

## Effects of two modes of exercise training on physical fitness of 10 year-old children

Lígia G. dos Santos Chaves Ribeiro<sup>1</sup>, Maria de Nazaré Dias Portal<sup>2</sup>, João Bittencourt da Silva<sup>1</sup>, Alan Saraiva<sup>1</sup>, Gerson da Cruz Monte Jr<sup>1</sup>, Estélio H. M. Dantas<sup>1</sup>

<sup>1</sup>Laboratório de Biociências da Motricidade Humana – LABIMH / UCB-RJ, Brazil; <sup>2</sup>Programa de Doutorado Em Ciências do Desporto. UTAD, Portugal

### Summary

*Study aim:* To compare two exercise training modes on the physical fitness of 10 year-old children.

*Material and methods:* A sample of 60 schoolboys aged 10 years were randomly divided into 3 groups: Traditional (TG), trained according to the Brazilian national curricular parameters, Maturational (MG), in which the degree of difficulty of the activities was adjusted to the level of maturity of subjects, and Control group (CG). The Greulich-Pyle protocol was used to assess biological maturity. The following fitness tests were applied: 5×10 m shuttle run (SHR), Burpee's test (BCT), goniometric (LABIFIE) measurement of shoulder joint flexibility (SAA), horizontal shoulder flexion (HSF), shoulder joint abduction (SJA), lumbar spine flexion (LSF), hip joint extension (HJE) [10], Sargent's Jump Test (SJT), endurance shuttle run (ESR) and 50-m run. The TG and MG groups trained 16 weeks, twice weekly.

*Results:* The only significant ( $p < 0.05$ ) between-group differences were found for SJA (TG > MG) and LSF (TG > CG).

*Conclusions:* Despite the lack of clear-cut results, biological maturation combined with chronological age should be considered when applying various methodological approaches in order to encourage the engagement in physical exercises as this would have favourable carry-over effects.

**Key words:** Physical fitness – Schoolchildren – Motor skills

### Introduction

Training and regular physical fitness are known to have favourable effects on growth, maturation and physical aptitude of children and young adults [1,11,12,15,17,30]. The methodological approach to this study was the traditional one based on the Brazilian national curricula, using games, gymnastics, wrestling, as well as expressive and rhythmic activities respecting the cultural specificities of various regions [6]. Another approach employed the so – called maturational methodology that adjusted the degree of exercise difficulty to the level of maturity of the child [20]. These two approaches were selected for the former one is used in public schools in Brazil, the latter being developed recently with good results in schoolboys from Rio de Janeiro.

The development of motor skills in children is often related to their body characteristics, especially body mass and height, taking into account the biological and

physical maturity as crucial points [12]. The aim of this study was to compare the effects of two exercise training modes in schoolboys from a public school in Belém (Pará, Brazil).

### Material and Methods

A sample of 60 boys aged 10 years from a public school in Belém city, not participating in extramural physical activities, were randomly divided into 3 groups, 20 boys each: Traditional (TG), Maturational (MG) and Control (CG). The traditional and maturational methodologies provided the same energy expenditure; schoolboys from the control group participated in table games. The parents of all boys gave their written consents to their participation.

Both experimental groups (TG and MG) participated in physical education (PE) classes (60 min each) that stimulated the development of physical skills (agility,

co-ordination, flexibility, explosive strength, aerobic endurance and speed) during a 16-week period twice a week. The activities included a 15-min warm-up, 30 min of exercise and a 15 min cool-down.

The exercises applied to the TG group, based on the national curricular recommendations considering chronological age, included sports, games, wrestling, gymnastics, and expressive and rhythmic activities, respecting regional cultural specificities [6]. In the MG group, the degree of difficulty of the activities was adjusted to the level of maturity of subjects with an emphasis on psychomotor co-ordination, local muscle endurance, flexibility, aerobic capacity and other fitness abilities; the rules were adapted so as to make the activities and competitions playful. The goal of the MG methodology was to take into account the degree of biological maturity of children. That methodology was designed by Portal [25], who assumed that children of that biological age attained Stage 3 of maturity. The control group (CG) was not subjected to any training; they were exempted from physical activities at PE classes and only attended lectures throughout the 4-month period.

To evaluate biological maturity, the Greulich-Pyle standards [14] were used (X-ray of hand and wrist). The

following fitness tests were applied: 5×10 m shuttle run (SHR) reflecting agility [16], Burpee's test (BCT) reflecting co-ordination [16], goniometric (LABIFIE) measurement of shoulder joint flexibility (SAA), horizontal shoulder flexion (HSF), shoulder joint abduction (SJA), lumbar spine flexion (LSF), hip joint extension (HJE) [10], Sargent's Jump Test (SJT) reflecting the explosive strength, endurance shuttle run (ESR) reflecting the aerobic endurance and 50-m run.

The SPSS 14.0 software was used in data analysis; mean between-group differences were assessed using one-way ANOVA or Kruskal-Wallis' analysis followed by Wilcoxon's or Student's *t*-test for dependent data, the level of  $p \leq 0.05$  being considered significant.

## Results

The results of the study are presented in Table 1. No significant between-group differences were found in most variables; only in case of shoulder joint abduction (SJA) the TG group proved superior ( $p < 0.05$ ) to the MG group and in case of lumbar spine flexion – to the control group ( $p < 0.05$ ).

**Table 1.** Mean values ( $\pm$ SD and ranges) of somatic and fitness variables recorded in boys aged 10 years

| Group            | TG                           | MG                           | CG                           |
|------------------|------------------------------|------------------------------|------------------------------|
| n                | 20                           | 20                           | 20                           |
| Body height (cm) | 141.2 $\pm$ 6.2 (135 – 156)  | 137.2 $\pm$ 4.0 (130 – 145)  | 140.1 $\pm$ 6.0 (130 – 156)  |
| Body mass (kg)   | 35.7 $\pm$ 7.6 (27 – 52)     | 34.0 $\pm$ 5.3 (28 – 46)     | 34.4 $\pm$ 6.6 (27 – 52)     |
| BMI              | 17.9 $\pm$ 3.54 (14 – 26)    | 18.1 $\pm$ 2.8 (14.7 – 24.5) | 17.5 $\pm$ 3.2 (13.9 – 24.5) |
| SJT (cm)         | 29.0 $\pm$ 5.2 (19.5 – 37)   | 31.7 $\pm$ 4.7 (20 – 38.5)   | 29.4 $\pm$ 4.9 (19.5 – 35.5) |
| SHR (n)          | 11.9 $\pm$ 0.7 (9.7 – 12.7)  | 12.3 $\pm$ 2.6 (10.6 – 23)   | 12.6 $\pm$ 2.5 (11 – 23)     |
| BCT (n)          | 19.0 $\pm$ 5.6 (10 – 27)     | 20.2 $\pm$ 5.1 (10 – 28)     | 20.2 $\pm$ 5.2 (10 – 28)     |
| 50-m run (s)     | 10.2 $\pm$ 1.6 (8 – 13.5)    | 10.3 $\pm$ 1.2 (8.3 – 13.2)  | 10.4 $\pm$ 1.2 (8.3 – 13.5)  |
| ESR (n)          | 28.7 $\pm$ 1.3 (27 – 31)     | 28.9 $\pm$ 1.4 (27.1 – 30.5) | 29.0 $\pm$ 1.2 (27.1 – 30.5) |
| HSF (deg)        | 125.4 $\pm$ 12.8 (110 – 150) | 123.8 $\pm$ 11.5 (94 – 136)  | 125.7 $\pm$ 10 (110 – 149)   |
| SJA (deg)        | 115.5 $\pm$ 20.6 (101 – 172) | 104.9 $\pm$ 6.0* (92 – 115)  | 110.6 $\pm$ 20.2 (92 – 172)  |
| LSF (deg)        | 25.0 $\pm$ 9.3 (11 – 49)     | 21.8 $\pm$ 9.7 (10 – 49)     | 19.9 $\pm$ 5.7* (10 – 30)    |
| HJE (deg)        | 22.0 $\pm$ 8 (10 – 33)       | 21 $\pm$ 6.4 (10 – 39)       | 20.5 $\pm$ 8.0 (10 – 39)     |

Legend: TG – Traditional exercise training; MG – Maturation exercise protocol; CG – Control group; SJT – Sargent's jump test; SHR – Shuttle run 5×10 m; BCT – Burpee's test; ESR - Endurance shuttle run; HSF – Horizontal shoulder flexion; SJA – Shoulder joint abduction; LSF – Lumbar spine flexion; HJE – hip joint extension; \* Significantly ( $p < 0.05$ ) different from the TG group

## Discussion

Our findings regarding aerobic endurance are consistent with those of other authors [2,5,6,11,12,21,30] who emphasised that continuously intermittent exercise

increased the aerobic capacity of children and in the 10-year old ones improved their oxygen uptake[3,4,7,8]. To assess flexibility, 4 measurements of motion ranges were performed according to the report [29] on teenagers' flexibility. Another study [9] presented a new approach

to evaluate flexibility which has been implemented in training programmes containing stretching exercises.

The significant between-group differences in LSF and SJA could be explained by the fact that flexibility did not develop identically in various movements [6]. The greatest mobility in the joints is observed in the age interval 10 – 14 years, training effects on flexibility at that age being twice as effective as in case of younger individuals [24]. Our results are consistent with those of Suris and Parrera [30] who applied similar training protocols and reported significant improvements in flexibility and aerobic endurance in young boys of diverse maturity.

No significant between-group differences in agility, strength and co-ordination were found by us; further studies should be performed to assess the agility and strength which are essential for motor development [28]. As to the lack of differences in co-ordination, it is difficult to find proper tests for this variable [9,23]; motor co-ordination in prepubertal children improves with age but the trainability of physical fitness components in children remains a complex issue [13].

Regarding strength, boys at the age of 10 years are not yet under the influence of testosterone which augments the hypertrophy of muscle fibres [30] and, as shown by many authors [2,12,15,19,20,22,27,28], strength is correlated with maturity, chronological age, testicular volume, body height, and fat-free body mass.

The flexibility tests were performed separately, on one day, so as not to affect the flexibility-strength relationship [26]. Even though stretching has a negative effect on strength, adequate flexibility can promote muscle adaptation to effort and an increase in muscle amplitude [24,26,29].

The methodological sequence of the tests was maintained thus minimising the risk of slowing down the performance of flexibility and outburst strength, as emphasised by study on the effects of different warm-up protocols on children's performance [12]. This kind of research is of major importance because a good fitness activity plan for elementary school children makes it possible to control children's physical fitness level and encourage physical activity in teenagers [1]. In conclusion, despite the lack of clear-cut results, biological maturation combined with chronological age should be considered when applying various methodological approaches in order to encourage the engagement in physical exercises as this would have favourable carry-over effects.

## References

1. Araujo S.S., A.C.C.Oliveira (2008) Aptidão física em escolares de Aracajú. *Rev.Bras.Cineantropom.Desempenho Hum.* 10:271-276.

2. Baldari C., L.Di Luigi, G.PEmerenziani, M.C.Gallotta, P.Sgrò, L.Guidetti (2009) Is explosive performance influenced by androgen concentrations in young male soccer players? *Br.J.Sports Med.* 43(3):191-194. DOI:10.1136.

3. Berthoin G., E.V.Praagh (2006) Critical velocity during continuous and intermittent exercises in children. *Eur.J.Appl. Physiol.* 98:132-138.

4. Biernat E., G.Zalewski, R.Stupnicki (2007) Leisure physical activity of male youths training football. *Phys.Educ.Sport* 51:36-39 (<http://versita.com/science/healthsciences/pes>) DOI: 10.2478/v10030-007-0004-0.

5. Brasil. Casa Civil (1990) *lei n° 8.069*, de 13 de julho.

6. Brasil. Secretaria de Educação Fundamental (1997) Parâmetros curriculares nacionais. Secretaria de Educação Fundamental. Brasília, MEC/SEF.

7. Chamari K., I.Moussa-Chamari, L.Boussaïdi, Y.Hachana, F.Aouech, U.Wisloff (2005) Appropriate interpretation of aerobic capacity: allometric scaling in adult and young soccer players. *Br.J.Sports Med.* 39:97-101.

8. Colantonio E., R.V.Barros, M.A.P.M.Kiss (2008) Pico de consumo de oxigênio em nadadores e escolares do sexo masculino. *Rev.Bras.Cineantropom.Desempenho Hum.* 10:354-359.

9. Deus R.K.B.C., A.Bustamante, V.P.Lopes, A.F.T.Seabra, R.M.G.Silva, J.A.R.Maia (2008) Coordenação motora: estudo de tracking em crianças dos 6 aos 10 anos da região autónoma dos Açores, Portugal. *Rev.Bras.Cineantropom.Desempenho Hum.* 10:215-222.

10. Dantas E.H.M., J.T.L.Carvalho, R.M.Fonseca (1997) O protocolo de LABIFIE de Goniometria. *Rev.Trein.Desport.* 2:21-34.

11. Faigenbaum A.D., M.Bellucci, A.Bernieri, B.Bakker, K. Hoorens (2005) Acute effects of different warm-up protocols on fitness performance in children. *J.Strength Cond.Res.* 19:376-381.

12. Georgopoulos N.A., A.Theodoropoulou, M.Leglise, A.G.Vagenakis, K.B.Markou (2004) Growth and skeletal maturation in male and female artistic gymnasts. *J.Clin.Endocrinol.Metab.* 89:4377-4382.

13. Guedes D.P. (2007) Implicações associadas ao acompanhamento do desempenho motor de crianças e adolescentes. *Rev. Bras.Educ.Fís.Esp.* 21:37-60.

14. Hansen L., K.Klausen (2004) Development of aerobic power in pubescent male soccer players related to hematocrit, hemoglobin and maturation. A longitudinal study. *J.Sports Med.Phys.Fitn.* 44:219-23.

15. Johnson B.L., J.K.Nelson (1979) *Practical Measurement of Evaluation in Physical Education* (3ª ed.) Burgess, USA.

16. Kaczor J.J., W.Ziolkowski, J.Popinigis, M.A.Tarnopolsky (2005) Anaerobic and aerobic enzyme activities in human skeletal muscle from children and adults. *Ped.Res.* 57:331-335.

17. Koutedakis Y., C.Bouziotas (2003) National physical education curriculum: motor and cardiovascular health related fitness in Greek adolescents. *Br.J.Sports Med.* 37:311-314.

18. Machado D.R.L., V.J.Barbanti (2007) Maturação esquelética e crescimento em crianças e adolescentes. *Rev.Bras.Cineantropom.Desempenho Hum.* 9:12-29.

19. Malina R.M., J.C.Eisenmann, S.P.Cumming, B.Ribeiro, J.Aroso (2004) Maturation-associated variation in the growth and functional capacities of youth football (soccer) players 13-15 years. *Eur.J.Appl.Physiol.* 91:555-562.

20. Nelson G. A., J.Kokkonen, A.D.Arnall (2005) Acute muscle stretching inhibits muscle strength endurance performance. *J.Strength Condit.Res.* 19:338-343.

21. Nhantumbo L., J.Maia, S.Saranga, R.Fermino, A.Prista (2007) Efeitos da idade, do sexo e da área geográfica, no crescimento somático e aptidão física nas crianças e jovens rurais de Calanga, Moçambique. *Rev.Bras.Educ.Fís.Esp.* 21:271-289.
22. Philippaerts E.M., R.Vaeyens, M.Janssens, B.V.Reterghem, D.Matthys, R.Craen, J.Bourgeois, J.Vrijens, G.Beunen, R.M.Malina (2006) The relationship between peak height velocity and physical performance in youth soccer players. *J.Sports Sci.* 24:221-230.
23. Portal M.N.D., L.G.S.Chaves, A.Saraiva, J.L.S.Bitencourt, G.Monte Jr, E.H.M.Dantas (2008) Avaliação dos Efeitos do treinamento em crianças futebolistas da vila olímpica da mangueira. *Rev.Motricidade* 4(2):48-53.
24. Portal M.N.D., J.F.Toniato (2005) A criança, o adolescente e a flexibilidade. In: Alongamento e Flexionamento (5<sup>th</sup> ed.). Shape, Rio de Janeiro.
25. Quatman C.E., K.R.Ford, G.D.Myer, T.E.Hewett (2006) Maturation leads to gender differences in landing force and vertical jump performance. *Am.J.Sports Med.* 34:806-8130.
26. Ré, A.H.N., L.P.Bojikian, C.P.Teixeira, M.T.S.Böhme (2005) Relações entre crescimento, desempenho motor, maturação biológica e idade cronológica em jovens do sexo masculino, *Rev.Bras.Educ.Fís.Esp.* 19:153-162.
27. Silva L.J.D., R.A.J.Santos, M.P.M.B.Oliveira(2006) A flexibilidade em adolescentes – um contributo para avaliação global. *Rev.Bras.Cineantropom.Desempenho Hum.* 8:72-79.
28. Silva M.C. (2006) Crescimento físico e aptidão física relacionada à saúde de adolescentes de diferentes níveis sócio-econômicos. *Rev.Bras.Cineantropom.Desempenho Hum.* 8:111.
29. Stabelini Neto A., L.P.G.Mascarenhas, R.Bozza, A.Z.Ulbrich, I.Q.A.Vasconcelos, W.Campos (2007) VO<sub>2</sub> máximo e composição corporal durante a puberdade: comparação entre praticantes e não praticantes de treinamento sistematizado de futebol. *Rev Bras Cineantropom Desempenho Hum.* 9:159-164.
30. Suris J.C., N.Parrera (2005) Don't stop, don't stop: physical activity and adolescence. *Int.J.Adolesc.Med.Health* 17:67-78.

---

**Received 24.06.2009**

**Accepted 11.11.2009**

© University of Physical Education, Warsaw, Poland