Original article (short paper)

Reference index and reduction in physical fitness tests proposed by PROESP-BR

Camila Fernanda Brandão
Núcleo de Aptidão Física, Informática, Metabolismo, Esporte e Saúde da Universidade Federal de Mato Grosso, MT, Brasil
Universidade de São Paulo, Ribeirão Preto, SP, Brasil

José Henrique de Queiróz Fontes
Arturo Alejandro Zavala Zavala
Waléria Christiane Rezende Fett
Roberto Jaime dos Santos
Carlos Alexandre Fett
Núcleo de Aptidão Física, Informática, Metabolismo, Esporte e Saúde da Universidade Federal de Mato Grosso, MT, Brasil

Abstract—The purpose of this study was to create an unifying index of the PROESP-BR tests for school aged teenagers and propose a reduction in the physical fitness tests. A total of 414 adolescents between the ages of 15 and 17 years old, representative of the public school population in the city of Cuiaba were evaluated. The tests include general physical fitness, proposed by PROESP-BR. Multivariate factorial analysis was used, observing the commonality/ representativeness of each test with regard to the set, and the index was created for girls and boys. With this analysis we can choose to use the following tests: female - throwing medicine ball, horizontal jump and run 20 meters; male - throwing medicine ball, representing the overall performance. The created index was divided into quintiles and allowed you to view the whole performance of the six tests, as well as their distribution within the group and away from the ideal reference.

Keywords: performance, diagnosis, motor activity, physical exercise, health and physical fitness.

Introduction

There is growing concern about identifying the existent conditions of risk for any change in the development of children and adolescents (Zajons, Muller & Valentini, 2008). Physical capabilities are directly related to health and sporting performance, and evaluating them has helped with the diagnosis and prevention of diseases as well as in detecting sporting talents (Saraiva & Rodrigues, 2010).

Some international surveys that describe the profile of motor performance of youngsters have observed the association between low physical fitness and school performance (Koutedakis & Bouziotas, 2003). In addition, low physical fitness in adolescence has a negative reflection on adult life (Mikkelsson *et al.*, 2006). Silva, Lima, Silva, and Prado (2009) found a prevalence of 83.1% of sedentary adolescents in the Brazilian population whereas other studies have observed variations between 39% and 93.5% of Brazilian students (Tassitano *et al.*, 2007; Silva *et al.*, 2005).

The lack of standardization of instruments for measuring physical activity hampers comparisons between Brazilian regions, with the Mid-Western region being prejudiced by the scarcity of studies (Silva *et al.*, 2009; Hallal *et al.*, 2007), as well as comparisons with other populations in this area. Therefore, it is crucial to establish equivalent normative values and reference parameters for Brazilian population establishing parameters with others studies of other regions and countries (Drews, Cardozo, Corazza, & Flôres, 2013). Thus, to get a representative number of population it is necessary to have a large scale of the samples, the goal of our study was to evaluate the largest possible number of children and adolescents. It would be interesting to have a general evaluation index for all the factors, whether it is with regard to health or to sporting performance. Therefore, the more condensed the evaluations could be, the easier the reproducibility will be.

Thus, the aim of this study was to create a general index of the tests performed by the parameters of Project Sport Brazil (PROESP-BR) and verify the possibility of reducing the number of tests established by PROESP-BR to the lowest possible number and how reliable is.

Methods

Data was analyzed from 414 adolescents representing the study population of 11.006 high school level students of the 28 schools in the state public network. All of them were within the age-range of 15 to 17 years of age for both sexes and residents within the urban perimeter of the municipality of Cuiabá-MT, situated in the Mid-Western region of Brazil. This study was performed using data Fontes (2013),

which held sporting diagnosis and health of students using the parameters and classification of PROESP-BR (2011), in the following tests: abdominal resistance, throwing the medicine ball, horizontal jump, 20-meter run (displacement speed), 4x4 meter square (agility) and 9-minute run (Table 1 and 2).

The project was approved by the Research Ethics Committee of " University Hospital Júlio Muller", Protocol No. 658/CEP/HUJM/09 of July 26, 2009.

Table 1. Performance of PROESP-BR tests of 185 female students from 15 to 17 years of age from Public Network state schools in Cuiabá-MT, Brazil.

		Excellent	Very good	Good	Reasonable	Weak
Abdominal Resistance	%	0.00	3.24	15.14	21.62	60.00
Throwing Medicine Ball	%	2.16	17.30	18.92	25.41	36.22
Horizontal Jump	%	3.24	19.46	23.24	17.30	36.76
20-Meter Run	%	1.08	43.78	19.46	13.51	22.16
Square	%	0.00	3.24	16.22	16.22	64.32
9-Minute Run	%	0.00	17.30	17.84	25.41	39.46

N = no. of subjects % = percentage of subjects with regard to sample of 185 students.

Table 2. Performance of PROESP-BR tests of 229 male students from 15 to 17 years of age from Public Network state schools in Cuiabá-MT, Brazil.

		Excellent	Very good	Good	Reasonable	Weak
Abdominal Resistance	%	0.00	9.17	17.03	24.02	49.78
Throwing Medicine Ball	%	1.31	24.02	30.13	21.40	23.14
Horizontal Jump	%	3.06	24.02	25.33	22.71	24.89
20-Meter Run	%	16.16	37.99	31.00	6.55	8.30
Square	%	0.44	8.73	24.02	18.34	48.47
9-Minute Run	%	0.00	19.21	22.27	24.02	34.50

N = no. of subjects % = percentage of subjects with regard to sample of 229 students.

Statistical Analysis

Multivariate factorial analysis was used to detect the factor of correspondence of each test and afterwards create the index. This was performed with the statistical software program Minitab version 15.0 which, by means of the raw data of the variables found the matrix of correlation and determined the number of factors necessary (≥1). We used commonality for the proposed reduction of the variables with the correlation of each variable being explained by all the factors.T herefore, the higher the value of communality (closer to 1.00); the higher the power of explanation of the variable would be. For the creation of the students' rating it was necessary to create a 'gold standard' reference. Arbitrarily a "school best" was developed, which was established from the best outcome of each test for each sex. In short, no individual had the best marks in all tests, so it was necessary to use the best result obtained in each test for different schools.

The index was obtained by multiplying the standardized variables by the factors obtained, thereby we determined the amplitude between the indices obtained and the data were grouped into 05 groups, in which the lowest values corresponded to the greatest proximity to the values of the excellent adolescent students, therefore meaning the best result.

Results

To create the index of each student, it was necessary observe the score of each test on the whole (values of commonality), thus we see the possibility to reduce the amount of testing and the difference between male and female groups. Regarding the proposal for reduction in the tests, there was a variance of 65% and 58% of the importance of each variable for female and male group, respectively. The female group had two tests with high values, three with medium values, and one with a low value and in the male group there was one high, four medium and one low test value. Thus, if we consider values of correspondence above 70% to represent the set, only two tests would be necessary for the female group and one test for the male group (Tables 3 and 4). However, we observed that there was correlation between the tests themselves, and only 01 test in each group had values below 50%.

Table 3. Result of correspondence factors of each physical test stipulated by PROESP-BR of females.

Tests	Factor 1	Factor 2	Commonality
Abdominal Resistance	0.66	-0.35	0.57
Throwing Medicine Ball	0.34	0.84	0.82
Horizontal Jump	0.75	0.38	0.72
20-Meter Run	-0.83	0.03	0.69
Square	-0.81	-0.15	0.69
9-Minute Run	0.64	-0.07	0.42
Variance	2.9052	1.0216	3.9268
% Var.	0.484	0.170	0.654

Rotated Factors - Quartimax. Rotation.

Table 4. Result of correspondence factors of each physical test stipulated by PROESP-BR of males.

Tests	Factor 1	Factor 2	Commonality
Abdominal Resistance	0.40	0.52	0.43
Throwing Medicine Ball	0.75	-0.26	0.64
Horizontal Jump	0.78	-0.22	0.67
20-Meter Run	-0.64	-0.30	0.50
Square	-0.70	0.05	0.50
9-Minute Run	0.16	0.84	0.73
Variance	2.2965	1.1913	3.4878
% Var.	0.383	0.199	0.581

Rotated Factors - Quartimax. Rotation

According to analysis, we obtained the index of adolescent students and with the creation of the excellent female and male students within our own sample; we divided the classification into five groups, stratifying by the amplitude among the data. For the female classification, the amplitude was 19.56 resulting in the interval of 3.85 for each classification; for the male classification the amplitude was 17.49, resulting in the interval of 3.50 between the classifications. The classification of each student was determined by the distance between the school adolescent students from the excellent adolescent student, and the shorter the distance between them, the better the result (Tables 5 and 6, Figures 1 and 2).

Table 5. Index created for classification of females.

Interval		N	%	Group	Classification
0.00	0.01	1	0.5	Excellent	-
0.01	3.85	5	2.7	G1	Excellent
3.86	7.70	39	21.0	G2	Very Good
7.71	11.55	95	51.0	G3	Good
11.56	15.40	43	23.1	G4	Reasonable
15.41	more	3	1.7	G5	Weak
TOTAL		186	100		

Excellent group: excellent student created
N and %: quantity of students in each group.

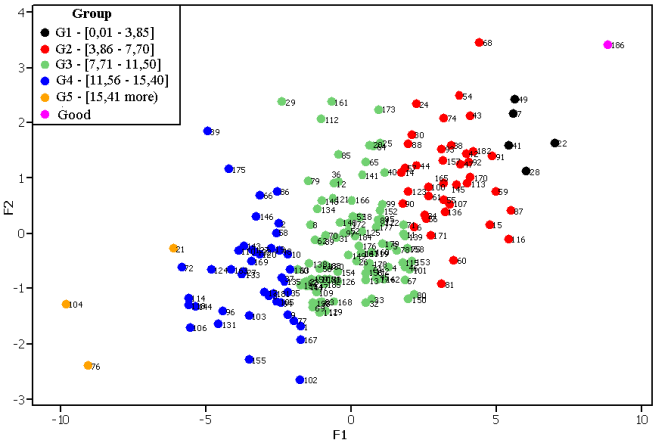

Figure 1. Dispersion graph according to the female group.

Table 6. Index created for classification of males.

Interval		N	%	Group	Classification
0.00	0.01	1	0.4	Excellent	-
0.01	3.50	2	0.8	G1	Excellent
3.51	7.00	16	7.0	G2	Very Good
7.01	10.50	117	51.0	G3	Good
10.51	14.00	83	36.0	G4	Reasonable
14.01	more	11	4.8	G5	Weak
TOTAL		230	100		

Excellent group: excellent student created
N and %: quantity of students in each group.

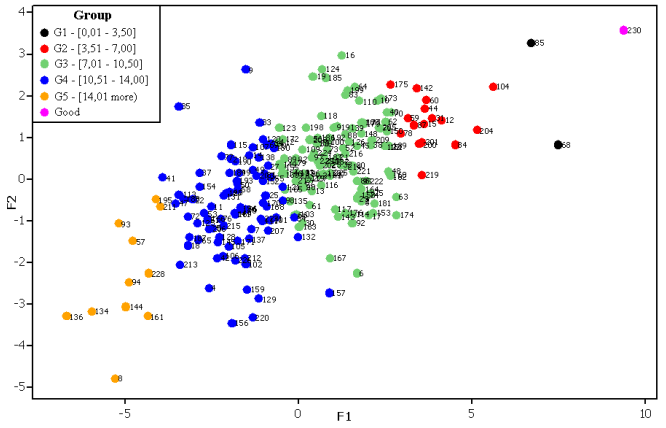

Figure 2. Dispersion graph according to the male group.

Discussion

The present study is a continuation of the work of Fontes (2013) who had identified a low performance of adolescent students in the PROESP-BR tests. Subsequently, we developed a statistical analysis that allowed a different manner of observing the behavior between the genders with regard to the power of the tests. In the female group, two tests were of high importance to represent the overall performance whereas in male group only one test seems high representative. In addition, an index that represents the overall performance of the adolescent students was developed, which provides a spatial view of the distribution of the physical capacity among these adolescent students and in comparison with the excellent adolescent students. This approach shows that these adolescent students had a low physical performance because the best classified among them were equidistant from both the excellent adolescent students and the worst classification. Moreover, it allows an approach to a specific classification for this group, considering that with regard to the original PROESP-BR classification, they are only at the margin of the excellent category.

Studies using multivariate factorial analysis have been explored to a small extent in the field of physical education up to now. In our study, the determination of an index may help future evaluations with the proposal of a smaller number of tests. Thus, we observed that the extraction of two factors

was possible, for girls and boys, these representing 65% and 58%, respectively, of the total variance in the results, showing that these tests have greater impact on the entire battery of evaluations performed.

A reduction in the number of tests may facilitate the development of the evaluations, since we observed that if some tests were not performed would not affecting the final score of the overall index. Indeed, Peterson, Alvar & Rhea (2006) stated that the horizontal jump is sufficient in the evaluation of power, speed and agility; while Guedes (2007) reported that the 20-meter run is capable of providing information about the same physical fitness level. One of the main reasons for physical follow-up is related to health; the components of force, resistance, and agility are directly related to the prevention of neuromuscular problems (Welk, Going, Morrow, & Meredith, 2011) since it has been associated with maintaince of the metabolism of some substrates and hormone regulation (Guedes,, Miranda-Neto, Germano, Lopes & Silva, 2012).

Sharkey (1997), demonstrated that performance of physical tests that use greater muscle recruitment are more efficient in the diagnosis of overall physical fitness of youngsters who are not athletes. This corroborates with the finding for the male group in our study, in which the test with greatest score was the 9-minute run. On the other hand, we found that the tests with the greatest score, for the female group, were throwing the medicine ball and horizontal jump. However, in the female group this is not an absolute factor, because the horizontal jump is considered important for overall evaluation. Castro-Pinero *et al.* (2010), observed a strong association between the horizontal jump test and tests of muscle force of the upper and lower limbs. Furthermore, they considered that this test could be used as a general index of muscle aptness in adolescents. Further studies with different populations and biochemical analyses are necessary, in order, to better determine these inter-gender variations.

With the factors of each test, we verified that the female group had more distributed physical performance results, and only two tests were necessary to obtain the same index. Differently, in male group, which was more homogeneous, only one test could be performed providing the same information. With regard to classification, we observed that the female group had better results than the male group. This differs from the classification made by Fontes (2013) and other studies, such as Dumith *et al.*, (2010) and Guedes, Neto & Silva (2011) which analyzed the difference between the genders in some physical fitness tests and found that boys received higher scores than girls in the majority of the tests. Silva, Nahas, Hoefelmann, Lopes and Oliveira (2008) pointed out that male adolescents are more physically active, particularly in the field of leisure and work, due to cultural influences and the strong trend towards self-determination (Viana, Andrade & Matias, 2010).

The index created may facilitate the diagnosis and follow-up of school physical education in the population diagnosed. Persisting with that which the study of Silva, Böhme, Uezu and Massa (2003) considered, the importance of creating indices that provided references for each specific population, with the justification of helping with the follow-up of lessons; and considering that in the present study the adolescent students presented low physical performance. This suggests that they are exposed to a low quality/quantity of motor activities. Similar to our results, Pelegrini, Silva, Petroski, & Glaner (2011) observed that adolescent Brazilian students presented inadequate levels of physical fitness. This situation may be due to cultural changes, as regards exposure to passive leisure, such as electronic games, TV and other entertainment (Dumith *et al.*, 2010). According to Hallal, Knuth, Cruz, Mendes, and Malta (2010), the majority of adolescents in the Mid-Western region of Brazil are insufficiently active.

Physical Education lessons, in turn, which must contribute to improving this situation, are apparently not changing the lack of physical activity. Indeed, other studies have observed that the level of physical effort in the Physical Education lessons are not sufficient to increase physical fitness (Guedes & Guedes, 2001) both in public and private schools (Hallal *et al.*, 2010; Silva, Lima, Silva, & Prado, 2009). Another studied has related that only 49.2% of the adolescents in major Brazilian cities responded to participating in two weekly physical education classes (Hallal, Knuth, Cruz, Mendes & Malta, 2010). Therefore, with the help of school planning, it is necessary for teachers to interact and develop socialization, challenging the processes of upbringing and lifestyles and demonstrating to the adolescent students the importance of physical activity as the opportunity to improve their quality of life (Gallahue & Donnelly, 2008).

Although we created the excellent adolescent students with the best results in our sample, this is not the ideal, because considering the general classification used by PROESP-BR, those students are not within the 98th percentile; so far, obtaining excellent results in at least two tests. The present index is representative for the sample population. Of note, we observed that the studied population lacks specific evaluations, and this instrument is useful for teachers to follow-up the development of their pupils. Furthermore, knowledge of the local reality leads us to the need for formulating public policies and specific interventions with regard to physical education lessons and the promotion of school sports.

Conclusion

With the results of factorial analyses we obtained the score of each test, allowing a reduction in the tests and showing that these tests do not have the same gradet for both sexes, therefore, it is necessary to observe the most characteristic physical qualities of each gender. From the factors analyzed, an index could be created for each pupil, helping with visualization of the overall motor performance of adolescent students, and this can be used by Physical Education teachers for following-up their pupils' performance. This index facilitated visualization of the results of the adolescent students' performance, which pointed out a low level of physical fitness in both genders and

demonstrating that the intervention in physical activity may not be adequate for this population.

References

Castro-Pinero, J., Ortega, F.B., Artero, E.G., Girela-Rejon, M.J., Mora, J., Sjostrom, M., & Ruiz, J. (2010). Assessing Muscular Strength In Youth: Usefulness Of Standing Long Jump As A General Index Of Muscular Fitness. *Journal of Strength and Conditioning Research***,** 24, 1810-1817.

Drews, R., Cardozo, P.L., Corazza, S.T., & Flôres, F.S. (2013). Análise do desempenho motor de escolares praticantes de futsal e voleibol. *Motricidade*, 9, 105-116.

Dumith, S.C., Ramires, V.V., Souza, M.J.A., Moraes, D.S., Petry, F.G., Oliveira, E.S., Ramires, S.V., & Marques, A.C. (2010). Aptidão física relacionada ao desempenho motor em escolares de sete a 15 anos. *Revista Brasileira Educação* F*ísica e Esporte*, 24, 5-14.

Fontes, J.H.Q. (2013). *Diagnóstico do potencial olímpico de alunos de 15 a 17 anos da rede estadual de ensino de Cuiabá-MT*. Dissertação de mestrado.

Gallahue, D.L., & Donnelly, F.C. (2008). Educação Física desenvolvimentista para todas as crianças**,** 4. ed., São Paulo: Phorte.

Guedes, D.P. (2007). Implicações associadas ao acompanhamento do desempenho motor de crianças e adolescentes. *Revista Brasileira Educação Física e Esporte*, 21, 37-60.

Guedes, D.P., & Guedes, J.E.R.P. (2001). Níveis de prática de atividade física habitual em adolescentes. *Revista Brasileira Medicina do Esporte*, 7, 187-99.

Guedes, D.P., Neto, J.T.M., & Silva, A.J. (2011). Desempenho motor em uma amostra de escolares brasileiros. *Motricidade*, 7, 25-38.

Guedes, D.P., Miranda-Neto, J.T., Germano, J.M., Lopes, V., & Silva, A.J.R.M. (2012). Aptidão física relacionada à saúde de escolares: Programa Fitnessgram. *Revista Brasileira Medicina do Esporte*, 18, 72-76.

Hallal, P.C., Dumith, S.C., Bastos, J.P., Reichert, F.F., Siqueira, F.V., Azevedo, M.R. (2007). Evolução da pesquisa epidemiológica em atividade física no Brasil: revisão sistemática. *Revista de saúde pública*, 41, 453-60.

Hallal, P., Knuth, A.G., Cruz, D.K.A., Mendes, M.I., & Malta, D.C. (2010). Prática de atividade física em adolescentes brasileiros. *Ciência e Saúde Coletiva*, 15, 3035-42.

Koutedakis, Y., & Bouziotas, C. (2003). National physical education curriculum: motor and cardiovascular health related fitness in Greek adolescents. *British Journal of Sports Medicine*, 37, 311-4.

Mikkelsson, L.O., Nupponen, H., Kaprio, J., Kautiainen, H., Mikkelsson, M., & Kujala, U.M. (2006). Adolescent flexibility, endurance strength, and physical activity as predictors of adult tension neck, low back pain, and knee injury: a 25 year follow up study. *British Journal of Sports Medicine*, 40, 107-13.

Pelegrini, A., Silva, D.A.S., Petroski, E.L., & Glaner, M.F. (2011). Aptidão física relacionada a saúde de Escolares brasileiros: dados PROESP-BR. *Revista Brasileira Medicina do Esporte*, 17, 92-96.

Peterson, M.D, Alvar, B.A, & Rhea, MR. (2006). The contribution of maximal force production to explosive movement among young collegiate athletes. J*ournal of Strength Conditioning and Research*, 20, 867-73.

Projeto Esporte Brasil (PROESP-BR). (2011). Disponível em: <http://www.proesp.ufrgs.br> Acesso em: 10 jul. 2011.

Saraiva, J.P., & Rodrigues, L.P. (2010). Relações entre atividade física, aptidão física, morfológica e coordenativa na infância e adolescência. *Motricidade*, 6, 35-45.

Sharkey, B.J. (1997). *Fitness and health*. (4 ed.) Champaign: Human Kinetics.

Silva, L.R.R, Böhme, M.T.S, Uezu, R., & Massa, M. (2003). A utilização de variáveis cineantropométricas no processo de detecção, seleção e promoção de talentos no voleibol. *Revista Brasileira Ciência e Movimento*, 11, 69-76.

Silva, M.A., Rivera, I.R., Ferraz, M.R., Pinheiro, A.J, Alves, S.W., Moura, A.A., & Carvalho, A.C. (2005). Prevalência de fatores de risco cardiovascular em crianças e adolescentes da rede de ensino da cidade de Maceió. *Arquivos Brasileiro de Cardiologia*, 84, 387-92.

Silva, K.S., Nahas, M.V., Hoefelmann, L.P., Lopes, A.S., & Oliveira, E.S. (2008) Associações entre atividade física, índice de massa corporal e comportamentos sedentários em adolescentes. *Revista Brasileira Epidemiologia*, 11, 159-168.

Silva, D.A.S., Lima, J.O., Silva, R.J.S., & Prado, R.L. (2009). Nível de atividade física e comportamento sedentário em escolares. *Revista Brasileira Cineantropometria e Desempenho Humano*, 11, 299-306.

Tassitano, R.M., Bezerra, J., Tenorio, M.C.M., Colares, V., Barros, M.V.G., & Hallal, P.C. (2007). Atividade física em adolescentes brasileiros: uma revisão sistemática. *Rev Bras Cineantropom Desempenho Hum*, 9, 55-60.

Viana, M.S., Andrade, A., & Matias, T.S. (2010). Teoria da autodeterminação: Aplicações no contexto da prática de exercícios físicos de adolescentes. *Pensar a Prática*, 13, 1-18.

Welk, G.J., Going, S.B., Morrow, J.R., & Meredith, M.D. (2011). Development of new criterion-referenced fitness standards in the Fitnessgramge program: rationale and conceptual overview. *American Journal of Preventive Medicine*, 41, 63-7.

Zajons, R., Muller, A.B., & Valentini, N.C. (2008). A influência de fatores ambientais no desempenho motor e social de crianças da periferia de Porto Alegre. *Revista Educação Física/UEM*, 19, 159-171.

Authors' note

Camila Fernanda Brandão, master in physical education of Federal University of Mato Grosso and PhD student in the Ribeirão Preto Medical School, University of São Paulo

José Henrique de Queiroz Sources, Master in Biosciences, Federal University of Mato Grosso

Arturo Alejandro Zavala Zavala, PhD in statistics and professor at the Faculty of Economics of the Federal University of Mato Grosso;

Waléria Christiane Rezende Fett, PhD in Medical Sciences and professor at the Faculty of Physical Education, Federal University of Mato Grosso

Roberto Jaime dos Santos, professor at the Faculty of Physical Education, Federal University of Mato Grosso

Carlos Alexandre Fett, PhD Medical Sciences and professor at the Faculty of Physical Education, Federal University of Mato Grosso.

Corresponding author

Camila Fernanda Brandão
Faculdade de Medicina de Ribeirão Preto da Universidade de São Paulo, Anexo A, Bloco B, sala 103 - Avenida Bandeirantes, 3900, Vila Monte Alegre, Ribeirão Preto, SP, Brasil.
Email: camilafbrandao@hotmail.com

Manuscript received on July 05, 2015
Manuscript accepted on January 13, 2016