Influence of age and body composition in endurance, flexibility and strength of children and adolescents

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ABSTRACT: The aim of the present study was to identify factors which are able to influence the physical fitness of children and youngsters, such as age and body composition. The sample included 92 Caucasian individuals (48 girls and 44 boys) with a mean age of 13.49±1.54, of 7th and 10th grades. The subjects were submitted to a single evaluation moment, in which the data concerning the body composition were obtained by anthropometric measurement, while the physical fitness followed the Fitnessgram® protocol. The statistic procedures consisted in descriptive analysis, correlative analysis and comparative analysis for a significance level of p≤0.05. To evaluate the robustness of regression models, the adjusted determination coefficient (R2adj) and the standard error of the regression (Syx) were used. The main results showed higher body fat percentage as well as higher body mass indexes in females. These indicators seemed to relate positively with age. These variables also seem to influence the endurance ability of the subjects (the larger the body mass index and % of body fat the lower was the endurance ability). The strength and endurance measurements increased progressively with age on the male subjects.

Keywords: Body composition, physical fitness, resistance, strength, flexibility.
INTRODUCTION

The scientific evidence of the benefits of physical activity related with health and the prevalence of different derived upsets of the immobilization justify the interest of the efforts driven to the prevention and modification of conducts (CHATRATH et al. 2002), as well as the investigation initiatives that contribute to an deepen of the exhausting knowledge of this epidemiology through the development of evaluation procedures and effective intervention.

A good motive aptitude is a fundamental attribute in the repertoire of motive conduct of children and adolescents, becoming essential for the effective participation in activity programs (OKANO, 2001).

In this sense, the pertinence of the factors identification appears, namely of the aspects related with the corporal composition, susceptible of influencing the individuals’ physical fitness (SILVA, 2002).

In the health field, it is sought that the components of the physical fitness reflect biological particularities that offers some protection to the emergence and development of organic disturbances induced by compromising of the functional condition (GUEDES, 2002). In operational terms, these components contemplate indicators for the cardiorespiratory capacity, to the force and muscular resistance, to the flexibility and the corporal fat (CORBIN AND LINDSEY, 1997).

The differences in the resistance indexes seems to be associated or to reflect different lifestyles (BRAGGION et al. 2000; CHATRATH et al. 2002; MALINA, 1996). This way, a more and more sedentary lifestyle from low ages, related more and more with the socioeconomic statute of the populations (BRAGGION et al. 2000) implicates a larger Index of Corporal Mass (IMC) that, for its time, reflects indexes of inferior cardiorespiratory resistance (CHATRATH et al., 2002).

The cardiorespiratory component seems to inversely relate with the corporal adiposity (GUERRA, 2002), and, when associated to a pondered overload, the negative effect is equally reflected in the tests that implicate support of the weight of the body, as are the tests of superior force of the torso (FITNESSGRAM, 2002).

The muscular strenght tends to depend united with the growth factors related with the gender, increasing the differences, initially superior in the boys, with the process of maturational development (MARQUES, 1993).

Beyond the corporal weight, the height variation associated to the maturation process seems also to influence in the physical fitness during the height growth pick, due to the children’s considerable variability in this phase of the process maturational (FITNESSGRAM, 2002).

The somatotype still seems to contribute for the flexibility capacity, the corporal fat presenting a negative correlation with the flexibility degree, in people of the same sex (FERNANDES, 1994).

The more frequently used techniques in the evaluation of the public health or clinic tracking are the anthropometrics measures (MEI, 2002). There are examples the subcutaneous adiposity pleats, the perimeters, the height and the corporal weight.

RESUMO

Influencia da idade e da composição corporal na resistência, flexibilidade e força em crianças e jovens

O objetivo do presente estudo foi identificar fatores capazes de influir na aptidão física de crianças e jovens, como sejam a idade e a composição corporal. A amostra foi constituída por 92 indivíduos caucasianos (48 meninas e 44 rapazes), com uma média de idades de 13,49±1,54, do 7º e 10º anos de escolaridade. Os sujeitos foram submetidos a um momento de avaliação único, em que os dados relativos à composição corporal foram obtidos por medição antropométrica, enquanto que a aptidão motora seguiu o protocolo definido pelo Fitnessgram®. Os procedimentos estatísticos consistiram em análise descritiva, análise correlativa e análise comparativa, para um nível de significância de p≤0,05. Para avaliar a robustez dos modelos de regresão foi utilizado o coeficiente de determinação ajustado (R2adj) e o erro padrão da regressão (Syx). Os principais resultados evidenciam porcentagens de gordura, assim como índices de massa corporal superiores no sexo feminino, indicadores que parecem relacionar-se positivamente com a idade. Estas variáveis parecem influir sobretudo na capacidade cardiorespiratória, sendo que quanto maior o IMC e o % de gordura, menor a capacidade de resistência. As capacidades de força e resistência revelaram-se superiores no sexo masculino, aumentando progressivamente com a idade.

Palavras-chave: composição corporal, aptidão motora, resistência, força, flexibilidade.

RESUMEN

Influencia de la edad y composición corporal en la resistencia, flexibilidad y fuerza en criancas e jovenes

El objetivo de lo presente estudio ha sido de identificar los factores capaces de influir en la aptitud física de criancas y jovenes, como sean la edad y la composición corporal. La muestra ha sido constituida por 92 individuos caucasianos (48 niñas y 44 niños), con una media de edades de 13,49±1,54, del 7º y 10º años de escolaridad. Los sujetos han sido sometidos a un momento de evaluación único, en lo que los datos relativos a la composición corporal han sido obtenidos por mediación antropométrica, mientras que la aptitud motora ha seguido el protocolo definido por lo Fitnessgram®. Los procedimientos estadísticos han consistido en lo analitico descritivo, analitico correlativo y analitico comparativo, para un nivel de significancia de p≤0,05. Para evaluar la robustez de los modelos de regresión ha sido utilizado el coeficiente de determinación ajustado (R2adj) y el error padrón de la regresión (Syx). Los principales resultados evidencian porcentajes de gordura así como índices de masa corporal superiores en lo sexo femenino, indicadores que parecen relacionar-se positivamente con la edad. Estas variables parecen influir sobretodo en la capacidad cardiorespiratoria, siendo que cuanto mayor el IMC y lo % de gordura, menor la capacidad de resistencia. Las capacidades de fuerza y resistencia revelaran-se superiores en lo sexo masculino, aumentando progresivamente con la edad.

Palabras clave: composicion corporal, aptitud motora, resistencia, fuerza, flexibilidad.
The weight and height are the variables that, due to its simplicity and low cost, are revealed better instrument to verify the nutritional state. This way we can calculate IMC, one of the more recommended methods to determine the excess weight and obesity in adolescents (MEI, 2002).

The measurement of the subcutaneous pleats constitutes one of the most practical methods of appreciation of total and regional adiposity, since portable and cheap instruments are used, providing a fast evaluation, with minimum of cooperation and reasonably precision (MOREIRA AND SARDINHA, 2003).

Considering that this constitutes an indirect method of evaluation, allows to obtain prediction mistakes of the % of inferior Fat Mass (MG) (estimate standard error of = 3.4%) that obtained by other indirect methods of estimate of the corporal composition, as the bioimpedance case (=4.6%) or of the Index of Corporal Mass (=4.5%) (MOREIRA AND SARDINHA, 2003).

In this conceptual picture, the purpose of this study was to analyze the age and corporal composition influence in different parameters of the physical fitness - endurance, flexibility and strength - of children and youngsters portuguese students.

**METHODOLOGY**

**Sample**

The sample of the present study was of the intentional type, meaning that the sampling was driven (no casual), being accepted the group of subjects as soon as selected a particularly representative of a subset of the global population with certain identical characteristics.

The sample was constituted by 92 Caucasian children and adolescents (48 girls and 44 boys), with ages understood between the 11 and the 17 (13.49 + 1.54) of 2 year of school (7th and 10th year) and 3 different groups. All the subjects belonged to the Escola Secundária de Morgado de Mateus (Vila Real), which previously authorized the data withdrawal of the study.

Specific inclusion criteria were not considered, having, however, 2 purged cases of the statistical analysis, due to their characteristics, that could not integrate comparative groups of certain values already validated for the equations for children and young (subject with age > 18 years and students bearer of limitative deficiency).

The used procedures respected the defined international norms in the Declaration of Helsinki, 1975.

**Procedures**

The data were collected in two different sessions (2 classes of physical education) by 3 appraisers (teachers of physical education). Each one of the teachers always made the same measurements in all students, so that there were not differences of current results of the appraisers’ inter individual differences(objectivity of the tests). For such, were defined in each group and session 3 outposts of evaluation, in that each appraiser proceeded to the measurement and registered the data in a registration sheet designed for the effect.

With the intention of esteeming the percentage of corporal MG, the tricipital and geminal subcutaneous adiposity pleats were measured, through an Slim Guide adipometer (Creative Health products, USA). The evaluation was made in triplicated, on the right side of the body and with approach of 0.1 mm. The values were obtained through the predictive equations of Slaughter et al. (1988), for they are the ones that manifest larger agreement with direct calculation values, especially Double Energy Radiological Densitometry (DXA) (MOREIRA AND SARDINHA, 2003).

For height determination, an estadiometer was used with measure scale of 0.1 cm. To evaluate the span a measuring tape was used with the same measure scale.

The indicators related to the cardiorespiratory aptitude were reached through estimates as for the maximum consumption of oxygen, by the sway test of Fitnessgram®.

Information concerning the indicators of flexibility and strength and muscular resistance were obtained starting from the application of

**Table 1 - Descriptive analysis of the study variables, for sex**

<table>
<thead>
<tr>
<th></th>
<th>Feminine gender</th>
<th>Masculine gender</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=48)</td>
<td>(n=44)</td>
</tr>
<tr>
<td>M + SD</td>
<td>M + SD</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>13.48 ±1.68</td>
<td>13.50 ± 1.41</td>
</tr>
<tr>
<td>IMC</td>
<td>22.40 ± 3.91</td>
<td>20.86 ± 3.14**</td>
</tr>
<tr>
<td>Fat %</td>
<td>23.99 ± 6.28</td>
<td>15.67 ± 6.02**</td>
</tr>
<tr>
<td>Weight</td>
<td>54.68 ± 11.83</td>
<td>54.16 ± 13.46</td>
</tr>
<tr>
<td>Height</td>
<td>1.56 ± 0.73</td>
<td>1.60 ± 0.12</td>
</tr>
<tr>
<td>Span</td>
<td>1.62 ± 0.85</td>
<td>1.65 ± 0.13</td>
</tr>
<tr>
<td>Abdominals</td>
<td>34.54 ± 19.60</td>
<td>41.82 ± 21.26</td>
</tr>
<tr>
<td>Torso extension</td>
<td>27.27 ± 2.86</td>
<td>28.02 ± 2.42</td>
</tr>
<tr>
<td>Arm extension</td>
<td>6.71 ± 6.14</td>
<td>12.18 ± 5.46**</td>
</tr>
<tr>
<td>Sway</td>
<td>17.38 ± 7.47</td>
<td>36.64 ± 16.27**</td>
</tr>
</tbody>
</table>

M - Mean, SD - Standard Deviation * * (p ≤ .01)

**Table 2 - Descriptive analysis of the study variables, for year of education**

<table>
<thead>
<tr>
<th></th>
<th>7th grade (n=53)</th>
<th>10th grade (n=39)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M + SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>12.36 ± 0.92</td>
<td>15.03 ± 0.58</td>
</tr>
<tr>
<td>IMC</td>
<td>20.59 ± 3.26</td>
<td>23.12 ± 3.63**</td>
</tr>
<tr>
<td>Fat %</td>
<td>19.80 ± 6.89</td>
<td>20.29 ± 8.15</td>
</tr>
<tr>
<td>Weight</td>
<td>48.79 ± 10.26</td>
<td>62.09 ± 11.39**</td>
</tr>
<tr>
<td>Height</td>
<td>1.53 ± 0.77</td>
<td>1.64 ± 0.93**</td>
</tr>
<tr>
<td>Span</td>
<td>1.59 ± 0.91</td>
<td>1.69 ± 0.99**</td>
</tr>
<tr>
<td>Abdominals</td>
<td>36.40 ± 20.39</td>
<td>40.23 ± 21.00</td>
</tr>
<tr>
<td>Torso extension</td>
<td>27.94 ± 2.33</td>
<td>27.21 ± 3.05</td>
</tr>
<tr>
<td>Arm extension</td>
<td>8.96 ± 5.87</td>
<td>9.82 ± 7.13</td>
</tr>
<tr>
<td>Sway</td>
<td>22.53 ± 13.42</td>
<td>32.10 ± 17.08**</td>
</tr>
</tbody>
</table>

M - Mean, SD - Standard Deviation * * (p ≤ .01)
the tests of motor acting of Fitnessgram®: extension of the torso, extensions of arms and abdominals test, respectively.

**Statistical analysis**

Initially, we used the descriptive statistics in to making the characterization of the sample on one side, and for other, to verify the medium value obtained by each one of the variables (measures of central tendency).

To analyze associations among variables simple and multiple regressions were used. To investigate the combined influence of the independent regressions of variables multiple were designed. In these, were just included the independent variables that demonstrated significant association degrees with the dependent variable in cause. To evaluate the robustness of the regression models it was used the adjusted determination coefficient (R2adj) and the standard regression error (Syx).

For the treatment and analysis of the collected data was used the statistical program SPSS 10,0 and considered the significance level of \( p \leq 0.05 \).

**RESULTS**

The medium valorization of the constructs in study, for differentiation of the subjects gender is presented in the Table 1.

When analyzed the statistical indicators related with the corporal composition, percentile values of superiors fat are observed in the female individuals, comparatively to the masculine gender, for approximate values of weight and heights corporal lightly superiors in the second group.

The results regarding the components of the physical fitness demonstrate tendency for the boys’ higher indexes in the items related with the muscular strength (abdominal and extensions of arms), as well as in the relative parameter to the cardiorespiratory aptitude (sway).

The Table 2 display a superiority of values of the subjects that frequent the 10th grade of education, above all the level of the indicators of strength and endurance. These subjects present equally larger corporal weight, as well as larger medium age.

The indicators of robustness of the multiple regressions are exposed in the Table 3, by the tests physics aptitude definition as dependent variables and of the items related to the age and corporal composition as independent variables.

**DISCUSSION**

The results evidenced, relatively to the corporal composition of the subjects, a % of MG higher in the feminine gender, comparatively to the masculine gender, for a very approximate age mean, what is in agreement with the existent studies that propose a female tendency to accumulate larger amounts of corporal fat (GUEDES, 2002; MOREIRA AND SARDINHA, 2003). This difference seems to accentuate with the puberty (OKANO, 2001), since the increase of the MG in the masculine gender happens at 10-12 years of age (MOREIRA AND SARDINHA, 2003), period which starting from a fast increase of the Exempt Mass of Fat (MIG) is verified (GUEDES, 1996). This way, and in spite of the data, didn’t show a significant correlation between the age and the fat%, studies indicate that, between the 10 and the 18 years, this variable decreases annually in the boys about 1.15%, increasing in the same period for the girls (MOREIRA AND SARDINHA, 2003).

However, both groups present values out of the indexes of hypercholesterolemia and hypertension risks (> 25% for boys and > 30-35% for girls) (WILLIAMS 1992), although the fat accumulation during the maturation seems to happen preferentially in the visceral area (GUEDES, 1996), situation associated to a larger cardiovascular (MOREIRA AND SARDINHA, 2003).

On the other hand, weight, height and IMC seems to positively relate with the age, increasing in a significant way, what doesn’t happen with the MG %, that increases being correlated positively with the weight and negatively with the height. These data are corroborated by the literature, that indicates an increase of IMC with the age (15% and 14% for boys and girls, respectively (OKANO, 2001), demonstrating the existence of a statistical relationship among the age, weight and height variables (WEILER, 2000).

**Table 3 - Multiple regressions**

<table>
<thead>
<tr>
<th>Total</th>
<th>Dependent Variable</th>
<th>Independent Variable</th>
<th>R2adj</th>
<th>Syx</th>
</tr>
</thead>
<tbody>
<tr>
<td>sway</td>
<td>age, IMC, % fat, weight, height, span</td>
<td>.47</td>
<td>11.43</td>
<td></td>
</tr>
<tr>
<td>sway</td>
<td>age, IMC, % fat</td>
<td>.48</td>
<td>11.38</td>
<td></td>
</tr>
<tr>
<td>Feminine gender</td>
<td>abdominais</td>
<td>IMC, % fat, weight</td>
<td>.14</td>
<td>18.21</td>
</tr>
<tr>
<td>Feminine gender</td>
<td>extensões braços</td>
<td>% fat, height</td>
<td>.12</td>
<td>5.77</td>
</tr>
<tr>
<td>Feminine gender</td>
<td>sway</td>
<td>Age, % fat</td>
<td>.36</td>
<td>13.05</td>
</tr>
<tr>
<td>Masculine Gender</td>
<td>sway</td>
<td>age, IMC, % fat peso, height, span</td>
<td>.43</td>
<td>10.13</td>
</tr>
<tr>
<td>Masculine Gender</td>
<td>sway</td>
<td>IMC, % fat, weight</td>
<td>.35</td>
<td>10.85</td>
</tr>
<tr>
<td>Masculine Gender</td>
<td>Arm extensions</td>
<td>age, IMC, % fat, weight, height, span</td>
<td>.34</td>
<td>4.78</td>
</tr>
<tr>
<td>Masculine Gender</td>
<td>Arm extensions</td>
<td>IMC, % fat, weight</td>
<td>.32</td>
<td>4.82</td>
</tr>
<tr>
<td>10 th ano</td>
<td>sway</td>
<td>% fat, height, span</td>
<td>.53</td>
<td>11.76</td>
</tr>
<tr>
<td>10 th ano</td>
<td>sway</td>
<td>% fat, height</td>
<td>.50</td>
<td>12.14</td>
</tr>
</tbody>
</table>

M - Mean  SD - Standard Deviation
The girls present in this sense an IMC superior to the boys, that although present very similar values of corporal weight, revealing a difference of 0.04 meters in the height variable.

In what concerns to the influence of the corporal composition in the components of motive aptitude studied, and considering an only moment of evaluation, we verified that the considered independent variables explain in its group 47% of the results obtained in the sway test (resistance capacity). Of these, the age, IMC and fat % variables seems to be those that demonstrate larger influence, explaining 48% of the results, although with very high relative errors (relative error = 42.98 and 42.79, respectively).

When considered the sample totality, the IMC and fat% variables are negatively correlated with the endurance (sway test), manifesting this, on the other hand, a positive correlation with the age. This way, individuals with higher values of IMC and MG % obtained lower results in the sway test (meaning smaller aerobic capacity), while older (10th grade) individuals registered higher values and significant statistics. These results are corroborated in another study, which indicates the obesity as the largest contribution for the capacity decrease on the individuals’ resistance (CHATRATH et al. 2002).

It is still important to consider, the existence of significant statistical differences for the resistance component, when considered the gender of the subjects. The boys present visibly superiors mean values (36.64 comparatively to the 17.38 evidenced by the girls), discrepancy that can be explained by the fact of the girls have a larger % of corporal fat comparatively to the boys. The masculine superiority in this parameter was demonstrated in other studies, that analyzed \( \text{VO}_2\max \) as indicator of the cardiorespiratory aptitude. In these, the boys presented significantly superiors mean values (GUEDES, 2002), being this superiority particularly evident starting from the 10 years of age (SILVA, 2002).

Relatively to the flexibility capacity, the values are lightly higher in the masculine gender, not revealing like this statistically significant. These results are contrary to the existent studies that attribute higher flexibility indexes to the feminine gender (GUEDES, 2002; OKANO, 2001) in all of the age groups (SILVA, 2002); differences that can be attributed to anatomical factors, as well as to the largest acceptability of the girls to activities in that the movements that request this capacity are emphasized (OKANO, 2001). This disagreement can be associated to characteristics of the flexibility evaluation test. The torso extension can, in this sense, not the most appropriate for this measurement, for that the application with this intention should be questioned.

Considering the age of the subjects, the obtained values are lightly superior in the 10th grade students, indicating a relationship between the age and this component, in spite of a significant in statistical terms didn’t exist. The literature indicates, however, that the highest flexibility indexes are observed at the 13 years of age for both genders (GUEDES, 2002; OKANO, 2001), and 16 years old boys have a smaller flexibility, when compared with boys of 10 and 13 years of age (ZAKAS, 2002).

The muscular strength component was evaluated using two different tests, abdominal and arms flexing. The results obtained in the arms extension test showed significant differences among the genders, and for the feminine gender, a negative correlation was verified with the MG % and height. The same is not verified relatively to the abdominal test, in spite of a negative correlation that exist with IMC, fat % and weight, were not found statically significant differences between genders and years of education.

The boys demonstrated in a general way, in this test, higher indexes, that seems to happen, especially, starting from 14 years, while the girls present superior indexes between 11 and 13 years (SILVA, 2002).

In the abdominal flexing, the gender showed very decisive, evidencing a higher aptitude/installment level in male elements, data leaning in existent studies (OKANO, 2001), while others do not find differences among genders (GUERRA, 2000).

In what refers to the sample totality, a negative correlation is verified among the MG % and the abdominals.

The fact that the age not show a significant relationship with this aptitude component, eventually it can be explained by the fact of only the chronological age was considered, as well as superior strength indexes of body. In this context, the maturational age seems to correlate positively with the strength and flexibility, particularly to the inferior members, constituting this a more reliable indicator than the chronological age (VELDRE, 2004). However, in spite of the chronological age be a fallible indicator of the individual’s maturational degree, it is revealed of capital importance for the understanding of the processes of the child’s development and of the youth, making possible an appropriate intervention (BARATA, 1999).

Starting from the second childhood (between 6 and 10-12 years), the boys usually present a better acting in the motive tasks that involve more vigorous efforts. This is an example that the strength / endurance muscular, favorite for the boys to the detriment of the flexibility (OKANO, 2001). Studies consider, however, the possible influence of other factors that are not controlled in this study, such as, anatomical factors, level of motive ability and motivation of the appraised in the execution of the test (SILVA, 2001).

When we referred to post-pubescent adolescents, due to the maturational aspects and physical growth are close to the adult state, in theory, with base in the beginnings of biological adaptations documented in the literature, it is assumed that the more activate are the youths, more physically capable they should present (FRANKLIN, 1999). It is stood out that in the present study was not equally considered the level of physical activity of the subjects. The indicators of the physical fitness components related to the health seem to be strongly influenced by attributes linked to the biological maturation and the physical growth, as well as habits of practice of constant physical activity (GUEDES, 1996).

When there is an evaluation in sense of verify which are the factors involved in a best or worse motive aptitude in children and adolescents, the results interpretation comes complicated, due to the
multiplicity of cultural, environmental, genetic and maturational factors, being revealed difficult to detach the individual contribution of each one of those factors in the motor acting (Silva, 2002; Okano, 2001).

In agreement with the found results, and in spite of having considered the eventuality of the applied tests are not the most appropriate for this population type, the physical fitness seems to be considerably more affected in the female individuals with the modification of the corporal composition in the adolescence. This situation seems to reveal a larger inactivity above all considering the girls, flowing in a larger corporal weight and especially larger percentage of accumulated fat. For this, it seems to us once fundamental again the need of implementation of programs addressed to the modification of alimentary habits and the increment of the practice of physical activity in precocious ages, in way to reduce the manifests incidence of this kind of problem.

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