XIX SDMC

ESTUDOS EM DESENVOLVIMENTO MOTOR DA CRIANÇA

XVII

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ASSOCIATION BETWEEN MOTOR COMPETENCE, HEALTH-RELATED FITNESS AND BODY MASS INDEX IN 4TH GRADE SCHOOL CHILDREN

ASSOCIAÇÃO ENTRE COMPETÊNCIA MOTORA, APTIDÃO FÍSICA RELACIONADA COM A SAÚDE E ÍNDICE DE MASSA CORPORAL EM CRIANÇAS DO 4º ANO

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Abstract
The purpose of this study was to analyze the relationship between Motor Competence (MC), Cardiorespiratory Fitness (CRF), Muscular Strength (MS) and Body Mass Index (BMI) in 4th grade school children. This cross-sectional study included 116 children enrolled in the 4th grade (62 boys; M_{age} 9.95yrs ± -0.33). Motor competence was assessed by a Motor Competence Assessment instrument, CRF was assessed by a 20m shuttle run test, and MS was assessed by a countermovement vertical jump power on a force platform. The BMI was calculated from measured weight and height. Pearson's correlation was used to analyze correlations between all variables.
There were large positive associations between MC and both CRF and MS, as well as a large inverse association between MC and BMI; there were inverse associations between BMI and both CRF (moderate) and MS (large); there was a positive moderate association between CRF and MS (p≤0.005). The associations found among these parameters, both in boys and girls, highlight the critical role of MC in health, as it is related to better physical fitness levels. Given that association, it may be important to promote MC to enhance physical fitness and reduce the negative effects of a higher BMI in children.

Key words
Motor development; physical fitness; school-age; motor performance; nutritional status.

Resumo
O objetivo deste estudo foi analisar a relação entre a Competência Motora (CM), a Aptidão Cardiorrespiratória (AC), a Força Muscular (FM) e o Índice de Massa Corporal (IMC) em crianças do 4º ano. Este estudo transversal incluiu 116 crianças a frequentar o 4º ano (62 meninos, 9,95 anos ± 0,33). A CM foi avaliada pelo instrumento *Motor Competence Assessment*, a aptidão cardiorrespiratória foi avaliada pelo teste de vaivém de 20m, a força muscular foi avaliada pelo salto vertical com contramovimento numa plataforma de força. O IMC foi calculado a partir do peso e da altura. A correlação de *Pearson* foi usada para analisar as correlações entre todas as variáveis. Foram encontradas associações positivas entre a CM e a AC e a CM e a FM, e uma associação negativa entre a CM e o IMC; encontraram-se associações negativas entre o IMC e a AC e o IMC e a FM, e uma associação positiva entre a AC e a FM (p≤0.005). As associações encontradas entre estes parâmetros, quer em rapazes, quer em raparigas, destacam o papel crítico da CM na saúde, pois está relacionada a melhores níveis de aptidão física. Dada esta associação, poderá ser importante promover a CM para melhorar a aptidão física e reduzir os efeitos negativos de um IMC mais elevado nas crianças.

Palavras chave
Desenvolvimento motor; condição física; idade escolar; performance motora; estado nutricional.

INTRODUCTION

Motor competence (MC) can be defined as a person's ability to proficiently execute a variety of motor tasks. It encompasses the coordination quality in both gross and fine motor skills essential for performing daily activities (1). Motor competence is positively associated with various health aspects, including

cardiorespiratory fitness (CRF), muscular strength (MS) and endurance, and a healthy weight status (2,3). Conversely, an inverse relationship between MC and weight status (i.e., Body Mass Index (BMI) values) is found in the literature (2,4). Motor competence plays a crucial role in children's development, providing opportunities for an active lifestyle and yielding various health benefits (5,6). The relationship between MC and multiple aspects of health-related fitness (HRF) suggests that developing MC in childhood can directly and indirectly improve HRF. This enhancement may contribute to better long-term health outcomes for children and adolescents (6). Along with MC, physical fitness (PF), which includes CRF and MS, is also considered crucial for fostering good trajectories in HRF. Physical fitness is a key determinant in the healthy development of children, as it is linked to various beneficial health outcomes (7) and is considered an important health marker in childhood and adolescence (8). Cardiorespiratory and muscular fitness are associated with both traditional and emerging cardiovascular disease risk factors, together affecting adolescent's cardiovascular profile (8).
Children with normal weight have been shown to have an advantage in the PF levels. The relationship between MC and PF is moderate to large (9) and both are important predictors of children's physical activity participation. Weight reflects both health and nutritional status, and when adjusted for height, it is a useful tool to predict fatness. Numerous studies use BMI as a measure of body weight status (6), given its effectiveness in indicating excessive adiposity (10). Physical fitness, particularly CRF, is also an important factor associated with BMI, and CRF levels are associated with total and abdominal adiposity (8). In Portugal, the prevalence of overweight affects one in every three children, with 31.9% of Portuguese children living with overweight (including obesity) and 13.5% classified as obese (11). Childhood obesity is a major public health issue with long-term implications for both mental and physical health (12).
As mentioned above, PF and MC are important health-related constructs. Promoting MC and PF in school-aged children, along with encouraging a lifestyle involving physical activity participation, has been associated with HRF benefits (13). Additionally, these initiatives may play a preventative role in reducing various health risks and diseases.
The school context is widely accepted as one of the strategic settings for promoting PF, healthy eating, and overall healthy lifestyle behaviors due to children's daily attendance. Identifying overall levels and trends in children's health outcomes is crucial for informing and delivering effective initiatives, health strategies, and interventions aimed at increasing MC, improving HRF, and reducing unhealthy BMI while promoting healthy lifestyle behaviors.
In this context, this cross-sectional study was developed within the RUN UP project (14) to analyze the relationship between MC, CRF, MS and BMI in 4th-grade children from public primary schools in Évora. By providing more insight into these relationships, the RUN UP project (*c.f.* 14) aims to inform public health strategies, guidelines and actions for promoting a health-related lifestyle, as well as to develop an innovative school and community model oriented towards the well-being of children.

METHODS

Procedures

Ethical approval was obtained from the Ethics Committee of University of Évora (22814), Ethics Research Committee of Nova Medical School/FCM-UNL (127/2023/CEFCM), and Ethics Committee for Health of the *Alentejo* Regional Health Administration (24/CE/2023). Authorization to carry out surveys/conduct research studies in a school environment was approval from Ministry of Education and was carried out in agreement of Declaration of Helsinki. The parents of the children gave their written consent and children provided their verbal assent. Each child was assessed by a well-trained team in the field of human kinetics with assessment experience in school-age children. Children were assessed individually in a quiet and private room (weight and height measures and MS) or in small groups (for the MC and 20m shuttle-run test), taking about 50-60min to complete the assessment. A team member ran with the children during the 20m shuttle-run test (20m SRT) to ensure they achieved their maximum performance. Children were familiarized with the procedures for each task/test before recording data.

Participants

Participants were 116 children enrolled in the 4th grade (Boys: 53.45%, M_{age}9.90yrs ± -0.34 years; girls: 44,55%, M_{age}9.99yrs ± -0.31 years), from public primary schools in Évora. None of the children presented neurodevelopmental challenges. All children have physical education according to the national curriculum.

Measures

Body mass index: Weight and height were measured, and BMI was computed and defined as kg/m². Cardiorespiratory fitness: the maximal aerobic capacity of children was assessed using the 20m shuttle run (SR20m) test (15). The data were recorded as laps taken to complete the SR20m test. Muscular Strength: MS was assessed through maximum vertical jump height (VJH) and power during a double leg countermovement maximal vertical jump (16). Motor Competence: MC was assessed with the Motor Competence Assessment (MCA) instrument (17). The results were computed into age and sex related percentiles using the normative values (18).

Data Analysis

All data were analyzed using IBM SPSS Statistics version 24. Statistical significance was set at $p<0.05$. Descriptive statistics (mean and standard deviations) were calculated for all variables assessed. The relationship between all studied variables was examined by Pearson correlation. Pearson correlation coefficients of 0.10, 0.30, and 0.50 were used to define small, moderate, and large magnitude, respectively (19).

RESULTS

Table one shows the descriptive statistics of all included variables, by sex and total sample.

Table 1. Descriptive statistics of all measures.

	Boys (n=62)	Girls (n=54)	Total sample (n=116)
Decimal Age (years)	9.90 ± 0.34	9.99 ± 0.31	9.95 ± 0.33
Weight (kg)	36.15 ± 7.16	36.60 ±8.31	36.36 ± 7.67
Height (m)	138.39 ± 5.87	139.83 ±7.66	139.06 ± 6.77
BMI kg/m²	18.80 ± 3.19	18.59 ±3.27	18.71 ± 3.21
CRF (SR20m, n.º laps)	36.77 ± 20.41	25.87 ±13.78	31.67 ± 18.32
MS (VJH, cm)	19.24 ± 4.63	18.00 ± 4.38	18.67 ± 0.42
MC (percentile)	50.82 ± 16.23	46.15 ± 16.43	48.65 ± 16.42

The data are presented as means and standard deviations. Body Mass Index; CRF - Cardiorespiratory Fitness; 20m SRT - 20m shuttle-run test; MS - Muscular Strength; VJH – Vertical jump height; MC – Motor Competence

Pearson's correlation results for the overall sample indicated that there were positive and significantly associations between MC and both CRF ($r= 0.55$, $p < 0.001$) and MS ($r= 0.64$, $p < 0.001$) and an inverse and significant association between MC and BMI ($r= -0.50$, $p < 0.001$). There were inverse and significantly associations between BMI and both CRF ($r= -0.44$, $p < 0.001$) and MS ($r= -0.61$, $p < 0.001$). MS was positively and significantly associated with CRF ($r= 0.43$, $p < 0.001$). Moreover, we explored potential differences in the trend of correlates for boys and girls. The results of the Pearson correlation between these variables, separately for boys and girls, are depicted in Figures 1 and 2.

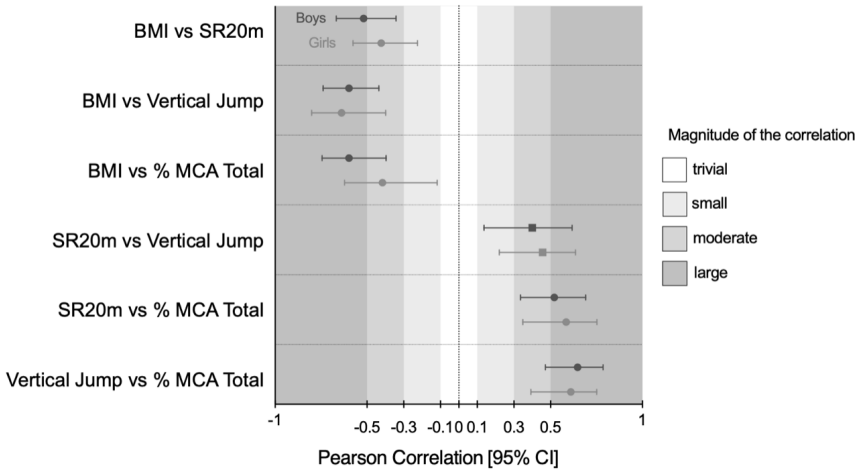

Figure 1. Correlations between all testing variables and their correlation magnitude, separated by sex.

For boys, Pearson's correlation results indicated that there were positive and significant associations between MC and both CRF (r= 0.52, p < 0.001) and MS (r= 0.65, p < 0.001) and an inverse and significant association between MC and BMI (r= -0.59, p < 0.001). There were inverse and significant associations between BMI and both CRF (r= -0.52, p < 0.001) and MS (r= -0.59, p < 0.001). MS was positively and significantly associated with CRF (r = 0.40, p = 0.001).

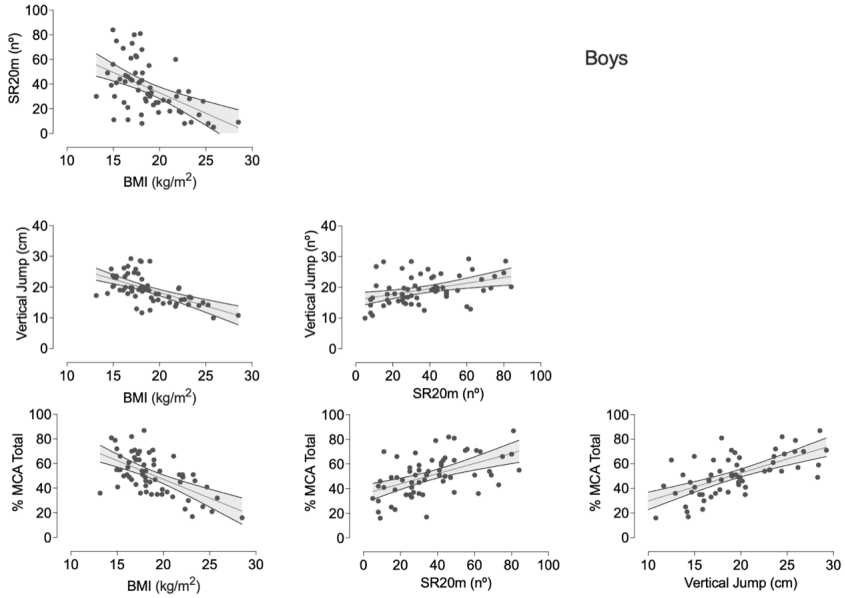

Figure 2. Pearson correlations coefficient and 95% confidence intervals between all testing variables, for boys.

For girls, Pearson's correlation results indicated that there were positive and significantly associations between MC and both CRF (r= 0.59, p < 0.001) and MS (r= 0.61, p < 0.001) and an inverse and significant association between MC and BMI (r= -0.42, p < 0.002). There were inverse and significant associations between BMI and both CRF (r= −0.42, p < 0.001) and MS (r= -0.64, p < 0.001). MS was positively and significantly associated with CRF (r = 0.46, p = 0.001).

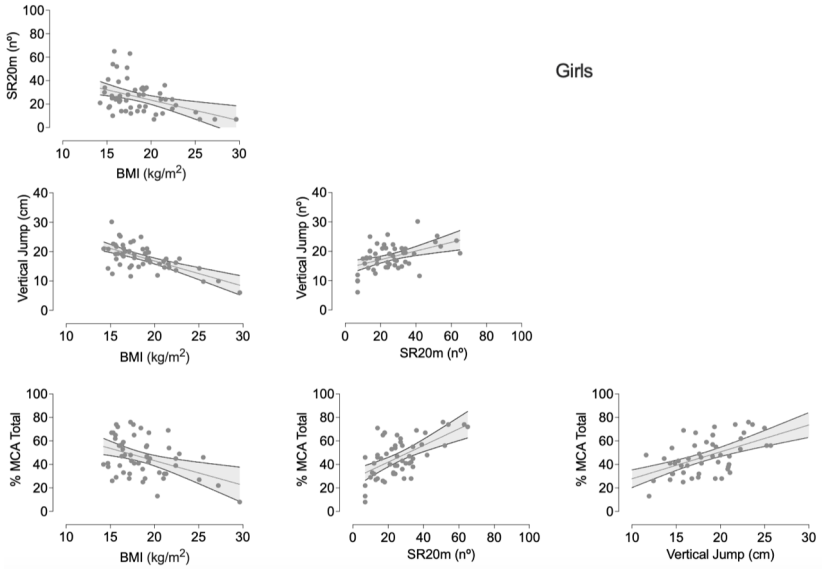

Figure 3. Pearson correlations coefficient and 95% confidence intervals between all testing variables, for girls.

While comparing the magnitudes of the correlation coefficients, we observed an increase for boys in the association between BMI and both SR20m (r= -0.52 vs r= -0.42) and MC (r= -0.60 vs r= -0.42). To test whether the correlation coefficients of boys and girls differed statistically, we conducted Fisher's z-tests for each pair of correlations and found no significant differences in the magnitude of correlation coefficients.

DISCUSSION

This study analyzed the associations between MC, CRF, MS, and BMI in children enrolled in the 4th grade in the municipally of Évora. The results indicated significant and positive associations between MC, CRF, and MS, while BMI showed a significant negative association with those parameters. The findings are consistent with several cross-sectional (2,3,6,20) and longitudinal studies (4), showing that higher MC is associated with better CRF and other components of PF, while BMI has an inverse association with CRF and MC. In the present study, boys had medium overall level of MC ($M_{percentile}$ = 50.82), whereas girls were classified as slightly below the median level ($M_{percentile}$ = 46.15). This study considered the number of laps performed in the SR20 test as an indicator of cardiorespiratory fitness (CRF). Both genders had average results within the healthy fitness zone, defined as performing at least 13 laps (21). Regarding VJH, girls are marginally situated in the healthy zone (M=18; girls: ≥17.9) and boys are situated in the healthy zone (M=19.24; boys: ≥15.7) (22). Concerning BMI, girls are marginally within the healthy zone (M=18.59 kg/m^2; ranging between 13.3 - 18.7 kg/m^2), while boys exceed it slightly (M=18.80 kg/m2; ranging between 13.6 - 18.2 kg/m^2)(23,24). Overall, the findings of this study highlight the importance of developing children's MC, CRF, and MS. Low performance in these parameters is associated with an unfavorable trend in BMI. Children with poor MC have higher BMI compared to those with high MC, and this trend worsens with age. In particular, boys with lower MC show a more rapid BMI increase than girls (25). In our study, the values for girls (18.59 ±3.2fit7 kg/m^2) are very close to the unhealthy zone, while for boys (18.80 ±3.19 kg/m^2), the threshold value for healthy was slightly exceeded. According to Stodden's conceptual model, MC promotes a positive spiral of engagement (or a negative of disengagement) in physical activity and weight status. MC is a central factor that drives the PA levels in middle and late childhood. High levels of obesity impact the spiral of disengagement. Stodden's model also proposes that HRF and perceived motor competence play crucial roles in this process, mediating the relationship between MC and physical activity (5). Therefore, it is necessary to develop early interventions to improve MC, and PF, as they are fundamental components of healthy physical development from childhood into adolescence (6). Improving PF, particularly CRF, could support sustained engagement in physical activity and further contribute to MC

levels (26). The development of both MC and HRF may foster positive and sustainable pathways toward health and contribute to long-term health outcomes (6).

CONCLUSIONS

Focusing on MC should be a priority for monitoring and intervention efforts to prevent the rise of childhood obesity, as MC was shown to be negatively associated with BMI and positively associated with PF. In this study, the boys are already outside the healthy BMI range, while the girls are at the borderline. This interventive approach is relevant as a public health strategy, contributing to the development of both health-related and skills-related PF. Policymakers can use this information to counteract childhood obesity by promoting weight control through physical activity and stimulating MC in schools. Future studies should consider analyzing other factors affecting these relationships and can be targeted for holistic intervention approaches.

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