Open Access Journal of Sports Medicine

Dovepress
open access to scientific and medical research

Open Access Full Text Article

ORIGINAL RESEARCH

Small-Sided Games are More Enjoyable Than High-Intensity Interval Training of Similar Exercise Intensity in Soccer

This article was published in the following Dove Press journal:
Open Access Journal of Sports Medicine

Okba Selmi[1,2]
Ibrahim Ouergui[1]
Danielle E Levitt[3,4]
Pantelis T Nikolaidis[5]
Beat Knechtle[6]
Anissa Bouassida[1]

[1]Research Unit, Sportive Performance and Physical Rehabilitation, High Institute of Sports and Physical Education of Kef, University of Jendouba, Kef, Tunisia; [2]High Institute of Sports and Physical Education, Ksar Said, University of Manouba, Tunis, Tunisia; [3]Applied Physiology Laboratory, University of North Texas, Denton, TX, USA; [4]Department of Physiology, School of Medicine, Louisiana State University Health Sciences Center New Orleans, New Orleans, LA, USA; [5]Exercise Physiology Laboratory, Nikaia, Greece; [6]Institute of Primary Care, University of Zurich, Zurich, Switzerland

Introduction: High-intensity interval training (HIIT) and small-sided games (SSG) have been applied and tested for athletes in order to enhance the soccer performance. For this reason, this experimental study aimed to compare the effects of SSGs and HIIT on power, physiological responses and perceived enjoyment.

Materials and Methods: Sixteen youth soccer players (age, 17.5±0.6 years, mean±standard deviation; height, 178.2±6.4 cm; body mass, 70.4±5.4 kg; body fat, 10.6±0.8%) completed one session each of HIIT and SSG on separate days with 1 week between sessions. Each session lasted 25 mins (4x4 mins work with 3 mins of passive recovery in-between). SSGs consisted of 4 versus 4 player games on a 25×35 m pitch, and HIIT consisted of intermittent 15-s runs at 110% maximal aerobic speed separated by 15 s of passive recovery. Psychological responses following each protocol were assessed using the Physical Activity Enjoyment Scale (PACES). Heart rate (HR) was continuously recorded, rating of perceived exertion (RPE) and lactate concentration [La] were measured after each training session. Lower body muscular power was assessed using the 5-jump test relative to leg length (5JT-relative) before and after each training session, where greater average distance per stride over five sequential jumping strides indicated greater muscular power.

Results: HIIT and SSG showed no significant difference in HR, RPE and [La] responses ($p=0.70$, ES=0.11; $p=0.61$, ES=0.08 and $p=0.38$, ES=0.21, respectively). 5JT-relative decreased significantly for SSG and HIIT ($p<0.05$, ES=0.50 and $p<0.05$, ES=0.40, respectively). PACES score was greater in SSG compared to HIIT (ES=5.35, $p<0.001$).

Conclusion: HIIT and SSG sessions induced similar physiological responses; however, SSGs induced a higher enjoyment level than HIIT. Coaches could choose between these training modalities according to the objective of their training session, considering the enjoyment-related advantages of SSGs.

Keywords: aerobic fitness, psychology, motivation, soccer, athletes

Introduction

It is well known that soccer competition stresses aerobic and anaerobic metabolism while demanding high-intensity activity.[1] Several training methods have been included in soccer training regimens to improve aerobic fitness, including high-intensity interval training (HIIT) and small-sided games (SSGs).[2,3] HIIT is an exercise modality alternating short bouts of high-intensity effort with recovery periods.[4] SSGs are soccer games played on smaller fields with fewer players than the 11 versus 11 on the field in competition.[5] Although previous studies have shown that adding HIIT to soccer training regimens can improve cardiorespiratory fitness of players,[6] coaches and

Correspondence: Beat Knechtle
Institute of Primary Care, University of Zurich Medbase St. Gallen Am Vadianplatz, Vadianstrasse 26, St. Gallen 9001, Switzerland
Tel +41 71 226 93 00
Fax +41 71 226 93 01
Email beat.knechtle@hispeed.ch

submit your manuscript | www.dovepress.com
DovePress
http://doi.org/10.2147/OAJSM.S244512

physical trainers use SSGs in order to simultaneously train physiological systems, technical movements, and tactical aspects required during soccer games.[7–10] Selmi et al[11] indicated both SSGs and short intermittent running training (110% of maximal aerobic speed) induced similar lactate concentration, mean heart rate and percentage of maximal heart rate. Moreover, Dellal et al[27] reported that 4 vs 4 SSGs and 10 vs 10 SSGs resulted in the same rating of perceived exertion (RPE) scores as HIIT (l10% of maximal aerobic speed with 15 s of work to 15 s of rest) in elite soccer players. These parameters are important because they provide objective assessments of exercise intensity.

In SSGs, the pitch size, number of players, coach encouragement, bout duration, different game rules, recovery period and the presence of goalkeepers directly impacts the intensity of players' activity.[5,11] The most obvious difference between HIIT and SSGs is the presence of the ball during SSGs, which imposes a soccer-specific challenge allowing for the improvement of technical-tactical skills.[9] Furthermore, a recent study indicates that 4 vs 4 SSG may be used to promote greater motivation and positive mood state when compared to intermittent training (15s/15s) in professional soccer players.[5] Indeed, Toh et al[12] reported that involvement in SSGs (30 min) is expected to increase motivation and improve positive behavior and enjoyment in overweight boys and can elicit desirable physiological responses.

It is thought that in comparison to general physical conditioning, sports-specific exercise training is related to positive affect in soccer players.[5,11] In particular, enjoyment of soccer-specific training has been associated with positive psychological responses to activity and with greater player contribution during training.[13] Enjoyment has been defined as a positive emotional response to a sport practice that reflects generalized feelings such as pleasure, liking, and fun.[14] Likewise, enjoyment is a positive psychological state that leads to perform an activity primarily for its own sake and is associated with positive feeling states.[11,15,16] Several authors concur that enjoyment and pleasure are the key factors which can result in improving exercise motivation[3,11,13] and positive behavior.[17] In contrast to the available knowledge regarding physiological responses to different training methods (ie, HIIT and SSGs), few studies have evaluated the physiological effects of HIIT and SSG.[18] To the knowledge of the authors, no studies have directly compared physical enjoyment of these two training modalities in competitive soccer players and the potential influences of exercise intensity and fatigue. To determine the athlete's enjoyment during exercise training, several self-report questionnaires have been utilized in existing literature.[19,20] Among these tools, the Physical Activity Enjoyment Scale (PACES) is widely used into measuring the degree of enjoyment of individuals during a sport practice.[19] Investigations that have utilized the PACES have evaluated enjoyment as a determinant of training sessions and related motivation.[11,21]

To the knowledge of the authors, no previous study has directly compared physiological responses, muscular power and physical enjoyment of HIIT and SSGs in competitive soccer players. Given the importance of physical enjoyment in athlete motivation and the potential influences of exercise intensity, exertion and muscular fatigue, research to fill this gap in the literature is warranted. Therefore, the aim of this study was to compare the physiological responses, muscular power, and perceived physical enjoyment of HIIT and SSG among youth soccer players during the competitive season. It was hypothesized that the measured physiological responses and muscular power would be similar between both methods of training, whereas SSG would result in greater enjoyment than HIIT.

Methods

Participants

Sixteen male youth soccer players competing in the first Tunisian national league took part in the study (mean ± SD: age = 17.5 ± 0.6 years, height = 178.2 ± 6.4 cm, body mass = 70.4 ± 5.4 kg and body fat = 10.6 ± 0.8%). All players had a minimum of 6 years of experience in competitive soccer. For their regular training, players participated in five training sessions and in one match per week. Goalkeepers were excluded from the investigation because they did not participate in the same physical training program as all other players. The participants were familiar with all protocol procedures as part of their regular performance assessment program. Participants refrained from additional exercise outside of the study requirements as well as alcohol and caffeine intake for at least 24 h prior to any of the assessment sessions. The study was conducted according to the Declaration of Helsinki and the protocol was fully approved by the research ethics committee of high institute of Sports and physical education of Kef, and according to the ethical standards in sport and exercise science research.[22] All participants provided written informed consent after a researcher provided a detailed explanation of the aims, procedures, and risks involved in the study.

Experimental Design

This study analyzed physiological responses, muscle power, and enjoyment of youth soccer players during both HIIT and SSGs. The study was conducted during the 2016–2017 competitive season (month of April) in Tunisia. The experimentation consisted of four visits on separate days with a 1-week interval between each visit (Figure 1). During the first visit, measurements of height and body mass were performed (OHAUS, Florham Park, NJ) and body fat percentage was calculated and resting heart rate (HR) was taken. During the second visit, maximal heart rate (HRmax) and maximal aerobic speed (MAS) (201.0±4.0 beats.min^{-1} and 17.75±0.90 Km.h^{-1}, respectively) were determined through the progressive field test for the evaluation of maximum aerobic speed (VAMEVAL field test). During the two subsequent visits, HIIT and SSG training sessions were conducted. Participants were assigned to complete either HIIT or SSG during visit 3, and the other training session was completed on visit 4. The order of visits was randomized and counterbalanced such that half of the participants completed HIIT first and the other half completed SSG first. Muscle power was measured before and after each training session and HR was monitored throughout each training session. RPE, a fingertip blood sample and psychological measurements were obtained after each training session. HIIT and SSG sessions were conducted on the same training field (natural grass) and at the same time of day (between 9:00 AM and 10:30 AM) to avoid circadian rhythm variations. Data for each test session were collected by the same physical coach.

Measures

The Progressive Field Test for the Evaluation of Maximum Aerobic Speed (VAMEVAL)

In order to obtain individual HRmax and maximal aerobic speed (MAS), all players performed the VAMEVAL test[23] during the second session. The test was performed on a 200-m outdoor running track using 10 cones placed every 20-m at specific sites of the field following a pre-programmed auditory signal (ie, beep). The speed of the test was initially set at 8 km·h^{-1} and increased subsequently by 0.5 km.h^{-1} every minute until exhaustion.[23] The test was stopped when a subject could no longer maintain the required running speed dictated by the beep for two consecutive occasions or felt that he could not complete the stage. The speed of the last 1-min stage completed by each subject was retained as the player's MAS and the highest average value over 5 s during the test was recorded as VamevalHRmax.

Jump Test

To assess lower body muscular power, the 5-jump test (5JT) was performed 5 mins before and 8 mins after each experimental session (ie, HIIT and SSG). The first

Visits	Measurements	Variables
First visit	HR	• Resting HR
	Anthropometric measurements	• Height (cm) • Body mass (Kg) • % body fat
Second visit	Field test for the evaluation of maximum aerobic speed (VAMEVAL filed test)	• HRmax (beat.min^{-1}) • MAS (Km.h^{-1})
	HIIT and SSG training sessions (order of training session was assigned in a randomized and counter balanced manner)	• %HRmax (beat.min^{-1}) • %HRreserve (beat.min^{-1}) • [La] (mmol.l^{-1})
Third and fourth visits	Lower body muscular power	• 5 jump test relative to leg length (5JT relative)
	Perceptive measurements	• RPE • PACES

Figure 1 Experimental design figure.
Abbreviations: SSG, small-sided game; HIIT, high-intensity interval training; HR, heart rate; MAS, maximal aerobic speed; %HRmax, percentage of maximal heart rate; % HRreserve, percentage of reserve heart rate; [La], blood lactate concentration; RPE, rating of perceived exertion; PACES, The Physical Activity Enjoyment Scale.

5JT was performed after a 20-mins standardized warm-up (jogging, coordination movements, dynamic stretching, and 4 x 10 m sprints). The 5JT consisted of a 5-jump series of strides. Feet were in line with each other at the start and the end of the fifth jump. Athletes began with legs shoulder-width apart and they performed five horizontal leaping strides. Jumps were executed by raising the knee on one leg (right or left) and jumping with the other in an alternating manner. During the fifth stride, the two legs were brought together to achieve the same position as at the start.[24] The total distance (m) from the beginning to the end of the test divided by 5 indicated average stride, where a longer average stride indicated greater muscular power.[24] 5JT performance was expressed relatively to leg length (5JT-relative). The participants performed two trials separated by a rest period of 2 min with the best retained for analysis. Two minutes of recovery separated the 5JT from the beginning of SSG or HIIT.

Small-Sided Games

Four vs 4 SSG was performed on an outdoor field with natural grass and pitch size of 25 m × 35 m. The SSG duration was strictly controlled (4 bouts of 4 min duration with 3 min of passive recovery in-between) as reported in other investigations.[5,10] The players were asked to perform at maximum effort during the games and to maintain possession of the ball for the longest possible time. During the SSGs, two coaches were around the pitch to provide new balls when necessary to allow continuity of play during the sessions. All SSGs were played without a goalkeeper.

High-Intensity Interval Training

HIIT was performed on an outdoor field with natural grass. Players covered a predetermined distance in 15-s intervals.[25] After each interval, players passively rested for 15 s, and then began the next 15-s interval but ran in the opposite direction.[25] The distance was individualized according to the MAS of each player and corresponded to 110% of their MAS.[26] This task was repeated for 4 bouts of 4 mins with 3 mins of passive rest between bouts.

Measurements of Exercise Intensity

As an objective measure of exercise intensity, HR was measured every 5 s throughout the training sessions (Polar Team2 Pro System; Polar Electro OY). HR data are expressed both as percentage of HRmax (%HRmax) and HRreserve (%HRreserve). The average HR (HR_{mean}) for each of the training sessions (ie, HIIT and SSG) was calculated. The %HRmax for each form of training was calculated by the following formula:

$$\%\text{HRmax} = \frac{\text{HRmean}}{\text{HRmax}}.100$$

The %HRreserve was calculated by the following formula:[27]

$$\%\text{HRreserve} = \frac{\text{HRmean} - \text{HRrest}}{\text{HRmax} - \text{HRrest}}.100$$

As another objective indicator of exercise intensity, blood samples were collected from the fingertip 3 mins after each experimental session (HIIT and SSG), and blood lactate concentration [La] was measured using the Lactate Pro Analyzer (Arkray, Tokyo, Japan).[28] As a subjective measure of exercise intensity, all athletes indicated their RPE (Borg's CR-10 scale)[29] at the end of the last bout of HIIT and SSG.

Physical Activity Enjoyment Scale (PACES)

Five minutes after last bout of HIIT and SSG, the Physical Activity Enjoyment Scale (PACES)[19] was completed for the assessment of enjoyment. Athletes were asked to rate "how you feel at the moment about the physical activity you have been doing". The inventory contains 18 items rated on a 7-point bipolar rating scale. A total of 11 items are reverse scored. An overall enjoyment of physical activity score was generated by summing the individual item scores and this yielded a possible range of 18 through 126. Higher PACES scores reflect greater levels of enjoyment.

Statistical Analyses

Statistical analyses were performed using SPSS version 20 for Windows (SPSS Inc, Chicago, Il, USA). Data are presented as mean ± standard deviation (SD). The normality of distribution was verified using the Kolmogorov–Smirnov test. Paired *t*-tests were used to compare RPE, perceived enjoyment, %HRmax, %HRreserve and [La] between HIIT and SSG. A two-way [exercise type (SSG and HIIT) and time (pre- and post-exercise)] analysis of variance with repeated measures was used to assess differences in the muscular power (5JT-relative). Practical significance was also assessed by calculating the Cohen's *d* effect size.[30] Effect sizes (ES) were considered trivial (0 to 0.20), small (>0.20 to 0.50), medium (>0.50 to 0.80), and large (>0.80).[31] The alpha level of statistical significance was set at $p < 0.05$.

Results

No differences (p>0.05) in %HRmax, %HRreserve, [La] and RPE (Table 1) between HIIT and SSG were observed. In contrast, perceived enjoyment was significantly higher (p<0.001; ES=5.35) after SSG (PACES score=85±6AU) compared to HIIT (PACES score=53±6 AU) (Figure 2).

A significant (p<0.05; ES=0.54) main effect of time was observed for 5JT-relative performance. 5JT-relative decreased significantly from pre- to post-exercise (p<0.05) (Figure 3). However, no main effect of exercise type or exercise type × time interaction effect was observed.

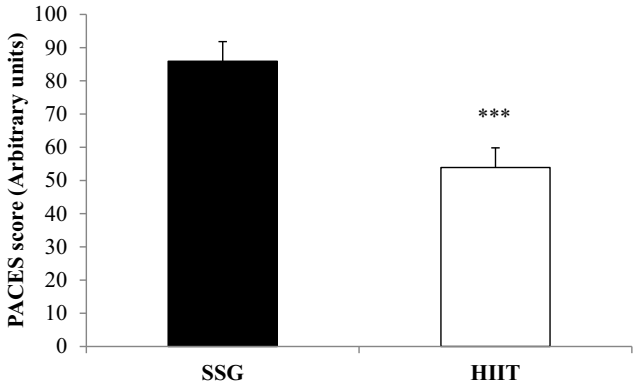

Figure 2 Ratings of physical enjoyment measured by the physical activity enjoyment scale (PACES) after completing the small sided games (SSG) protocol and high-intensity interval training (HIIT) protocol. Mean ± SD. ***Significantly (p<0.001) different from HIIT protocol.

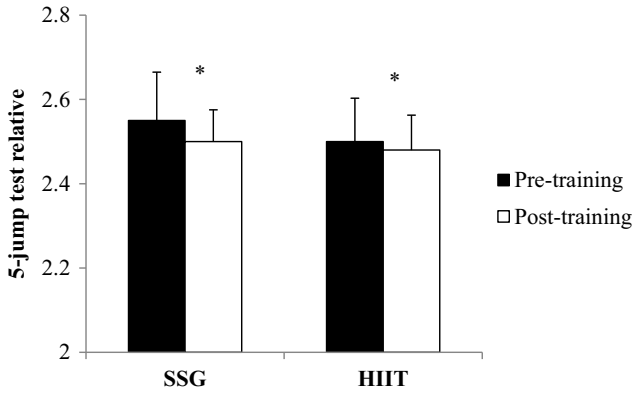

Figure 3 Mean 5-jump test scores relative to leg length measured before (pre-training) and after (post-training) SSG and HIIT training protocols. Mean ± SD. *Significant difference between pre-training and post-training values for each training method.

Discussion

The aim of the present study was to compare physiological responses, changes in muscle power, and enjoyment during HIIT and SSG training protocols among youth soccer players during the competitive season. The results indicate that SSG and HIIT induced similar decreases in lower body muscular power and require players to train at similar intensities (HR values, RPE); however, players indicated greater enjoyment during SSG compared to HIIT.

The two training protocols investigated in this study, HIIT and SSG, elicited HR values above 88% of HRmax and 86% of HR reserve, indicating that both training protocols were cardiovascularly demanding[27] and that players performed both training protocols at a similar high intensity. The cardiovascular demand indicates that both training methods could lead to improvements in aerobic fitness for soccer players.[2,5] This result has been confirmed by Kelly & Drust,[32] who indicated that HIIT produced similar cardiovascular responses as SSG. The present study also showed no significant differences between HIIT and SSG in post-training blood lactate concentrations [La], demonstrating that the energetic contribution by anaerobic metabolism was similar for both training modalities.

Players in the present study rated their perceived exertion similarly for both training modalities, and the average [~7 (very hard)] confirmed that players perceived that they were exerting a high internal intensity of effort for both training sessions. Previously, it was reported that both decreasing the number of players (4 vs 4) and the playing area (35×25 m) resulted in higher RPE.[2] However, another previous study reported that there were no significant differences in RPE scores when comparing 4 vs 4 SSG with 15s-15s HIIT at 110% of MAS among professional soccer players.[27] Altogether, our results combined with those of others demonstrate that competitive soccer

Table 1 Comparison of Measures of Exercise Intensity Between HIIT and SSG

Variables	Training Method	Mean ± SD	p	ES
%HRmax (beat.min^{-1})	HIIT SSG	87.98 ± 2.31 88.23 ± 2.25	0.70	0.11 (trivial)
%HRreserve (beat.min^{-1})	HIIT SSG	83.75 ± 2.28 84.08 ± 3.34	0.74	0.12 (trivial)
[La] (mmol.l^{-1})	HIIT SSG	4.98 ± 0.88 5.20 ± 1.26	0.38	0.21 (small)
RPE	HIIT SSG	7.09 ± 0.98 7.01 ± 1.01	0.61	0.08 (trivial)

Abbreviations: SSG, small-sided game; HIIT, high-intensity interval training; % HRmax, percentage of maximal heart rate; %HRreserve, percentage of reserve heart rate; [La], blood lactate concentration; RPE, ratings of perceived exertion; ES, size effect.

players can achieve similar internal ratings of intensity by performing SSG and HIIT, and further, that subjective exertion does not explain the differences in enjoyment between these two training modalities.

Muscle power, measured using the 5JT, decreased from pre- to post-exercise and was not different between HIIT and SSG, indicating that both forms of training induced similar neuromuscular fatigue. Muscle fatigue and decreased muscular power have previously been reported with repeated bouts of high-intensity efforts, increased blood lactate concentrations, and limited recovery between bouts.[33] Previous studies in young soccer players indicated that 3 vs 3 SSGs produced significant alterations in muscle strength and balance after fatigue.[34] These previous results coupled with reductions in muscle power after exercise observed in this investigation demonstrate that both HIIT and SSG induce muscle fatigue sufficient to decrease muscular power, and that the extent of this decrease is similar between the training modalities.

Overall, the results of this study demonstrated that SSG and HIIT session elicited similar aerobic and anaerobic contributions to energetic demands, perceived exertion, and decreases in lower body muscle power, confirming the comparability of these training forms in the development of soccer players' physical fitness. Such demanding training can allow for players to better cope with the demands of competitive matches.

The participants' PACES scores indicated that SSG was more enjoyable than HIIT. The findings of the present study are consistent with those reported by the study of Los Arcos et al,[3] who also observed that soccer players enjoyed SSG more than HIIT. However, this previous study administered SSG or HIIT over a 6-week training period, suggesting that the differences in enjoyment observed acutely in the present study persist over a longer training period. Similarly, in professional soccer players, HIIT is associated with less enjoyment and with a disturbed mood state, whereas SSG is associated with greater enjoyment and with a stable mood state.[5] In fact, exercise enjoyment and psychological state are consistently positively related.[3,5,11,13,18,35,36] Key differences between HIIT and SSG that could affect enjoyment are ball presence and opponent presence, which mimic the competitive atmosphere during soccer competition. In turn, these differences may be related to the high levels of enjoyment and play level enhancement observed with SSG.[35,37,38] It has also been established that enjoyment is a key predictor of motivation,[3,11] participation,[12] and engagement in training.[12]

This field study was conducted in a real-world training environment with competitive youth soccer players which enhance the applicability of the results for such population. The number of participants in the study is relatively small due to the difficulty in recruiting a large number of homogeneous participants. The experimentation was conducted during the competitive period and utilized only one format of SSG with a single age cohort of soccer players. Future investigations comparing the two training modalities should be conducted during other periods of the sport season use different parameters for SSG (ie, duration of each bout, pitch size, number of players, coach encouragement, different game rules, recovery period, and the presence of goalkeepers) and using soccer players at different levels and ages to extend the applicability of the findings.

This study was conducted in a real-world training environment with competitive soccer players which provide important practical implications. To the best of our knowledge, this study is the first to compare physiological responses, changes in muscle power, and enjoyment of HIIT and SSG in youth soccer players. SSG can be considered soccer-specific training that elicits similar physiological responses and neuromuscular fatigue compared to HIIT but provides greater perceived enjoyment. For that reason, coaches of competitive youth soccer players should consider prioritizing the implementation of carefully designed SSGs over HIIT in their athletes' training programs.

Conclusions

HIIT and SSG sessions induced similar physiological responses; however, SSGs induced higher enjoyment level than HIIT. Coaches could choose between these training modalities according to the objective of their training session, considering the enjoyment-related advantages of SSGs. Future investigations comparing SSGs and HIIT should be conducted during other periods of the sport season, altering different parameters of the game (eg, duration of the game, pitch size, number of players, coach encouragement, game rules change, recovery period) and using soccer players with different levels, sex and age categories to extend the applicability of the findings.

Acknowledgments

The authors thanks all soccer players who participated in this study.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Aguiar MV, Botelho GM, Gonçalves BS, Sampaio JE. Physiological responses and activity profiles of football small-sided games. *J Strength Cond Res*. 2013;27(5):1287–1294. doi:10.1519/JSC.0b013e318267a35c
2. Alexandre D, Da Silva CD, Hill-Haas S, et al. Heart rate monitoring in soccer: interest and limits during competitive match play and training, practical application. *J Strength Cond Res*. 2012;26(10):2890–2906. doi:10.1519/JSC.0b013e3182429ac7
3. Los Arcos A, Vázquez JS, Martín J, et al. Effects of small-sided games vs. interval training in aerobic fitness and physical enjoyment in young elite soccer players. *PLoS One*. 2015;10(9):e0137224. doi:10.1371/journal.pone.0137224
4. Laursen PB, Jenkins DG. The scientific basis for high-intensity interval training. *Sports Med*. 2002;32(1):53–73. doi:10.2165/00007256-200232010-00003
5. Selmi O, Haddad M, Majed L, Ben WK, Hamza M, Chamari K. Soccer training: high-intensity interval training is mood disturbing while small sided games ensure mood balance. *J Sports Med Phys Fitness*. 2017;58(7–8):1163–1170.
6. Helgerud J, Høydal K, Wang E, et al. Aerobic high-intensity intervals improve V˙ O2max more than moderate training. *Med Sci Sports Exerc*. 2007;39(4):665–671. doi:10.1249/mss.0b013e3180304570
7. Clemente FM, Wong DP, Martins FML, Mendes RS. Acute effects of the number of players and scoring method on physiological, physical, and technical performance in small-sided soccer games. *Res Sports Med*. 2014;22(4):380–397. doi:10.1080/15438627.2014.951761
8. Dellal A, Jannault R, Lopez-segovia M, Pialoux V. Influence of the numbers of players in the heart rate responses of youth soccer players within 2 vs. 2, 3 vs. 3 and 4 vs. 4 small-sided games. *J Hum Kinet*. 2011;28:107–114. doi:10.2478/v10078-011-0027-8
9. Hill-haas SV, Dawson B, Impellizzeri FM, Coutts AJ. Physiology of small-sided games training in football. *Sports Med*. 2011;41(3):199–220. doi:10.2165/11539740-000000000-00000
10. Rampinini E, Impellizzeri FM, Castagna C, et al. Factors influencing physiological responses to small-sided soccer games. *J Sports Sci*. 2007;25(6):659–666. doi:10.1080/02640410600811858
11. Selmi O, Gonçalves B, Ouergui I, Sampaio J, Bouassida A. Influence of well-being variables and recovery state in physical enjoyment of professional soccer players during small-sided games. *Res Sports Med*. 2018;26(2):199–210.
12. Toh SH, Guelfi KJ, Wong P, Fournier PA. Energy expenditure and enjoyment of small-sided soccer games in overweight boys. *Hum Mov Sci*. 2011;30(3):636–647. doi:10.1016/j.humov.2010.12.001
13. Carraro A, Gobbi E, Ferri I, Benvenuti P, Zanuso S. Enjoyment perception during exercise with aerobic machines. *Percept Mot Skills*. 2014;119(1):146–155. doi:10.2466/29.06.PMS.119c15z3
14. Kimiecik JC, Harris AT. What is enjoyment? A conceptual/definitional analysis with implications for sport and exercise psychology. *J Sport Exerc Psychol*. 1996;18(3):247–263. doi:10.1123/jsep.18.3.247
15. Csíkszentmihályi M. Enjoyment and the quality of life. *Flow*. 1990:43–70.
16. Tsang TW, Kohn MR, Chow CM, Singh MF. Self-perception and attitude toward physical activity in overweight/obese adolescents: the "martial fitness" study. *Res Sports Med*. 2013;21(1):37–51. doi:10.1080/15438627.2012.738444
17. Rhodes RE, Kates A. Can the affective response to exercise predict future motives and physical activity behavior? A systematic review of published evidence. *Ann Behav Med*. 2015;49(5):715–731. doi:10.1007/s12160-015-9704-5
18. Bartlett JD, Close GL, MacLaren DP, Gregson W, Drust B, Morton JP. High-intensity interval running is perceived to be more enjoyable than moderate-intensity continuous exercise: implications for exercise adherence. *J Sports Sci*. 2011;29(6):547–553. doi:10.1080/02640414.2010.545427
19. Kendzierski D, DeCarlo KJ. Physical activity enjoyment scale: two validation studies. *J Sport Exerc Psychol*. 1991;13(1):50–64. doi:10.1123/jsep.13.1.50
20. Stanley DM, Williams SE, Cumming JPreliminary validation of a single-item measure of exercise enjoyment: the exercise enjoyment scale. Journal of Sport & Exercise Psychology; 2009;31,S138–139.
21. Hammami A, Kasmi S, Farinatti P, Fgiri T, Chamari K, Bouhlel E. Blood pressure, heart rate and perceived enjoyment after small-sided soccer games and repeated sprint in untrained healthy adolescents. *Biol Sport*. 2017;3(3):219. doi:10.5114/biolsport.2017.65997
22. Harriss D, Atkinson G. Update–ethical standards in sport and exercise science research. *Int J Sports Med*. 2011;32(11):819–821. doi:10.1055/s-0031-1287829
23. Carminatti LJ, Possamai CA, De Moraes M, et al. Intermittent versus continuous incremental field tests: are maximal variables interchangeable? *J Sports Sci Med*. 2013;12(1):165.
24. Chamari K, Chaouachi A, Hambli M, Kaouech F, Wisløff U, Castagna C. The five-jump test for distance as a field test to assess lower limb explosive power in soccer players. *J Strength Cond Res*. 2008;22(3):944–950. doi:10.1519/JSC.0b013e31816a57c6
25. Dupont G, Blondel N, Berthoin S. Performance for short intermittent runs: active recovery vs. passive recovery. *Eur J Appl Physiol*. 2003;89(6):548–554. doi:10.1007/s00421-003-0834-2
26. Harrison C, Kinugasa T, Gill N, Kilding A. Aerobic fitness for young athletes: combining game-based and high-intensity interval training. *Int J Sports Med*. 2015;94(11):929–934.
27. 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(5):1449–1457. doi:10.1519/JSC.0b013e31817398c6
28. Pyne DB, Boston T, Martin DT, Logan A. Evaluation of the lactate pro blood lactate analyser. *Eur J Appl Physiol*. 2000;82(1–2):112–-116. doi:10.1007/s004210050659
29. Foster C, Florhaug JA, Franklin J, et al. A new approach to monitoring exercise training. *J Strength Cond Res*. 2001;15(1):109–115.
30. Cohen J. A power primer. *Psychol Bull*. 1992;112(1):155. doi:10.1037/0033-2909.112.1.155
31. Hopkins W, Marshall S, Batterham A, Hanin J. Progressive statistics for studies in sports medicine and exercise science. *Medicine & Science in Sports & Exercise*. 2009;41(1):3. doi:10.1249/MSS.0b013e31818cb278
32. Kelly DM, Drust B. The effect of pitch dimensions on heart rate responses and technical demands of small-sided soccer games in elite players. *J Sci Med Sport*. 2009;12(4):475–479. doi:10.1016/j.jsams.2008.01.010
33. Lattier G, Millet G, Martin A, Martin V. Fatigue and recovery after high-intensity exercise part II: recovery interventions. *Int J Sports Med*. 2004;25(7):509–515. doi:10.1055/s-2004-820946
34. Katis A, Kellis E. Effects of small-sided games on physical conditioning and performance in young soccer players. *J Sports Sci Med*. 2009;8(3):374.
35. Aslan A. Cardiovascular responses, perceived exertion and technical actions during small-sided recreational soccer: effects of pitch size and number of players. *J Hum Kinet*. 2013;38:95–105. doi:10.2478/hukin-2013-0049
36. Raedeke TD. The relationship between enjoyment and affective responses to exercise. *J Appl Sport Psychol*. 2007;19(1):105–115. doi:10.1080/10413200601113638
37. Álvarez MS, Balaguer I, Castillo I, Duda JL. Coach autonomy support and quality of sport engagement in young soccer players. *Span J Psychol*. 2009;12(1):138–148. doi:10.1017/S1138741600001554
38. Maltby J, Day L. The relationship between exercise motives and psychological well-being. *J Psychol*. 2001;135(6):651–660. doi:10.1080/00223980109603726