

THE RELEVANT USE OF THE TRADITIONAL TUNISIAN GAME “RAQASSA” FOR CARDIOVASCULAR STIMULATION IN SCHOOLCHILDREN

■ Accepted
for publication
15.06.2013

AUTHORS: Jebali T.^{1,2}, Moalla W.^{2,3}, Elloumi M.^{3,4}, Padulo J.^{1,5}, Baquet G.⁷, Chamari K.^{1,6}

¹ Research Laboratory “Sport Performance Optimisation” CNMSS, Tunis, Tunisia

² UR EM2S, ISSEPS, Sfax University Tunisia

³ Laboratory « Physiologie et Explorations fonctionnelles » Faculty of Medicine, Sousse. Tunisia

⁴ ISSEP Ksar-Saïd, Manouba University, Tunisia

⁵ Faculty of Medicine and Surgery, University of “Tor Vergata” Rome, Italy

⁶ Research and Education Center, Aspetar, Doha, Qatar

⁷ Laboratory of Human Movement Studies, Faculty of Sport Sciences and Physical Education, Lille 2 University, Ronchin, France

Reprint request to:

Johnny Padulo

Institution: University of “Tor Vergata”

Address: Via Columbia s.n.c. CAP

00173 Rome ITALY

E-mail: sportcinetic@gmail.com

ABSTRACT: The aim of this study was to investigate the heart rate (HR) responses, the rate of perceived exertion (RPE), and the feeling during physical education schooling while performing traditional games activities compared to intermittent exercise. Nineteen pre-pubertal children randomly performed on different days two types of lessons (intermittent running mode vs. traditional Tunisian “Raqassa” game) lasting 12-min each. HR was continuously recorded during both lessons, while ratings of perceived exertion and Feeling values were recorded after the sessions. The mean HR value during the traditional game was significantly higher than during intermittent exercise ($p < 0.05$). Conversely, the perceived exertion score was significantly higher after intermittent exercise than the traditional exercise game ($p < 0.05$), showing that the higher cardiovascular strain of the game was perceived as “lighter” than the run. Simultaneously, the children’s Feeling was significantly higher after the traditional game than intermittent exercise ($p < 0.001$), showing a higher satisfaction from playing with respect to running. Exercise based on the “Raqassa” traditional game could be used in pre-pubertal children as an alternative or as an additional method for suitable cardiovascular stimulation during physical education lessons with lower perceived exertion and better feeling compared to intermittent running.

KEY WORDS: Rejeski feeling scale, ratings of perceived exertion, game activity, training mode, field testing, heart rate

INTRODUCTION

Physical activity (PA) is an integrated component of a healthy lifestyle. The practice of PA in children has several health benefits [34]. In 2008, the U.S. Department of Health and Human Services recommended that children (up to 11 years of age) and adolescents (age 12 to 17 years) accumulate ≥ 60 minutes/day of moderate-to-vigorous physical activity to prevent obesity, and improve their physical fitness and bone health, while decreasing metabolic and cardiovascular risk factors, and symptoms of depression and anxiety [28]. To achieve this objective American College of Sport Medicine (ACSM) in 2010 recommends a training frequency of three to four sessions a week, and advises moderate to vigorous intensity for cardiovascular training in healthy children [2].

Epidemiological studies emphasized that the promotion of PA and sport in the overall population had become one of the major concerns of public health in the two last decades [3]. Several stud-

ies have shown that the amount of PA from childhood to adolescence has been reduced, and that physical fitness, particularly aerobic capacity, has been decreasing [36]. In this context, Tomkinson et al. tested 130,000 children and adolescents from 11 countries between the years 1981 and 2000 using the 20-metre shuttle running test [36]. They observed a decrease in the average aerobic capacity of about 0.43% per year, which represents an 8.6% decrease over 20 years [36]. Recently, it has been demonstrated that exercise might reverse the present downward tendency of the level of physical fitness in children and adolescents as long as intermittent exercise is achieved at rates of running speeds reaching or exceeding maximal aerobic speed (MAS) [30]. However, the exercise sessions proposed in this perspective using interval training are quite intense and thus involve high cardiovascular system stimulation and thus could be perceived as exhausting by the exercising children.

Furthermore, these exercises are usually relatively boring despite their recognized efficacy. Thus, one may question the pertinence of such exercises for pre-pubertal schoolchildren. Indeed, children naturally prefer activities based on games that are often intermittent, short and more attractive than classical running [39]. In order to promote life-long physical activities, a broader base of physical education activities needs to be offered to reinforce the fact that it is not necessary for young people to be talented sports athletes but rather just to be active and healthy. While motor, cognitive, social, spiritual, cultural and moral developments are valid areas of learning, they can be inconsistent with maximizing participation in health-enhancing physical activities [32]. In this context, several studies have proposed game-based exercise programmes and have shown that shorter games as well as specific and integrated exercises may improve aerobic fitness through high-intensity stimulation (over 90% of maximal heart rate (HR_{max})) [22].

Additionally, it is interesting to note that exercises using shorter games in team sports such as soccer might be an excellent alternative to intermittent exercises and might develop aerobic capacity in addition to technical and tactical aspects [29]. Furthermore, even if this mode of exercising pattern is empirically practised at school by young pupils, to the best of our knowledge, no study has yet described cardiac responses, feeling, and effort perception during school games activities in order to objectively assess their possible usefulness as a means of cardiovascular stimulation in pre-pubertal children. Therefore, the aim of this study was then to measure the HR responses, the feeling, and the ratings of perceived exertion (RPE) during a lesson of games activity compared to those recorded during intermittent exercise used as a reference mode of exercise aimed at developing aerobic capacity.

MATERIALS AND METHODS

Subjects. Nineteen schoolboys (age: 11.3 ± 0.6 years, height: 142.3 ± 3.4 cm and body mass: 35.4 ± 5.6 kg) volunteered to participate in this study. Before beginning the protocol, all subjects underwent a complete medical check-up (heart rate, blood pressure, oxygen saturation, etc.) by an experienced paediatrician to eliminate any sick children or those suffering from any pathology. The same physician determined that children were in the pre-pubertal stage according to Tanner's method [33]. The children practised PA only at school, for a two-hour session each week. All subjects and their parents were informed about the nature and the experimental protocol before they signed written informed consent. The study protocol was approved by the ethical University committee and was designed in accordance with principles of the Helsinki Declaration of Human Rights.

Procedures

All subjects performed a 20-metre Shuttle Run Test (20-MST) to determine their maximal aerobic speed (MAS) [23]. The latter test was performed twice, with a one-week interval, in order to habituate

the subjects to the test effort pattern. After performing the maximal test, in the next week's physical education lesson, the subjects randomly performed two types of training lasting 12 minutes each, as follows:

1. An intermittent running exercise consisting of 3 sets of 2 minutes of running at 100% of the MAS with 2 minutes of passive recovery in between, as a model of intermittent training sample;
2. A Tunisian traditional exercise game called "Raqassa" also played for 3 sets of 2 min with 2 min of passive recovery in between.

A period of recovery of 15 min separated the two exercise bouts, and a 15-min standardized warm-up was performed at the beginning of the session.

HR was recorded every 5 s during both exercise bouts using Polar S410 heart rate monitors (Polar Electro OY, Kempele, Finland). Average HR was calculated every 30 s to get an indication of the overall intensity of each type of exercise. "RPE" (rating of perceived exertion) and "Feeling" experienced at the end of each lesson were estimated through the Children's Effort Rating Table (CERT) of Williams et al. [38], and the Rejeski Feeling Scale (FS) [18], respectively. The two PE exercise modes – intermittent running and the Tunisian traditional game – were performed in the same afternoon between 14:30 and 18:30 in all subjects at a temperature and a relative humidity ranging between 21 and 23°C, and 46 to 51%, respectively.

Measures

Maximal aerobic performance

During the 20-MST (20-m multi-shuttle test) the subjects ran back and forth between 2 parallel lines separated by 20 m. The running speed was dictated from calibrated CD audio beeps. Initial speed was fixed at $8.5 \text{ km}\cdot\text{h}^{-1}$ and increased by $0.5 \text{ km}\cdot\text{h}^{-1}$ every minute until exhaustion. The protocol began without a warm-up since running speed is very low in the first stages of the test, which are considered as an integrated warm-up. The subjects simultaneously performed the test indoor on a wooden floor. Before beginning the 20-MST, the test protocol was thoroughly explained and demonstrated for children who performed it twice and the best performance was recorded for analysis. The two testing sessions were separated by a one-week interval. The test ended when the subject stopped running or when he was unable to reach the line on 3 consecutive occasions (2 m or more from the line). The last completed stage was considered as the Maximal aerobic speed (MAS) of the subject. HR was continuously monitored for all subjects during the test. The HR_{max} was defined as the peak HR measured at the end of the two test sessions. Temperature and relative humidity in the gymnasium during the two sessions ranged between 20 and 22°C and 48 and 52%, respectively.

Assessment of perceived exertion and feeling experienced

In order to evaluate the feeling mood and the rating of perceived exertion (RPE) after each exercise session (Raqassa game or intermittent run), the FS and the CERT scales were used, respectively. Each scale was presented ~15 minutes after the end of each exercise to each

subject being isolated from the rest of the study subjects. The CERT scale is graduated from 1 to 10 (easy to hardest), and each subject had to assess his perception of the effort he performed (Williams et al. [38]). The FS scale is graduated from -5 (displeasure) to +5 (pleasure) [18]. Instructions for using the scales were clearly illustrated and verbally explained by the instructor. Subjects were familiarized with these scales during 4 weeks before the tests for each PE session at school.

Intermittent running exercise

During this intermittent exercise, participants performed a succession of high intensity efforts interspersed by recovery breaks. The subjects had to run at an individualized intensity corresponding to 100% of their MAS on a short specific track according to the disposition described by Gerbeaux and Berthoin [16]. The protocol consisted of 3 sets of 2-min continuous run at 100% of each child’s MAS with 2 minutes of passive recovery in between. Each child had to run the full length of his square lane in 30 s according to his MAS. Every 30 s, the children had to be on the start line again at the sound signal, etc. (Figure 1). For example the theoretical Group 1: (MAS=12 km·h⁻¹) ran 100 m in 30 s along the square. It took 2 minutes to complete 4 laps of the square (Table 1). The assessor was placed at the starting/finishing zone for timing control.

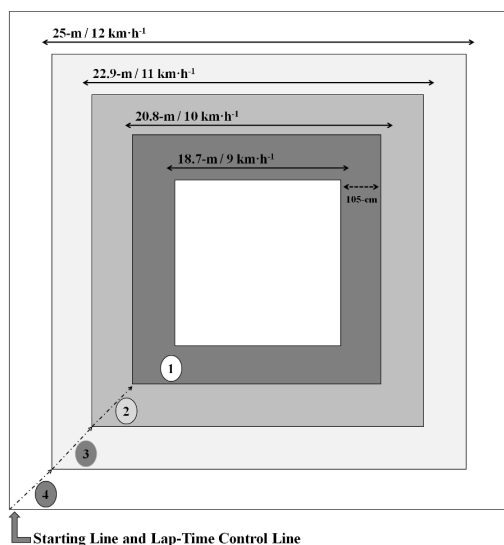


FIG. 1. DIAGRAM OF INTERMITTENT TRAINING CIRCUIT.
 Note: Pupils of different groups take the same-line departure and then run in their respective corridors. They have to complete the square corridor in 30 s, running at 100% of their respective MAS. The whole duration of exercise is 2 min, during which the pupils complete 4 squares’ laps.

TABLE I. DETERMINING THE TRAVELLED DISTANCE BY THE MAS

| Level | To 100% of MAS in 30-s | Length on a side of the square |
|--------------------------------|------------------------|--------------------------------|
| 1 (MAS 12 km·h ⁻¹) | 100 m | 100 ÷ 4= 25m |
| 2 (MAS 11 km·h ⁻¹) | 91.66 m | 91.66 ÷ 4= 22.91m |
| 3 (MAS 10 km·h ⁻¹) | 83.33 m | 83.33 ÷ 4= 20.8m |
| 4 (MAS 9 km·h ⁻¹) | 75 m | 75 ÷ 4= 18.75m |

Note: MAS - maximal aerobic speed

“Raqassa” traditional game

Game directives. The game diagram is shown in Figure 2. During the game, six players were assigned to either “hunters” (n=2) or “hunted” (n=4) who were scattered over a maze measuring 20×15 m. The two “hunters” try to catch the four “hunted” while respecting the maze circuit. The hunted who are touched or who trespass beyond the lines are penalized by one point. The two hunters were randomly appointed by the instructor. They had to count up to ten before beginning the game to allow the hunted to escape from them. It should be noted that the game consisted of 3 sets of 2 minutes of play with 2 minutes of passive recovery in between. At each recovery period hunters/hunted changed role, with three pairs of hunters being designated in advance by the instructor. The main game rules were as follows: The hunter/hunted could not trespass beyond the lines and forbidden zones of the maze to reach/escape each other.

When the hunter touched the hunted he had to keep on running and pursue other hunted boys. In that case, the touched hunted had to escape again from the hunter until the end of the 2-min game period.

The winner is the hunted subject who has accumulated the fewest penalty points.

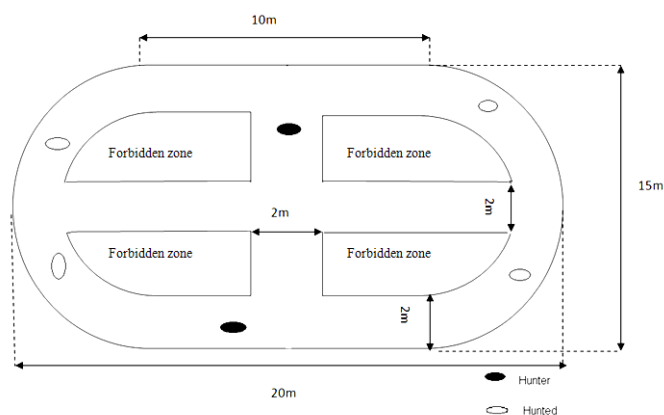


FIG. 2. DIAGRAM OF THE TRADITIONAL “RAQASSA” GAME.

Statistical analysis

Statistical analyses were performed using *Statistica*TM 6 software. The results are given in mean values ± (SD). The normality distribution of the data was checked with the Kolmogorov-Smirnov test. A one-way repeated measures analysis of variance was used to evaluate the differences in means HR, RPE, and FS between “Raqassa” games and intermittent running. A p value ≤ 0.05 was considered as statistically significant.

RESULTS

Mean MAS and HRmax obtained after MST were 12.4±1.58 km·h⁻¹ and 200±4.0 b·min⁻¹, respectively.

HR kinetics during both intermittent runs and “Raqassa game”

During intermittent exercise all subjects performed the six minutes of effort without premature stop (no subject gave up during the ses-

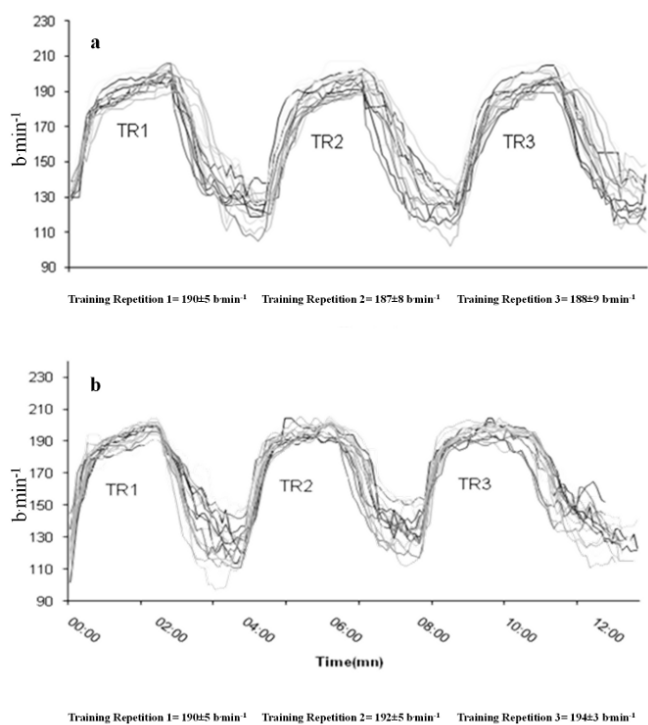


FIG. 3. HEART RATE (HR) DURING INTERMITTENT RUNNING (A) AND “RAQASSA” GAME (B). THE GRAPHIC REPRESENTS THE VARIATION OF HR FOR EACH SUBJECT THROUGHOUT THE DURATION.

sions). The mean HR registered was $188.3 \pm 8.0 b \cdot min^{-1}$, corresponding to 94% of HRmax. The HR kinetics during intermittent exercise is shown in Figure 3. During the “Raquassa” game exercise, mean HR achieved $192 \pm 4.9 b \cdot min^{-1}$, corresponding to 96% of HRmax (Figure 3). The mean HR value during the traditional game was significantly higher than during intermittent exercise ($p < 0.05$, 170 ± 4.8 vs. $166 \pm 4.9 b \cdot min^{-1}$ with $p < 0.05$, Figure 4a). The inter-subject coefficient of variation (CV) was 10.3% and 16.5% for the intermittent exercise and the “Raquassa game”, respectively.

Effort perception

The effort perception assessed by CERT showed a significant difference between the game and intermittent exercise (Figure 4b). The subjects perceived the game as less hard than running exercise (7.7 ± 0.8 vs. 9.1 ± 0.7 , respectively, $p < 0.05$).

Feeling scale

The subjects felt the “Raquassa” game pleasant while intermittent exercise was felt as unpleasant, as shown in Figure 4c. The score of FS was much higher after the game than after intermittent running (-4.4 ± 0.6 vs. $+3.4 \pm 1.5$ with $p < 0.001$, respectively).

DISCUSSION

The aim of this study was to demonstrate that a lesson of physical activity based on a traditional game (Tunisian Raquassa game) could be a useful tool for stimulating the cardiovascular system at the required level for triggering aerobic fitness improvements among school-

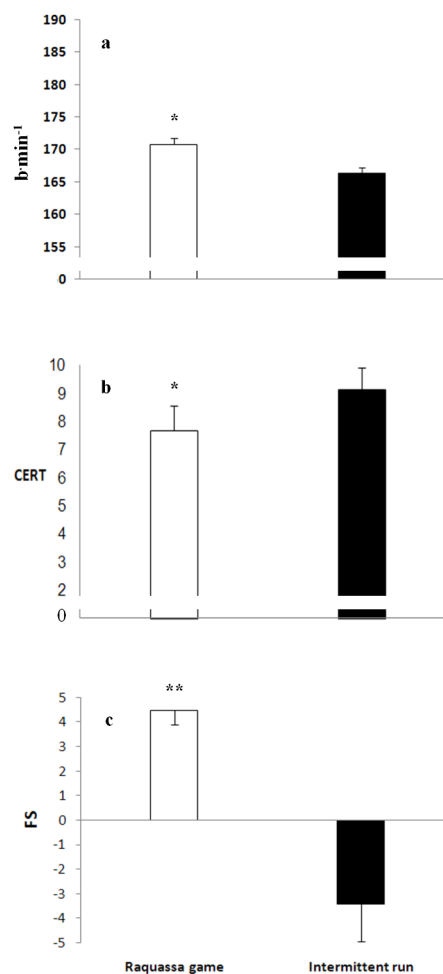


FIG. 4. HEART RATE (A), CERT (B), FEELING (C) DURING THE TWO LESSON MODELS (INTERMITTENT RUNNING VS. RAQASSA GAME). Note: “*” $p < 0.05$ and “**” $p < 0.001$ significant differences.

children. The results show higher HR, better feeling, and lower perception of effort while playing with respect to high intensity intermittent running. The present study results showed that HR responses showed similar kinetics and time course during the two modes of exercise, i.e., the “Raquassa” traditional game and the high intensity intermittent exercise. This is in accordance with previous studies which have highlighted the beneficial effects of games [21]. It has been previously reported that small-sided soccer game training can elicit high exercise intensities ($>90\%$ HRmax) and provide an appropriate stimulus for improvement of aerobic fitness.

In this context, a training intensity of $170/180 b \cdot min^{-1}$ was considered sufficient to allow an improvement of the maximal oxygen uptake ranging from 10 to 15% over a few months of training [26]. Likewise, Baquet et al. reported [6] that increasing aerobic power in children was obtained through relatively high training intensity (i.e. over 75% HRmax). Consequently, mean HR values reported in the present study during “Raquassa game” and the intermittent runs were sufficiently high to solicit the cardiovascular system, especially the game which induced a significantly higher mean HR than the inter-

mittent run (mean HR representing 96 and 94% of HRmax, respectively).

Therefore, it could be interesting to propose games as an alternative option with respect to running during physical education (PE) sessions at school. In this regard, it has been previously reported that mean HR of PE sessions' intensity was usually lower than $150 \text{ b}\cdot\text{min}^{-1}$ [15]. Similar data were obtained in the school environment by Baquet et al. [5]: they tried to introduce at school other modes of intensified training modes that involved a high level of HR response and consequently allowed the pursuit of health objectives [5]. These authors noted that “bound-race” exercises and intermittent race exercises generate the same level of cardio-respiratory stimulation in children aged 11 to 16. This approach encouraging games was also reported by Stratton, who assessed the physical activity (PA) levels of children aged 9 to 15 years [33]. This author showed that during netball and soccer sessions the mean HR reached values exceeding $150 \text{ b}\cdot\text{min}^{-1}$.

The importance and usefulness of games have been widely reported in the last decade especially in team sports such as soccer. However, several authors have raised questions on the physiological and physical involvement for exercises with balls such as small-sided games and specific ball exercises. Mallo and Navarro [25] noted that small-sided games allowed the development of the footballers' (soccer) aerobic capacity; this was also reported by Hill-Haas et al. [19]. Indeed, Balsom et al. measured the training load of players using heart rate monitors, recording HR every 5 seconds during 8 different small-sided games (3 vs. 3) with different work and rest times for each game [4]. It was concluded that the cardiovascular stimulation was high enough to develop or at least maintain the players' level of endurance-fitness. Rampinini et al. [29] also showed that a reduced game of 6 vs. 6 allowed a mean value of 84% of HR max to be reached and that a 3 vs. 3 game allowed a mean value of 91% of HR max to be obtained with a venous blood lactate concentration of $6.5 \text{ mmol}\cdot\text{L}^{-1}$ and an RPE of 7.2 (on a 10-point scale) [29]. In soccer, the main used small-sided games have been proven to reach cardiovascular stimulation that is high enough to develop or maintain relatively high aerobic capacity [20].

On the other hand, specific integrated training under the aspect of ball-dribbling circuit corroborates the present study results. Chamari et al. [11] showed that specific ball exercises (ball dribbling and small sided games in young soccer players over 2 months of training) directly influenced the cardiovascular system and oxygen consumption, inducing an improvement of aerobic capacity with such a training method. In this context, Dellal et al. [14] compared intermittent running and a dribbling circuit in soccer during a period of 8 minutes of exercise each. They found HR responses ranging between 79 and 91% of HRmax, corroborating the present study results. They noted that this intensity allows involvement of the cardiovascular system which is close to that observed during intermittent running as they observed during 30-30 s (work-rest) high intensity intermittent training. The present study children's HR response was less homogeneous

during the “Raqassa” game compared to intermittent running (inter-subject coefficients of variation (CV) = 16.5 vs. 10.3%, respectively). Indeed, the activity of the children was not totally controlled by the staff because the free moves of the children were different depending on their position during the game, the movements of the opponents (hunters/hunted), and their motivation. This is in line with the difference of homogeneity in HR responses between intermittent running and small sided games in soccer as reported by Dellal et al. with intermittent running providing more homogeneous HR responses [13].

As for the “Raqassa” game, the small sided games do not “impose” an exercise pattern. Therefore, depending on the game situations, the subject's motivation and other factors, the exercise intensity can vary from subject to subject, much more than what is observed during monitored intermittent runs. The average intensities for the two modes of intermittent exercise, i.e. running and “Raqassa”, were significantly different with higher HRs for the game mode [$192 \text{ b}\cdot\text{min}^{-1}$ (96% HRmax) vs. $188 \text{ b}\cdot\text{min}^{-1}$ (94% HRmax) with $p < 0.05$]. Hence, cardiac activity would seem to be more important during the game compared to the intermittent in-line running. The “Raqassa” game, in contrast to running, requires psychological concentration and high attention, which could also explain this divergent HR level. In this regard, Borg suggested a significant relationship between perceived difficulty and cardiovascular stimulation [10]. This difference might be explained by the accelerations and changes of direction during the game, but also by the motivation generated by the competition in the game. These results are in accordance with the study of Dellal et al. [11]. In this regard, changes of direction induce an increase in anaerobic metabolism and therefore induce different adaptations than in-line running [14]. Blood lactate concentration and ratings of RPE were different for intermittent exercise in specific shuttle running, which requires 180° directional changes, compared to traditional in-line running. In this context, it is well admitted that continuous running (like the 2-min exercise bouts used in the present study) is a source of monotony and lassitude, which could partly explain this difference between the HR of the games and that of running. The U.S. Department of Health and Human Services recommends exercise and training for the promotion of health [28]. However, games could be an interesting alternative to the more classical and monotonous exercises such as in-line running. This corroborates the statements of Strong et al., who reported that high intensity activities produce better results for health than moderate intensity activities when associated with the children's physical activity, besides a decrease in adiposity and in blood pressure, as well as beneficial effects of physical activity on skeletal health [34]. The traditional game used in the present study provided higher HR intensities than intermittent running and ensured variety of actions for the children. Therefore, the “Raqassa” game studied should allow aerobic training that is equivalent to the intermittent running while having the advantage of being perceived as lighter and being more pleasant for the children.

The CERT scale used to evaluate the children's perception of effort showed significantly lower RPE values for the "Raqassa" game compared to intermittent running, despite higher cardiovascular stimulation as assessed by HR. Usually, the game involves accelerations and changes of direction that are considered as explosive actions [27], generating relatively high fatigue [37]. This might also, on a chronic long-term basis, possibly induce higher muscular adaptations, but this has to be checked by experiment. The game was felt to be less stressful (less perception of effort) than the intermittent effort. This might suggest that the children's environment affects the perception of effort independently of work intensity. The game spontaneously includes active recoveries that are well known for facilitating the clearance of lactate [1]. This might partly explain the low CERT values found during the game compared to running, as it was shown that the RPE was greatly influenced by lactataemia [12]. Nevertheless, as lactate was not measured in the present study, this assumption remains speculative. We assume that one of the present study limits was the absence of lactate measurements due to its invasive character and ethical issues in children.

Nevertheless, HR and RPE are also considered as helpful markers of exercise load assessment [24]. The results also significantly illustrated the influence of the mode of training on the participants' feelings and pleasure/displeasure and showed significantly higher values for the "Raqassa" game with respect to intermittent running. Indeed, pupils provide positive affective feelings after an exercise they enjoy, compared to the activities they dislike [8]. Goudas et al. [17] showed that pupils feel more pleasure doing activities they prefer such as team sports (football and netball) as opposed to

gymnastics, for instance. This difference in preference is better explained by self-determination. Nevertheless, the promotion of brief, intense and intermittent exercises is recommended, due to the spontaneous natural physical effort pattern of the children [7]. Thus, the use of games may be recommended during physical education sessions for school pupils [31]. This approach is in accordance with the findings of Biddle and Chatzisarantis, who recommend pursuit games to maintain the pupils' interest and attention when the objective is the stimulation of the cardiovascular system [9].

CONCLUSIONS

The present study showed higher HR, better feeling, and lower perception of effort during "Raqassa" playing exercise mode than during high intensity intermittent running. Thus, exercising based on this traditional game could be used as an alternative or as an additional method of training during physical education sessions in children. As a perspective, it would be interesting in the future to assess the long-term training effects based on this game mode on the endurance capacity adaptation in schoolchildren. The authors of the present study also encourage other researchers to experiment with other "traditional games" in order to take advantage of their beneficial effects and therefore stimulate physiological functions of the school pupils through amusing games.

Conflicts of interest: There are no conflicts of interest in this paper.

Grant: The present study was financially supported by the "Ministry of Higher Education and Scientific Research", Tunisia.

REFERENCES

- Ahmaidi S., Granier P., Taoutaou Z., Mercier J., Dubouchaud H., Prefaut C. Effects of active recovery on plasma lactate and anaerobic power following repeated intensive exercise. *Med Sci Sports Exerc.* 1996;28:450–456.
- American College of Sport Medicine. Guidelines for Exercises Testing and Prescription. Wolters Kluwer health/ Lippincott Williams & Wilkins, Philadelphia 2010.
- Andersen L.B. Physical activity and physical fitness as protection against premature disease or death. *Scand. J. Med. Sci. Sports* 1995;5:318–328.
- Balsom P.D., Lindholm T., Nilsson B., Ekblom B. Precision Football. Finland: Polar Electro Oy 1999.
- Baquet G., Berthoin S., Van P.E. Are intensified physical education sessions able to elicit heart rate at a sufficient level to promote aerobic fitness in adolescents? *Res. Q. Exerc. Sport* 2002;73:282–288.
- Baquet G., Van P.E., Berthoin S. Endurance training and aerobic fitness in young people. *Sports Med.* 2003;33:1127–1143.
- Baquet G., Gamelin FX, Mucci P, Thevenet D, Van Praagh E, Berthoin S. Continuous vs. interval aerobic training in 8- to 11-year-old children. *J. Strength Cond. Res.* 2010;24:1381–1388.
- Biddle S. Emotion, mood and physical activity. In: Biddle S., Fox K.R., Boutcher S.H. (eds.). *Physical activity and psychological well-being.* Routledge, London 2000;pp.63–87.
- Biddle S., Chatzisarantis N.L.D. Motivation for a physical activity lifestyle through physical education. In: Auweele Y.V., Bakker F., Biddle S.J.H., Durand M., Seiler R. (eds.). *Psychology for physical educators.* Human Kinetics, Champaign, IL 1999;pp.5–26.
- Borg G. A category scale with ratio properties for intermodal and interindividual comparisons. In: Geisler H.G. & Petzold P. (eds.). *Psychophysical judgement and the process of perception.* VEB Deutscher Verlag der Wissenschaft, Berlin 1982;pp.25–34.
- Chamari K., Hachana Y., Kaouech F., Jeddi R., Moussa-Chamari I., Wisloff U. Endurance training and testing with the ball in young elite soccer players. *Br. J. Sports Med.* 2005;39:24–28.
- Coutts A.J., Rampinini E., Marcora S.M., Castagna C., Impellizzeri F.M. Heart rate and blood lactate correlates of perceived exertion during small-sided soccer games. *J. Sci. Med. Sport* 2009;12:79–84.
- Dellal A., Chamari K., Pintus A., Girard O., Cotte T., Keller D. Heart rate responses during small-sided games and short intermittent running training in elite soccer players: a comparative study. *J. Strength Cond. Res.* 2008;22:1449–1457.
- Dellal A., Keller D., Carling C., Chaouachi A., Wong D.P., Chamari K. Physiologic effects of directional changes in intermittent exercise in soccer players. *J. Strength Cond. Res.* 2010;24:3219–3226.
- Gavarry O., Bernard T., Giacomoni M., Seymat M., Euzet J.P., Falgairette G. Continuous heart rate monitoring over 1 week in teenagers aged 11–16 years. *Eur. J. Appl. Physiol. Occup. Physiol.* 1998;77:125–132.

16. Gerbeaux M., Berthoin S. Aptitude et pratique aérobies chez l'enfant et l'adolescent. Presses Universitaires de France – PUF 1999;pp.15–48 (in French).
17. Goudas M., Biddle S., Fox K. Perceived locus of causality, goal orientations, and perceived competence in school physical education classes. *Br. J. Educ. Psychol.* 1994;64(Pt 3):453–463.
18. Hardy C.J., Rejeski W.J. Not what, but how one feels: the measurement of affect during exercise. *J. Sport Exerc. Psychol.* 1989;11:304–317.
19. Hill-Haas S., Coutts A., Rowsell G., Dawson B. Variability of acute physiological responses and performance profiles of youth soccer players in small-sided games. *J. Sci. Med. Sport* 2008;11:487–490.
20. Hill-Haas S.V., Dawson B., Impellizzeri F.M., Coutts A.J. Physiology of small-sided games training in football: a systematic review. *Sports Med.* 2011;41:199–220.
21. Hoff J., Wisloff U., Engen L.C., Kemi O.J., Helgerud J. Soccer specific aerobic endurance training. *Br. J. Sports Med.* 2002;36:218–221.
22. Impellizzeri F.M., Marcora S.M., Castagna C., Reilly T., Sassi A., Iaia F.M., Rampinini E. Physiological and performance effects of generic versus specific aerobic training in soccer players. *Int. J. Sports Med.* 2006;27:483–492.
23. Leger L.A., Lambert J., Goulet A., Rowan C.M., Dinelle Y. Capacité aérobie des Québécois de 6 à 17 ans: Test navette de 20 mètres avec paliers de 1–minute. *Can. J. Appl. Sci.* 1984;9:64–69.
24. Lucia A., Hoyos J., Santalla A., Earnest C., Chicharro J.L. Tour de France versus Vuelta a España: which is harder? *Med. Sci. Sports Exerc.* 2003;35:872–878.
25. Mallo J., Navarro E. Physical load imposed on soccer players during small-sided training games. *J. Sports Med. Phys. Fitness* 2008;48:166–171.
26. Massicotte D.R., Macnab R.B. Cardiorespiratory adaptations to training at specified intensities in children. *Med. Sci. Sports* 1974;6:242–246.
27. Mendez-Villanueva, A., Hamer P., Bishop D. Fatigue in repeated-sprint exercise is related to muscle power factors and reduced neuromuscular activity. *Eur. J. Appl. Phys.* 2008;103:411–419.
28. Physical Activity Guidelines Advisory Committee: Physical Activity Guidelines Advisory Committee Report. In *Physical Activity Guidelines Advisory Committee Report*. U.S. Department of Health and Human Services, Washington DC 2008.
29. Rampinini E., Bishop D., Marcora S.M., Ferrari B.D., Sassi R., Impellizzeri F.M. Validity of simple field tests as indicators of match-related physical performance in top-level professional soccer players. *Int. J. Sports Med.* 2007;28:228–235.
30. Ratel S., Lazaar N., Dore E., Baquet G., Williams C.A., Berthoin S., Van P.E., Bedu M., Duche P. High-intensity intermittent activities at school: controversies and facts. *J. Sports Med. Phys. Fitness* 2004;44:272–280.
31. Sallis J.F., Simons-Morton B.G., Stone E.J., Corbin C.B., Epstein L.H., Faucette N., Iannotti R.J., Killen J.D., Klesges R.C., Petray C.K.. Determinants of physical activity and interventions in youth. *Med. Sci. Sports Exerc.* 1992;24:S248–S257.
32. Simons-Morton, B.G. Implementing health-related physical education. In: Pate, R.R. & Hohn, R.C. (eds), *Health and Fitness Through Physical Education*. Human Kinetics, Champaign, IL 1994; pp.137–146.
33. Stratton G. Children's heart rates during British physical education lessons. *Pediatr Exerc Sci* 1997;16:215–233.
34. Strong W.B., Malina R.M., Blimkie C.J., Daniels S.R., Dishman R.K., Gutin B., Hergenroeder A.C., Must A., Nixon P.A., Pivarnik J.M., Rowland T., Trost S., Trudeau F. Evidence based physical activity for school-age youth. *J. Pediatr.* 2005;146:732–737.
35. Tanner J.M. Sequence and tempo in the somatic changes in puberty. In Grumbach M.M., Grave G.D. & Meyer F.E. (eds.). *The Control of the Onset of Puberty*. John Wiley and Sons, New York 1974.
36. Tomkinson G.R., Leger L.A., Olds T.S., Cazorla G. Secular trends in the performance of children and adolescents (1980–2000): an analysis of 55 studies of the 20m shuttle run test in 11 countries. *Sports Med.* 2003;33:285–300.
37. Thompson, D., Nicholas C.W., Williams C. Muscular soreness following prolonged intermittent high-intensity shuttle running. *J. Sports Sci.* 1999;17:387–395.
38. Williams J.G., Eston R., Furlong B. CERT: a perceived exertion scale for young children. *Percept Mot. Skills* 1994;79:1451–1458.
39. Zwiren L.D. Exercise prescription for children. In: Blair, SN, Painter, P. (eds.). *Resource manual for Guidelines for Exercise Testing and Prescription*. Lea and Febiger, Philadelphia 1988;pp.309–314.