Body mass index, perceived and actual physical competence: the relationship among young children

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Abstract

Background The purpose of this study was to examine the relationship between perceived physical competence (PPC), actual motor competence (MC) and body mass index (BMI) in young children.

Methods We assessed MC (Test of Gross Motor Development – 2nd Edition), PPC (Pictorial Scale of Perceived Competence and Social Acceptance) and BMI (CDC calculator) of 178 young children ages 4–7 years.

Results The linear regression model for the overall sample showed that BMI was a better predictor of PPC than MC. Also, obese children had lower PPC, but showed no differences in MC compared with leaner peers.

Conclusions PPC of young obese children was lower than their leaner counterparts, yet their MC was similar. That outcome draws attention to the importance of promoting positive PPC in young children.

Introduction

The World Health Organization estimates that over 42 million children are overweight globally (Wang & Lobstein 2006; Sullivan 2011; Swinburn et al. 2011). In the USA, obesity among children has almost tripled since 1980 (Ogden et al. 2010). To understand the aetiology of childhood obesity, researchers have examined a range of socio-psychological factors associated with weight and physical activity. Stodden and colleagues (2008) draw our attention to the relationship among motor competence (MC), physical activity, health-related fitness and perceived physical competence (PPC). Our interests focused on relations that have received little attention to date – the association between MC, PPC, and body mass index (BMI). More specific, we were interested in the role of PPC in actual MC and body weight status (BMI).

Perceived competence refers to a child’s beliefs regarding his/her skills and abilities in different domains of human behaviour (e.g. social, athletic and cognitive) (Harter 1999). A child’s repeated success or failure in tasks could lead to high or low perceived competence, affecting the development of global self-worth and motivation. Research indicates that children who perceive themselves as motor competent tend to be more physically active (Carroll & Loumidis 2001; Barnett et al. 2009; Barnett et al. 2011). Therefore, it would appear that MC and physical activity are mediated by PPC. Furthermore, this also implies that to be active and build positive PPC, MC is an influencing factor (Larson & Silverman 2005; Stodden et al. 2008). Interestingly,
although positive and significant relationships between children’s physical fitness, MC and self-perception have been reported, associations are stronger between self-perception and fitness than between self-perception and MC (Vedul-Kjelsås et al. 2011).

As obesity is a major health concern in contemporary society (Wang & Lobstein 2006; Sullivan 2011; Swinburn et al. 2011), the investigation of this intricate relationship has been the focus of several studies. Research indicates that overweight compared with non-overweight children have a lower perception of their motor abilities (Southall et al. 2004; Sung et al. 2005); lower levels of MC (Southall et al. 2004; Jones et al. 2010) are less active and physically competent (Jones et al. 2010). Furthermore, studies indicate that children with high BMI are significantly less motor competent than their peers with low BMI (Logan & Getchell 2010; Logan et al. 2011). To date, no studies to our knowledge have examined the relationship among PPC, BMI and MC in young children. Therefore, the purpose of the current study was to determine the relationship between PPC, MC and BMI in young children ages 4–7 years. We hypothesized that: (1) there will be a positive association between PPC and MC; (2) a negative association between BMI and MC; and (3) children with a high BMI will have lower PPC and MC.

**Methods**

**Participants**

Participants were 178 children (82 boys; 96 girls) ages 4–7 years ($M_{age} = 5.36, SD = 1.0$) recruited from eight public schools in Rio Grande do Sul, a large state in southern Brazil. Participants had no known history of sensorimotor impairments or disabilities. Permission for the study was obtained from the Federal University of Rio Grande do Sul (UFRGS) ethics committee and written informed consent was collected from schools and parents.

**Instrumentation**

**Perceived physical competence**

The Pictorial Scale of Perceived Competence and Social Acceptance (Physical Competence Subscale) (Harter & Pike 1984) was used to assess PPC. The six-item subscale assesses children’s self-perceptions as it relates to the psychomotor domain (e.g. ability to run, hop, swing, climb, tie shoelaces and skip). The assessment is organized in a structured pictorial response format. In essence, two pictures showing opposite motor skill performance (e.g. success/failure) are displayed side by side. The child is asked to select a picture that resembles them. Then, he/she is asked if they are ‘a little’ or ‘a lot’ like the child in the picture they selected. Responses are scored on a scale of 1–4, 1 representing the lowest perceived competence, 4 the highest. The instrument has an internal consistency that ranges from 0.85 to 0.89 assessed in samples of children attending preschool ($n = 90$), kindergarten ($n = 56$), first ($n = 65$) and second grade ($n = 44$) (Harter & Pike 1984). According to French and Mantzicopoulos (2007), these scales are the oldest and most widely used assessment of perceived competence in young and school-age children.

**Body mass index**

Height and weight were measured for each participant. For height, the participant stood straight while the researcher adjusted the horizontal lever using a portable stadiometer to the apex of the skull. Height was recorded to the nearest half centimetre. Weight was measured using an electronic calibrated scale, with weight recorded to the nearest tenth of a kilogram. BMI was calculated from those measures and classified according to CDC guidelines: underweight (less than the 5th percentile), healthy weight (5th percentile to less than the 85th percentile), overweight (85th to less than the 95th percentile) and obese (equal to or greater than the 95th percentile) (Centers for Disease Control and Prevention 2008).

**Actual motor competence**

The Test of Gross Motor Development – 2nd Edition (TGMD-2; Ulrich 2000) was used to assess MC. The TGMD-2 is a well-validated standardized test that assesses fundamental motor skills of children between the ages of 3 and 10 years. The 12-item test includes two subscales: locomotor skills (run, gallop, hop, leap, horizontal jump, and slide) and object controls skills (striking a stationary ball, stationary dribble, catch, kick, overhand throw, and underhand roll). Each skill is evaluated on three to five performance criteria. If a participant demonstrates the criteria he/she received a 1, if not a 0. The totals for each skill were summed and represented the raw score (values range from 0 to 96). Raw scores were converted into a motor quotient ($>130 = $ very superior; $121–130 = $ superior; $111–120 = $ above mean; $90–110 = $ mean; $80–89 = $ below mean; $70–79 = $ poor; $<70 = $ very poor). The TGMD-2 total score was used for the analyses as a measure of MC (Ulrich 2000). The TGMD-2 has been reported as a reliable and valid assessment for Brazilian
children (Valentini 2012). Mean test–retest reliability coefficients were 0.88 and 0.89 for the locomotor and object control subscale respectively.

Procedure

Upon receiving permission from the Institutional Review Board for Research Involving Human Subjects, parental consent and participant assent were obtained. The assessment of PPC and MC took place on an individual basis. Measurements were taken at the child’s school in a time established by the classroom teacher. Motor assessments were completed in the gym. Participants received instructions and observed a model (one of the examiners) performing the movement skill once and then was asked to reproduce the skill three times. All trials were recorded on videotape and analysed by three physical education teachers with more than 2 years of experience using the test. Trained investigators also administrated PPC and BMI assessments. The assessments were completed for each participant in an isolated room away from distractions and the standard test protocol were followed.

Treatment of the data

In addition to descriptive statistics, one-way ANOVA tests were used to assess BMI category differences within MC and PPC. Pearson’s correlations were calculated to determine the extent and direction of linear relationships among PPC, BMI and MC. Regression analysis was used to investigate the relationship between BMI and MC upon PPC overall and by age. All statistical analyses were completed with SPSS 20 and P-values of 0.05 were considered statistically significant.

Results

Table 1 provides the means and standard deviations for all variables. For BMI, 118 (66%) were assessed as healthy weight, 33 (19%) as overweight and 27 (15%) as obese. In reference to MC, four children (2%) were classified below average, 78 (44%) average, 50 (28%) above average, 24 (14%) as superior, and 22 (12%) as very superior.

ANOVA results showed significant differences between children in different MC categories for PPC \(F(2,175) = 5.6, P < 0.05, \eta^2 = 0.06\]. Tukey post hoc tests indicated that obese children had lower PPC (M = 19.22, SD = 2.0) compared with healthy weight children (M = 21.27, SD = 2.58). No significant differences were found in overweight children (M = 20.79, SD = 3.04) and all other BMI categories. No MC differences \(F(2,175) = 2.12, P = 0.12, \eta^2 = 0.024\] were found between children in different BMI categories (Mhealthy weight = 46.02, SD = 12.81; Moverweight = 48.23, SD = 10.72; Mobese = 41.61, SD = 13.04).

Pearson’s bivariate correlational results indicated that BMI was negatively and significantly correlated with PPC \((r = -0.27, P < 0.001)\), but not with MC \((r = -0.035, P = 0.32)\). PPC was positively, but not significantly correlated with MC \((r = 0.08, P = 0.51)\).

Table 1. Participant’s characteristics

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (cm)</td>
<td>108.07 (6.5)</td>
<td>114.25 (5.53)</td>
<td>120.44 (3.96)</td>
<td>127.00 (6.7)</td>
<td>116.27 (8.76)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>19.12 (3.36)</td>
<td>21.66 (3.17)</td>
<td>25.21 (3.84)</td>
<td>27.81 (6.20)</td>
<td>22.88 (5.11)</td>
</tr>
<tr>
<td>MC</td>
<td>35.50 (12.37)</td>
<td>43.81 (6.73)</td>
<td>50.00 (9.44)</td>
<td>59.62 (9.02)</td>
<td>48.23 (12.56)</td>
</tr>
<tr>
<td>PPC</td>
<td>20.77 (2.53)</td>
<td>21.39 (2.55)</td>
<td>20.82 (2.74)</td>
<td>20.12 (3.53)</td>
<td>20.87 (2.80)</td>
</tr>
<tr>
<td>BMI</td>
<td>16.33 (2.14)</td>
<td>16.53 (1.53)</td>
<td>17.33 (1.99)</td>
<td>17.03 (2.48)</td>
<td>16.74 (2.02)</td>
</tr>
<tr>
<td>n</td>
<td>48</td>
<td>58</td>
<td>40</td>
<td>32</td>
<td>178</td>
</tr>
</tbody>
</table>

BMI, body mass index; MC, actual motor competence; PPC, perceived physical competence.

Table 2. Pearson’s bivariate correlation

<table>
<thead>
<tr>
<th>4 years old</th>
<th>5 years old</th>
<th>6 years old</th>
<th>7 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>PPC</td>
<td>MC</td>
<td>BMI</td>
<td>PPC</td>
</tr>
<tr>
<td>PPC</td>
<td>1.0</td>
<td>0.06</td>
<td>-0.12</td>
</tr>
<tr>
<td>MC</td>
<td>0.06</td>
<td>1.0</td>
<td>-0.13</td>
</tr>
<tr>
<td>BMI</td>
<td>-0.12</td>
<td>-0.13</td>
<td>1.0</td>
</tr>
</tbody>
</table>

*Correlation is significant at the 0.05 level \((P < 0.05)\).

BMI, body mass index; MC, motor competence; PPC, perceived physical competence.
Correlations by age were small-to-moderate and only significant for 6- and 7-year-olds (see Table 2 for correlations by age).

Linear regression results indicated that the model with BMI ($\beta = -0.27, P < 0.05$) and MC ($\beta = 0.06, P = 0.34$) was significant and explained 8% of the variance of PPC ($r^2 = 0.08, F(2,175) = 7.54, P < 0.001$). While group analysis indicated that for 4- and 5-year-olds, the model was not significant and explained only 1% ($r^2 = 0.01, F(2,45) = 0.38, P = 0.68$) and 7% ($r^2 = 0.07, F(2,55) = 2.22, P = 0.08$) of the variance respectively, significance was found and explained 15% ($r^2 = 0.15, F(2,36) = 3.25, P = 0.050$) and 20% of the variance ($r^2 = 0.2, F(2,29) = 3.6, P < 0.05$) for 6- and 7-year-olds.

Discussion

The purpose of this study was to determine the relationship between PPC, MC and BMI in young children. We hypothesized that: (1) there would be a positive association between PPC and MC; (2) there would be a negative association between BMI and MC; and (3) children with a high BMI would have lower PPC and MC.

Results did not support our first hypothesis; we did not find an overall significant positive relationship between PPC and MC. That finding is in contrast to Robinson’s (2010) study that reported a significant positive and moderate relationship between PPC and MC for young children. On the other hand, Goodway and Rudisill’s study (1997) found a small positive and significant correlation between object control skills and PPC, but no relationship between TGMD-2 total score and PPC. Similarly, our results for the overall sample with the TGMD-2 total score, was not significant. The relationship between PPC and MC seems to be consistent across other studies, yet we only found a small positive significant correlation for the 6-year-olds. One possible explanation for the small or non-significant relationships between MC and PPC in our study is the fact that the perceived motor tasks of Harter scale and motor tasks of the TGMD-2 are not closely linked (complimentary). We would like to note that, it could be a contention among this type of research and also be considered a limitation.

Our second hypothesis stated that there would be a significant negative association between BMI and MC. We found partial support with a significant moderate negative correlation for 6- and 7-year-old children; however, for the overall sample, the value was not significant. Other studies have reported a negative weak-to-moderate relationship between motor skills and BMI, in contrast to ours (Graf et al. 2004; Wrotiniak et al. 2006; Logan et al. 2011; Lopes et al. 2012). According to a recent large-scale study of 4-, 5- and 6-year-old children, only gross motor skills (e.g. jumping) directly influenced by body weight were negatively associated with BMI (Castetbon & Andreyeva 2012). Our findings, along with the literature, support Lopes and colleagues’ (2012) statement that the association between motor proficiency and BMI is not strong among young children; however, it does strengthen with age.

Our findings also indicated that the statistical model for BMI and MC explained part of the variance in PPC. It is important to note that the model explained the variance for PPC for the overall sample (8%) and when broken down by age, the model accounted for increasing amounts of variance in PPC as age increased. For 4-year-olds, it accounted for 1%; 5-year-olds, 7%; 6-year-olds, 15%; and 7-year-olds, 20% of PPC variance. Rudisill and colleagues (1993) reported that age influenced the development of PPC among older children. A rather common observation among young children is that they tend to overestimate their abilities and as such overestimation might explain the non-significant relationship found in our 4- and 5-year-olds. Stodden’s theoretical model also states that the relationship between PPC and MC is weak in early childhood and increases as children age. As children age and develop cognitively, they become more aware of their abilities. That is, with development, maturation and experience, children become better judges of their abilities (Harter 1978). This notion was partially supported by our results.

In regard to the third hypothesis comparing PPC and BMI, results indicated that obese children reported lower PPC, but surprisingly no differences were found regarding MC. Most studies indicate that overweight children have lower PPC and MC then their leaner peers (Southall et al. 2004; Poulsen et al. 2011). In the Jones et al.’s (2010) study, overweight girls showed less MC when compared with their leaner counter parts, but those findings did not hold true for the boys. Those studies, however, were conducted with older children.

Other studies show a significant positive relationship between PPC and MC (Robinson 2010) and differences in MC between children in different BMI categories (Logan et al. 2011). To our knowledge, no studies have collectively assessed these variables in young children. In summary, the most interesting finding in the present study was that BMI was a stronger predictor of PPC than MC in the overall model. One might expect MC to be a better predictor because motor performance seems to be so intrinsic to PPC; however, that was not true in this study. Although we only assessed children’s BMI objectively, one possible explanation we speculate about is that young children might do a better job perceiving their body size than their actual motor skills.
Body size is more concrete and easier to understand with the help of mirrors, pictures and clothing sizes. In the doctor’s office, in school and at home, children learn about their own body size, its relation to others and what it means socially. Furthermore, children are relatively accurate in estimating their body size and relate overweight and obesity to negative outcomes, such as not exercising and laziness (Truby & Paxton 2008; Rees et al. 2011).

Similarly, perceived competence is developed socially and depends on, among other factors, previous experiences and feedback (Harter 1978). However, children might not have enough diversity of motor experiences and specific feedback to help them perceive more accurately their MC. Furthermore, children are typically not very accurate assessing their motor abilities (e.g. Harter 1978; Valentini & Vilwock 2007). It is also important to bear in mind that our argument, that differences between accuracies in self-perceptions of body size and physical competence can explain our findings, is supported by two other results in our study. First, MC did not differ among children in different weight categories, yet PPC did; second, obese children perceived themselves as less motor competent, but in fact they were not significantly different from their peers.

Motor competence and PPC are factors that play an important role in being physically active and need to be addressed more often by researchers, teachers and parents alike. Our findings would suggest that it is important to promote opportunities for the development of MC along with emphasizing positive perceptions of physical abilities, especially for obese young children. The development of MC can only be achieved when teachers and parents acknowledge the importance that PPC and MC may play in children’s health and well-being and know how to help children develop MC and PPC appropriately.

Regarding limitations of our work, one has already been mentioned, but unfortunately, at least to date, is inherent in such research; the fact that the perceived motor tasks of Harter scale and motor tasks of the TGMD-2 are not closely linked. Some might also consider our use of BMI as the single weight status measurement as a limitation. However, it is the most common method reported with relatively large-scale studies. Obviously, there are other motor skills tests that could have been used. Our particular interest is with the development of fundamental motor skills and in addition to the good reputation of the TGMD-2, the recent report of its validation with Brazilian children made it attractive for our needs.

Our findings draw attention to the need to gain a better understanding of the association among PPC, obesity and MC in young children. In our study, we have a glimpse of this relationship, but PPC’s developmental complexity in young children is multifaceted. Future investigations are needed and should incorporate a multifactor longitudinal approach in order to provide a more thorough understanding of self-perceptions’ evolution along with its mediating role in motor behaviour and weight status in young children.

Key messages

- Obese young children tend to perceive themselves as less motor competent than their peers.
- It is important to promote the development of positive PPC along with MC, especially with obese children.
- The relationship between PPC, BMI and MC is stronger for older children.

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