Association between body mass index, physical activity and motor competence in children: Moderation analysis by different environmental contexts

Rocha, D., Aguilar, J. A., Martins, T., Hardman, C., Antunes Lima, R., Duncan, M., dos Santos, M. A. M. & Barros, M.

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Title: Association between body mass index, physical activity and motor competence in children: Moderation analysis by different environmental contexts.

Background: Although the association between body mass index (BMI), physical activity (PA), and motor competence (MC) has been widely investigated, the influence of different environmental contexts is not well defined.

Aim: To analyze the relationship between BMI, PA, and MC and the moderating role of the environmental context.

Material and methods: A cross-sectional study was performed with 668 children (318 boys) aged 5 to 7 years (north-eastern district – Brazil). MC (KTK), BMI, and PA (parents reporting) were assessed. To classify three contexts of the environment a variable was created based on the presence of a sports court in school and/or environment for play or sports practice out of school. Multilevel mixed-effects linear regressions, interaction test and estimation of coefficients in moderation analysis were used.

Results: BMI (β= -2.93; $p<.01$) and age (β= 19.02; $p<.01$) were associated, and PA was not associated (β= 0.07; $p=0.09$) with MC. The strength of the association between BMI and MC changed based on the environmental contexts. The better the environment context the weaker the association between BMI and MC (β= -2.93, $p<.01$ to β= -2.38, $p=0.37$ to β= 0.26, $p=0.94$). Conclusion: The association between BMI and MC is moderated by environmental contexts.

Keywords: child; motor skill; body mass index; physical activity; environment

Introduction

The health of the adult population is closely related to health in childhood, and children´s health depends on factors such as physical activity (PA), physical fitness, and motor competence (Haskell et al., 2007; Ortega et al., 2008; Janssen and Leblanc, 2010; Robinson et al., 2015). If we consider the importance of physical activity in health, many studies have been undertaken to examine the mechanisms related to physical activity, aiming to promote active and healthy lifestyles (Malina et al., 2004; Stodden et al., 2008; Janssen and Leblanc, 2010; De Meester et al., 2018; Tomaz et al., 2019).

In this context, Stodden et al. (2008) proposed a conceptual model describing the dynamic relations between physical activity and motor competence. The model suggests that, in early childhood, physical activity will initially promote the development of motor competence because motor skills are developing through a variety of exploratory movement experiences. However, when children enter middle and later childhood, the model suggests that the relationship becomes more reciprocal. This conceptual model is an important contribution to knowledge related to the synergic relationship between physical activity and motor competence, which could result in positive or negative trajectories of physical activity levels and, consequently, to healthy or unhealthy weight status. In this sense, children with higher levels of physical activity and lower adiposity present greater motor competence during childhood and adolescence, and longitudinal evidence reinforces that high levels of motor competence during childhood positively influence levels of physical activity in later years (Barnett et al., 2008; Lopes et al., 2011; Holfelder and Schott, 2014; Cattuzzo et al., 2016; Utesch et al., 2019; Lopes, Utesch, & Rodrigues, 2020).

Better understanding of how the development of multiple variables related to physical activity and health may have a synergistic impact among themselves to promote positive or negative health trajectories might be the piece of the puzzle that is missing (Robinson et al., 2015). In general, correlates such as sex, age, socioeconomic status, and body mass index are well established as being related to physical activity and/or motor competence (Barnett et al., 2016; Tonge et al., 2016; Zeng et al., 2019). Despite this, the development of motor competence results from complex interactions of biological, maturational, physical, and behavioral characteristics, and a wide range of aspects related to environmental contexts could also impact these developments, as well as the possible interactions between them (Bouchard et al., 1997; Clark and Metcalfe, 2002; Chaves et al., 2015). To date, studies examining how the environmental context influences both physical activity and motor competence are scarce.

The ecological systems theoretical model (Bronfenbrenner, 1979) proposes that child development is the result of biological, family, and environmental influences. Thus, each specific context could shape the motor competence and development of physical activity in children and adolescents (Venetsanou and Kambas, 2010; Barnett et al., 2010; Barnett et al., 2013; Queiroz et al., 2016; True et al., 2017; Zeng et al., 2019). Some prior studies have identified different environmental contexts, such as type and size of the school, physical environment, activities structured in adequate spaces within the school, playgrounds outside the school, and places for sports practice (Barnett et al., 2016; Tonge et al., 2016) that may specifically influence the development of motor competence (Newell, 1986; Chaves et al., 2015). However, whilst considering the effect of environmental context it is necessary to identify the influence of different environmental contexts such as school, sports clubs, or even the neighborhood where children reside, on the relationship between many biological and physical individual characteristics such as physical activity, body mass index, and motor competence of children. It is possible that living in better conditions or with access to more positive environmental contexts moderates and improves the associations between physical activity, motor competence, and BMI in children, compared to those who live in poorer conditions with less access to school facilities or sports clubs.

As far as we know, the role of the environmental context as a moderator in relation to physical activity practice, body mass index, and motor competence in children has not been evaluated. The following hypotheses were tested: (a) there would be a negative association between body mass index and motor competence; and (b) a positive association between physical activity and motor competence. Thus, the purpose of the present study was to analyze the relationship between BMI, physical activity, and motor competence in children, and to investigate the potential moderation role of the environmental context in the association between physical activity, body mass index, and motor competence.

Material and methods

This is a cross-sectional study, based on the project entitled "Longitudinal Study of Health and Wellbeing of Children in Preschool" (Estudo Longitudinal de Observação da Saúde e Bem-Estar da Criança em Idade Pré-escolar, ELOS-Pré). The initial target population of the ELOS-Pré project was preschool children (3 to 5 years old; baseline) enrolled in public and private schools in the area covered by the Regional Education Management of Recife, State of Pernambuco, Brazil. The project was approved by the local ethics committee (CEP 097/10; CAAE – 0096.0.097.000-10). Parents or legal guardians of participating children signed the Free and Informed Consent Form.

Sample

The minimum sample size was defined considering the following parameters: (a) population estimated at 49,338 children; (b) prevalence of the variables of interest in the target population set at 50%; (c) 95% confidence interval; (d) maximum tolerance error of four percentage points; and, (e) effect size of the pre-established sampling of 1.5 due to the cluster sampling resource. To minimize possible losses and refusals during follow-up, the minimum sample size at baseline, initially estimated at 890 children, was increased by 20%. The sample was selected using a cluster sampling single-stage technique, considering the school as the sample unit. All schools with pre-school classes were considered eligible for inclusion in the study. These data were provided by the Department of Education of Recife estimated in 2010 at 49,338 pre-school children distributed in 782 schools. Considering an average number of 38.5 children enrolled in each school and in order to achieve the desired sample size (n=1,113), it was established that data collection would be performed in 28 schools.

In order to select a representative sample of preschoolers, the proportionality of children in schools according to type (public or private) and their distribution in the six political and administrative regions of Recife were considered in the sampling process. In addition, the size of the school, "small-size" (<50 students), "medium-size" (50 to 199 students), and "large-size" (≥200 students) was adopted as a stratification criterion. All children were followed and evaluated every two years.

The baseline of the ELOS-Pré was conducted between August and November in 2010 and re-evaluated at the same months in 2012 and 2014. No seasonality is to be expected in the PA measures and motor competence given that the temperature and weather conditions are stable during this period. This study was implemented with all children aged 5-7 years, who participated in the second evaluation in 2012, considering children who had been evaluated at baseline in 2010 and remained residing in Recife. The data collection team was composed of undergraduate and graduate students. All field collections were directly supervised by researchers involved in the project.

Motor Competence

Motor competence was measured by assessing gross motor coordination with the Körper koordination test fur Kinder (KTK) test battery (Kiphard and Schilling, 1974). The KTK consists of four independent tests: (a) balance while moving backwards - walking backward on balance beams of decreasing width, including 6.0 cm, 4.5 cm, and 3.0 cm; (b) hopping on one leg over an obstacle - hopping a foam obstacle with increasing height in consecutive steps of 5 cm; (c) jumping laterally - jumping from side to side, two-legged, for 15 s; (d) shifting platforms - moving sideways on wooden boards for 20 s. The sum of the raw scores of each of the four tests was used as the dependent variable. Test-retest reliability (intraclass correlation coefficients) ranged from 0.70 (shifting platforms) to 0.94 (hopping on one leg over an obstacle), presenting satisfactory indices according to previous studies (Cools et al., 2009; Vandorpe et al., 2011).

Body Mass Index

Body mass was obtained using a G.Tech® portable digital scale (model Glass 6) previously calibrated, with a variation of 0.1 kg and maximal capacity of 150 kg. Height was measured using a portable Welmy® stadiometer with a support base (model II), with an accuracy of 0.5 cm. The body mass index (BMI) was calculated using the standard formula [weight (kg)/ height^2 (m)].

Physical Activity

Level of physical activity was measured by parental self report. Parents reported the time spent by children on games and playing outdoors in the three periods of the day (morning, afternoon, and night) on a typical weekday and weekend day (Burdette et al., 2004). The time reported by parents in each of these six reference periods (three reported for a typical weekday and three reported for a typical weekend day) was recorded considering five numerical scores: (a) 0 minutes; (b) 1-15 minutes; (c) 16-30 minutes; (d) 31-60 minutes; and, (e) more than 60 minutes. Next, a global score was calculated based on the sum for the week and weekend [week: 3 reference periods X 4 (maximum score per period) X 5 days = 60 points; weekend: 3 periods X 4 (maximum score per period) X 2 days = 24 points], with variation from 0 (insufficiently active) to 84 points (active). For this measurement, good reproducibility indicators were found with Spearman correlations equal to or greater than 0.83 ($p < 0.01$).

Environmental context

Environmental context was assessed by multiple means. Information relating to the presence of a sports court at school was assessed via an educational online platform

QEdu (https://www.qedu.org.br/). A population-based questionnaire (ELOS-Pré) provided sociodemographic and biological information about the child (sex, age, and gross family income) and information relating to the environment for play or sports practice out of school, using the following question: (a) Where your child lives, is there any space where he/she can play, or play sports? For the moderation analyses, a new variable was created using a scale to represent different environmental contexts: (Context 1) absence of an environment with sports court in school and environment for play or sports practice out of school = 0; (Context 2) presence of a sports court in school or environment for play or sports practice out of school = 1; (Context 3) presence of a sports court in school and environment for play or sports practice out of school = 2.

Statistical analysis

Data tabulation was performed in EpiData Entry software for Windows (version 3.1), by two different people. Each person entered data independently, and a cross-reference was performed using automatic controls of amplitude and consistency in data entry. Outliers and normality analyses (Kolmogorov-Smirnov test) were conducted to explore the data. Descriptive analyzes were performed using mean, standard deviation, and relative and absolute frequency. A *t*-test was used to compare the continuous variables by sex, and the chi-square test for the categorical variables.

Multilevel mixed-effects linear regressions with robust standard error were used to analyze the associations between body mass index, physical activity and motor competence. In the multilevel analyses, were used the sampling weights at higher level, the variance related to the clusters (school) and the intraclass correlation coefficient (ICC) for each model were calculated to interpret the variation among schools and individuals, in all regressions analyzes the variation (ICC) was at the individual level (the variation from school were always below 8%).

The analysis was carried out in different stages. In the null model, a model without predictors was performed to identify how much of the total variance of motor competence can be attributed to the school. In step 1, the variable body mass index and physical activity were added. In step 2, the confounding variables age, sex and gross family income were added. In step 3, the environmental contexts were added and in step 4, the interaction factors were tested by adding the variable BMI*environmental contexts, PA*environmental contexts, and gross family income*environmental contexts. Step 3 and step 4 will be compared by analyzing Bayesian information criterion (BIC), and the likelihood-ratio test. Subsequently, analyzes were stratified by the moderator variable using with a post estimation command (lincom). The quality of models was based on the differences of deviance and the simultaneous estimation of all model parameters was performed based on the maximum likelihood estimation. All analyzes were performed in STATA software (version 13.0), adopting a significance value of $p < 0.05$.

Results

The final sample involved 668 (318 boys) children aged 5 to 7 years of age (mean = 6.31, SD = 0.73), representing 62.54% from the baseline of the ELOS-Pré (2010). Descriptive statistics for age, body weight, height, BMI, physical activity, and motor competence by sex are shown in Table 1.

Insert table 1

Regarding gross family income, it was found that 257 (38.47%) of the children were classified as low income, 318 (47.61%) as medium income, and 93 (13.92%) as high income. With respect to the environmental context, 195 (29.19%) children were included in context 1, 341 (51.05%) in context 2, and 132 (19.76%) in context 3. None of the variables presented significant differences between sexes.

Results for the multilevel analysis are provided in Table 2. Based on the null model, the ρ was calculated as follows: ρ = 97.04 / (97.04 + 1,106.74) = 0,080; i.e., 8,0% of the total variance in children's motor competence is explained by differences in school contexts, whereas the remaining 92,0% are explained by individual predictors.

Findings from the first model (Model 1) considered body mass index and physical activity as predictors of motor competence, and showed that a greater body mass index was associated with a lower motor competence (β = -2.67; $p<0.01$), but that there was no significant physical activity effect (β = 0.05; $p=0.15$). The second model (model 2) included age, sex, and gross family income as covariables, showed that older children presented greater motor competence (β = 18.95; $p<0.01$), and body mass index remained associated with MC (β = -2.93; $p<0.01$), and physical activity was not associated with MC (β = 0.07; $p=0.06$). The third model (Model 3) included the environmental context and showed BMI (β = -2.93; $p<0.01$) and age (β = 19.02; $p<0.01$) associated with MC, and physical activity remained not associated with MC ($p=0.05$). The fourth model (Model 4) included the interaction factor (BMI*Environmental context) and showed an interaction between environmental context and BMI in relation to MC (β = 5.41; $p<0.01$), indicating an analysis of moderation by the environmental context. Physical activity and gross family income did not show interaction with environmental context.

Insert Table 2

Table 3 presents the association between the exposures and MC depending on the environmental contexts. The association between BMI and MC depended on the environmental contexts. More specifically, BMI was only associated with MC (β= -2.93; $p<0.01$) in absence of environment with sports court in school and environment for play or sports practice out of school (Context 1). Moreover, BMI was not associated with MC in any of the more enriched environmental contexts (Contexts 2 and 3). No moderation was found in the physical activity according to contexts. Furthermore, in the age, moderation was determined by the increase in magnitude in the different contexts (β= 19.02, $p<.01$ to β= 19.57, $p<.01$ to β= 22.22, $p<.01$).

Insert Table 3

Discussion

The present study aimed to analyze the relationship between BMI, physical activity, and motor competence in children; and investigated the potential moderating role of the environmental context. This is the first study to examine whether this relationship is influenced by the environmental context in Brazilian children and as such the current study presents novel data. It was expected that there would be a negative association between BMI and motor competence, a positive association between physical activity and motor competence, and moderation by the environmental contexts, presenting better magnitudes in the context with the presence of a sports court in school and environment for play or sports practice out of school.

However, contrary to our hypothesis, no associations between physical activity and motor competence were found. Nevertheless, our findings showed that BMI has a negative association with motor competence performance, i.e., children with higher BMI values present lower motor competence. In addition, in our main analysis, a positive association was found between age and motor competence, demonstrating that older children demonstrate better motor competence. The association between BMI and MC was moderated by the environmental context. Thus, there were reductions in the magnitude of the associations between BMI and motor competence in contexts 2 and 3, meaning that BMI had lower importance in relation to MC in children in enriched environmental contexts.

These findings are consistent with other studies (Lima et al., 2017; Henrique et al., 2018), which demonstrated through tracking of motor competence that children with higher BMI are more likely to exhibit low levels of motor competence during childhood and early adolescence and children that slow increase in BMI showed better motor competence improvements (Lopes, Utesch, & Rodrigues, 2020). Other studies have also shown negative associations between BMI and motor competence (Lopes et al., 2012; D'hondt et al., 2014; Antunes et al., 2015; Chaves et al., 2016; Hardman et al., 2017). A longitudinal study also identified that gross motor competence levels were strongly related to children's weight status, and could demonstrate a negative role in predicting motor competence (D'hondt et al., 2014). Thus, being overweight prevents body stabilization and/or propulsion, promoting lower motor competence, which decreases the likelihood of overweight/obese individuals being physically active (Morrisson et al., 2012; D'hondt et al., 2014).

The current study showed a positive association between age and motor competence, demonstrating a considerable increase of 22.22 points in motor competence for each completed year of life. This result corroborates with systematic reviews that demonstrated the existence of positive associations with small magnitudes in early childhood and a tendency to increase throughout childhood and adolescence (Cattuzzo et al., 2016; Barnett et al., 2016). Equally, longitudinal studies presented evidence that children who demonstrate better motor competence during childhood, will have positive levels of motor competence and physical activity in later years (Barnett et al., 2008; Ortega et al., 2008). This improvement in motor competence as people age is part of a process that is strengthened by the practice of motor skills (Stodden et al., 2009; Stodden et al., 2014). A recent meta-analysis (Utesch et al., 2019) adds robustness to these findings, showing that older children with a lower BMI present better motor competence performance than children with a higher body mass index and lower age.

Regarding the role of environmental contexts as a moderator in the association between BMI and motor competence, the current study observed that the importance of BMI in the development of motor competence depends on sufficient availability of environments for the practice of physical activity, including environments that enable the use of equipment and materials related to sports practice (Giagazoglou et al., 2008; Chow and Louie, 2013; Queiroz et al., 2014). According to our findings, this was especially problematic for children with higher BMI in the least enriched environmental context. Although physical activity was not associated with motor competence in our study, it is likely that the context in which children live in early childhood can impact the development of motor skills and engagement in physical activity (Erwin et al., 2007; Cools et al., 2011). Also, environmental context to promote the increase of moderate-to-vigorous physical activity and/or decrease a sedentary behaviour may be an important factor for develop of motor competence (Adank et al., 2018; Matarma et al., 2018; Van Kann et al., 2019).

From a socio-ecological perspective, our results reaffirm that environmental contexts can impact on behavior in childhood; since children are thought to be part of a multi-level social structure (e.g., family, school, local community, society, etc.) and factors at each level may impact their behaviors, and, consequently, their physical and motor development (Bronfenbrenner, 1979; Barnett et al., 2013; Barnett et al., 2018; Zeng et al., 2019). According to our study, the fact of having facilities for playing and sports practice, both inside and outside school, positively moderates the associations, allowing improvement in motor competence, which could contribute to children being more active in their adult life. It is important to understand that the school context and conditions can play an important role in a child's motor development, providing adequate and enriching motor opportunities (Chaves et al., 2015; Queiroz et al., 2016). In this scenario, the information obtained in the moderation analysis seems to attenuate the possible harmful impacts throughout the life cycle, considering that children inserted in the better contexts seemed protected of the deleterious impact of BMI on motor competence scores. Thus, it may be that BMI in younger children has less influence on motor competence but becomes increasingly important during the development process (Henrique et al., 2016). In summary, the environment could thus be considered a protective factor for the relationship between BMI and motor competence.

In the present study, physical activity was not associated with motor competence. This finding differs from the proposed theoretical model by Stodden et al. (2008), where the practice of physical activity will promote the development of motor competence in early and middle childhood. Several studies show that more active children have higher levels of motor competence compared to physically less active children (Lubans et al., 2010; Lopes et al., 2011; Holfeld and Schott, 2014; Barnett et al., 2016; Lima et al., 2017). A possible explanation is that we have not used objective measures, thus, the measure may not represent well the physical activity, besides not evaluate different intensity of the physical activity. In addition, recent studies have agreed that physical activity of moderate to vigorous intensity can provide a better development of motor competence and that total physical activity does not seem to be the best indicator of this development (Adank et al., 2018; Farooq et al., 2019; Van Kahn et al., 2019).

Another explanation may be related to more opportunities for physical activity practice in children, and consequently improve motor competence levels. For example, some studies showed a positively association between practice of sports (Queiroz et al., 2014; Souza et al., 2014; Henrique et al., 2016) or different types of sports (Wood et al., 2020) and motor competence, from which it is consequently possible to infer that adequate spaces to practice sports are necessary. Additionally, Lopes et al. (2014) identified that the trend to a decrease in physical activity levels over the years was attenuated for those who had better motor competence and was amplified for those who had poorer motor competence. In our study, we have used a measure of physical activity that is based on the participation of the children in outdoor play and games, a different domain of PA in this specific age. This specific result might suggest that enrolment in organized activities might be a need to enhance motor competence in small children.

Some limitations should be established in this study. The study design does not allow the inference of causality in the results found. In addition, the absence of an evaluation of the presence of school physical education classes and/or participation in sports may limit the interpretation of our results. As the level of physical activity was reported by the parents through a questionnaire, physical activity may have been overestimated. Future research employing objective means of physical activity assessment would therefore be welcome in confirming the assertions made in the present study. Nevertheless, the study was conducted with a representative sample of school-age children. Gross family income could be an important confounding factor; however, the systematic effect was tested and showed no differences for the other variables. All data collection procedures were previously tested and presented good reproducibility indicators in the pilot study. The choice of specific researchers for the application of motor tasks, the use of control strategies in the adjusted analyses for the main confounding variables, and the double-entry of tabulated data contributed to the internal validity of the study. However, the results presented in this study provide important information on the practice of physical activity considering the environmental contexts that provide more opportunities for the practice of physical activity, games, and sports in childhood. The information provided is useful in shaping public policies both in educational spaces, such as school, as well as in community environmental contexts, such as squares, parks, and/or free areas, to enhance opportunities to increase motor competence and physical activity in Brazilian children.

In conclusion, in the present study, a negative association was found between BMI and motor competence, and no association was found between physical activity and motor competence. However, these associations were moderated by the environmental context. In summary, the better the environment context the weaker the association between BMI and MC. Thus, exposure to appropriate environmental contexts at school and out of school decreases the impact of BMI on motor competence, and promotes better opportunities to develop motor competence in children.

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Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1. Descriptive variables and comparison of groups according to sex (n=668).

Variables	Boys (n=318) Mean (SD)	Girls (n=350) Mean (SD)	p	Total (n=668) Mean (SD)
Age (years)	6.31 (0.73)	6.31 (0.73)	0.95	6.31 (0.73)
BMI (kg/m^2)	16.87 (3.13)	16.90 (3.23)	0.91	16.88 (3.18)
Physical activity (points)	64.90 (25.92)	65.83 (25.66)	0.64	65.39 (25.77)
Motor competence (points)	94.01 (32.96)	97.66 (35.55)	0.17	95.92 (34.37)
		Frequency (%)		
Gross Family income			0.93	
Low	120 (37.74)	137 (39.14)		257 (38.47)
Medium	153 (48.11)	165 (47.14)		318 (47.61)
High	45 (14.15)	48 (13.72)		93 (13.92)
Environmental context			0.44	
Context 1	100 (31.45)	95 (27.14)		195 (29.19)
Context 2	159 (50.00)	182 (52.00)		341 (51.05)
Context 3	59 (18.55)	73 (20.86)		132 (19.76)

***** SD=standard deviation; BMI= body mass index; (Context 1)=absence of environment with sports court in school and environment for play or sports practice out of school; (Context 2) presence of sports court in school or environment for play or sports practice out of school; (Context 3) presence of sports court in school and environment for play or sports practice out of school.

Table 2. Multilevel analysis between BMI, physical activity, and motor competence (n=668)

Regression coefficients (fixed effects)	Null model β (95% CI)	p	Model 1 β (95% CI)	p	Model 2 β (95% CI)	p	Model 3 β (95% CI)	p	Model 4 β (95% CI)	p
Intercept	94.54 (90.05 to 99.04)	<0.01	136.13 (119.95 to 152.31)	<0.01	20.97 (-9.20 to 51.16)	0.17	20.60 (-9.67 to 50.88)	0.18	13.61 (-18.81 to 46.05)	0.41
Body Mass Index (kg/m²)			-2.67 (-3.45 to -1.90)	<0.01	-2.93 (-3.67 to -2.18)	<0.01	-2.93 (-3.67 to -2.19)	<0.01	-2.38 (-3.33 to -1.44)	<0.01
Physical Activity (Points)			0.05 (-0.02 to 0.13)	0.15	0.07 (-0.01 to 0.15)	0.06	0.07 (-0.01 to 0.15)	0.05	0.08 (0.01 to 0.15)	0.05
Age (years)					18.95 (15.43 to 22.47)	<0.01	19.02 (15.47 to 22.57)	<0.01	18.69 (15.16 to 22.21)	<0.01
Sex (Girls)					3.71 (-0.82 to 8.25)	0.10	3.75 (-0.62 to 8.13)	0.09	3.35 (-1.16 to 7.87)	0.14
Gross family income (Tertile)					-3.15 (-7.59 to 1.27)	0.16	-2.16 (-6.39 to 2.06)	0.31	-2.32 (-6.59 to 1.94)	0.28
Context 2§							-0.54 (-5.03 to 3.93)	0.81	-4.33 (-9.83 to 1.16)	0.12
Context 3§							-3.20 (-10.53 to 4.12)	0.39	-9.85 (-19.71 to -0.33)	0.04
Context*BMI									5.41 (1.87 to 8.95)	<0.01
Variance components (random effects)										
Variance between schools	97.04		86.57		3.98		4.81		4.83	
Variance between children	1,106.74		1,031.06		885.99		882.08		876.67	
Deviance	6,795.70		6,746.22		6,614.97		6,583.61		6,579.44	
Number of parameters	3		5		8		10		11	

Likehood-ratio test between model 4 and model 3: p= 0.04; Bayesian information criterion for model 3 (BIC= 6,648.89) and model 4 (BIC= 6,651.25); §(Context 1 - reference).

Table 3. Moderation analyses for the association between BMI, physical activity, and motor competence (n=668).

	Motor competence (points)					
	Context 1 n= 195		Context 2 n= 341		Context 3 n= 132	
	β (95% CI)	p	β (95% CI)	p	β (95% CI)	p
Body Mass Index (kg/m²)	-2.93 (-3.67 to -2.19)	<0.01	-2.38 (-7.22 to 2.45)	0.33	0.26 (-7.16 to 7.69)	0.94
Physical Activity (Points)	0.07 (-0.01 to 0.15)	0.05	0.62 (-3.87 to 5.13)	0.78	3.28 (-4.03 to 10.59)	0.37
Age (years)	19.02 (15.47 to 22.57)	<0.01	19.57 (14.35 to 24.78)	<0.01	22.22 (13.79 to 30.65)	<0.01
Sex (Girls)	3.75 (-0.62 to 8.13)	0.09	4.30 (-1.34 to 9.94)	0.13	6.95 (-2.34 to 16.26)	0.14
Gross family income (Tertile)	-2.16 (-6.39 to 2.06)	0.31	-1.61 (-6.87 to 3.64)	0.54	1.03 (-7.38 to 9.46)	0.80

* (Context 1)=absence of environment with sports court in school and environment for play or sports practice out of school; (Context 2) presence of sports court in school or environment for play or sports practice out of school; (Context 3) presence of sports court in school and environment for play or sports practice out of school.