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ORIGINAL RESEARCH

EFFECT OF SEDENTARY LIFESTYLE, NUTRITIONAL STATUS AND SEX ON THE FLEXIBILITY OF SCHOOL CHILDREN

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Abstract

Introduction: assart-day life habits have led to a more sedentary lifestyle, contributing to increased obesity. In view of these changes, it is necessary to understand whether the flexibility of the individual has also been influenced. **Objective:** to investigate the influence of sex, sedentary lifestyle and nutritional status on the flexibility of elementary school children. **Methods:** 60 cheldren of both sexes aged five to 14 years were divided into a normal flexibility group (n = 21) and a reduced flexibility group (n = 39). Flexibility was evaluated by photogrammetry using the straight leg raise test, considering the leg angle. The physical activity level was evaluated using the Physical Activity Questionnaire for Older Children, and nutritional status was assessed by Body Mass Index for age and sex. **Results:** the normal flexibility group and the reduced flexibility group presented no significant differences regarding age, weight or height ($p > 0.05$). No differences were found ($p > 0.05$) in leg angle between the active and sedentary groups, the obese and nonobese or between males and females. **Conclusions:** sex, sedentary lifestyle and nutritional status exercized to influence on the flexibility of students.

Key words: pliability; sex; body mass index; motor activity; child.

INTRODUCTION

Flexibility is a physiological characteristic that allows an individual to execute voluntary movements of maximum joint angular amplitude within morphological limits[1], free of pain and restrictions[2]. This physical attribute results from an interrelationship between ligaments, muscles, tendons, skin and joints[3]. The shortening of these structures results in a limited range of motion[2], and may lead to a number of consequences for individuals with this limitation.

A good flexibility level can greatly impact an individual's quality of life. Among its benefits are: improved skills in daily activities and sports; reduced risk of musculotendinous injuries and incidence of muscle pain, reduced stress and improved posture[3]. In addition, psychosocial factors and fitness are crucial for stimulating physical activity[4], essential for health.

In recent decades, however, constant technological advances[5] and an increasing lack of security in urban areas have contributed to a sedentary lifestyle[6] in whir by activities such as watching television, playing video games and spending long hours on the computer predominate[7,8]. This lifestyle, coupled with inadequate diet, has contributed to increased overweight and obesity among children. The increase in these indexes is becoming a public health problem since their consequences affect overall quality of life for these individuals[9] .

Therefore, a better understanding of the influences that these changes have on flexibility levels is also necessary, since this characteristic plays a fundamental role in everyday life. A number of studies have demonstrated that flexibility is influenced by nutritional status[10-12], physical activity levels[3] and sex[3,10,13,14]. However, other studies have reported controversial results regarding nutritional status[15-17], physical activity level[18] and sex[19,20].

There is no consensus as to whether the changes resulting from nutritional transition and increased sedentarism and sex are factors that can influence the physical fitness of children, especially

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regarding flexibility. Considering the important benefits of flexibility for quality of life during childhood, it is important to investigate the possible influence of the above-mentioned factors on this parameter.

Thus, the objective of this study was to verify whether sex, sedentary lifestyle and nutritional status influence student's flexibility level.

METHODS

Subjects

The sample of this cross-sectional survey included 60 school cheldren's of both sexes between the ages of five and 14 years old who were enrolled in elementary schools in Florianópolis, Brazil. children with special needs, i.e. who participated in any orthopedic treatment and/or physical therapy, were excluded.

The school children were divided into two groups according to leg angle measurement on the straight leg raise test: Group 1 (G1), normal flexibility, included 21 subjects with values > 65°; Group 2 (G2), reduced flexibility, included 39 subjects with values < 65°[21].

The Human Research Ethics Committee approved this research project in Protocol 165/2011. The participating children's parents or guardians were informed about the objectives and procedures of this study and signed an informed consent form.

Instruments

The instruments used in this study were: anamnesis, the physical activity questionnaire for children (PAQ-C) and photogrammetry. Anamnesis was used to characterize the sample and consisted of anthropometric data and inclusion and exclusion criteria. The body mass and height of the children were used to calculate the Body Mass Index (BMI), which was used to determine nutritional status. On the basis of the BMI adjusted for age and sex. The children were classified, as either underweight (below the fifth percentile), normal weight (between the fifth and 85th percentiles), overweight (between the 85th and 94th percentile) or obese (> the 95th percentile)[22]. According to this classification, the sample was divided into the following groups for data analysis: an obese group (childrens classified as obese and overweight) and a nonobese group (classified as underweight and normal weight).

The PAQ-C, validated by Crocker et al.[23], is a questionnaire used to assess the physical activity level of children and adolescents over the seven previous days. It consists of nine questions about sports, games and physical activities at school and during leisure time. Each question has a value of one to five and the final score is obtained by averaging the value of all the responses. The results range from very sedentary (1) to highly active (5)[24]. The children were classified as active when they obtain scores > 3 and sedentary when scoring < 3[24].

The straight leg raise test in conjunction with photogrammetry is considered a useful and reliable method for evaluating flexibility[21]. In this technique, angular measurements were used to categorize the subjects' flexibility. This analysis was performed using SAPO, a highly reliable software program[25].

Procedures

After completing the questionnaires, anamnesis was carried out. The school children were asked to wear appropriate clothes and remain barefoot. Anthropometric measurements were taken with the student in the standing position with feet supported forward and arms relaxed alongside the body. Body weight was measured using a digital scale (Filizola) with 100g precision. A stadiometer was used to measure the height.

The photogrammetry procedure involved a digital camera (SANYO VPC-HD2000) fixed to a tripod on level ground at a height of 85 cm three meters from a gurney measuring 1.82 m in length, 82 cm high and 60.5 cm wide. As a vertical axis reference, a 100 cm plumb line was used. White 1 cm spherical markers were attached bilaterally with double-sided tape to the subjects in order to identify the greater trochanter of the femur and the lateral malleolus as reference points.

After anamnesis, the straight leg raise test was conducted as follows: the child was placed on a stretcher in the supine position with legs extended and arms flexed with the hands behind the head. During the test the thigh of the contralateral limb was secured to stabilize movement. The test was performed on both legs. A photo was taken when the subjects began to feel muscular tension in the posterior region of the leg, before attempting a hip rotation of the limb under evaluation.

Two different, previously trained evaluators took images and calculated the angles so that interrater reliability could be checked. Sagittal plane analysis was carried out by measuring the leg angle (intersection between the leg segment and the horizontal line of the gurney)[21] (Figure 1).

Statistical analysis

Descriptive statistics were used for data processing (mean and standard deviation). Interrater reliability for flexibility measurements (leg angle) was assessed using the intraclass correlation coefficient (ICC). The difference between the leg angle measurements of the left and right legs was also evaluated with Student's *t*-test.

The normality of the data was tested using the Kolmogorov-Smirnov test. Student's *t*-test for independent samples was used to determine the difference between the average anthropometric characteristics and leg angles of the groups with normal and reduced flexibility. The same test was used to compare the means of the angles of the leg between the active and sedentary groups, between obese and non-obese groups and between males

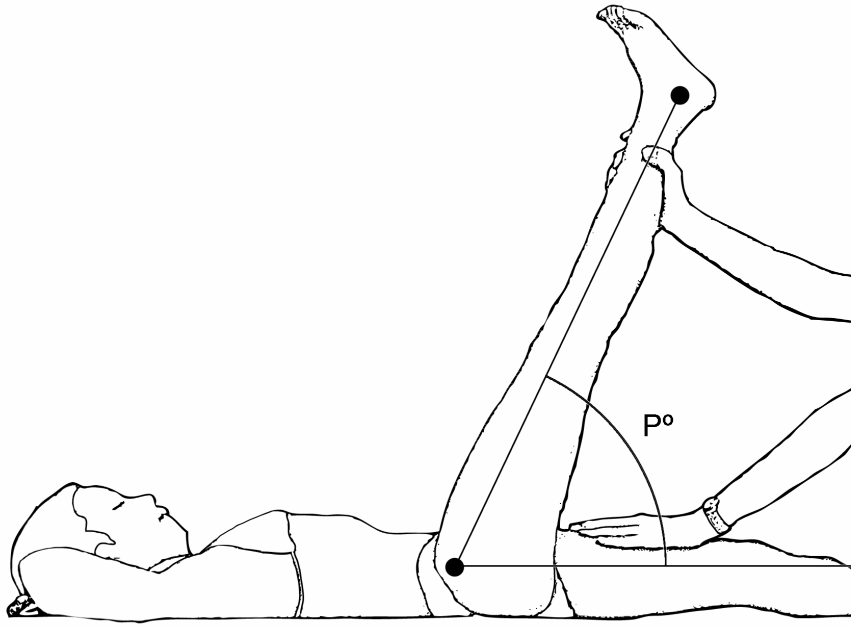

Figure 1: Straight leg raise test (Pº: angle of the leg). Florianópolis, SC, Brazil: 2011-2012

and females. In order to verify the existence of an association between the groups with normal and reduced flexibility factors and physical activity, nutritional status and sex bivariate logistic regression analysis was applied. The effect of the explanatory factors on the occurrence of reduced flexibility was assessed by calculating the odds ratio (OR) with a confidence interval of 95%.

The Statistical Package for the Social Sciences (SPSS) version 17.0 for Windows used for the statistical analysis, and a significance level of 5% ($p<0.05$) (with a two-tailed distribution) was adopted for all procedures.

RESULTS

Of the 60 school children assessed, 21 were classified as having normal flexibility and 39 as having reduced flexibility. Table 1 describes the anthropometric characteristics and leg angles of the groups with normal and reduced flexibility. The mean leg angle scores of the active and sedentary groups, nonobese and obese groups and both sexes are compared in table 2. The results of the binary logistic regression are presented in table 3.

DISCUSSION

It was observed that the groups with normal and reduced flexibility were homogeneous. There were no statistically significant differences between the groups in terms of age, weight or height ($p>0.05$). The results also show that the leg angle was significantly lower in G2 (reduced flexibility) than G1 (the expected results for the groups were divided in accordance with the angle).

Since high reliability for the leg angle measurements was obtained between the two evaluators (ICC>0.960, $p<0.000$), their arithmetic mean was considered. There were no significant differences ($p>0.05$) between left and right leg measurements, so an average for the two members was used. No significant differences ($p>0.05$) in leg angle were observed between the active and sedentary groups, the nonobese and obese or between males and females. A predictive association was observed for the physical activity factor (odds ratio < 1.00). Sedentary students had a 2.5 x greater chance of normal flexibility.

A restricted range of hip motion is related to decreased flexibility of the hamstrings[26]. In this study, hamstring flexibility was measured with the straight leg raise test. As expected, there was a significant difference in leg angles between the groups with normal and reduced flexibility, with average values of 76° and 53°, respectively. Although the present study used the same classification parameters as Carregaro et al.[21], it was observed that the average leg elevation was greater for both groups. The above-mentioned study found mean leg elevation values of 53º and 33º, respectively, for its normal and reduced flexibility groups. However, those values were for individuals between 18 and 35 years old, whereas the subjects evaluated in this study. The different results found in these studies may be due to the chronological age of the participants, since it has been demonstrated that flexibility decreases with advancing age[14].

It was expected that the physical activity level would positively influence leg flexibility. Neverthe-

Table 1: Mean and standard deviation for age, weight, height and leg angle of the students with normal (n = 21) and reduced (n = 39) flexibility. Florianópolis, SC, Brazil: 2011-2012

	Flexibility		***P***
	Normal Mean ± SD	**Reduced Mean ± SD**	
Age (years)	10.000 ± 2.607	9.666 ± 2.1316	0.595
Weight (kg)	39.238 ± 15.998	40.712 ± 12.044	0.689
Height (m)	1.413 ± 0.172	1.455 ± 0.145	0.325
Leg angle	76.414 ± 7.039	53.052 ± 8.535	0.000*

T test for independent data; * statistically significant.

Table 2*:* Comparison between the mean scores obtained in the leg angle assessment according to the variables studied. Florianópolis, SC, Brazil: 2011-2012

Variables		**Leg angles**	**P**
Physical activity	Active(n = 30)	58.060 ± 10.562	0.075
	Sedentary (n = 30)	64.397 ± 15.943	
Nutricional Status	Non-obese (n = 35)	63.940 ± 13.189	0.071
	Obese (n = 25)	57.434 ± 13.960	
Sex	Female (n = 35)	62.757 ± 13.879	0.313
	Male (n = 25)	59.090 ± 13.637	

T test for independent data

Table 3: Frequency distribution of 60 school children 5-14 years old with normal and reduced flexibility according to risk factors. Florianópolis, SC, Brazil: 2011-2012

	Normal (n = 21)	**Flexibility Reduced (n = 39) n (%)**	**OR n (%)**	**CI 95%**	**P value**
Physical activity					
Active	6 (28.571)	24 (61.538)	1	0.080 - 0.786	**0.018***
Sedentary	15 (71.428)	15 (38.461)	0.250		
Nutricional status					
Nonobese	13 (61.904)	22 (56.410)	1	0.424 - 3.714	0.681
Obese	8 (38.095)	17 (43.590)	1.256		
Sex					
Female	15 (71.428)	20 (51.282)	1	0.763 - 7.397	0.136
Male	6 (28.571)	19 (48.718)	2.375		

* statistically significant, OR = odds ratio, CI95% = confidence interval of 95%

less, the results of this study did not confirm this hypothesis. Active students had a lower, although not significantly so, leg angle than the sedentary group. Regarding the comparative analysis of factors between children with normal and reduced flexibility, we found an association between physical activity and reduced flexibility.

Flexibility results from the sit-and-reach test in adolescents older than 15[27] and an index of seven joints of the human body[18] also indicated no differences between individuals with different levels of physical activity. The results of the present study showed that leg flexibility in children between five and 14 years old cannot be differentiated according to physical activity level and therefore must be considered as an independent factor[27].

However, the association found between active students and reduced flexibility is curious. It is known that regular physical activity provides physiological and psychological benefits, and the aerobic components, flexibility and muscle overload it entails warrant respect[28]. Therefore, the importance of including exercises involving physical aptitude during physical education classes must be considered. It is worth mentioning that, at least in Brazil, the content of most physical education classes is limited to teaching the techniques, rules and history of different sports, especially handball, basketball, volleyball and soccer[29].

Flexibility can be influenced by the type of exercise performed, i.e., the type of movement most often employed in certain activities can result in better mechanical efficiency and specific performance[18]. However, the evaluation methodology in this study was limited in that it did not distinguish between the type of physical activity in which the subjects were involved. Thus, to evaluate such influence, it would be necessary to consider the type of physical activity performed as well as specific categories of movements and the joints most involved in such activity. The study was limited to assessing flexibility by means of the hip flexion angle with the leg extended. It was assumed that those who achieved a better score in the test participated in activities involving large movements of this joint.

In agreement with other studies[19,20], no difference in the leg angles was observed between the sexes. Although some authors have reported such a difference[10,13,14], these results are controversial. Bim and Nardo[10] assessed the flexibility of adolescents 16 to 17 years old with the sit-and-reach test and concluded that male performance was better. Penha and João[13] found the same result when evaluating children seven to eight years old by the fingertip-to-floor test. Pagnussat & Paganotto[14], using the hamstring length test with a group of six- to 13-year-olds, reported that females were more flexible than males. Further studies are necessary to determine whether sex influences flexibility. Other sex-factors could affect this parameter and should be considered. Sex differences could be due to anatomical and physiological differences[2], genetic variation and sociocultural factors[19].

There was no difference in leg angle values between the obese and nonobese students, which corroborated Contel et al., Kim et al. and Minato et al.[15-17]. On the other hand, other studies using the sit-and-reach test found different results[11,12,30]. It was observed that in cases of overweight and obesity, fat accumulation at the joints could increase friction and reduce myoarticular stretching ability[19].

In the present study, the only classification method used to categorize the subjects' nutritional profile was BMI adjusted for age and sex, which cannot discriminate between lean and fat mass. Thus, it was not possible to determine fat percentage. For this reason, some students classified as having reduced flexibility could have had a BMI similar to those considered to have normal flexibility, although with different percentages of fat. However, it is impossible to confirm this hypothesis, since this component was not assessed in this study.

Furthermore, it is known that flexibility can be influenced by factors such as biological individuality, somatotype[17], the type of physical activity in which the individual is involved and age[3]. It could be presumed, therefore, that flexibility is influenced by the sum of all these factors. Thus, when the actual existence of these influences is verified, it becomes necessary to control all the variables that could affect flexibility levels.

More than half of the children in the present study were classified as having reduced flexibility according to the classification parameters of Carregaro et al[21]. Pelegrini et al[31]. assessed 7507 children aged seven to 10 years from all the regions of Brazil with the sit-and-reach test and also found that the majority did not attain the minimum flexibility criteria established for health. Other studies[10,32,33] have also found the same results, so it may be that there is a trend among Brazilian children and adolescents towards low levels of physical fitness.

Some authors have stated that this tendency may be related to increasing physical inactivity in children[31,33], but the present study found that a sedentary lifestyle cannot be considered a risk factor for flexibility deficits. Nevertheless, what we can take into account are the types of activities that predominate in these individuals' routines.

It is known that due to the constant advances in technology in recent decades, children have become accustomed to remaining seated in front of computers, television and video games for extended periods of time[7,8]. Moreover, the sitting posture also predominates during the school day. One study found that individuals who spend much of their time seated have lower overall flexibility of the posterior chain[34]. This occurs because such a posture tends to shorten the posterior muscles of the lower limbs, especially the hamstrings and gastrocnemius[34]. Thus, it is assumed that the subjects evaluated in this study who had low levels of flexibility may be spending too much time in this position.

The flexibility results presented in this study merit attention, since this component is important for promoting better health and reducing pain levels, risk of injury and stress[3]. Furthermore, when there is limited range of motion, sports performance and activities of daily living may be impaired[35]. Moreover, lower levels of physical fitness among children can contribute to inactivity, leading to reduced participation in physical activity and games[36] and resulting in a less healthy lifestyle.

Thus, the need to include physical fitness as an essential component of physical education classes should be emphasized. Such programs, besides addressing social aspects and motor coordination skills, should also include exercises to improve flexibility, muscle strength and cardiorespiratory endurance.

By improving fundamental movement skills, it is likely that children will be more willing to participate in activities that involve physical fitness components[36]. Thus, when designing an exercise program for this population, activities that promote improved levels of all physical fitness components should be included so that children are encouraged to develop a more physically active and healthy lifestyle[37].

In conclusion, sex, sedentary lifestyle and nutritional status were did not found to influence the fle-0xibility of the children we studied and that reduced flexibility was prevalent.

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