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ORIGINAL ARTICLE

Level of physical activity and motor coordination of schoolchildren in different maturational stages

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Abstract

Introduction: Studies and debates in the field of motor development reveal that sport and physical activity develop and improve motor skills. These studies seek to understand the changes that occur with movement, which becomes more complex as it develops through physical activity.

Objective: To compare the level of physical activity and motor coordination of students in different maturational stages and to relate the level of physical activity with the motor coordination of young people.

Methods: Descriptive research with cross section. The study included 46 male individuals, aged between 10 and 14 years. The Baecke Habitual Physical Activity questionnaire was applied; the maturity stage was verified through the Pubertal Maturation Prediction Equation; body composition was assessed using the Guedes protocol for children and adolescents; Finally, the coordinating performance was rated using the Korperkoordinationstest fur Kinder (KTK) test battery.

Results: There were significant differences for the variables Age and Height between all stages: P3, P4 and P5 of maturation. The differences found in body mass occurred only between stages P3 and P5; P4 and P5. It was also observed that no significant differences were found for motor coordination between the maturation stages. The same occurred when the physical activity indices were compared.

Conclusion: There is no difference in the level of physical activity between stages 3, 4 and 5 of sexual maturation, nor does the maturational stage seem to influence the level of motor coordination of young schoolchildren.

Keywords: motor activity, motor skills, sexual development.

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Authors summary

Why was this study done?
This study was the work of conclusion of course in Physical Education - Degree, of the author Ayrton Bruno. The choice of the theme occurred through the author's observation, as an intern of the private primary school, the lack of interest in the practice of physical activities by children and adolescents in the last decade.

What did the researchers do and find?
We sought to compare the level of physical activity and motor coordination of students in different maturational stages and to relate the level of physical activity with motor coordination. It was observed that there is no difference in the level of physical activity between stages 3, 4 and 5 of sexual maturation, as the maturational stage does not seem to influence the level of motor coordination of young students. In addition, an association was identified between the level of school physical activity and leisure time with coordinating performance.

What do these findings mean?
They mean that the Physical Education teacher can work with the development of motor coordination during the phases of all stages of sexual maturation, unlike the development of physical abilities, which have sensitive periods of adaptation.

INTRODUCTION

In the last decade the profile of physical activity in adolescents and children has changed considerably and adolescents have an increasingly sedentary profile[1]. Low level of physical activity (NAF) may promote the occurrence of chronic diseases, disorders and organic dysfunctions[2-4]. Among the factors that influence, the abuse of smartphones[5], use of TV, computer and electronic games[6] has stimulated a sedentary lifestyle in about 61.8% of waking time[7]. Although a recent literature review has pointed out that school health programs can stimulate a more active lifestyle in young people[8], a deeper understanding of the factors that interfere with youth NAF and how this lifestyle can affect the physical and motor components is still needed.

As a result, children's activities, such as running, jumping, dancing or cycling, enable a large volume of activity and a wide range of movements[9]. Experiencing a wide range of movements can help children not only to develop self-perception, but also to understand their surroundings[10]. In addition, they learn new movements more easily, getting more success in the activities performed and taking more pleasure from them[11]. It is noteworthy that greater experience can also promote benefits regarding the physical capabilities of young people, because the higher the level of complexity of a motor task, the higher level of coordination required for efficient performance[12]. Thus, it is possible to hypothesize that the motor experience previously developed through daily activities can assist in the accomplishment of complex tasks.

It is noteworthy that the motor development process is basically revealed by changes in motor behavior throughout the life cycle, provided by the interaction between the needs of the task, the individual's biology and environmental conditions[12]. Therefore, the maturational process is an important biological mechanism that influences physical capabilities[13] and the level of physical activity[14]. The process of maturity directly affects the body composition of young people[15], which together with perceived barriers and self-efficacy were indirectly related to the association between pubertal status and NAF[14].

Thus, this study is justified considering the importance and need to identify the levels of motor coordination of school-age children and adolescents, as it allows detecting possible deficits in coordination and, from this, adopt strategies that may contribute to the motor development, health and quality of life of the public concerned.

Thus, the objective is to compare the level of physical activity and motor coordination of students (10 to 14 years old) in different maturational stages and to relate the level of physical activity with the motor coordination of young people.

METHODS

This is a cross-sectional study[16]. The sample consisted of 46 intentionally and non-probabilistically selected male subjects. To be included in the sample, the participant must have a chronological age between 10 and 14 years, give written informed consent and not present physical and/or mental health and/or disability problems, which made the tests impossible or could be a confounding factor in the data analysis. The study was approved by the Ethics and Research Committee of the Federal University of Rio Grande do Norte (Opinion No. 1249937/2015). The entire data collection procedure complied with National Health Council Resolution 466/12, as well as the ethical terms contained in the Declaration of Helsinki.

The evaluations were performed in a single day in the school environment. Initially the participants went through the evaluation of the physical activity level. The previously validated habitual physical activity questionnaire for young people was used[17]. The questionnaire was initially proposed by Baecke *et al.*[17], consisting of 16 questions covering three indices of habitual physical activity in the last 12 months: 1) school occupational physical activity index (IAFE) with eight questions; 2) leisure physical exercise index (IAFLA) with four questions; 3) rate of physical activity of walking, excluding physical exercise (IAFL), with four questions. Finally, the habitual physical activity index (IAFH) is obtained by summing the three indexes mentioned above (IAFH = IAFE + IAFLA + IAFL). All participants received the same instructions for understanding the questionnaire.

Then, measurements of body mass, height, trunk-head height were measured; neck, forearm and waist circumference; acromio-radial and tibial bone heights; femoral diameter; triceps and subscapular skinfolds. All measures followed the guidelines of the International

Society for the Advancement of Kineanthropometry (ISAK)[18]. Body mass and height were evaluated using a Welmy®-branded stadiometer with a precision of 100g and 1cm, respectively; measurements of perimeter and trunk-head height were performed using a 1 mm precision inelastic anthropometric tape (Sanny® brand); Bone diameters and heights were verified from a 1mm precision metal caliper (Sanny® brand). Skinfolds were measured using a scientific adipometer (Sanny® brand).

Anthropometric data were used in the prediction equation for pubertal maturation proposed by Medeiros *et al.*[19] (Equation 1), which shows a high agreement with the genital evaluation method (ICC = 0.840). With the result, the participants were stratified according to the stage of sexual maturation. All participants were qualified in stage 3 or higher.

Equation 1:

EQPP = (0.49436 * age) + (10.74526 * Cephalic Height) + (0.11583 * acromial bone height) – (0.01394 * tibial bone height) – (0.02808 * femoral diameter) + (0.05963 * Forearm Perimeter) + (0.22397 * Neck perimeter) – (0.05155 * Waist circumference) – 19.69139.

Guedes protocol was used to assess body composition for children and adolescents aged 7 to 18 years with the sum of two skinfolds (tricipital and subscapular)[20] in white and black boys (Table 1).

Table 1: Equations for fat percentage prediction according to maturational stage in children.

	Fat Percentage Prediction Equations	
	White boys	Black boys
Prepubescent	% G = 1,21 (S) – 0,008 (S)² - 1,7	% G = 1,21 (S) – 0,008 (S)² - 3,5
Pubescent	% G = 1,21 (S) – 0,008 (S)² - 3,4	% G = 1,21 (S) – 0,008 (S)² - 5,2
Post-pubescent	% G = 1,21 (S) – 0,008 – 5,5	% G = 1,21 (S) – 0,008 (S)² - 6,8

S = sum of skin folds

After evaluating the anthropometric characteristics, the participants moved to a covered court where they performed the Korperkoordinationstest fur Kinder (KTK) test battery[21]. The KTK can be used with children between 5 and 14 years old and is composed of four tasks (high balance, single jumps, lateral jumps and platform transfer) with high reliability (ICC = 0.90)[21]. Task contents present difficulties that increase as individuals get older. Age differentiation follows the following criteria: 1) increase in height or distance; 2) increased speed; 3) greater execution accuracy, measured by the highest number of hits in a given number of trials[21]. For the analysis, the final result was transformed into motor quotients (QM) based on the normative table proposed by Gorla; Araujo and Rodrigues[22].

Statistical analysis

Data normality was tested by the Shapiro-Wilk test and asymmetry and kurtosis analysis (-1.96 to 1.96). The Kruskall-Wallis test was then performed to compare the anthropometry, physical activity level, and Korperkoordinationtest fur kinder (KTK) variables between maturational stages. Spearman's correlation was used to verify the relationship between physical activity level and coordination. For all analyzes, a significance level of 5% (p value <0.05) was adopted.

RESULTS

Of the total sample, eleven young people were classified in stage three, twenty-two were classified in stage four and thirteen were classified in stage five. Figure 1 shows the behavior of anthropometric variables according to the stages of sexual maturation. Age and height showed statistically significant differences between all groups, while body mass differed only in groups P3 and P4 when compared with group P5. There was no difference in fat percentage between maturation stages (Figure 1).

Figure 2 shows the Physical Activity and Habitual Physical Activity Indexes according to the stages of sexual maturation. No statistical difference was found in the level

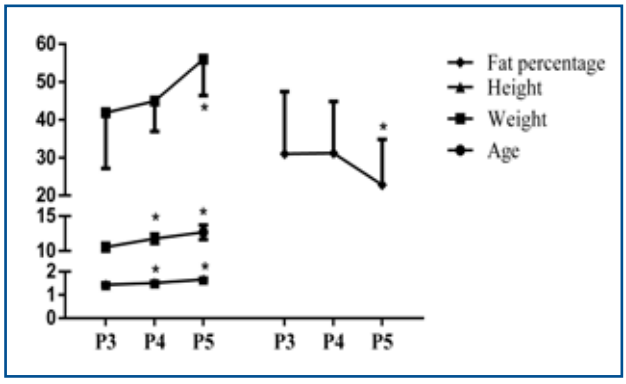

Figure 1: Comparison of anthropometric variables and chronological age between stages of sexual maturation.

* Statistical difference for the other maturation stages (p <0.05).

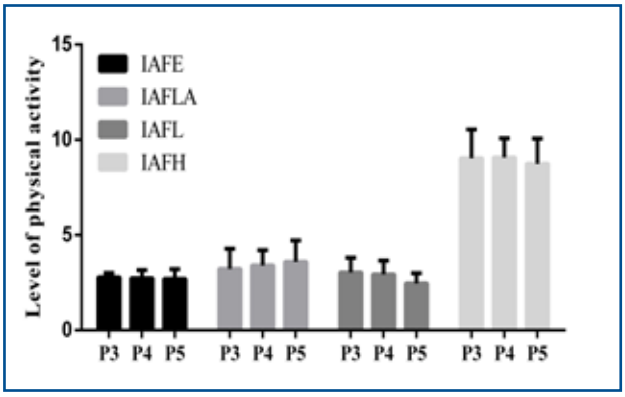

Figure 2: Physical Activity Index and Habitual Physical Activity Index according to sexual maturation stages.

of school physical activity (H = 3,005; p = 0,223), leisure-time physical activity level (H = 3,005; p = 0,223) and locomotion physical activity level (H = 3,952; p = 0,139). There was also no statistical difference in the level of habitual physical activity (H = 0.611; p = 0.737) (Figure 2).

Figure 3 reports the comparison of KTK test performances between maturation stages. There was no statistical difference in the equilibrium test (H = 0.594; p = 0.743), monopodal jumps (H = 5.611; p = 0.060), lateral jumps (H = 1.317; p = 0.518) and platform transfer (H = 1.869). p = 0.393) (Figure 3).

There was no linear association between balance test performance and school physical activity index (IAFE: r = -0.019; p = 0.901), nor did it occur for leisure-time physical activity index (IAFLA: r = -0.019; p = 0.901) and locomotion (r = 0.077; p = 0.804). However, monopodal jump performance was associated with both physical activity at school (r = 0.438; p = 0.002) and leisure-time physical activity (r = 0.438; p = 0.002), but not for the locomotion domain (r = -0.066; p = 0.663). The same pattern occurred for lateral jumps with physical activity at school (r = 0.368; p = 0.012), at leisure (r = 0.368; p = 0.012) and locomotion (r = 0.282; p = 0.057). Platform transfer was associated with school physical activity (r = 0.492; p = 0.001) and leisure (r = 0.492; p = 0.001), but not with locomotion activities (r = 0.086; p = 0.569) (Table 2).

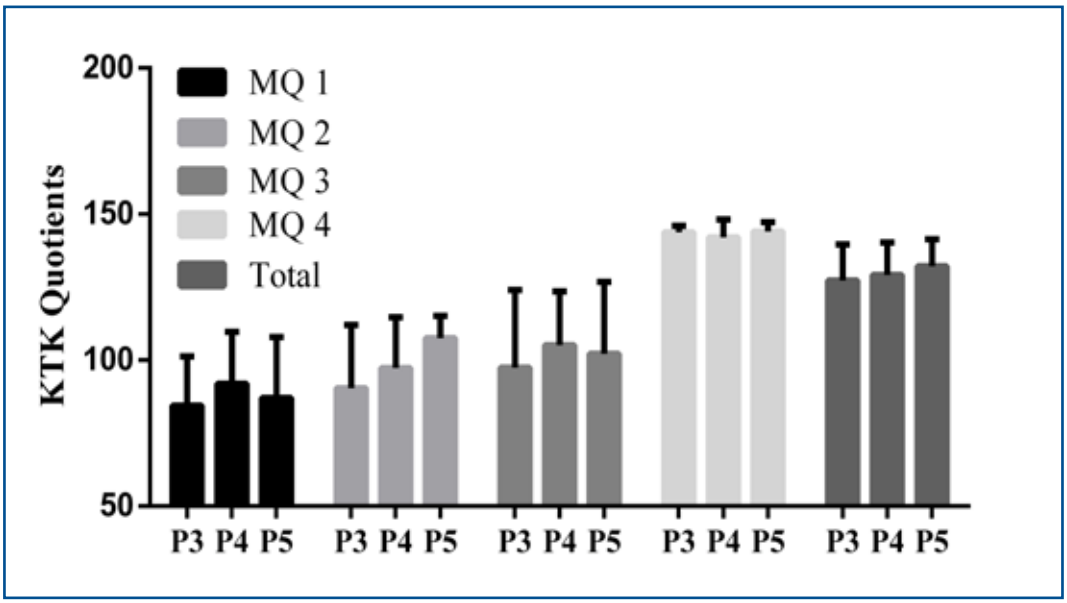

Figure 3: Motor Quotient Averages (MQs) for each KTK test task and Final Score of the total sum of MQs according to sexual maturation stage.

Note: QM1 = Balance test; QM2 = Monopodal jumps; QM3 = lateral jumps; QM4 = Transfer on Platform.

Table 2: Correlation matrix between motor coordination and children's physical activity level.

	IAFE	IAFLA	IAFL
MQ 1	- 0,019	- 0,019	0,077
MQ 2	0,438*	0,438*	-0,066
MQ 3	0,368*	0,368*	0,282
MQ 4	0,492*	0,492*	0,086
Sum	0,382*	0,382*	0,124

QM1 = Balance test; QM2 = Monopodal jumps; QM3 = lateral jumps; QM4 = Transfer on platform; Sum = overall performance on the coordination test. * Statistical difference (p <0.05).

DISCUSSION

Data from the present study report a linear increase in age and height between maturational stages (*i.e.*, P3 <P4 <P5). It was also shown that the participants in the faster stage have higher mass than their less mature peers (P5> P4 and P3), and there is no difference in fat percentage between groups. The level of physical activity was also similar between groups, as was the performance on the coordination test. Moreover, an association between the level of school physical activity and leisure with the coordination performance was identified.

Maturation seems to be an important factor of changes in body composition during adolescence[23]. Throughout adolescence development, it is possible to observe a linear increase of lean mass by ~ 54%, fat mass by ~ 19% and the smallest variation occurred for fat percentage, with a decrease of ~ 11% from stage 3 to Stage 5. The author also shows a strong relationship between changes in testosterone levels and lean mass gains. In fact, hormonal issues are strongly linked with the maturational process.

Cole *et al.*[24] developed a behavioral curve of serum testosterone and IGF-1 concentrations in 54 children, with follow-up from 8 to 16 years. At around 13 years of age

there was an increase in hormone secretion, occurring very close to the peak growth rate. Moreover, hormones showed strong correlations with height and with genital and hairiness stages (r = ~ 0.77 - 0.94). Therefore, it appears that the maturation process in young people is mediated by hormones that induce changes in body composition characteristics.

Although there was no statistically significant difference between the maturation stages for the IAFH, a reduction in the absolute values between stages 4 and 5 can be seen. It is likely that social and cultural aspects may influence the behavioral pattern, resulting in the decline in physical activity levels with increasing age[25]. One of the social factors that can help to understand the reduction of NAF is the change that is analyzed throughout the age in the models that guide adolescents' behaviors. While in childhood the family seems to be the first and most powerful socializing agent in the transmission of values, behaviors and norms, adolescent entry leads adolescents to develop a sense of autonomy and independence; most often leading to distancing from their parents, which may change their models and values, negatively influencing healthy behaviors and lifestyles[26]. Another aspect of social involvement in adolescence is school and, more specifically, the discipline and physical education teacher. In fact, adolescents spend most of their time in school on a daily basis and are subject to various positive and/or negative influences that may affect their physical activity habits[26].

In this sense, considering the association between the level of school physical activity and leisure with coordination performance, Physical Education teachers should enable cognitive, affective, social and motor development in their classes, using content such as games, dances, gymnastics, fights and sports[27], since children and adolescents are always ready for some kind of experience, but the selection and provision of stimuli that trigger the expected response are the teacher's responsibility[28]. Thus, one of the objectives of School Physical Education is to make children and adolescents learn movement, by movement and for movement[27]. Thus, physical assessment should be taken into account in any Physical Education program, as it provides the opportunity for teachers to measure students' strengths and progress[29].

Regarding motor coordination, the results showed that there was no significant difference in motor coordination levels when compared to different maturational stages. Changes in the maturational stage induce morphophysiological changes in the body, but these changes are more related to the actions of production of maximum strength or power (*e.g.*, increase in the percentage of type 2 fibers and increase of creatine kinase activity)[30,31]. Previous studies have shown a relationship between maturation and explosive strength of the upper and lower limbs[32-34]. However, as for the coordinating abilities, other factors may be more relevant, such as the type of training program and the training age of the individual. It is noteworthy that few studies have sought to use maturational stages in conjunction with motor coordination tests[35,36].

Freitas *et al.*[35] aimed to analyze the contribution of skeletal maturation in the performance of KTK tests in children from 7 to 10 years old, resulting in negative correlation coefficients, concluding that biological maturation alone, or even combined with body size, has little influence on KTK results. Whereas, Luz *et al*.[36] aimed to analyze the association of maturational stages with performance in motor coordination tests in children. The results showed that the maturational stages had no significant correlation with most of the KTK tests (single jump, lateral jump and transfer on platforms). On the other hand, there was a significant but inverse correlation with the balance beam.

Therefore, both studies cited above[35,36] corroborate the findings of the present study. In addition, the non-difference in physical activity levels presented in the present study sample may also have interfered with the final result, reinforcing the argument that: regardless of maturational stages, coordinative performance is efficient when associated with physical activity level[37].

Thus, it is necessary to stimulate the practice of physical activity during the phases of all maturation stages. For this reason, Physical Education classes and sports institutions are propitious spaces for the evolution of motor coordination levels[38].

In general, this study presents relevant contribution about the maturation and motor coordination processes, highlighting the importance of performing physical assessments with children and adolescents in the school environment, using the KTK, considering that it is a useful tool in sports talent detection process[39]. However, it is suggested to conduct studies with objective measurements (*e.g.,* accelerometer) in order to better understand the behavior of the variables in question during the children's growth and development process.

Thus, it is noteworthy that there is no difference in the level of physical activity between stages 3, 4 and 5 of sexual maturation, just as the maturational stage does not seem to influence the level of motor coordination of young students. However, the level of physical activity practiced at school and leisure time was significantly associated with motor coordination performance.

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Resumo

Introdução: Estudos e debates na área do desenvolvimento motor revelam que o esporte e a atividade física desenvolvem e melhoram as habilidades motoras. Esses estudos buscam compreender as mudanças que ocorrem com o movimento, o qual se torna mais complexo à medida que se desenvolve através da atividade física.

Objetivo: Comparar o nível de atividade física e coordenação motora de escolares em diferentes estágios maturacionais e relacionar o nível de atividade física com a coordenação motora de jovens.

Método: Pesquisa descritiva com corte transversal. Participaram do estudo 46 indivíduos do sexo masculino, com idades entre 10 e 14 anos. Foi aplicado o questionário de Atividade Física Habitual de Baecke; o estágio de maturidade foi verificado através da Equação de Predição da Maturação Puberal; a composição corporal foi avaliada através do protocolo de Guedes para crianças e adolescentes; por fim, o desempenho coordenativo foi classificado por meio da bateria de testes Korperkoordinationstest fur Kinder (KTK).

Resultados: Houve diferenças significativas para as variáveis Idade e Estatura entre todos os estágios: P3, P4 e P5 de maturação. As diferenças encontradas na massa corporal ocorreram apenas entre os estágios P3 e P5; P4 e P5. Observou-se também que não foram encontradas diferenças significativas para a coordenação motora entre os estágios de maturação. O mesmo ocorreu quando os índices de atividade física foram comparados.

Conclusão: Não existe diferença no nível de atividade física entre os estágios 3, 4 e 5 da maturação sexual, assim como o estágio maturacional não parece influenciar o nível de coordenação motora de jovens escolares.

Palavras-chave: atividade motora, destreza motora, desenvolvimento sexual.