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Aerobic Games and Playful exercises in 9-Year-Old Boys: Intensity and Fitness Effects

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ABSTRACT

Previous research on exercise for pre-adolescents with the purpose of improving aerobic fitness levels has yielded contradictory results. Sufficient training intensity, frequency and duration are the crucial factors in achieving this goal; the question, however, is whether it is possible to reach sufficient intensity levels using aerobic games and playful exercises. Variety and fun are the important factors in motivating children to participate in physical exercises and sports. Therefore, the aim of the study was to investigate the effect of high intensity exercises in pre-adolescent boys, using programs consisting of fun activities and aerobic games. The findings show that the participants achieved intensity levels above 80 % of HRpeak on average in about 60 % of the total exercise time, resulting in significantly improved aerobic fitness.

Key words: Physical fitness, children, exercise, aerobic games

Aerobne igre in igralna vadba pri devetletnih dečkih: učinki intenzivnosti in telesne kondicije

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POVZETEK

Predhodne raziskave o vadbi predadolescentov z namenom izboljšanja aerobnih ravni telesne forme so dale nasprotujoče si rezultate. Zadostna intenzivnost vadbe, pogostost in trajanje so odločilni dejavniki pri doseganju tega cilja, vprašanje pa je, ali je zadostno raven intenzivnosti mogoče doseči z uporabo aerobnih iger in igralnih vaj. Pestrost in zabavnost sta pomembna dejavnika motiviranja otrok za udeležbo v telesni vadbi in v športu. Cilj raziskave je bil torej proučiti učinek visoko intenzivnih vaj pri predadolescentnih dečkih z uporabo programov, ki jih sestavljajo zabavne dejavnosti in aerobne igre. Ugotovitve kažejo, da so udeleženci dosegli ravni intenzivnosti nad 80 % Sumax povprečju v 60 % celotnega časa vadbe, rezultat česar je bila pomembno izboljšana aerobna kondicija.

Ključne besede: telesna kondicija, otroci, vadba, aerobne igre

Introduction

Aerobic fitness is an important factor in determining success in various sports, and especially in endurance sports (Helgerud et al., 2007). Moreover, positive long-term health effects have been reported in children in conjunction with improved aerobic fitness (Andersen et al., 2006; Hussey et al., 2004; Janz et al., 2002). It has been claimed that there are no training-induced changes in aerobic power (VO_{2peak}) in healthy active children, and that any cardiovascular changes are mainly due to maturation (Rowland & Boyajian, 1995). However, more recent research does show improvement in aerobic power after aerobic training, even in children (Resaland et al., 2011; Baquet et al., 2010; Gamelin et al., 2009). That previous intervention programs had no effect on aerobic power after intermittent training was probably due to inadequate training parameters or insufficient intensity (Ratel et al., 2004). It is suggested that intensities above 80 % of maximal heart rate (HR_{max}) are necessary in order for there to be a significant improvement in aerobic fitness (Berthoin et al, 2004; Baquet et al., 2003). Research consisting of high intensity aerobic training programs in children have often used training intervals from 10 to 30 seconds (Zaferidis et al., 2005); however, there is little evidence of longer high-intensity activity periods in children nine years old or younger.

Activity patterns in children are characterised by spontaneous, intermittent activity (Baquet et al., 2010; Ratel et al., 2004), while fun activities and aerobic games are often the key motivating elements for children (Barkley et al., 2009; MacPhail et al., 2008). Moreover, children's physiology is different from that of adults, since children can activate their aerobic metabolism more rapidly, and have a lower need for anaerobic metabolism (Ratel et al, 2004). Furthermore, children need shorter recovery periods than adults after high-intensity exercise, thus being able to complete a substantial amount of time at high intensity with each session (Falk & Dotan, 2006; Zaferidis et al., 2005). Because they have less muscle mass, children have less to recover from (lower lactate values), and as a consequence, the heart rate returns to baseline pre-exercise levels more rapidly than in adults (Ratel et al., 2006; Zaferidis et al., 2005). Our hypothesis is that it is possible to reach high intensities close to HR_{peak} by practicing playful exercises and aerobic games. We also wanted to test whether the training program would result in aerobic fitness improvement measured as an improvement in running capacity. To the best of the authors' knowledge, there have been no studies with children nine years old or younger using only fun activities and aerobic games as a training method to enhance aerobic fitness.

Material and methods

The participants, 10 boys aged 9.6 (± 0.7) years, completed 60-minute training sessions, twice a week over a six-week period. The sessions comprised four different playful aerobic activities, mostly consisting of soccer, indoor bandy, various

ballgames, variations of tag and relay races, and other aerobic games. The exercise program was organized on the interval principle, with high intensity periods followed by lower intensity recovery periods. HR was monitored every 5 seconds with the Polar Sport Tester (Finland). This is a common method for controlling intensity levels during aerobic exercise, one that has been validated across a range of exercise levels (Iannotti et al., 2004). The HR_{peak}-test (highest HR-value reached), and the aerobic fitness level were tested in the progressive treadmill test until termination caused by total exhaustion. We used the Oslo protocol designed for testing children, based on the principle of increasing the speed and the angle every other minute (Fredriksen et al., 1998). Running capacity was calculated in total distance in meters, by dividing the speed of the protocol stages by the time at the point where the participants terminated the test. Participants were motivated to continue until they were totally exhausted, and we considered whether the subject could continue to run properly. Written informed consent to participate in the study was obtained from the children and their parents, and the study was given approval by The Committee for Medical Research Ethics.

Results

A significant improvement in aerobic fitness as a function of running performance was shown, and all of the test subjects improved their running performance (Table 1).

Table 1: Average HFpeak and test results in running distance (meters)

Test person	HFpeak test 1	HFpeak test 2	HFpeak in sessions	Running distance test 1	Running distance test 2
n-1	200	202	199	1600	1883,3
n-2	200	197	201	1141,6	1288,8
n-3	206	198	204	1666,6	1783,3
n-4	200	199	202	1141,6	1577,7
n-5	196	198	196	1733,3	2033,3
n-6	210	214	211	1600	2033,3
n-7	202	203	206	1895,8	2108,3
n-8	204	200	204	1688,8	1808,3
n-9	206	202	207	1666,6	1883,3
n-10	197	196	204	1758,3	2033,33
Average	202,1	200,9	203,4	1589,3	1843,3
SD	4,1	4,8	4	237,9	237,5

The paired sample *t*-test was applied for tracking down the differences between the initial and final values of the variables; the significance level was set at $p < 0.05$.

Table 2: Average distribution of intensity levels during all sessions, below and above 80 % of HFpeak, and over 90 % and 95 % of HFpeak

Above 80 % of HF_{peak}: 53,7 %
Above 90 % of HF_{peak}: 31,5 %
Above 95 % of HF_{peak}: 7,1 %

Two typical training sessions, all consisting of various aerobic games and play, carried out by the interval method, with high intensity activities interspaced by recovery periods, are shown in Figures 1 and 2.

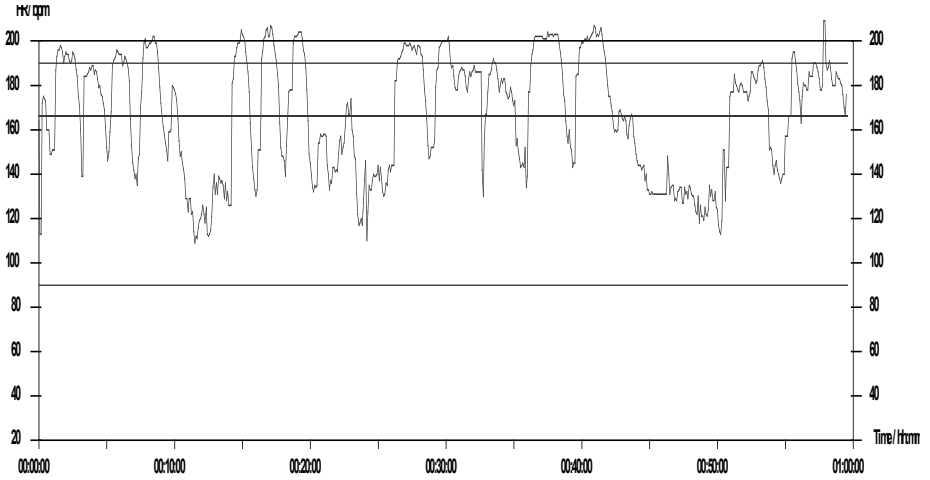

Figure 1: Example of distribution of HF-monitoring during a one-hour training session. 0-15 minutes: Catch game; 15-30 min: Hurdle run; 30-45 min: Ballgames, 45-60 min: Soccer play. The test subject HFpeak is 214 bpm

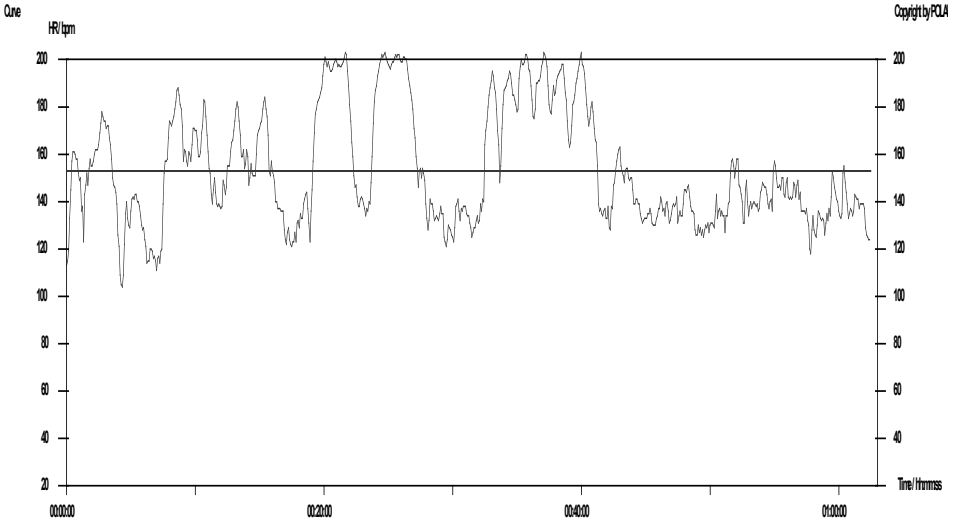

Figure 2. Example of distribution of HF-monitoring during a one-hour training session. 0-15 minutes: Playing tag; 15-30 min: Hurdle run; 30-45 min: Relay race; 45-60 min: Indoor bandy. The test subject HFpeak is 203 bpm

The distribution shows the difference in intensity levels between the activities; however, all activities reached relatively high intensity. The average distribution of intensity levels during all sessions showed that the participants on average performed about 60 % of the total exercise time above 80 % of HRpeak, and approximately 30 % of the total time above 90 % of HRpeak.

Discussion

The participants increased their running capacity significantly ($p < 0.05$), from 1589 meters to 1843 meters in running distance, from pre- to post-test (Table 1). The significant improvement is most likely a consequence of the intervention programs; however, one weakness in the study design is the lack of a control group. In addition, maturation effects cannot totally be ruled out. Nevertheless, the results are in accordance with previous research on children, which has shown that, if the exercise intensity and duration are sufficient, aerobic fitness will improve (Brøgger et al., 2013; Baquet et al., 2010, 2004; 2003; Gamelin et al., 2009; Ratel et al., 2006; 2004). Interestingly, the participants reached intensities higher than 80 % of HRpeak throughout about 60 % of the exercise periods, and higher than 90 % of HR_{peak} in 30 % of the one-hour sessions on average. In all the selected activities, the participants showed relatively high intensity levels; however, as shown in Figures 1 and 2, there were differences between the activities. The highest intensity level was reached during exercises consisting of relay races and the intermittent hurdle run (Figure 2), while the HR_{peak} reached intensities similar to that found in the treadmill test. Ballgames and soccer play (Figure 1) reached almost the same intensity; in contrast, indoor bandy (Figure 2) elicited more moderate heart rate values. This result is in line with previous research, which has shown children to be capable of exercising near their HR_{peak} with little accumulation of lactate, indicating a lower need for anaerobic metabolism during high-intensity exercise, mostly attributed to the inability to recruit higher-hierarchy motor units (Falk & Dotan, 2006; Ratel et al., 2004).

The exercises in this study were organized according to the interval principle, and that may have been an important factor in eliciting the high intensities observed. Moreover, the exercises are designed to mimic the natural activity patterns among children, with high intensity periods interspersed with shorter recovery periods (Baquet et al., 2010; Ratel et al., 2004). Previous reports have shown that children are able to sustain high intensity, especially if such activity alternates with periods of low intensity (Brøgger et al., 2013; Zaferidis et al., 2005). Another possible explanation of the high intensity levels reached could involve the motivational factors elicited by fun activities, as indicated in previous reports (Barkley et al., 2009; MacPhail et al., 2008). The variety and playful nature of the exercises are important factors in motivating children to exercise at high intensity, and are similar in nature to spontaneous physical activity among children (Barkley et al., 2009).

Conclusion

This study has shown that it is possible to reach intensity levels above 80 % of HR_{peak} using playful activities and aerobic games in pre-pubertal children. This is the recommended intensity for improving aerobic fitness in children, and the participants did show significant fitness improvement. However, controlled studies with high intensity training conducted at short interval periods, and with larger samples are needed. There is also a need for studies to investigate the motivational implications of high intensity exercise in children.

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