Original Article

Is there an effect of the order of realization of sprint and endurance for intermittent test?

JERSON MEKOULOU NDONGO¹, ABDOU TEMFEMO^{1,2}, PEGUY BRICE ASSOMO NDEMBA¹, ERNEST TCHOUDJIN¹, WILIAM RICHARD GUESSOGO³, GEORGES GASSINA¹, SAMUEL HONORE MANDENGUE¹

¹ Exercise and Sport Physiology Unit, Faculty of Science, University of Douala - CAMEROON

² Department of Biological Sciences, Faculty of Medicine and Pharmaceutical Sciences, University of Douala - CAMEROON

³ National Institute for Youth and Sports, PO Box 1016 Yaounde, CAMEROON

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Abstract:

The aim of this study was to examine whether the sequence in which sprint (S) and endurance (E) races are executed has effects on performance and physiological responses in children. Seventy-seven male pubescent students aged 18 ± 3 years performed two protocols (P_1 and P_2) consisting in 2000m walking to warm-up (W), followed by S on 100m and E on 1000m; ($P_1 = W + S + E$ and $P_2 = W + E + S$). Heart rate (HR) was monitored continuously. Systolic blood pressure (SBP) and skin temperature (Tsk) were measured at the beginning and at the end of protocol. Two resting electrocardiogram (ECG) were registered before and after protocols. Performances of W (1183 ± 119 vs 1186 ± 130 s); E (389 ± 59 vs 355 ± 104 s); S (21 ± 3 vs 21 ± 5 s) during P_1 and P_2 respectively were similar. HR, Tsk were lower after E than S ($p < 0.01$). SBP were higher after E than S ($p < 0.01$). No significant differences were found in ECG between P_1 and P_2 . In conclusion, the sequence in which S and E are executed induces different physiological responses and has no effect on physical performance in children.

Key words: physical education, physical activities, sport examination, performance, school children.

Introduction

The fight against physical inactivity which is one of the main associated factor of cardiovascular diseases, the leading cause of death worldwide (Mathers *et al.*, 2009) is done through a regular practice of physical exercises and prevention (Fletcher *et al.*, 2001). Many recommendations on the practice of physical exercises are continuously made by investigators (Haskell *et al.*, 2007; Georges *et al.*, 2012). Physical education and sports (PES) is a compulsory course unit in many educational systems in the world, with the aim to obtain significant effects on health, motor skills and socio-cultural relations development of the involved (Bailey, 2006; Cooper, 1994). Sprint and endurance races are the most popular exercises for anaerobic and aerobic development capacities. Short sprints (S) are more common exercises done by students out of PES classes in schoolyards and playgrounds; whereas endurance exercises (E) are less practiced. During national exams of PES students have to complete a series of standardized exercises among which sprint (100 m) and endurance running (1000 m) the same length of time. The sequence in which S and P are completed during PES exam is often questioned. In most cases, children prefer to complete S before E though in many occasions, they don't have the choice. This study therefore aimed to analyze the effects of the sequence in which S and E are executed on the performance and on physiological responses in children. We hypothesized that, the fact that children enjoy sprints during their routine physical activity in playgrounds, completing S before E may bring out good results in terms of performance.

Material & methods

Experimental approach to the problem

Two protocols were used to determine which test among sprint or endurance is better to start with. Protocol P_1 included sprint before endurance and Protocol P_2 endurance before sprint. We compared physical performance, physiological parameters between the two protocols.

Participants

Seventy-seven male pubescent students participated in this study. Students, parents or tutors and Principals of school institutions were thoroughly informed about the purpose, potential risks and benefits of the study before given their written consent. All students practice PES following a school program consisting of

gymnastics, team sports, high jump, and races (sprint and endurance) two hours/week. For each student, participation in PES was conditioned upon presentation of a certificate of fitness. The study was approved by the Institutional ethic committee and was conducted in accordance with the Helsinki Declaration as revised in 1989.

Experimental procedure

All participants performed two protocols starting by walking two kilometers as warm-up exercise (W) followed by two races. Protocol 1 (P_1) consisted of: W + S + E and Protocol 2 (P_2): W + E + S. P_1 and P_2 were performed in a random order with a gap of 72 hours minimum as recovery period. Warm-up was separated from S or E by 10 min recovery period and both S and E races were separated from each other by 20 min recovery period. Protocols were performed on a closed track of 400 meters, as during official the athletic competitions, with two investigators, one at the starting block and one time-recorder and the arrival. The experiments took place from 3 p.m to 5 p.m. To avoid all circadian variations, each participant performed protocol P_1 and P_2 in the same hour of day.

Electrocardiographic parameters.

Electrocardiographic (ECG) parameters [P wave, PR and QTc segment, QRS] were determined using a portable electrocardiograph 12 derivations CarTouch (Cardionics SA. Brussels) at a speed of 25 mm.s^{-1} and an amplitude of 10 mm.mv^{-1} following the recommendations of the American Heart Association (Kligfield *et al.*, 2007). ECG was performed in each subject at rest (ECG₁) and after the last recovery period (ECG₂) of P_1 and P_2 .

Heart rate (HR)

The HR was recorded continuously during the tests with a heart rate monitor (Polar RS800CX Electro Oy, Kempele, Finland) reliable with better precision with minimal artifacts (Cassirame *et al.*, 2007). The marks were made at the beginning and at the end of the period of exercise or at the rest period or recovery period. The successive heartbeats (RR) were analyzed using the software Polar Pro Trainer 5.1; and ectopic beats were visualized and manually replaced by interpolation of adjacent RR intervals.

Systolic blood pressure and skin temperature

Blood pressure (BP) and skin temperature (Tsk) were measured at rest, at the end of each exercise (W, S and E) and 5 min after the end of P_1 and P_2 . Blood pressure was measured using a BP monitor, Omron M3 (Kyoto, Japan). Tsk was measured at the left temple using an infrared thermometer, Thermo Flash LX-26 (Schezen, china) after wiping the sweat with a handkerchief.

Statistical analyses

Quantitative parameters were expressed as mean $\pm$ standard deviation. Comparisons of time to cover W, S and E of the two protocols were performed using the paired Student t-test. Comparisons of physiological parameters (ECG, HR, Tsk and BP) were performed using ANOVA repeated measures. Significance was located using the Student test and Newmann Keuls test. All analyses were performed using the StatView 5.0 software (SAS institute). The significance level was set at $P < 0.05$.

Results

Characteristics of participants were 18 ± 3 years, 59.5 ± 8.5 kg, 1.66 ± 0.01 m and 21.8 ± 2.3 size kg/m^2 respectively for age, weight, height and body mass index.

No significant differences were observed during exercise sessions (W, S, E) during P_1 and P_2 (Table 1).

Table 1. Performances during each protocol

P_1 : (W + S + E); P_2 : (W + E + S). E: (1000m); S: (100m); W: (2000m).

Protocol		
Tests	P_1	P_2
W(s)	1183.72 $\pm$ 118.95	1186.01 $\pm$ 130.05
E (s)	388.82 $\pm$ 58.94	355.03 $\pm$ 104.09
S (s)	20.91 $\pm$ 3.15	21.03 $\pm$ 5.51

ECG values before and after P_1 and P_2 revealed no major or minor abnormalities likely to affect the performance and health of subjects (Table 2).

Table 2. ECG parameters during each protocol

P_1 : (W + S + E); P_2 : (W + E + S) E: (1000m); S: (100m); W: (2000m)

ECG				
	P ₁		P ₂	
	rest	after	rest	after
P (ms)	101±15	103±10	102±12	105±6
PR (ms)	147±23	155±19	150±18	156±19
QRS (ms)	80±8	81±9	81±9	82±10
QRS (°)	52±24	49±28	50±29	48±29
QTc (ms)	423±19	428±18	411±26	409±20

Values of P, PR, QRS, QRS° and QTc during P₁ and P₂ showed no significant difference.

Resting HR values (Figure 1) for P₁ and P₂ were similar. HR after W and at the end the first pause (r₁) period For P₁ and P₂, were similar. HR increased more significantly with higher values ($p < 0.01$) in E than in S. At the end of 20 min recovery periods (r₂) between E and S or S and E, HR decreased to lower value after S ($p < 0.05$). But at the end of the last 5 min recovery period (r₃), the recovery heart rate was higher after E than after S. For successive recoveries, we observed $HR_{r_0} < HR_{r_1} < HR_{r_2} < HR_{r_3}$.

Fig.1. Heart rate profiles during each protocol

HR: Heart rate; E: endurance (1000m); S: sprint (100m); W: walk (2000m); r₀: rest; r₁: recovery after W; r₂: recovery after E/S; r₃: recovery at the end of the test.

*: $p < 0.05$ and **: $p < 0.01$ and ***: $p < 0.001$.

During the test, SBP increased with exercises (W, S, E) and decreased during recovery periods (r₁, r₂, r₃) (Figure 2). No difference in SBP was observed at rest (r₀) and at the end of the W between P₁ and P₂. Differences ($p < 0.01$) appeared between P₁ and P₂ at the end of S and E with higher values with S. During recovery periods (r₁, r₂, r₃), no difference was observed between P₁ and P₂.

Resting Tsk values were similar for P₁ and P₂ (Figure 3). After W, Tsk values dropped in P₁ and P₂ to move up at the end of the recovery period (r₁) without reaching the resting values (Tsk_{r0}). During r₂, Tsk values decreased significantly after S and slightly after E leading to a significant difference between the mean values of Tsk between P₁ and P₂ ($p < 0.01$). During the recoveries periods, Tsk values increased without reaching the values of previous recovery periods (Tsk_{r0} > Tsk_{r1} > Tsk_{r2} > Tsk_{r3}). The Tsk values were significantly higher after r₂ ($p < 0.01$) for P₁ compared to P₂ and after r₃ ($p < 0.05$) for P₂ compared to P₁.

Fig. 2. Systolic Blood Pressure profiles during each protocol
SBP: Systolic Blood Pressure; E: Endurance (1000m); S: Sprint (100m); W: Walk (2000m); r₀: rest; r₁: recovery after W; r₂: recovery after E/S; r₃: recovery at the end of the test. *: P < 0.05 and **: p < 0.01 and ***p < 0.001.

Fig.3. Skin temperature profiles during each protocol
Tsk: Skin temperature; E: Endurance (1000m); S: Sprint (100m); W: Walk (2000m); r₀: rest; r₁: recovery after W; r₂: recovery after E/S; r₃: recovery at the end of the test.
*: P < 0.05 and **: p < 0.01 and ***p < 0.001.

Discussion

This study investigated the physiological and physical responses related to the order of realization of sprint and endurance races during two protocols (P₁ and P₂). The main finding was that, the overall performance is not affected by the order of realization of S and E during the two protocols (Table 1). P₁ and P₂ included intermittent tests; and one of the great interests of intermittent tests compared to continuous exercise is the possibility to maintain greater work intensities for longer durations (Astrand *et al.*, 1960; Christensen *et al.*, 1960; Gorostiaga *et al.*, 1991, Billat *et al.*, 1996, 2000a, b). The recovery duration (20 min) between each exercise was sufficient to allow physiological parameters to return to their baseline values, preventing thus participants to perform the consecutive exercise with the feeling fatigue. In our study, the duration of recovery was enough for energy synthesis which is necessary for the subsequent test (Bangsbo *et al.*, 1994, Dupont *et al.*, 2004). Whatever the protocol (P₁ or P₂), a lower drop of performance was observed during the second test. Physical Performances of participants enrolled in P₁ and P₂ revealed moderately low level of training. In fact, Mero *et al.* (1990) found in their study that the time to perform 100 m and 1000 m by prepubescent children specialized in aerobic and anaerobic was respectively 14.45 ± 0.63 s and $3.29.6 \pm 0.63$ min.

The significant increase in HR (Figure 1) during E compared to S could be explained by the intensity and duration of E, inducing higher cardiovascular adaptations. ECG values (Table 2) at rest were similar in the two protocols (P_1 and P_2). ECG screening is often required as a preparticipation clinical checking among athletes in order to reduce the risk of sudden cardiac death (Corrado *et al.*, 2005). This study did not reveal any major or minor abnormalities, and this was in accordance with some similar studies (Katibi, 2010; Bonny *et al.*, 2013, Rijnbeek *et al.*, 2014) including young black school children with lower training intensity. The reduced sample size does not allow for objective conclusion with regards to ECG features.

The significant increase of SBP (Figure 2) after S compared to E is related to the cardiac physiological mechanisms. Sprint is explosive and induces sudden SBP rise compare to endurance running where SBP increases usually moderately because of vasodilatation (Soares *et al.*, 2015). In both exercise sessions, SBP slightly decreases after all recovery periods. Carter *et al.*, (1999) suggested that, the abrupt interruption of exercise decreases a sudden interruption of muscle pump, diminishing venous return and consequently, blood pressure. SBP remains the same during recovery periods between P_1 and P_2 . This result was similar to what reported Soares *et al.*, (2015) where the time of recovery period was more than five minutes.

Tsk (Figure 3) was higher during E than S. Temfemo *et al.*, (2006) observed that brief and intense exercises (like S in our study) involve skin temperature storage which will dissipate during recovery, whereas in endurance exercises (E) the rise of body temperature is associated to higher oxidative metabolism.

Conclusion

The order of realization of foot races such as speed and endurance exercises has significant impact on heart rate, blood pressure parameters and the skin temperature without having an impact on physical performance in students. We suggested a larger period of recovery between the two exercises to prevent any difference in performances.

Practical Application

For coaches who have students enrolled in protocol carrying out both races (speed and endurance) in the same day, it is not necessary to choose one race before another; the realization order doesn't impair performance. Coaches should observed adequate length recovery period, necessary for the physiological parameters to approach their basic values, and for students to reach same performances.

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