HEALTH-RELATED PHYSICAL FITNESS OF SCHOOLCHILDREN: THE FITNESSGRAM PROGRAM

EXERCISE AND SPORTS MEDICINE CLINIC

ORIGINAL ARTICLE

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ABSTRACT

The study identified the proportion of children and adolescents of the school population from Montes Claros, Minas Gerais, Brazil, who meet the health–related criteria determined by physical fitness components. The sample was composed of 2,849 subjects (1,457 girls and 1,392 boys), with age range between 6 and 18 years. The physical fitness components were assessed by a test battery of five items: back-saver sit-and-reach; curl-up; trunk-lift; push-up and endurance run (PACER), following cut off-points for gender and age suggested by the Fitnessgram. It was possible to observe with the obtained results that the proportion of schoolchildren that reached the minimum motor requirements established was not higher than 8%, and the global amount able to meet the health-related criteria was lower from 10 years of age in both genders. The data also show that great part of the studied youngsters demonstrate physical fitness components that could compromise a better health status, indicating the urgent need of implementing intervention programs addressed to the improvement of the practice of physical exercise in the school population.

Keywords: criterion-referenced standards, Fitnessgram, health promotion, children and adolescents.

INTRODUCTION

Physical activity is considered a behavior focusing on the individual willingness to move part or his/her entire body, while physical fitness is defined as a biological characteristic aimed at the capacity to perform physical exertion. Therefore, if on one hand physical activity should be understood as a multidimensional constructor which includes type, intensity, duration and frequency of the body movement, on the other hand physical fitness comprises different components identified with more efficient practice of sports (sports performance related-physical fitness) and with some protection against the onset and development of chronic-degenerative disorders induced by debility in the energetic triggering and musculo-articular systems (health-related physical fitness)[1]. Thus, it can be speculated an occasional association between levels of habitual practice of physical activity and scores related to the health-related physical fitness components, which does not seem to be the case, at least in young ages. A previous study has identified that the time spent in physical activities from moderate to heavy intensity of the daily life of adolescents explained for not more than 8% of the variations observed in the scores of cardiorespiratory resistance. Other indicators such as muscular strength/resistance and flexibility did not present any variation which could be statistically explained by the habitual levels of physical activity practice[2].

In adults, both insufficient levels of habitual physical activity practice and compromising physical fitness scores are associated with high levels of morbidity and mortality[3,4]. However, evidence made available in the literature suggests that scores equal to the cardiorespiratory resistance are characterized as better predictors of the health status than levels of habitual physical activity practice[5,6]. Moreover, epidemiological studies have shown decrease of at least 50% in the mortality indices amongst subjects with high scores of physical fitness compared to the ones less physically fit[7].

Specifically in young populations, higher physical fitness scores are associated with lower prevalence of risk factors which lead to cardiovascular diseases, reduction in total and abdominal adiposity as well as better bone and mental health condition[8-14]. Furthermore, scores of health-related physical fitness components are more straightly related to metabolic risks than habitual physical activity practice levels in youngsters at school age[8,11,14].

Although many studies trying to describe health-related physical fitness of young populations of other countries have been found [15-19], in Brazil these data are scarcer. Among the rare Brazilian studies already carried out with epidemiological characteristics, we highlight the compilation previously performed by Guedes and Guedes[20] involving the school population of the city of Londrina, Paraná. Monitoring of the physical fitness components requires simultaneous application of many motor tests, demanding hence specific logistics and higher time and personnel demand, which also increase cost. These difficulties may partly explain the lower quantity of studies, especially in less developed countries or regions.

Thus, the aim of the present study was to identify the proportion of the schoolchildren population from Montes Claros, Minas Gerais, Brazil, who meet the referenced criteria for health from scores related to the physical fitness components.

METHODOLOGY

This study was designed using the data contained in the database built from the transversal cut-off descriptive collection of population basis of schoolchildren from the city of Montes Claros, Minas Gerais, Brazil. However, in the present study only the information associated

with health-related physical fitness was treated. The data collection was conducted from April to November, 2007 and the intervention protocols used were approved by the Ethics in Research Committee of the State University of Montes Claros – Unimontes (file # 529/2007) and followed the guidelines from the 196/96 Resolution of the National Health Board on research involving humans.

The city of Montes Claros, scenery of the present study, is situated in the north of the state of Minas Gerais, Brazil. In order to have it characterized, and having the Human Development Index (HDI) as reference, it is verified that the city of Montes Claros, in the last decades, has presented important evolution. Nevertheless, it still presents lower HDI values compared to cities of similar population density located in other Brazilian regions, especially in the southeast and south. As illustration, in the period between 1991-2006, the HDI of Montes Claros increased 10%, going from 0.713 in 1991 to 0.783 in 2006. The dimension which contributed the most to this increase was education (0.793 *versus* 0.872) followed by income (0.629 *versus* 0.681) and longevity (0.741 *versus* 0.787). In that period, the gap in human development; that is, the distance between the HDI of the city and the maximum threshold of HDI (1 – HDI), decreased 32%. The mean HDI-2006 of the cities situated in the southeast and south regions is 0.844 and 0.825, respectively, and the Brazilian HDI-2006 0.800[21].

Sample and subjects selection

The reference population to the study included students of both sexes, aged between six and 18 years, who were regularly enrolled in the school year of 2007 in the elementary and high schools belonging to the public (state and city) and private sectors of the city of Montes Claros, Minas Gerais, Brazil. In order to illustrate the dimension of the treated population, according to the Statistics Sector of the Education Secretary of Minas Gerais State, 84,675 students were enrolled in the beginning of the school year of 2007 in the 237 elementary and high schools situated in the urban region of the city, out of these, 45,033 were female and 39,642 male. The sample size was established considering confidence interval of 95%, sample error of 3% and addition of 10% for occasional cases of losses in the data collection. Considering that the sample plan involved conglomerates, the effect of the sample outlining (*deff*) corresponding to 1.5 was defined, initially expecting minimum sample of 2,600 students. Nevertheless, the final sample used in the treatment of the data was composed of 2,849 students (1,457 girls and 1,392 boys).

Concerning the students' selection, probabilistic sample by conglomerates which could effectively represent the considered population was aimed, having as reference the number of students concerning gender, school year and shift in which they were enrolled in each stratum of the school structure separately (state, city and private). Thus, the first phase was to determine the representativity of the number of students of each stratum of the school structure concerning the studied population as a whole. Subsequently, the representativity of the number of students enrolled in each school selected for the study concerning the school population of the school structure stratum to which it belongs was determined. In order to select the students in each school, the classes specifically composed for the physical education sessions were raffled and later, within each selected class, the necessary students to compose the sample representative of the school were also raffled.

The exclusion criteria of any student raffled for the study were: a) refusal to participate in the study; b) lack of authorization from the parents or legal tutors; c) absence in the classes on the day scheduled for the data collection; d) any physical problem which temporarily or permanently avoided the student from performing the motor tests.

Data collection

The evaluating team was composed of four physical education professionals and eight physical education senior college students, supervised by the authors themselves. The entire data collection was performed in the premises of the United Colleges of Northern Minas – Funorte, which presented the necessary conditions for the performance of the study, considering the equipment involved in the measures determination, the need for standardization for administration of the motor tests and the limitations of the physical space presented by some of the schools which were involved in the study.

Chronological age of the students was determined in a centesimal way, from the confrontation between the data collection date and the birth date. However, for data analysis, three age groups were established. The first age group joined students aged from six to nine years; the second group from 10 to 14 years; and the third age group from 15 to 18 years.

The components associated with health-related physical fitness were analyzed with scores equivalent to the results observed with the application of the motor tests battery composed of five items, following this order: a) alternate "sit-and-reach" (*back-saver sit-and-reach*); b) modified crunch (*curl-up*); c) trunk elevation (*trunk-lift*); d) modified suspension push-up on bar (*push-up*); and e) endurance run (*Pacer*). Concerning the cut-off points used to meet the health criteria, the proposal suggested by the *Fitnessgram* was adopted [22].

Statistical treatment

The data statistical treatment was performed with the computer package *Statistical Package for the Social Science* (SPSS), version 17.0. In order to identify the proportion of students who met the *Fitnessgram* health criteria, the relative frequencies according to the cohort points applied were used. Statistical verification concerning occasional differences between sexes and age groups was performed with the significance test for comparisons of multiple comparisons with the use of the chi-square statistics (χ^2).

RESULTS

Table 1 describes the proportion of students who reached the cohort points established for the results of each motor test in the evaluation proposal referenced by criterion suggested by the *Fitnessgram*. Thus, considering these cohort points as health indicators connected with physical fitness, it was verified that a high quantity of students analyzed in the study was exposed to the unhealthy condition, considering that, in some age groups, less than half of their members presented scores equivalent to the results of the motor tests which meet the established cohort points.

The percentage points demonstrated that the quantity of students able to meet the health criteria was significantly higher in early ages. Moreover, similarities in the proportion of girls and boys who met the healthy condition for physical fitness have

Table 1. Proportion (%) of students who reached the health criteria with scores equivalent to the motor tests suggested in the *Fitnessgram* proposal– Montes Claros, Minas Gerais, Brazil.

Age group (years)	Sit and reach	curl-up	trunk-lift	push-up	Pace
Girls					
≤ 9	77.2	31.9	67.6	41.6	–
10 – 14	62.4	20.5	48.6	34.8	45.1
≥ 15	56.7	18.1	41.3	15.3	19.3
6 – 18	63.4	23.8	53.2	30.7	32.3
Boys					
≤ 9	80.4	36.1	81.9 [b]	57.1[b]	–
10 – 14	71.6[b]	33.9[b]	75.1 [b]	48.3[b]	55.5 [b]
≥ 15	60.2	23.5[a]	69.9 [b]	39.5[b]	32.4[b]
6 – 18	72.3[b]	31.2[b]	75.6 [b]	48.7[b]	44.1[b]
c^2_{Sex}	7.917 (p=0.005)	19.220 (p<0.001)	54.332 (p<0.001)	35.769 (p<0.001)	31.545 (p<0.001)
$c^2_{age\ group}$	32.142 (p<0.001)	18.629 (p<0.001)	49.924 (p<0.001)	65.682 (p<0.001)	84.647 (p<0.001)

Letters on top show statistically significant differences between both sexes: [a] 0.01 < p < 0.05; [b] p < 0.01.

Table 2. Proportion (%) of students who reached the accumulated health criteria in the scores equivalent to the results of the motor tests suggested in the *Fitnessgram* proposal - Montes Claros, Minas Gerais, Brazil, 2007.

Age group (years)	No test	One test	Two tests	Three tests	Four tests	Five tests
Girls						
≤ 9	0.7	9.5	30.9	33.1	21.8	4.0
10 – 14	1.8	15.3	32.0	30.2	15.4	4.3
≥ 15	8.8	24.5	29.9	22.3	13.1	1.4
6 – 18	3.7	16.5	30.9	29.2	16.8	2.9
Boys						
≤ 9	0.4	2.9[b]	24.4	38.2	25.4	8.7[b]
10 – 14	1.7	5.9[b]	24.9[a]	34.4	25.8[b]	10.1[b]
≥ 15	4.2[a]	10.2[b]	28.3	32.6[b]	19.5[a]	5.2[a]
6 – 18	2.1[a]	6.2[b]	25.0	35.1	23.6[a]	8.0[a]
c^2_{Sex}	8.139 (p=0.004)	78.621 (p<0.001)	7.220 (p=0.052)	11.859 (p<0.001)	21.768 (p<0.001)	44.407 (p<0.001)
$c^2_{rAge\ group}$	39.519 (p<0.001)	32.582 (p<0.001)	1.159 (p=0.285)	2.166 (p=0.151)	3.217 (p=0.078)	2.928 (p=0.092)

Letters on top show statistically significant differences between both genders: [a]0.01 < p < 0.05; [b]p < 0.01.

been identified among the students ≤ 9 years. However, in the older ages, clear tendency of the boys presenting higher proportions was observed, especially from 15 years old.

Regarding the results analysis of each motor test individually, it was observed that the students were able to reach the highest proportions of the health criterion in the motor tests in which participation of the physical fitness associated with flexibility was required. In that case, in the alternate "sit and reach" test, 63.4% and 72.3% of the girls and of the boys, and in the trunk elevation test, 53.2% and 75.6%, respectively. The lowest proportions of the health criteria fulfillment in both sexes were observed in the results of the crunch test – 23.8% of the girls and 31.2% of the boys.

Considering that a student can reach the health criteria given to the result of a specific motor test and not to another, since each of the five motor tests analyzed in the study mainly requires different components of physical fitness, table 2 presents the proportion of students who reached at the same time the cohort points proposed by the *Fitnessgram* in multiple motor tests. The information found pointed to decrease in the proportion of students who presented satisfactory conditions in accumulated components related to health in the three age groups considered and in both sexes. From 15 years old, not more than 1.4% of the girls and 5.2% of the boys were able to simultaneously meet the motor demands connected to the health criteria required in the five motor tests, while in the younger ages these proportions reached values of 4.0% and 8.7%, respectively.

DISCUSSION

In the present study, data about the motor indicators associated with health-related physical fitness in members of the school population of the city of Montes Claros, Minas Gerais, Brazil, are presented through the use of the *Fitnessgram* motor tests battery. It is worth mentioning that when the scores of the motor tests results are compared with the information produced with laboratory device, such is the case of the maximal oxygen uptake, the muscle strength values, muscular endurance and articular mobility estimation, the scores of the motor tests results may occasionally present limitations concerning the analysis of the health-related physical fitness components[23].

Nevertheless, despite the limitations, the scores of the results of the motor tests may be extremely useful for the analysis of indicators associated with the components of health-related physical fitness. Therefore, more recently, *Fitnessgram* motor tests battery has been used in some studies with satisfying results[24-29].

Studies aimed at health-related physical fitness of populations involving youngsters at school age are rare in the literature. Moreover, the motor tests batteries applied for analysis of their components do not reach to a consensus in the already performed studies. The distinct definitions attributed to the health criteria involving scores of the motor tests results should be considered as another limitation when comparisons between different studies are performed. Differences concerning the types of samples also represent limitations for the comparative analyses. Thus, these situations should be considered when comparisons between the findings of the present study and the results available for consultation are established.

The theoretical assumption which guide the analyses of the components of health-related physical fitness by criteria are based on the trial to reach positive scores in the scores of the motor tests, which can guarantee any level of protection with the onset and development of organic disorders associated with hypokinetic diseases and capacity of performing the daily tasks[30]. Thus procedure has the aim to alter the focus offered to the analyses referenced by guidelines, in which the aim is to try to reach scores equivalent to the results of the motor tests which correspond to the highest values in specific percentile distributions, by the idea to reach cohort points previously established.

The essence which tries to justify the proposal of cohort points for components of health-related physical fitness is based on the premise that in order to occur reduction of organic disorders, it is necessary that desirable thresholds of cardiorespi-

ratory endurance, flexibility, muscle strength and endurance are reached, which may contain occasional degenerative process induced by debilities in the systems of energetic and musculo-articular mobilization. Thus, clashing with the approach offered to the analyses referenced by guidelines, the individuals who do not reach the cut-off points previously set as the desirable health-related physical fitness indicators present are more prone to the chronic-degenerative symptoms, while the ones who reach or surpass the cut-off points set present lower risk. Therefore, the important is not to compare the scores of the results of the motor tests presented by a subject with other scores in the presence of tables of normative values, but rather to verify if their scores reach the cut-off points set concerning health.

In that case, the highest difficulty found by the specialists in the field was to determine the scores for the results of motors tests associated with the physical fitness components which are able to be used as cut-off points and guarantee the necessary expected and absolute thresholds to better health condition. Unfortunately, evidence shows that currently there may be not any reliable mechanism to propose the cut-off points which are able to guarantee with some conviction, minimum thresholds required to reduction of the risks of the onset and development of degenerative disorders in the light of physical fitness indicators, since the cause-effect ratio between physical fitness and health condition is more vulnerable in the young body than in the adult one[31].

Facing this uncomfortable situation, based on experimental research, clinical findings and arbitrary designation based on normative data, some initiative aimed at the proposal of cut-off points related with the physical fitness components and health status are observed. The literature of the field shows that one of the first initiatives for the establishment of cut-off points which are able to be applied in the analyses referenced y criteria was designed by the *South Carolina Physical Fitness Test* Project. Subsequently, other initiatives followed it, such as the case of the *Fit Youth Today*, *Physical Best* and *Fitnessgram*[32].

However, if on one hand there is a consensus between the many proposals concerning the type of information to be applied in the analyses referenced by health criterion; on the other hand the proposal of cut-off points to meet identical scores of results of motor tests presents difference between the two proposals. This discrepancy may probably occur due to the disagreement presented by the literature concerning the necessary adjustments to the correction of the impact of the physical growth and biological maturation indicators in the scores of the results of the motor tests[3], where some subjective judgment which may differ between the proposals is be requested in this case. Thus, when the scores of the results of the motor tests in the analyses referenced by criterion, it is necessary to consider that identical values produced by the same individual and in a same moment, may receive different judgment if analyzed by distinct cut-off point proposals. Therefore, the health criteria with scores equivalent to the results of motor tests presented in the *Fitnessgram* proposal are the ones which have received the widest acceptance worldwide and have been applied in many other studies[24-29].

The findings in the present study demonstrate that the proportion of students who reached the health criteria was significantly higher in the earlier ages. Additionally, among the students ≤ 9 years, similarities have been identified between both sexes concerning the proportions of reach of healthy levels of physical fitness. Nonetheless, in the more advanced ages, it was observed that the girls demonstrated significantly lower proportions compared with the boys, especially from 15 years of age. This situation may reinforce the hypothesis that children are naturally more physically capable at younger ages, demonstrating hence higher capacity to reach the cut-off points previously set. After that, gradually with age progression, especially amongst the girls, there is a tendency in acquiring more sedentary habits, declining hence the levels of physical fitness[34].

Specifically concerning the proportions of reach of the cut-off points suggested for analysis of the scores of the results of the back saver "sit-and-reach" and trunk-lift tests, the percentage values revealed that a significant quantity of students collected in the study presented a healthy condition of physical fitness in the component associated with flexibility. In the case of the back saver "sit-and-reach" test, 63.4% and 72.3% of the girls and the boys and, in the case of the trunk-lift test, 63.2% and 75.6%, respectively.

On the other hand, the proportions of students who reached the cut-off points suggested for analysis of the scores of the results of the curl-up test and push-up considerably decreased. Concerning the curl-up test, 23.8% of the girls and 31.2% of the boys reached the health criteria, while in the push-up test the proportions of students who met the health criteria corresponded to 21.7% and 38.7% of the girls and the boys, respectively.

Thus, it is interesting to highlight that in the two motor tests the component of physical fitness involved is flexibility; in none of the age groups considered in the age group in the study less than 60.2% of the boys and 41.3% of the girls failed to meet the health criteria. However, regarding the motor tests in which the physical fitness components involved are muscular strength and endurance, the opposite situation occurred, that is, not more than 57.1% of the boys and 41.6% of the girls were able to meet the health criteria.

The selection of the scores of the results of the back saver "sit-and-reach", trunk-left, curl-up and push-up tests as indicators of the health conditions concerning physical fitness is associated with the fact that the flexibility, muscular strength and endurance components are considered important factors in the prevention and recovery of occasional postural and articular disorders as well as musculo-skeletal injuries[30].

Strength and endurance debilities presented by the trunk muscles are considered risk indicators for low back pain, as well as subjects with higher levels of muscular strength and endurance are less exposed to local fatigue and less remarkable increase of blood pressure when submitted to more intense physical exertion. Suitable levels of muscular strength and endurance may also play an important role in the hormone regulation and in the metabolism of some substrates, especially in the insulin sensitivity of the muscle tissues[35].

Furthermore, subjects with higher flexibility levels tend to move more easily and are less prone to injuries when submitted to more intense physical exertion and generally present lower incidence problems in the muscular and osteoarticular spheres. Difficulty in moving the trunk and hip regions due to lower levels of flexibility demonstrate high association with the onset and evolution of posture swerves, and many times, with irreversible chronic lumbar problems which lead to discomfort, pain, inca-

pacity and decrease in performance of the daily life activities[36].

However, until the present moment, there is little evidence that objectively establish minimum scores concerning the results of motor tests involving flexibility, muscular strength and endurance which are able to induce to movement restriction which may cause higher incidence of health-related problems. Thus, due to the lack of information scientifically supported, the cut-off points set in the *Fitnessgram* for these four motor tests were intuitively suggested based on experiences and judgment of specialists in the field, and should hence be carefully used.

Concerning the proportion of students who met the health criteria in the scores of the results of the endurance run test (*Pacer*), it was observed that between 10 and 14 years, approximately half of the students presented the proposed cut-off points (45.1% of the girls and 55.5% of the boys). Nevertheless, with age progression, important decrease in the proportion of cut-off points reach was observed, especially in the female sex, where in every five girls, only one met the health-criterion proposed for the test (19.3%). Regarding the boys, the proportion of cut-off points reach was significantly higher; even though, very worrisome (32.4%).

The cut-off points related with the health condition involving scores of the results of motor tests where the component for cardiorespiratory endurance is prioritarily required are proposed based on the values of maximal oxygen consumption adjusted to running economy and other factors associated with age and gender of the individuals, who, *a priori*, present good health status diagnosed by clinical exams. Consequently, contrary to what is observed concerning the flexibility, muscular strength and endurance neuromuscular components, the data which ground the proposition of the criteria for cardiorespiratory endurance should be considered more accessible and therefore more reliable. Moreover, the importance of the component for cardiorespiratory endurance as an indicator for physical fitness for better health status becomes evident as studies have presented the straight inverse correlation between the estimated values for maximal oxygen consumption and the onset and development of countless risk factors for chronic-degenerative diseases[8,10,12-14,37].

CONCLUSION

Regarding the health criteria in the *Fitnessgram* motor tests battery, the information collected in the study pointed that the proportions of students analyzed, which met the minimum motor requirements in each item specifically, ranged between 24% and 76%. Nevertheless, when the five items of physical fitness are considered as a whole, it was observed that the proportion of students who met the health criteria was not higher than 8%, with greater compromising in the girls and older students.

When it is considered that the cut-off points suggested by the *Fitnessgram* presented satisfactory validity, the results found in the study suggest that great proportion of students shown here demonstrated scores of physical fitness which can significantly compromise the acquisition of a better health status. Thus, when considering a broader health conception and since the onset of risk factors in childhood and adolescence predict irreversible organic disorders in adult life, it seems logical to imagine that the reach for minimal fulfillment of the criteria required for the physical fitness components may cause considerable improvement in the health conditions of the youngsters with consequences for the entire life.

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