Physiological and psychological effects of a new racket sport in children with and without overweight at primary school

Efectos fisiológicos y psicológicos de un nuevo deporte de raqueta en niños con y sin sobrepeso en la escuela primaria

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Abstract

Literature have shown the positive effects of participation in classical sports on children health. However, innovative ideas are necessary to increase their participation according to motivations and individual needs. The purpose of the present study was to know if a new racket sport of reduced play space provokes similar physiological and psychological effects to traditional sports [basketball (BASKET) and indoor football (FUTSAL)] in children with and without overweight at primary school. A cross-sectional study was developed with 54 children (10.4±0.1 years old; 44.4% with overweight) who participated in one session of 25 minutes of each sport. Physiological [total physical activity (TPA), mean (MHR) and maximum heart rate (MXHR), activity energy expenditure (AEE)] and psychological [rate of perceive exertion (RPE), affect, Results showed that the new racket sport is indicated for overweight children because its physiological and psychological effects are similar to other traditional team sports.

Key words: Spiribol; basketball; futsal; health.

Resumen

La literatura ha demostrado los efectos positivos de la participación en los deportes clásicos sobre la salud de los niños. Sin embargo, se necesitan ideas innovadoras para aumentar su participación de acuerdo con las motivaciones y las necesidades individuales. El propósito del presente estudio fue saber si un nuevo deporte de raqueta de espacio de juego reducido provoca efectos fisiológicos y psicológicos similares a los deportes tradicionales (baloncesto y fútbol sala) en niños con y sin sobrepeso en la escuela primaria. Se desarrolló un estudio transversal con 54 niños (10.4 ± 0.1 años; 44.4% con sobrepeso) que participaron en una sesión de 25 minutos de cada deporte. Se evaluaron los parámetros fisiológicos (actividad física total, frecuencia cardíaca media y máxima, gasto energético de actividad) y psicológicos (tasa de esfuerzo percibido, afecto, disfrute). Los resultados mostraron que el nuevo deporte de raqueta está indicado para niños con sobrepeso porque sus efectos fisiológicos y psicológicos son similares a otros deportes de equipo tradicionales.

Palabras clave: Spiribol; baloncesto: fútbol sala; salud.

Introduction

The physical inactivity in young people is a public health problem (Blair et al., 1989), due to increases the risk of obesity, diabetes and cardiovascular disorders, along with emotional and psychological problems in adulthood (Lee et al., 2012). Achieving a suitable level of physical activity (PA) is essential for physical, cognitive, emotional and social well-being in adults, adolescents, and especially in children (Donnelly et al., 2016). In typically developing children, participation in sports has been proven to be positively correlated to both physical and psychosocial health outcomes (Eime, Young, Harvey, Charity & Payne, 2013). However, only a relatively small proportion of children and adolescents meet the public health recommendations for physical activity (Ellis et al., 2017).

Recently, a systematic reviews and meta-analyses have shown the beneficial effects of participation in classical sports on overall PA level, body composition and metabolic profile in children and youth (Bangsbo et al., 2016; Milanović, Pantelić, Čović, Sporiš & Krustrup, 2015; Milanović et al., 2018). Furthermore, some specific conclusions can be highlighted about the beneficial health effects of participating in traditional sports, particularly team sports, because it looks like that promoting the engagement of children in these activities is a proper tool for the prevention of the overweight and obesity (Castagna, de Sousa, Krustrup & Kirkendall, 2018). Additionally, an expert panel from the 28th European Childhood Obesity Group Congress arrived at the same conclusions in their opinion article ``Could sport be part of pediatric obesity prevention and treatment?´´ (Ring-Dimitriou et al., 2019).

However, the selection of the PA or sports modality to be performed varies according to the motivations related to age and gender. While the health benefits are the main motivation to do PA for adolescents and adults (Costello, Kafchinski, Vrazel & Sullivan, 2011), enjoyment and satisfaction are the main reason for children (Tannehill, MacPhail, Walsh & Woods, 2015). Along with motivational factor, the sociodemographic and socioeconomic factors must take into account. The price of materials and the necessary facilities can limit the possibilities of practice PA for children and institutions with economic disadvantaged (Costello, Kafchinski, Vrazel & Sullivan, 2011). Accordingly, two of the most practiced sports at primary school are BASKET and five-a-side indoor football format; commonly named Futsal (Fakhouri et al., 2014). However, both are more attractive for boys than for girls (Cuberos, Giráldez, Zagalaz, Sánchez & García, 2016) and both have a higher risk of injury compared to divided court sports such as tennis (Pujals, Rubio, Marquez, Sánchez & Barquín, 2016).

Due to these factors, innovative ideas are necessary to increase physical activity in children (Baranowski, 2019), and alternative sport modalities have emerged in recent years. The Spiribol (SBOL) is one of them. The SBOL is a racket sport characterized by a high degree of adaptability to the environment owing to it can be practiced on any surface (asphalt, beach, snow and mountain) and it requires reduced space to practice it (Colado et at., 2017). In addition, the SBOL allows a high degree of participation since it does not require a high technical or tactical ability for its elementary practice (Colado et at., 2017) and the number of players who can participate simultaneously ranges from one to four. Moreover, only a racket, a tennis ball and a central support with a rope (station) are necessary to practice it, therefore the little necessary material and its low cost can facilitate its use (Capitán, Ruíz, Canovas, Imbroda & Candel, 2003). To see more details about the history and the rules of this new sport see annex.

As previously stated, BASKET and FUTSAL are two of the most practiced sports at primary school, and for these reason, several studies show their physiological response in childhood (Abdelkrim, El Fazaa & El Ati, 2007; Barbero-Alvarez, Soto, Barbero-Alvarez & Granda-Vera, 2008; Beato, Impellizzeri, Coratella & Schena, 2016; Krustrup, Dvorak & Bangsbo, 2016; Seabra et al., 2014). Nevertheless there are very few research that show the effects of other alternative sports modalities, as the SBOL, in this educational stage (Griggs, 2011). The evaluation of the heart rate (HR) and the TPA in counts per minute (counts/min) though accelerometer are the most common physiological parameters used to quantify the internal and external load generated by the practice of a sport, both in adults and children (Cuadrado & Grimaldi, 2012; Godard et al., 2016). Nevertheless, to analyze the suitability of the introduction of a new sport in school, it is necessary not only to know its physiological effects, but also to realize the psychological responses it generates in children. At the same time, it would be convenient to know if there are differences by gender and as well as by body composition (with and without overweight) since the needs of one or others may differ. For instance, the optimal sport activities for overweight children can be those that involve a lower RPE for don't get discouraged in the practice (Ekkekakis & Lind, 2006) and an adequate AEE, facilitating the control of body weight. Certainly, it should also provide a sense of enjoyment so that children can consider it an

Table 1. General characteristics of participants.

	Global		Boys		Girls	
	NW (n=32)	OW (n=22)	NW (n=19)	OW (n=11)	NW (n=13)	OW (n=11)
Age (years)	10.2 ± 0.8	10.7 ± 0.8	10.3 ± 0.9	10.6 ± 0.9	10.0 ± 0.7	10.8 ± 0.8
Height (cm)	145.5 ± 6.7	150.1 ± 5.9	146.7 ± 6.3	148.1 ± 6.3	143.6 ± 7.1	153.2 ± 3.9
Weight (Kg)	36.2 ± 5.8	56.4 ± 10.6	36.9 ± 5.2	52.6 ± 8.5	35.2 ± 6.6	62.3 ± 11.4
Fat (%)	15.8 ± 7.3	33.7 ± 7.6	13.8 ± 4.3	31.3 ± 7.5	18.8 ± 9.8	37.5 ± 6.3
BMI (kg/m2)	17.1 ± 1.8	24.9 ± 3.6	17.1 ± 1.7	23.9 ± 2.6	16.9 ± 2.2	26.5 ± 4.6
PAQ-C	3.37 ± 0.8	2.78 ± 0.9	3.42 ± 0.6	3.0 ± 0.7	2.95 ± 1.2	2.66 ± 1.3
MA (sec)	12.5 ± 1.2	16.6 ± 1.2	12.2 ± 0.8	13.5 ± 1.3	13.2 ± 1.4	13.9 ± 1.2

Note. Data are presented as the mean ± standard deviation. BMI: body mass index; PAQ-C: Physical Activity Questionnaire for Older Children MA: motor agility for 4x10 Shuttle run test; NW: normoweight. OW: overweight.

intrinsically attractive and motivating activity (Beato, Impellizzeri, Coratella & Schena, 2016).

Therefore, the purpose of the present study was to compare the physiological and psychological effects of the practice of SBOL with respect to BASKET and FUTSAL in children with and without overweight at primary school. Regarding to the physiological parameters, we hypothesized that (a) SBOL would have similar effects on HR and AEE, especially in overweight children, while it would produce (b) lower TPA in normoweight and overweight children without differences by gender in any of these variables. According to the psychological parameters, we hypothesized that (c) SBOL would produce lower level of RPE than BASKET and FUTSAL and (d) similar levels of affection and enjoyment than both traditional sports, contributing to adequate psychological acceptance.

Methods

Experimental Design and blinding

Study was conducted with an observational cross-sectional methodology in which each participant experienced one trial of the three conditions of the sports analyzed: SBOL, BASKET and FUTSAL. We adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement (Von Elm et al., 2014).

Due to the design of the study, where the participant knows at least the exposure condition, we followed some advice from Parker & Berman (2016), of their chapter "Blinding in Observational Studies" to minimize the potential for bias in the results. In this case, the research staff who performed the data collection were different from those who carried out the data analysis.

Participants

A total of 54 children (22 girls and 32 boys) aged 9 to 11 (10.4±0.1 years old) from a public elementary school (fourth to sixth grade) in Carcaixent, Valencia (Spain) participated in this study across one academic year. The inclusion criteria were as follows: (1) be enrolled in a public elementary school; (2) aged 9–11 years; (3) be able to provide parental consent and child assent. The exclusion criteria were as follows: (1) diagnosis of physical, mental disabilities or acute injuries that would prevent the participant from performing the sports modalities: (2) intake of prescription medications that were expected to alter the results of the study or are incompatible with the exercise practice (e.g., bronchodilators, flu antiviral, antihistamine). The general characteristics of the subjects are presented in table 1.

Before being included in the study, the children's parents or guardians were comprehensively informed about the study purpose and procedures as well as the benefits, risks, and discomfort that might result from participation. Families were also informed that the training sessions would be controlled by the physical education teachers of the school along with the research staff, both with previous experience teaching the modality sports implemented. Students who had the informed consent from signed by their parents or guardians, and who met the eligibility criteria were finally included. The study was designed in accordance with the Helsinki declaration of 1975, revised in 2008, and received the approval of the Ethics Committee of the University of Valencia, Spain (H1460650708672).

Procedures

Three weeks before starting the sports sessions, Physical Activity Questionnaire for Older Children

(PAQ-C) and the 4x10 Shuttle run Test for evaluating general level of PA and motor agility were performed. The results of both tests were used to perform the pairings in the SBOL modality, in order to homogenizing and harmonize the levels of the pairings. The students performed four familiarization sessions of 25 min of SBOL two weeks prior to start the study due to they had never played this sport before, and the lack of practice and knowledge could increase the risk of bias. The assessments of the anthropometric measurements were performed 24 hours before the field registers.

Three supervised sessions (one of each sport) of 25 min of SBOL, BASKET and FUTSAL were recorded in three non-consecutive days (separated by 48 hrs.) during school hours (in physical education classes). All sessions were carried out during April, under standardized conditions and were always conducted in the same outdoor sportive facility (mean temperature between 15°C and 22°C). The order of the sports modalities was randomized as well as the assignation at the different teams in the BASKET and FUTSAL using a computer-generated random permutation procedure. For SBOL, all children played at the same time in pairs (two children / station). In BASKET and FUTSAL, since they can only play ten participants simultaneously (five in each team in both sports), several sessions were necessary to register all the subjects. The participants who played as goalkeepers in the FUTSAL modality were not taken into account since this demarcation is considerably less active than the rest of the players. Each session consisted of a competition between teams (in the case of BASKET or FUTSAL) or between students (in the case of SBOL) during the session (25 minutes) where the team or student who scored more points won. The TPA, HR and the AEE were register during the time the sessions lasted.

The questionnaires of RPE, enjoyment and affection were performed at the end of the sessions in this order, being administered by the same investigator. Before entering the study, each participant was familiarized with all the testing procedures, and all the technicians had previous experience with the tests assessed. The sport and test sessions were always supervised by the same qualified technicians. All participants were asked to maintain their normal daily routines and eating habits.

Assessments protocols

Anthropometric assessments

Height (m) was measured to the nearest 0.1 cm using a portable stadiometer (Leicester Tanita® HR-001, Tanita, IL, USA). Total body weight (kg) and percentage body fat (%) were measured to the nearest 0.1kg using an electrical bioimpedance analyzer (Tanita® model BF-350, Tokyo, Japan). This is a valid and reliable tool [intraclass correlation coefficient (ICC) > 0.99] to assess body composition in children (Gutin et al., 1996). The participants refrained from ingesting solid intake at least two hours before and were advised to wear light clothes and remove shoes and metal items that could disrupt the electrical current during the measurement. Body mass index (BMI) (kilogram per square meter) was calculated by dividing the body mass (in kilogram) by the square of the body height (in meter). The scale proposed by Galache (2008) was used to classify the subjects according to the BMI in subjects with normoweight and overweight.

Total physical activity

The accelerometer output in counts per minute was determined by the accelerometer ActiGraph GT1M (Actigraph, Pensacola, FL, USA). This is a validated objective measure of PA for being used in children and adolescents with an ICC of 0.87 (De Vries, Bakker, Hopman-Rock, Hirasing & van Mechelen, 2006). Each participant wore the accelerometer initialized to collect data in one second epochs and was placed on the anterior superior iliac spine along the anterior axillary line on the non-dominant hip. Average count per minute, an indicator of TPA level, was calculated by first multiplying the count per second by sixty to get (counts·min−1), and then the total activity counts divided by the number of valid minutes (twenty-five min for each sport). Detailed specifications of the monitor and the definition of "counts" as a PA unit of measure and how it is recorded by ActiGraph GT1M were previously published (ActiGraph, 2005).

Heart rate

Physiological performance during sports sessions was assessed on the basis of HR analysis, which was recorded every second using a telemetric device (Polar Team System model H7, Polar Electro Oy, Kempele, Finland). The HR monitors was worn around the chest at the level of the xiphoid process. The MHR and the MXHR were recorded for the final analysis. The HR monitoring is a previously validated method by Goodie, Larkin & Schauss (2000) and has been used in children populations before (Brazendale et at., 2019, Freedson, 1991; Sirard & Pate, 2001). The results of both as expressed in % of the theoretical maximum heart rate.

Activity energy expenditure

The AAE, understood as the energy expended during physical activities (along with basal metabolic rate and

the thermic effect of food, forming the total energy expenditure) (Teske J, Mavanji, 2012) was measured indirectly with a telemetric device (Polar Team System model H7, Polar Electro Oy, Kempele, Finland). AEE is estimated by this device using a mathematical equation based on the assumption of a linear regression between HR and oxygen consumption (VO2) (Hackney, 2016). Despite being an indirect method, is consistent for an individual across a range of activities and age (Hills, Mokhtar & Byrne, 2014) and several works validate it as a useful and accurate tool (Hiilloskorpi, Pasanen, Fogelholm, Laukkanen & Mänttäri, 2003). The results are expressed in consumed kilocalories (Kcal).

Rate of perceived exertion

The Bug and Bag effort rating scale (BABE) (Eston, Parfitt & Shepherd, 2001), was used for evaluating the perceived exertion immediately after the children finished the sports sessions. This scale depicts a cartoon character at various stages of exertion stepping up and down onto a bench whilst carrying a backpack that is progressively loaded with rocks and it's based in the Children's Effort Rating Table (CERT) (Eston, Lamb, Bain, Williams & Williams, 1994). The BABE scale is a valid and reliable (ICC > 0.84) tool for children between seven to eleven years old (Parfitt, Shepherd & Eston, 2007). These scales are characterized by fewer responses, a 1–10 verbally anchored scale and verbal expressions chosen by children as descriptors of exercise exertion. The RPE is a reliable indicator of physical discomfort, has sound psychometric properties, and is strongly correlated with several other physiological measures of exertion (Foster et al., 2001). Two weeks prior to start the evaluation, the children learned to use the scale at the physical education classes to perceive exertion accurately.

Affect

The Feeling Scale was used to measure the affect (Hardy & Rejeski, 1989). The Felling Scale were rated on an 11-point scale: +5, very good; +3, good; +1, fairly good; 0, neutral; –1, fairly bad; –3, bad; and –5, very bad. The scale was used to measure the affective component of exercise: whether the exercise felt pleasant or unpleasant.

Enjoyment

The Physical Activity Enjoyment Scale was used (PACES) to evaluate the enjoyment of the children after the practice of the sports modalities (Motl et al., 2001). The scale consisted of sixteen statements with a 5-point Likert-type answers (1 = "disagree a lot" to 5 = "agree a lot"). A score is computed by calculating the average of the sixteen items. This tool showed a high validity and reliability in elementary school children (Moore et al., 2009).

Physical Activity Questionnaire for Older Children

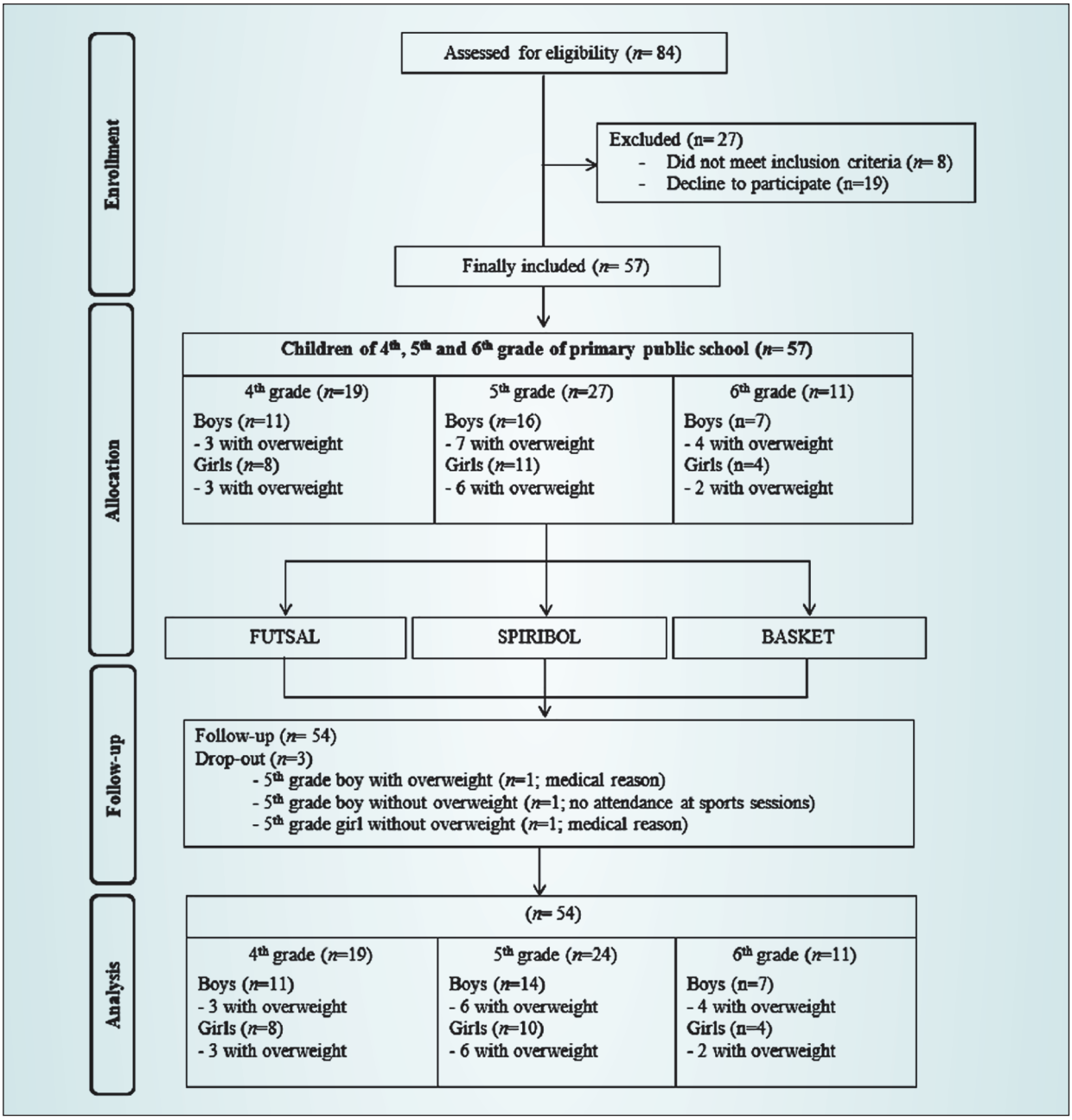
The PAQ-C was used for measure the general PA levels of each participant before starting the sports sessions. The PAQ-C is a self-administered, 7-day recall questionnaire that measure general moderate to vigorous PA levels during the school year. Provides a summary of physical activity score derived from nine items, each scored on a 5-point scale. It is a valid and feasible tool for elementary school-aged children (between 8-14 years old), with levels of test-retest reliability for males and females of 0.75 and 0.82, respectively (Croker, Bailey, Faulkner, Kowalski & McGrath, 1997; Kowalski, Crocker & Faulkner, 1997). Reliability of the test-retest questionnaire of PAQ-C was also tested in spanish population (children aged between 8 and 14 years), with an ICC of 0.83 (Manchola-González, Bagur-Calafat & Girabent-Farrés, 2017).

Motor Agility

The 4x10 Shuttle run test was used to assess the level of motor agility of the participants. Prior to do the test, participants performed two min mobility drills without ballistic movements to warm up. The test was performed according to a previous description (Calatayud et al., 2017). This test is valid and reliable to assess motor fitness and has been included in health fitness battery for children and adolescents (Ruiz et al., 2009).

Statistical analysis

Total sample size was calculated by G*Power software (Version 3.1.9.2) (Faul, Erdfelder, Lang & Buchner, 2007) with an a priori power analysis as follows: (1) two-way analysis of variance (ANOVA; repeated measures, within–between interaction), (2) four groups (boys and girls with and without overweight), (3) type I error = 5%, (4) type II error = 20%, (5) power of the statistical test = 80%, and (6) effect size (ES) = 0.25 according to Cohen's.[14] Using these parameters, the total sample size recommended was 40. Taking into account the participant drop-out, we was aim to recruit 55 participants. Statistical analyses were performed using commercial software (SPSS, Version 22.0; SPSS Inc., Chicago, IL). Homogeneity was verified by the Levene test, and the data distribution was tested with the Kolgomorov-Smirnov test with Lillierfors modification. All data are reported as the means ± the standard deviations.



To compare the variables between groups (gender, weight and sport modality factors), a Kruskal–Wallis test followed by Mann–Whitney U test was used for nonnormally distributed variables (psychological variables). A Wilcoxon signed-rank test was used for data with a non-normal distribution to compare the results within two related samples. An ANOVA repeated measures followed by Bonferroni corrections was performed to determine was used for within- and between-group comparisons for variables with a normal distribution (physiological variables). A 95% confidence level (significance $p \leq 0.05$) was accepted as statistically significant.

Results

Participant flow and demographic characteristics

Details of the participant flow through the study are displayed in figure 1. Finally, study was completed by fifty-four children (thirty-two boys and twenty-two girls) of the fifty-seven initially included. These three students that were excluded of the final analysis was due to injuries or because they not attended at all the sessions. Of the children who completed the study, 44.4% of them were classified with overweight (thirteen boys and eleven girls).

Table 2. Effects on physiological and psychological parameters.

		Global		Boys		Girls	
		NW (n = 32)	OW (n = 22)	NW (n = 19)	OW (n = 11)	NW (n = 13)	OW (n = 11)
TPA (counts/min)	FUTSAL	51.06 ± 2.46*	44.89 ± 3.08*	54.48 ± 2.97*	44.30 ± 3.74§	47.64 ± 3.91*	45.47 ± 4.90*
	BASKET	61.69 ± 2.33	54.48 ± 2.92	63.26 ± 2.82	50.68 ± 3.55§	60.12 ± 3.70	58.29 ± 4.64
	SBOL	33.57 ± 1.71‡	27.08 ± 2.15‡	33.12 ± 2.08‡	25.89 ± 2.61‡§	34.01 ± 2.73‡	28.26 ± 3.42‡
MHR (%)	FUTSAL	81.44 ± 1.62*	80.02 ± 2.03	85.16 ± 1.96	80.75 ± 2.46	77.73 ± 2.57	79.29 ± 3.23*
	BASKET	84.54 ± 1.61	83.14 ± 2.02	86.53 ± 1.95	81.00 ± 2.45	82.55 ± 2.56‡	85.29 ± 3.20
	SBOL	72.50 ± 1.58‡	74.86 ± 1.98*	72.74 ± 1.91*	73.58 ± 2.40*	72.27 ± 2.51	76.14 ± 3.14
MXHR (%)	FUTSAL	94.59 ± 1.38	91.75 ± 1.73	96.26 ± 1.67	93.50 ± 2.10	92.91 ± 2.20	90.00 ± 2.75
	BASKET	95.25 ± 1.25	93.86 ± 1.57	98.05 ± 1.51	92.58 ± 1.90§	92.45 ± 1.99	95.14 ± 2.49
	SBOL	85.08 ± 1.55‡	85.56 ± 1.95‡	84.89 ± 1.88‡	85.83 ± 2.36‡	85.27 ± 2.47‡	85.29 ± 3.09*
AEE (Kcal/min)	FUTSAL	146.37 ± 7.60	175.02 ± 9.53	175.37 ± 9.20	198.33 ± 11.57	117.36 ± 12.09	151.71 ± 15.15
	BASKET	155.49 ± 8.42	188.02 ± 10.57	181.16 ± 10.20	204.75 ± 12.83	129.82 ± 13.40	171.29 ± 16.80
	SBOL	122.12 ± 8.62‡	158.70 ± 10.82	142.79 ± 10.44‡	173.25 ± 13.14	101.45 ± 13.72	144.14 ± 17.20
RPE	FUTSAL	4.25 ± 0.53	4.14 ± 0.55	4.00 ± 0.76	4.85 ± 0.82	4.62 ± 0.69	3.11 ± 0.48
	BASKET	4.61 ± 0.56	4.30 ± 0.59	4.40 ± 0.75	5.00 ± 0.73	4.92 ± 0.85	3.00 ± 0.85
	SBOL	3.12 ± 0.44‡	3.05 ± 0.61	2.95 ± 0.61	3.93 ± 0.81	3.38 ± 0.65	1.50 ± 0.63
Affect	FUTSAL	4.00 ± 0.29	2.86 ± 0.48§	3.89 ± 0.41	2.62 ± 0.66	4.15 ± 0.42	3.22 ± 0.70
	BASKET	2.91 ± 0.57	2.55 ± 0.65	3.20 ± 0.68	1.85 ± 0.91	2.46 ± 1.00	3.86 ± 0.59
	SBOL	3.64 ± 0.37	2.87 ± 0.69	3.65 ± 0.53	2.43 ± 1.04	3.62 ± 0.53	3.62 ± 0.63
Enjoyment	FUTSAL	8.28 ± 0.80	13.09 ± 2.04	7.89 ± 0.98	13.46 ± 2.75	8.85 ± 1.40	12.56 ± 3.19
	BASKET	11.21 ± 1.62	10.90 ± 2.19	10.60 ± 2.05	13.00 ± 3.25	12.15 ± 2.74	7.00 ± 0.76
	SBOL	10.24 ± 1.31	10.55 ± 1.82	10.00 ± 1.62	11.29 ± 2.61	10.62 ± 2.26	9.25 ± 2.20

Note. Data are presented as the mean ± standard deviation. *P ≤ 0.05 statistically difference with respect to basketball; † P ≤ 0.05 statistically difference with respect to futsal; ‡ P ≤ 0.05 statistically difference with respect to the rest of the groups; § P ≤ 0.05 statistically significant difference between normoweight and overweight. TPA: total physical activity; MHR: mean heart rate; MXHR: maximum heart rate; AEE: activity energy expenditure; RPE: rate of perceived exertion; NW: normoweight. OW: overweight.

Total physical activity

In the factor GENDER * WEIGHT * MODALITY, there were not a significant interaction [$F_{(1.7, 76)} = 0.74$, $p > 0.05$, $\eta^2 = 0.02$]. The same happened in the interaction WEIGHT * MODALITY [$F_{(1.7, 76)} = 0.04$, $p > 0.05$, $\eta^2 = 0.00$] and in the in GENDER * MODALITY interaction [$F_{(1.9, 83.9)} = 1.00$, $p > 0.05$, $\eta^2 = 0.02$]. However, there was a significant interaction in the factor MODALITY [$F_{(1.7, 76)} = 103.56$, $p = 0.000$, $\eta^2 = 0.70$]. As it can see in the table 2, the total counts/min was significant lower in SBAL respect to BASKET and FUTSAL in children with ($p < 0.001$ and $p < 0.001$, respectively) and without overweight ($p < 0.001$ and $p < 0.001$, respectively). This same trend was verified when the analysis was performed for each of the subgroups created according to gender and weight ($p < 0.01$ for all the subgroups).

Heart Rate

In the factor GENDER * WEIGHT * MODALITY, there were not a significant interaction in the MHR [$F_{(1.5, 69)} = 0.45$, $p > 0.05$, $\eta^2 = 0.01$] and in the MXHR [$F_{(2, 90)} = 2.22$, $p > 0.05$, $\eta^2 = 0.05$]. The same occurred in the interaction WEIGHT * MODALITY in MHR [$F_{(1.7, 76,3)} = 1.24$, $p > 0.05$, $\eta^2 = 0.03$] and MXHR [$F_{(2, 90)} = 0.97$, $p > 0.05$, $\eta^2 = 0.02$] and in the GENDER*MODALITY interaction with both variables [MHR: $F_{(1,7, 76,2)} = 2.29$, $p > 0.05$, $\eta^2 = 0.05$], [MXHR: $F_{(2, 90)} = 0.99$, $p > 0.05$, $\eta^2 = 0.02$]. Nevertheless, there was a significant interaction in the factor MODALITY in MHR [$F_{(1.5, 69.5)} = 28.48$, $p = 0.000$, $\eta^2 = 0.39$] and in MXHR [$F_{(2, 90)} = 34.82$, $p = 0.000$, $\eta^2 = 0.44$]. In the group without overweight the MHR and MXHR in the SBOL were lower in comparison with BASKET and FUTSAL ($p = 0.000$). In the overweight group, the MXHR in SBOL was lower than FUTSAL and BASKET ($p = 0.006$ and $p = 0.000$, respectively), but the MHR was only lower than BASKET ($p = 0.004$) (table 2). Regarding the analysis by gender and weight, the trends were similar. The MXHR was lower in SBOL, except in the overweight girls where it only differed compared to BASKET ($p = 0.010$). Regarding the MHR in boys, it was lower for the SBOL compared to BASKET ($p = 0.000$), with no differences in girls, although the trend was similar.

Activity energy expenditure

For the AEE, there was a significant interaction only in the factor MODALITY [$F_{(1.4, 62.2)} = 12.40$, $p = 0.000$, $\eta^2 = 0.22$]. In the interactions GENDER * WEIGHT * MODALITY [$F_{(1.3, 57)} = 0.04$, $p > 0.05$, $\eta^2 = 0.00$], WEIGHT * MODALITY [$F_{(1.4, 62.2)} = 0.19$, $p > 0.05$, $\eta^2 = 0.00$] and GENDER * MODALITY [$F_{(1.4, 62.2)} = 0.90$, $p > 0.05$, $\eta^2 = 0.02$] there were not a significant interaction. In the normoweight group, the AEE was lower in the SBOL compared to FUTSAL and BASKET ($p = 0.034$ and $p = 0.003$, respectively). In overweight children, there were no statistically significant differences between any of the sports modalities. Regarding the analysis by gender and weight, the AEE was only significantly lower in the SBOL compared to FUTSAL and BASKET for boys without overweight ($p = 0.016$ and $p = 0.005$, respectively) (table 2).

Rate of perceived exertion

In the general analysis with all the children, the normoweight group showed a significant lower RPE in SBAL with respect to FUTSAL AND BASKET [(Z = -2.23, $p = 0.026$) and (Z = -2.27, $p = 0.023$), respectively] while in overweight students there were not a significant differences [FUTSAL: (Z = -1.34, $p > 0.05$); BASKET: (Z = -1.63, $p > 0.05$)]. Regarding by GENDER and WEIGHT analysis, there were not differences between modalities.

Affect

There were not significant differences between sports modalities in children with [(SBOL vs FUTSAL: Z = -0.06, $p > 0.05$), (SBOL vs BASKET: Z = -0.48, $p > 0.05$), (FUTSAL vs BASKET: Z = -0.93, $p > 0.05$)] and without overweight [(SBOL vs FUTSAL: Z = -0.79, $p > 0.05$), (SBOL vs BASKET: Z = -0.90, $p > 0.05$), (FUTSAL vs BASKET: Z = -1.75, $p > 0.05$)]. Regarding the analysis by gender and weight, there were not differences in any of the groups.

Enjoyment

There were not significant differences between sports modalities in children with [(SBOL vs FUTSAL: Z = -0.17, $p > 0.05$), (SBOL vs BASKET: Z = -0.35, $p > 0.05$), (FUTSAL vs BASKET: Z = -0.80, $p > 0.05$)] and without overweight [(SBOL vs FUTSAL: Z = -0.53, $p > 0.05$), (SBOL vs BASKET: Z = -0.60, $p > 0.05$), (FUTSAL vs BASKET: Z = -1.05, $p > 0.05$)]. Regarding the analysis by gender and weight, there were not differences in any of the groups.

Physical Activity Questionnaire for Older Children and Motor Agility

Results of the PAQ-C and the 4x10 Shuttle Run Test were similar between the students (table 1). The overweight children and girls had lower values in both tests.

Adverse events

No adverse events were reported for any participant during the study.

Discussion

To the best of our knowledge, this study is the first to investigate the physiological and physiological effects of a new sport modality, SBOL, regarding to two traditional team sports, BASKET and FUTSAL, in normoweight and overweight children at primary school. The aim of this study was to analyze this new sport modality as possible alternative in terms of health outcomes (physiological and physiological efficacy) in childhood, especially in children with overweight. The main and novel finding of the present study was that SBOL produces similar levels of AEE in children (boys and girls) with overweight than BASKET and FUTSAL, all this in addition with lower RPE and similar levels of affect and enjoyment. Furthermore, despite being slightly but significantly lower the MHR and MXHR in the SBOL, was the only sport modality in which boys and girls with overweight maintain a greater MHR and MXHR than those who don't have overweight.

As we hypothesized, our findings confirm that the SBOL showed lower levels of TPA than BASKET and FUTSAL. This result may be explained mainly because the practice of SBOL occurs in a smaller field ($6m^2$) than FUTSAL (800 m^2; 20 x40m) and BASKET (420 m^2; 15m width * 28m length). In SBOL, the players are in constant movement, but this displacement is shorter due to the characteristics of the play (the ball that is caught at the station always moves in a circular manner, and the players don't need to do a big displacements for the transition from attack to defense). However, the SBOL allows both horizontal and vertical displacement, and also explosively, with the relevance that it has for the correct development of bones and neuromuscular system (Baptista, Mil-Homens, Carita, Janz & Sardinha, 2016; Gomez-Bruton, Matute-Llorente, González-Agüero, Casajus & Vicente-Rodriguez, 2017; Larsen et al., 2017; Ondrak & Morgan, 2007). In addition, the SBOL favors the development of motor skill competence due to is a sport that require whole body activity and variable body motion,

with the importance that this entails in the development of the cardiovascular fitness, muscular endurance, muscular strength, and perceived competence (Gao & Wang, 2018; Hands, Larkin, Parker, Straker & Perry, 2009).

Regarding the AEE and HR, we hypothesized that SBOL would have similar effects on HR and AEE, especially in overweight children. This hypothesis was partially confirmed because we found no significant difference between the effects of the sports modalities on the AEE in the overweight children, and without differences by gender. However, in the HR, the MXHR were significantly higher in BASKET and FUTSAL than SBOL for all the groups (global, by gender and by weight), and similar happened with the MHR [significantly lower in SBOL that both traditional modalities in global normoweight children and a significantly lower than BASKET in global boys (with and without overweigh) and normoweight girls]. According with these results, SBOL is equally efficient in calories consumption for girls and boys with overweight than FUTSAL and BASKET. As knows, the intensity of the practice of PA is related to the energy expenditure (Makaje, Ruangthai, Arkarapanthu & Yoopat, 2012). In this sense, even though the SBOL not require large displacements, the high participation during all time that game lasts, makes that the students are in constant movement, unlike BASKET and FUTSAL, where players with fewer skills can stay more time without participating in the game. Furthermore, hit the ball in the SBOL implies a continue movements of both lower and upper extremities together with the trunk, contributing to greater energy expenditure. Seliger et al. (1973) indicated an AEE of 0.14 kcal/min during tennis practice, a value considerably lower than the one recorded in the present study (5.44 kcal/min). It should be considered that in tennis there are more breaks and interruptions than SBOL (Capitán, Ruíz, Canovas, Imbroda & Candel, 2003). In regards to BASKET and FUTSAL, previous studies with high level athletes showed higher levels of AEE than in the present study (Makaje, Ruangthai, Arkarapanthu & Yoopat, 2012; McArdle, Magel & Kyvallos, 1971). In this respect, it should be noted that AEE depends largely about the skills in sports and, therefore, in children with low levels of sports abilities or with overweight, SBOL can be as effective in caloric consumption as BASKET and FUTSAL.

Although the MXHR was significantly lower in the SBOL than BASKET and FUTSAL for all the groups (global, by gender and by weight), in the MHR when we analyze the overweight group we can see that there are predominantly only differences between SBOL and BASKET. Furthermore, despite being lower the MHR and MXHR in the SBOL, was the only sport modality in which boys and girls with overweight maintain a greater MHR and MXHR than those who don't have overweight. This result confirm that the SBOL could be a good alternative sport modality, especially for children with overweight because maintain a high MHR due to the permanent movement of different segments of the body. In BASKET and FUTSAL the activity in the positional phases of the game are lower compared to the transitions between attack and defense and there are more pauses than in SBOL game. Another possible explanation is that SBOL increase the sport participation of all players. In FUTSAL and BASKET, the participants with fewer skills to play these sports can see their participation diminished by their colleagues or by themselves due to the characteristics of the game. In this sense, the girls, with and without overweight, had less ability in FUTSAL, perhaps this is due to the lower rate of interest that this modality generates in the female gender (Cuberos, Giráldez, Zagalaz, Sánchez & García, 2016), therefore the differences in MHR between SBOL and FUTSAL were not statistically significant.

Overall, the MHR of the subjects practicing SBOL oscillated around 73% of the theoretical MHR (72.5% normoweight and 74.86% overweight), and the MXHR around 85%. These results agree with those obtained in other studies with young people in similar sports, such as paddle and tennis. During the practice of paddle, MHR has been reported between 65% and 75%, and MXHR between 80% and 90% (De Hoyo, Sañudo & Carrasco, 2007), being during tennis practice the MHR of 72% and the MXHR of 96% (Christmass, Richmond, Cable, Arthur & Hartmann, 1998; Torres-Luque, Sanchez-Pay & Moya, 2011). The results of MHR and MXHR in FUTSAL and BASKET for the participants with normoweight are similar with other studies (Abdelkrim, El Fazaa & El Ati, 2007; Barbero-Alvarez, Soto, Barbero-Alvarez & Granda-Vera, 2008; Castagna, D'Ottavio, Vera & Álvarez, 2009; Makaje, Ruangthai, Arkarapanthu & Yoopat, 2012; Matthew & Delextrat, 2009) If we compare the results of these research with the World Recommendations on Physical Activity for Health (World Health Organization, 2010), it can be verified that the three modalities are between the moderate and vigorous intensities. In this way, all of them could be included in a program for the improvement of health in school-aged children.

Regarding to the psychological parameters, the third hypotheses was partially confirmed. SBOL showed significantly lower level of RPE than BASKET and FUTSAL for children without overweight (only

for the general analysis). These results are very consistent with the differences found in the same group (normoweight) on the physiological parameters between SBOL and the others modalities, where the counts/min, MHR, MXHR and AEE were significantly lower in SBOL. However, for the overweight children, there weren't differences between sports modalities, which also coincides with the lower differences found in MHR and with the lack of difference in AEE for the overweight group between SBOL, BASKET and FUTSAL. In this way, the effort made and perceived in the SBOL was quite similar to that made in the other disciplines, possibly because in SBOL the activity was more continuous (beating all the time the tennis ball) and segmental (high involvement of the upper and lower limbs), compared to the other sports in which there could be more interruptions and displacements. The values of RPE in the SBOL obtained in the study are similar to those of tennis (Mendez-Villanueva, Fernandez-Fernandez, Bishop, Fernandez-Garcia & Terrados, 2007; Torres-Luque, Sanchez-Pay & Moya, 2011) while the results obtained in FUTSAL and BASKET are lower than those obtained in other studies with high-level young athletes (Cortis et al., 2011).

Our final hypothesis was that SBOL produces similar levels of affection and enjoyment than both traditional sports. Our findings confirmed this hypothesis, as we found no difference between sports in any of these variables and in any group (general, by gender or by weight). Many authors have argued that "fun" or enjoyment is considered one of the most important reasons that children and adolescents become involved and to continue to participate in physical activity - and a lack of fun or enjoyment is likely to lead them to withdraw (O'Reilly, Tompkins & Gallant, 2001; Salmon, Brown & Hume, 2009). Therefore, this is a very important finding due to the SBOL is a perceived activity by children as fun activity, equal than FUTSAL and BASKET, when usually the team sports show greater potential to generate enjoyment than individual sports (Fairclough, 2003). This result along with the results in affect, contribute to an adequate psychological acceptance of the SBOL, being this aspect even more relevant for children who are overweight or obese and for girls. In this sense, matching players with a similar skill could be important to ensure that positive experience for the students.

In terms of adherence, SBOL is an innovative sport that may contribute to increase PA in overweight children due to the high level of adaptation with the environment and the modifications that the physical educators can do concerning the rules of the game (duration of the match, number of opponents, kind of surface, etc.). Thereby, it is possible to facilitate the participation and the engagement of the child with adiposity, generating enjoyment, fun, self-efficacy, self-esteem, social integration and adherence due to the high adaptability of the SBOL.

Finally, the present investigation has some limitations that must be considered when attempting to draw evidence-based conclusions. The results reported in this experiment are specific to children between 9-11 years old; thus, they should not be extrapolated to other populations. In addition, the analysis based on gender and weight reduces the sample size. The risk of type II error increase in this analysis, therefore, the results should be taken with caution. For this reason, the global analysis has prevailed during most of the article.

Conclusion

The current study provides the first indications that participating in SBOL sport is equal beneficial for primary children (4th to 6th grade) than BASKET and FUTSAL for their physiological (in terms of AEE and MHR) and psychosocial health (in terms of affect and enjoyment), especially for the overweight children. It can be assumed that the benefits of participating in sports are universal for all children. However, the overweight children and girls participate less in competitive and recreational sports compared to their non-overweight peers and boys. For this reason, is essential that physical educator select the most appropriate sport to promote the health and the physical and mental well-being of children. In this sense, SBOL could be a good alternative for improving physical fitness and health in this population during the school hours because most of the barriers for do exercise at this population (low physical capacity, low physical ability and decreased motivation) can possibly be eliminated when this adapted sport is provided. Furthermore, it is convenient to remember that to play SBOL only are necessary 6m^2, a little and cheap material (a station with two racquets and a tennis ball), and not require a high technical or tactical ability for its elementary practice, what allows a high degree of participation. The findings of this study will provide valuable information for other research groups and multidisciplinary health teams that want to improve health levels of children via school-based sport interventions. Further investigation is required to evaluate the effects of this new sport modality in a randomized longitudinal studies, with a large-scale implementation and in other populations (i.e. high school children).

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Annex

To learn more about the practice of Spiribol, visit: *https://www.youtube.com/watch?v=FmoCpXFK1b0_*

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