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Motor fitness and preschooler children obesity status

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ABSTRACT

The aim of this study was to examine the association between motor fitness (MF) and obesity status in preschool children.

The sample comprised 467 children aged 3–6 years. Preschool children body mass index was classified according to International Obesity Task Force and categorised into three levels, normal, overweight and obesity. Total physical activity was assessed by accelerometer and MF test was assessed through two MF tests 10 × 5m shuttle run test (SRT) and a 7 m jumping distance on 2 feet test (J2F). Low MF was considered for MF if SD above 1. A single variable with three categories was created: low MF medium MF and high MF.

The prevalence of normal weight, overweight and obesity was 67.6%, 22.7% and 9.7%, respectively. The prevalence of SD > 1 for SRT was 13.7% and 14.4% for J2F, for single variable was 19.2%. Multinomial logistic regression analysis showed that obese preschoolers were more likely six times classified as having low MF level than their non-overweight counterparts (OR: 6.4; IC: 1.3–36.6).

This study showed a considerable prevalence of overweight and obesity among preschoolers. Obesity has already been associated with lower MF. Further longitudinal studies are needed to confirm this data.

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KEYWORDS
Physical fitness; motor fitness; preschool children; body mass index

Introduction

The high prevalence of childhood overweight and obesity have been cause for great concern since detrimental biological and psychological consequences of childhood overweight have been described. In addition, it was recognised that fitness and physical activity (PA) are associated with obesity. For instance, children and adolescents with overweight are less fit than their leaner peers (Kriemler et al., 2008; Ortega, Ruiz, & Castillo, 2013), while there is growing evidence that fitness during childhood and adolescence is negatively associated with total and central body fat in cross-sectional studies as well as later in life (Cadenas-Sanchez, Artero, Concha, Leyton, & Kain, 2015; Ortega et al., 2007).

Whereas physical fitness is considered a powerful health marker in children and adolescents (Ortega, Ruiz, Castillo, & Sjöström, 2008; Smith et al., 2014), motor fitness (MF) is a component of physical fitness that is related with the improvement of performance in sports and motor skills (Ortega et al., 2015). The main components of MF are speed, agility and balance (Caspersen, Powell, & Christenson, 1985; Ortega et al., 2015). Secular trends have shown a decrease for most of the basic motor abilities (Klein, Manz, Ferrari, Struder, & Graf, 2015). Although the preschool years are a critical period in terms of developing these components, available data are scarce (Klein et al., 2015). Therefore, in this age, it is very important to direct special attention in satisfying and developing fundamental motor skills, which enable children to overcome space, obstacles and resistance and to manipulate objects. Additionally, improvements in MF have shown to reduce the risk of becoming overweight/obese in adolescence (Haga, 2009; Moliner-Urdiales et al., 2011). However, the data addressing the relationship of MF with obesity status in preschool children is scarce (Bayer, Bolte, Morlock, Rückinger, & von Kries, 2009). Thus, the aim of this study was to examine the association between the MF and the obesity status in preschool children.

Methods

Participants and data collection

This was a cross-sectional study completed in kindergartens enrolled in the Preschool PA, Body Composition and Lifestyle Study (PRESTYLE), a longitudinal study that began in the autumn of 2012. All kindergartens located in the metropolitan area of Porto were invited to participate and 20 classrooms were selected. All children belonging to the selected classrooms were invited to participate. A random sample of 1160 children, aged 3–6 years, was recruited from kindergartens located in the metropolitan area of Porto, Portugal. Only 467 preschoolers met the inclusion criteria (52.8% girls). In this study, we have included results in the shuttle run test (SRT), 7 m jumping distance on 2 feet test (J2F) and total physical activity time (TPA). Height and weight information has also been included. Data collection took place between April 2013 and November 2014. A written consent was obtained from parents and school supervisors. Study procedures were approved by the Portuguese Foundation for Science and Technology and by the Scientific Board of Physical Activity and Health PhD programme.

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Anthropometric measures

Body mass and height were measured by standard anthropometric methods. Body mass was measured to the nearest 0.10 kg, with participants lightly dressed (underwear and t-shirt only) using a portable digital scale (Tanita Inner Scan BC 532, Tokyo, Japan). Height was measured to the nearest millimetre in bare or stocking feet with children standing upright against a Holtain portable stadiometer (Tanita). The measurements were repeated twice and the average was recorded. Body mass index was calculated and classified according to International Obesity Task Force into three groups, normal weight, overweight and obesity (Cole, Bellizzi, Flegal, & Dietz, 2000).

MF

For assessing MF we used the two MF tests, 10 × 5 m SRT and jumping a distance of 7 m on 2 feet (J2F). Some studies suggested that SRT and J2F are reliable tests to be used for assessing MF (speed/agility) in preschool children (Fjortoft, Pedersen, Sigmundsson, & Vereijken, 2011; Haga, 2008). Each MF test was standardised and standard deviation above one (SD > 1) was considered low motor abilities. Afterwards, MF was categorised as low MF and high MF. Afterwards, both MF tests were associated and a single variable was created with three categories: low MF (SD > 1 for SRT and J2F); medium MF (SD > 1 for SRT or J2F) and high MF (SD < 1 for SRT and J2F). Although several studies have examined the construct validation of MF tests, the majority assessed the overall scores of the subset rather than the single test measurements (Fjortoft et al., 2011; Fjørtoft, Pedersen, Sigmundsson, & Vereijken, 2003). Therefore, little information is available about which test is the most valid in this age group. In addition, no criterion-related validity or health-related studies (either longitudinal or cross-sectional) were identified (Fjortoft et al., 2011).

Children were tested individually. The SRT and JSF were explained and demonstrated before the child started. If a child made an error, instructions and demonstrations were repeated, and the child was allowed a new attempt. If a second error occurred or if a child could not perform the test, then the MF test was scored as missing.

PA

Daily PA was measured using the ActiGraph GT1M accelerometer (Pensacola, FL, USA). This accelerometer provides output in activity counts, which gives information about the intensity of PA (Janz, 1994). Alternatively, accelerometer output can be interpreted using specific cut-points, which identify time in different intensities of PA. Data reduction, cleaning and analyses of accelerometer data were performed using a specially written program described and used previously (Purslow, Hill, Saxton, Corder, & Wardle, 2008; Sardinha, Baptista, & Ekelund, 2008). Data were analysed using specific paediatric cut-points, which have been validated for young children: ≥150 cpm for active time (total PA time (TPA) as already been used in several studies (Byun, Beets, & Pate, 2015; Byun, Dowda, & Pate, 2011; O'Connor et al., 2014; Pate et al., 2015). For the purpose of this study, the epoch duration or sampling period was set to 5 s, which is more accurate for the spontaneous and intermittent activities of children as used previously with a similar sample (Vale, Santos, Silva, Soares-Miranda, & Mota, 2009). PA was monitored for seven consecutive days (Monday to Sunday). A minimum of 10 h of data per day was required for analysis. Periods of 60 min or more of continuous zeroes were considered non-wear times and were excluded from the analyses. Parents were instructed to attach the accelerometer when the child awoke and to remove it when they went to bed. The accelerometer was worn snuggly under clothing on the child's hip using a fully adjustable elastic waist belt.

Statistical analyses

Means and SD were calculated to describe children's characteristics by sex. It was analysed one association between each MF test and weight status by binary logistic regression.

The association between weight status and single variable (SRT+J2F) was examined using multinomial logistic regression. The model was adjusted by age and TPA. Statistical analysis was performed using the SPSS 21.0 software (SPSS Inc., Chicago, IL, USA). The level of significance was set at alpha level of 0.05.

Results

Table 1 shows descriptive characteristics of the sample according to gender, boys were significantly more active than girls (*P = 0.000*). Among girls, the prevalence of overweight and obesity was 23.8% and 12.6%, respectively. In comparison, the prevalence of overweight and obesity among boys was lower at 21.6% and 6.3%, respectively; this difference was statistical significance (*P = 0.014*). No other statistical significant differences were found.

Our sample has shown that 84.0% normal weight children had high MF, 14.9% medium and 1.1% low. Children with overweight, 81.3% had high MF, 17.7% medium and 1.0% low. Finally, 71.1% obese children had high MF, 23.7% medium and 5.3% high.

Binary logistic regression analysis (Table 2) showed that obese preschoolers were 4 times more likely to be classified as having low MF level in SRT than their non-overweight

Table 1. Preschool children's anthropometric and demographic characteristics.

Variables	Total (*n* = 467)	Girls (*n* = 244)	Boys (*n* = 223)	*P*-value
Weight (kg)	20.4 ± 3.8	20.6 ± 4.1	20.1 ± 3.5	0.202
Height (cm)	109.0 ± 6.4	109.1 ± 6.6	109.0 ± 6.2	0.854
BMI (kg/m^2)	17.0 ± 1.9	17.1 ± 2.1	16.8 ± 1.7	0.098
TPA (min per week)	20.3 ± 5.5	265.3 ± 49.7	289.0 ± 51.5	**0.000**
J2F (s)	5.7 ± 1.5	5.7 ± 1.4	5.8 ± 1.7	0.526
SRT (s)	27.0 ± 2.9	27.1 ± 2.7	26.9 ± 3.1	0.577
	%	%	%	
BMI group				
Normal weight (kg/m^2)	67.6	63.5	72.1	**0.014**
Overweight (kg/m^2)	22.7	23.8	21.6	
Obese (kg/m$^{2)}$	9.7	12.7	6.3	

BMI, body mass index; ≥3 h TPA, at least 3 h total physical activity per day each day a week; J2F, jumping a distance of 7 m on 2 feet; SRT, 10 × 5 m shuttle run test; bold figures indicate significant *P*-values.

Table 2. Association between performance in shuttle run test (SRT) and jumping 2 feet test (JSF) and obesity status in preschoolers.

	SRT			J2F		
BMI tests	OR (95% CI)	R^2_N	*P*-value	OR (95% CI)	R^2_N	*P*-value
Normal weight	1	0.27	1	1	0.28	1
Overweight	0.4 (0.1–1.5)		0.224	1.3 (0.5–3.2)		0.445
Obese	**4.5 (1.3–15.2)**		**0.015**	1.2 (0.3–5.0)		0.758

BMI, body mass index; TPA, total physical activity; J2F, jumping a distance of 7 m on 2 feet; SRT, 10 × 5 m shuttle run test; all analyses were adjusted for age, gender and TPA. Bold figures indicate significant *P*-values.

Table 3. Association between performance in SRT + J2F and obesity status in preschoolers.

SRT + J2F / BMI	OR (95% CI)	R^2_N	*P*-value
Normal weight	1	0.27	1
Overweight	0.3 (0,6–2.1)		0.277
Obese	**6.4 (1.3–36.6)**		**0.035**

BMI, body mass index; SRT, shuttle run test; J2F, jumping a distance of 7 m on 2 feet; TPA, total physical activity; all analyses were adjusted for age, gender and TPA. Bold figures indicate significant *P*-values.

counterparts. No statistical significant association was found for J2F (Table 2). In addition, multinomial logistic regression analysis (Table 3) showed that obese preschoolers were 6 times more likely to be classified as having low MF level than their non-overweight counterparts even after adjustment for age, gender and TPA.

Discussion

This study aimed to examine the association between MF and obesity status among Portuguese preschool children. The most important finding was that obese preschoolers were 6 times more likely to be associated with poor MF compared to their normal weight peers even after a set of adjustments such as gender and TPA. This outcome is worth highlighting because secular trends for most of the basic motor abilities showed a decline over time (Klein et al., 2015). Therefore, poor MF coupled with excess body fat along with sedentary lifestyle are significant predictors of developing coronary heart disease (Katzmarzyk et al., 2001; Ortega et al., 2008). There is also evidence that low MF results in a higher risk of later obesity in growing pre-pubertal children (Johnson et al., 2000; Moliner-Urdiales et al., 2011). In addition, our study showed that the association individually analysed was stronger in SRT and not statistically significant in J2F test. Our data has shown that the current prevalence of overweight and obesity was 22.7% and 9.7%, respectively.

Instead of evaluating only MF, the majority of the studies analysed physical fitness (either cardiorespiratory fitness (CRF) or muscular fitness (MusF)) through a set of tests using different methodologies. It has been well described that both CRF and MuscF are important markers of health in children and adolescents. A recent study showed that low aerobic fitness in late adolescence is associated with an increased risk of early death. Furthermore, the risk of early death was higher in fit obese individuals than in unfit normal-weight individuals (Högström, Nordström, & Nordström, 2015). To date only a few studies have assessed those associations in preschool children. However, those studies that examined either the association between CRF and/or MuscF with body composition have shown that obese children had lower physical fitness (Agha-Alinejad et al., 2015; Krombholz, 2013; Niederer et al., 2012; Ortega et al., 2015; Reeves, Broeder, Kennedy-Honeycutt, East, & Matney, 1999).

In our study, however, it is difficult to find data providing information on the association of MF and obesity among preschoolers having used on a single MF test. Rather, it focuses on compound activities that recruit various combinations of multiple factors, such as strength, endurance, motor coordination, balance and agility (Fjortoft et al., 2011). Hence, we used two MF tests: jumping distance, which is an important skill to assess a child's ability to co-ordinate the leg–arm movement aiming the assessment of their sense of rhythm and timing as well; the 10 × 5 m SRT which is usually used as a measure of speed and agility (Fjortoft et al., 2011). Our data has showed a significant association between lower performance in SRT (OR = 4.5) while we have not found significant association between obesity and J2F (OR: 1.2). However, when the two tests are taken together, data has shown that obese children were 6 times more likely to be associated with low MF (Table 3). Our findings are in line with previous studies in preschoolers (Agha-Alinejad et al., 2015; Halme, Parkkisenniemi, Kujala, & Nupponen, 2009). However, to the best of our knowledge, there is only one study analysing the individual items of MF in overweight and obese preschoolers (Bayer et al., 2009) A recent study in Spanish kindergarten children showed an association of health-related physical fitness components, mainly muscular strength, the 4 × 10 m SRT and CRF (i.e. speed–agility) with total and central body fat (Martinez-Tellez et al., 2015). The observed association between speed–agility and (i.e. 4 × 10 m SRT) total obesity status also agrees with data found in Thai preschoolers (Yamborisut, Sakamoto, Wimonpeerapattana, & Tontisirin, 2010) and might express, as suggested elsewhere, that obese preschool children have a lower performance on the test requiring propulsive movement of body mass in adolescents (Moliner-Urdiales et al., 2011). In our study, we could verify that there were statistically significant differences between MF categories. Children with high MF spent more time in PA than children who presented low MF. This data is in line with some studies that have shown children with low MF who had had also low levels of PA (Williams et al., 2008) and consequently spent less time outdoors as has been shown in preschoolers (Cleland et al., 2008). Moreover, the acquisition of basic skills will promote a worse motor performance.

We can assume that the importance of MF should be recognised as a target for intervention focusing in preventing the development of obesity in children. Furthermore, motor skill acquisition and PA play key roles in child development and promotion of health (Roth et al., 2015).

In addition, MF components are associated with different health findings. PA programs should be designed to improve not only the levels of cardiorespiratory and MusF but also be focused on MF, at least on these age groups (Ortega et al., 2008). Hence, the researchers in these age groups have focused on the compliance of PA guidelines and have not given so much attention to basic daily motor capacities. This panorama should be changed, once these capacities are also associated with diverse health indicators (Klein et al., 2015). Children with low MF have a tendency to be less physically active, to have increased obesity status and reduced aerobic fitness, which are all associated with cardiovascular risk factors. These factors are critical for leading to a vicious circuit that must be targeted in an earlier intervention (Pietilainen et al., 2008). If MF is seen as a PA compliance guideline, the preschoolers will be more likely to be physically active and healthy. The foundation for the basic movement skills is created during this period and should be specialised in later motor development. It is of high importance that children possess the best possible motor abilities and skills by the time they reach school age, since during the school period this development slows down, and further progress is greatly dependent on motor-ability-skill-base previously formed in preschool (Hinkley, Crawford, Salmon, Okely, & Hesketh, 2008). In the same way, a recent study has shown that obesity preceded the decline in motor skills rather than the reverse and suggested that early childhood obesity intervention efforts might help prevent decay in motor proficiency that, in turn, may positively impact children's PA and overall fitness levels (Cheng et al., 2016). Thus, these data lead to the implementation of the motor repertoire as timely as possible in these ages, once it has an enormous potential and should be recognised as a fundamental target on PA programs within school. This component connected with intervention in this area should entail crucial advantages to both a healthy development and health across childhood and to a participant's health and quality of life (Robinson et al., 2015).

The strengths of this study focus on the assessment of MF in preschool children. Nevertheless, some limitations should be recognised. The study includes preschool children from only one metropolitan area, which makes it difficult to generalise the findings to other samples. The use of only two MF tests might be a limitation and other MF tests might be more sensitive than the two used in this study. Furthermore, the study was cross-sectional and it was not possible to infer causal relationships using such a model design.

Conclusions

Our results suggest that obesity among preschoolers was associated with lower MF. Obese children were 6 times more likely to be classified as having lower performance in the combined MF variable, since MF consists of physical fitness components that have a relationship with motor skill improvement. Therefore, our findings provide evidence to support the establishment of a tailored MF test in epidemiological and intervention studies in preschool children, as it seems that they are associated to obesity status since early ages. Nonetheless, longitudinal studies are needed to confirm these findings.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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