was referred to as a modified 10-min bout.

Data Analysis

The assumptions of normality and homogeneity of variance were verified using Shapiro-Wilk and Levene tests, respectively. Independent sample *t* test or the non-parametric Mann-Whitney *U* test were used as appropriate to compare physical activity between genders and congenital/acquired blindness groups.

The chi-square test was conducted to compare the proportion of participants who achieved the recommended levels of physical activity by gender. One-way analysis of variance was used to compare physical activity between BMI categories, which were defined according to the World Health Organization (2000) classification: normal (≥ 18.5 kg/m^2 and < 25 kg/m^2), overweight (≥ 25 kg/m^2 and < 30 kg/m^2), and obese (≥ 30 kg/m^2).

Pearson's correlation test was used to study the associations between physical activity and age. For participants with acquired blindness, associations between physical activity and age of blindness onset were also computed. Physical activity data are presented as proportions, means, standard deviations, and 95% confidence intervals.

Analyses were conducted with the statistical software PASW Statistical for Windows (Version 18.0; IBM SPSS Inc.). For all statistical tests, significance was set at $p < .05$.

Results

Results for habitual physical activity as evaluated by accelerometry are presented in Table 2. The majority of participants' time was spent in sedentary activity, which accounted for an average of 679.8 min per day. Participants engaged in light physical activity for an average of 143 min per day. The average time spent in health-related physical activity was 25 min per day (moderate: 24.5 min per day; vigorous: 0.5 min per day). About 30% of the participants did not perform any vigorous activity. Participants accumulated an average of 5,412 steps per day. No significant differences were found between genders in any of the physical activity variables.

Nineteen participants (~30%) reached the recommendation of 30 min per day of physical activity, when every minute of moderate or greater intensity was counted (Figure 1). When one examines the cumulative daily physical activity accounting only for periods of time equal to or greater than 10 min of moderate or greater intensity and not the sum of all min spent at this intensity, no participant has achieved 30 min per day of physical activity. Moreover, from the group of 19 participants that reached the recommendation of 30 min per day of physical activity when every minute of moderate or greater intensity was counted, only 2 participants have completed 10 min of continuous activity at that intensity level

Table 2 Physical Activity by Gender

	Men (n = 41)		Women (n = 22)		All (N = 63)		
Parameter	Mean (SD)	95% CI	Mean (SD)	95% CI	Mean (SD)	95% CI	p
Number of days measured	5.8 (1.1)	[5.5, 6.2]	6.3 (0.9)	[5.9, 6.7]	6.0 (1.1)	[5.7, 6.3]	.101
Wear time (hr/day)	14.3 (1.3)	[13.9, 14.7]	13.9 (1.3)	[13.3, 14.4]	14.1 (1.3)	[13.8, 14.5]	.235
Sedentary behavior (hr/day)	11.5 (1.2)	[11.1, 11.9]	11.0 (1.6)	[10.3, 11.7]	11.3 (1.3)	[11.0, 11.7]	.148
Light PA (min/day)	140.3 (39.1)	[128.0, 152.6]	149.9 (58.2)	[125.5, 177.5]	143.0 (46.3)	[132.4, 155.7]	.537
Moderaté PA (min/ day)	24.9 (18.7)	[19.0, 30.8]	23.8 (12.8)	[18.7, 30.2]	24.5 (16.8)	[20.5, 29.0]	.800
Vigorous PA (min/ day)	0.7 (2.9)	[–0.2, 1.6]	0.2 (0.2)	[0.1, 0.3]	0.5 (2.3)	[–0.1, 1.1]	.306
Total PA (min/day)	165.9 (48.8)	[150.5, 181.3]	171.9 (61.2)	[149.2, 203.1]	168.0 (53.1)	[156.1, 182.7]	.674
Average PA (counts/ min)	194.9 (92.0)	[165.9, 224.0]	199.4 (81.6)	[168.5, 240.9]	196.5 (87.9)	[176.1, 220.5]	.850
Number of steps per day	5,434.6 (2741.1)	[4,569.3, 6,299.8]	5,367.9 (1,885.5)	[4,509.6, 6,226.1]	5,412.0 (2,468.5)	[4,785.1, 6,038.9]	.921

Notes. p values are for comparisons between genders. PA = physical activity. CI = confidence interval.

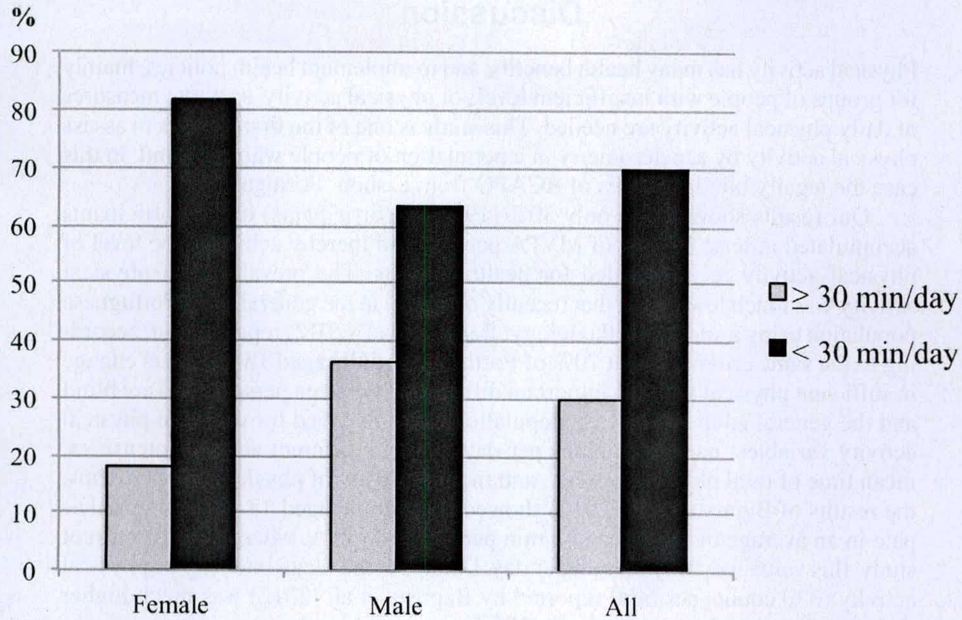

Figure 1 — Proportion of participants who accumulated at least 30 min per day of moderate to vigorous physical activity.

each day. Forty-nine participants (~78%) did not accumulate a single modified bout of 10 min of at least moderate-intensity physical activity during any day.

According to the BMI categories, 22 participants had a normal weight, 28 were overweight, and 13 were obese. No differences between groups were found across BMI categories for MVPA, $F(2, 60) = 0.332$, $p = .72$, average physical activity, $F(2, 60) = 0.052$, $p = .95$, number of steps per day, $F(2, 60) = 0.097$, $p = .91$, or sedentary behavior, $F(2, 60) = 1.005$, $p = .37$. Pearson's correlation showed that age was not associated with MVPA, $r(61) = -.152$, $p = .24$), average physical activity, $r(61) = -.152$, $p = .23$, number of steps per day, $r(61) = -.096$, $p = .46$, or sedentary behavior, $r(61) = 0.137$, $p = .29$. Likewise, for the persons who became blind after birth, no significant association was found between age of blindness onset and MVPA, $r(37) = -.03$, $p = .86$, average physical activity, $r(37) = .039$, $p = .82$), number of steps per day, $r(37) = -.184$, $p = .28$, or sedentary behavior, $r(37) = .115$, $p = .49$.

Finally, no significant differences were found between participants with congenital and acquired blindness in MVPA, $t(61) = -.617$, $p = .54$, average physical activity, $t(61) = -.512$, $p = .61$, number of steps per day $t(61) = -.566$ $p = .57$, or sedentary behavior, $t(61) = .626$, $p = .53$.

Discussion

Physical activity has many health benefits, and to implement health policies, mainly for groups of people with insufficient levels of physical activity, accurate measures of daily physical activity are needed. This study is one of the first surveys to assess physical activity by accelerometry in a population of people who are blind, in this case the legally blind affiliates of ACAPO from Lisbon, Portugal.

Our results showed that only 30% (19 in 63 participants) of the participants accumulated at least 30 min of MVPA per day and thereby achieved the level of physical activity recommended for health benefits. The prevalence of physical activity was much lower than that recently observed in the general adult Portuguese population using a similar methodology: Baptista et al. (2012) reported that, according to the same criteria, about 70% of Portuguese adults aged 18–64 years engage in sufficient physical activity. Important differences between persons who are blind and the general adult Portuguese population were observed for the main physical activity variables, namely minutes per day spent in different activity intensities, mean time of total physical activity, and mean intensity of physical activity. Thus, the results of Baptista et al. (2012) showed that people aged 18–64 years participate in an average of more than 40 min per day of MVPA, whereas in the current study, this value was only 25 min per day. Likewise, the mean intensity of physical activity (330 counts per min) reported by Baptista et al. (2012) was much higher than that found in the current study (196.5 counts per min).

Our results are in line with those from previous studies, which reported a large reduction in the prevalence of physical activity when the criteria for sufficient physical activity depended on engagement in 10-min bouts of MVPA (Baptista et al., 2012; Hagströmer et al., 2007; Troiano et al., 2008). In the case of the Swedish population, the prevalence of physical activity dropped from 52% to 1% (Hagströmer et al., 2007); in Portugal, the prevalence after the application of such criteria was 4–6% at 18–39 years, 7–9% at 40–64 years, and 3% in persons aged 65 or older (Baptista et al., 2012). This discrepancy in accelerometry-based studies when 10-min bouts of activity are considered, and the fact that current recommendations are based on epidemiological associations between self-reported physical activity and health, raises the question about the need for bouts of physical activity when accelerometers are used. In the particular case of people who are blind, it will be important to examine in future studies the level of concordance between self-reported physical activity and objective measures of physical activity.

Our results were congruent with those of previous studies that have measured physical activity in adults with visual impairments. In a study with a group of 25 adults (18–60 years old) with visual impairments, it was reported that the average number of daily steps was considerably lower even than that of aged healthy adults without visual impairments: Holbrook et al. (2009) reported an average daily step count noticeably higher than that found in the current study (8,028 ± 3,232 versus 5,412 ± 2,469 steps per day, respectively). However, a recent study (Holbrook, Kang, & Morgan, 2013) that collected data from 31 adults (45.9 ± 11.2 years old) with visual impairments reported an amount of physical activity (5,530 ± 3,808 steps per day) very similar to that found in the current study. It is important to note that the average daily step count achieved by the participants in the current study differs substantially from the general 10,000 steps per day recommendation for healthy adults (Tudor-Locke & Bassett, 2004). Nevertheless, previous studies have shown that a large part of the general population did not achieve the recommendation of 10,000 steps per day (e.g., Tudor-Locke, Johnson, & Katzmarzyk, 2011).

Previous studies among youngsters with visual impairment have also found low levels of physical activity in comparison with their peers without disability (Kobberling, 1991; Kozub & Oh, 2004; Longmuir & Bar-Or, 2000). Our results suggest that the low levels of physical activity previously demonstrated in childhood and adolescence continue into adulthood. It is important to note that although visual impairments seem to be one of the disabilities associated with a higher prevalence of sedentary lifestyles (Longmuir & Bar-Or, 2000), it has been shown that it is possible to motivate persons who are blind to be more active and that exercise programs could improve several components of physical fitness (Larsson & Frandin, 2006; Miszko, Ramsey, & Blasch, 2004; Surakka & Kivela, 2008).

The improvement of physical activity is an imperative goal, considering that individuals with disabilities are at an increased risk for a number of preventable health problems (e.g., obesity and diabetes mellitus; Rimmer, 2006; Rimmer & Rowland, 2008), and inpatient and medication costs have also been reported to be higher in people with disabilities compared with the general population (Fried, Ferrucci, Darer, Williamson, & Anderson, 2004; U.S. Department of Health and Human Services, National Institute of Child Health & Human Development, 1993; U.S. Department of Health and Human Services, Office of the Surgeon General, 2005). Thus, the problem of low levels of physical activity also occurs in persons with other disabilities, as demonstrated by a literature review, which concluded that the proportion of people with intellectual disability achieving 30 min of moderate-intensity physical activity on 5 or more days per week ranged only from 17.5 to 33% (Stanish, Temple, & Frey, 2006). A call for action is urgent because individuals with a disability can particularly benefit from an active lifestyle; it reduces the risk for secondary health problems, and all levels of functioning can be influenced positively (van der Ploeg, van der Beek, van der Woude, & van Mechelen, 2004).

Several environmental factors (such as accessibility to facilities, opportunities for activity, and safety) could account for reduced physical activity among people who are blind. For example, it is probable that the increased risk of falls and collisions that occurs among people who are blind interfere negatively in their confidence as independent travelers (Legood, Scuffham, & Cryer, 2002). Furthermore, it is likely that the availability of structured physical activities (e.g., sport activities in clubs or formal exercise programs) at the community level is very limited for people who are blind. Such personal factors as self-efficacy, level of disability, motivation, gender, and age have been also identified as correlates of physical activity behavior in people with disabilities (van der Ploeg et al., 2004). In the case of children who are blind, it has been noted that parents' and teachers' overprotection could in some cases compromise the adherence to physical activity (Lieberman, Stuart, Hand, & Robinson, 2006). Further studies should identify the factors amenable to modification that are associated with the low values of physical activity observed in adults who are blind.

Our study did not corroborate previous findings from general population surveys (including Portugal) of higher physical activity in males compared with females (Baptista et al., 2012; Hagströmer et al., 2007). However, similar findings have been previously reported for people with physical and sensory disabilities (including visual impairment) and adults with intellectual disability or cerebral palsy (Holbrook et al., 2009; Longmuir & Bar-Or, 2000; Nieuwenhuijsen et al., 2009; Stanish et al., 2006). It seems that the presence of some disabilities limits the participants' physical activity and attenuates gender disparities that are frequently found in general population surveys.

Chronological age was not associated with physical activity. However, it is important to note that the participation refusal rate was higher among older individuals, which could have led to an overestimation of physical activity levels with age. Likewise, age of blindness onset did not have a significant impact on physical activity patterns. One might expect that becoming blind later in life could be associated with higher physical activity values because of a theoretical advantage at the level of orientation and mobility skills. There are some possibilities why that was not the case in this study. If it is true that development in some areas (e.g., motor development) is delayed in children who are blind at birth, other factors that are relevant for orientation and mobility, particularly the development of spatial abilities, do not seem to be affected by age of blindness onset (Skaggs & Hopper, 1996; Tinti, Adenzato, Tamietto, & Cornoldi, 2006). In addition, all participants in this study are legally blind, but that does not mean that they all have the same level of disability; it is possible that minor differences in visual acuity or field of vision influence physical activity behavior. Nevertheless, this hypothesis was not confirmed in a recent study that used similar inclusion criteria for visual impairment, in which it was reported that activity levels (daily steps) of young and middle-aged adults did not vary by the severity of visual impairment (Holbrook et al., 2009). Future studies should address this issue.

The average BMI (27.1 ± 4.1 kg/m^2) was above the cutoff level for being overweight. In fact, almost two thirds of the participants were overweight or obese. The BMI of our population is relatively lower than that reported recently (averages between 29.9 and 30.8 kg/m^2) in two studies of young and middle-aged adults in the United States who are visually impaired (Holbrook et al., 2009, 2013). Body mass index was not related with physical activity behavior. Previous accelerometry-based studies in the general population provide little evidence for the role of BMI in physical activity patterns. For example, studies in Portugal and United States have not analyzed the association between BMI and accelerometry data (Baptista et al., 2012; Troiano et al., 2008). In a population-based study conducted in Sweden, it was reported that physical activity level was lower in people with higher BMI (Hagströmer et al., 2007). Holbrook et al. (2009), in their study of adults who are visually impaired, did not explore the association between BMI and physical activity.

The current study included a larger number of participants than previous studies of physical activity in people who have visual impairments; for example, 25 adults volunteered to participate in the study by Holbrook et al. (2009). The main limitations of our study include the lack of an evaluation of the severity of blindness and the relatively low participation rate (this latter limitation may have led to some overestimation of physical activity). To compare results of physical activity prevalence with those from previous studies, especially with the population of Portugal, cut points chosen for vigorous and moderate activity were the same as those used by Baptista at al. (2012) and Troiano et al. (2008) with the limitations already described by the latter. Finally, it is recommended that in future studies, the minimum number of valid days of accelerometer wear should be extended, because 3 days of physical activity data may be insufficient for acquiring a stable estimate in adults with visual impairment (Holbrook et al., 2013).

In conclusion, our findings indicate that young and middle-aged adults who are blind have low levels of physical activity and are less active than the general Portuguese adult population. Moreover, no association was found between physical activity and gender, chronological age, age of blindness onset, or body mass index. It is important that health promotion strategies should be implemented to increase daily physical activity in people who are blind.

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