

ORIGINAL RESEARCH ARTICLE

Open Access



Effect of Different Sports Practice on Sleep Quality and Quality of Life in Children and Adolescents: Randomized Clinical Trial

Camila Cassemiro Rosa¹, William Rodrigues Tebar¹, Crystian Bittencourt Soares Oliveira², Breno Quintella Farah³, Juliano Casonatto⁴, Bruna Thamyres Ciccotti Saraiva¹ and Diego Giulliano Destro Christofaro^{1*} 

Abstract

Background: Sports practice can promote several health benefits in pediatric populations; nonetheless, most of the studies that investigated these benefits are of cross-sectional design. Thus, our objective was to verify the effectiveness of two types of physical activities through sports, judo and ball games (soccer, volleyball, handball, and basketball) on the quality of sleep and life of Brazilian children and adolescents.

Methods: The study is a randomized clinical trial, conducted with 65 participants of both sexes (6–15 years old) in a philanthropic institution in Brazil. The variables investigated were the quality of sleep and life, using the mini-sleep questionnaire and KidsScreen-52 questionnaires (this instrument has a scale ranging from 0 to 100, where 100 is the best value for each domain), respectively. The interventions carried out during 12 weeks (twice a week) were judo and ball games. In the statistical analysis, analysis of variance (ANOVA) for repeated measures was used and the level of statistical significance used was 5%.

Results: Judo ($P=0.032$) and ball games ($P=0.005$) contributed to improving the quality of sleep in the participants. Considering the score of the domains of quality of life, judo and ball games significantly increased the perception of health and physical activity [mean = 6.9 (8.3%) and 8.91 (12.2%) points, respectively], autonomy [mean = 5.81 (7.3%) and 5.00 (6.9%) points], friends and social support (mean = 2.83 (3.8%) and 12.00 (15.9%) points), provocation and bullying [mean = 10.21 (18.1%) and 2.14 (4.1%) points].

Conclusion: It is concluded that both judo and ball games brought benefits to the quality of sleep and life of children and adolescents. Health promotion actions should encourage the increase in sports practice in children and adolescents to improve sleep and quality of life.

Keywords: Physical activity, Motor behavior, Children and adolescents, Sleep quality, Quality of life, Sport

Key Points

- Few randomized clinical trials have been carried out with the aim of verifying possible benefits of different sports practices on the quality of sleep and life in

pediatric populations.

- We observed that both sports modalities (judo and ball games) improved the quality of sleep in children and adolescents participating in this study.
- The results of this study may contribute to the development of health promotion strategies for young people, considering their well-being through the encouragement of sports practice.

*Correspondence: diego.christofaro@unesp.br

¹ Department of Physical Education, School of Technology and Sciences, São Paulo State University (UNESP), Roberto Simonsen Street, n° 305, Presidente Prudente, São Paulo 19060-900, Brazil

Full list of author information is available at the end of the article

Background

Childhood and adolescence are important periods of life for the development of healthy lifestyle habits and important physiological processes that can be carried into adult life [1]. Among these physiological processes is sleep quality, as it is at this stage that major changes occur in the neuromotor and hormonal systems, in which physical rest during sleep is extremely important for child growth and development, as well as changes and physical maturation in adolescents [2]. Therefore, sleep is characterized by a physiological need that influences biological functions, such as organic restoration, energy conservation, and physical and mental balance and when there is an absence or sleep disorders, neurodegenerative diseases develop, interfering in the individual's quality of life [3].

Poor sleep quality can be associated with several problems in children and adolescents, such as fatigue, anxiety, and depression, and can also interfere in the learning and academic performance of these young people [4]. Furthermore, quality of life also tends to be affected, since poor sleep can affect children and adolescents' self-perception of health and social relationships [5]. However, one health promotion action that is low cost and easy to apply and that can be used to improve the quality of sleep and life of children and adolescents is physical activity. In a study conducted with adolescents, it was observed that the quantity of moderate physical activity was associated with better sleep quality [6]. Considering quality of life, [7] a study with 276 Norwegian children observed that physical activity was associated with physical and mental well-being. Another study found that moderate- or high-frequency sports were associated with better quality of life in adolescents [8]. Additionally, high levels of physical exercise, low levels of sedentary behavior, and enough sleep have all been linked to improved mental health in children and adolescents [9–11]. The fact that physical activity, sedentary time, and sleep have been considered individually is worrisome, because research has demonstrated that these three behaviors are interdependent and should be considered together [12, 13].

In this sense, considering different sports among Brazilian children and adolescents, judo is a very popular sport, which has been associated with increases in other health parameters, such as bone mineral density and cardiac autonomic modulation [14, 15]. Due to its characteristics of discipline and promoting greater social interaction, in addition to high energy expenditure and physical conditioning, judo could be related to longer lasting, quality sleep, resulting in greater well-being. Ball sports, which are common in Physical Education classes in Brazilian schools, have been associated with a better body profile. In addition, the effect of ball sports on the

quality of sleep and life of children and adolescents has been reported in other countries [16].

In particular, no study, to our knowledge, has applied a longitudinal design in this field. The majority of studies that investigated the relationship between the practice of physical activity and quality of sleep and life in children and adolescents are cross-sectional [17, 18]. Another factor to be considered is that adjustments in possible confounding variables such as sex, age, and somatic maturation should be considered as potential confounders. Finally, most intervention studies aiming to verify the influences of physical activity on the quality of sleep and life were carried out with adults from developed countries [19, 20].

Therefore, the objective of the present study was to verify the effectiveness of two types of physical activities through sports, judo and ball games (soccer, volleyball, handball, and basketball) in the quality of sleep and life of Brazilian children and adolescents.

Methods

Sample and Design

The present study is a randomized Clinical Trial (Registered in the Clinical Trials platform: NCT03068000), carried out in a philanthropic institution in the city of Presidente Prudente (located in the southeastern region of Brazil). First, there was a meeting with the direction of the philanthropic institution explaining the types of sports practices to be offered to children and adolescents, as well as the evaluations to be carried out and the randomization process. Later, a meeting was held with parents and children and adolescents who were enrolled in this philanthropic institution, explaining that two types of sports practice would be offered, judo and ball games, and the evaluations of the health parameters that would be offered. However, the need for randomization was explained, as it is a scientific project. Both the management and the parents and the children and adolescents agreed with the proposal, and the sports activities offered were included in the activities of the philanthropic institution.

The sample consisted of 85 participants of both sexes, randomized into two groups (42 in judo and 43 in ball games). Sample size calculation was based on a previous study that evaluated the effects of sports on cardiac autonomic modulation (by heart rate variability) in children and adolescents [15]. Therefore, a standard deviation of 4 was used, and sampling power of 80% and significance of 5% were used. The minimum sample size was 62 participants. At the end of the study, 63 participants completed all assessments (judo=29 and ball games=36). This study was approved by the Research Ethics

Committee of Universidade Estadual Paulista (CAAE: 26702414.0.0000.5402).

Inclusion and Exclusion Criteria

As inclusion criteria, participants were required to be regularly enrolled in the philanthropic institution where the study was conducted, be between 6 and 15 years of age, and present a free and informed consent form signed by parents and/or guardians. As exclusion criteria, participants could not be taking any type of medication that would influence the variables evaluated, present any type of orthopedic problem that would prevent the performance of activities, and not be pregnant.

Sample Randomization Process

After data collection at the baseline, the young people who participated in this study were randomly distributed into one of two groups: systematic practice of judo or sports through ball games. The randomization process was carried out by a researcher who was not part of this project (with the objective of blinding the sample allocation process) through a sequence of numbers generated on the website <http://www.randomization.com>.

The sample allocation process was performed secretly with opaque envelopes, sealed and following the numerical sequence of the allocation. In the first session of sports practices, the envelope was opened in front of the participant, informing them which group they belonged to. This whole process is in line with CONSORT

recommendations for randomized clinical trials [21]. The sample distribution flowchart is shown in Fig. 1.

Sports Practice Protocol

Judo

Judo interventions were performed twice a week, lasting 60 min per session. The practice of judo was divided into general exercises, beginning with a warm-up and stretching specific to the sport, which lasted approximately 10 min. After the warm-up, specific exercises for this type of martial art were performed, such as shock absorption, fall cushioning (Ukemi-waza), immobilization techniques (hon-kesa-gatame and tate-shiho-gatame), and projection (o-soto-gari, o-goshi, ashi-guruma, koshi-guruma, tai-otoshi, and others). At the end of the session, a combat simulation (randori) was carried out and a return to calm with relaxation activities.

Ball Games

The alternative practice to judo was called ball games. This type of sports practice consisted of sports which used a ball, including football, volleyball, basketball, and handball. These sports were included because they are common in Physical Education classes in Brazilian schools. The ball games were held twice a week, lasting 60 min per session. On each day of the week, a type of ball sport was performed (example: 1st week of the month: 1st day of the week: football; 2nd day of the week: volleyball; 2nd week of the month: 1st day of the week: handball; and 2nd day of the week: basketball), divided

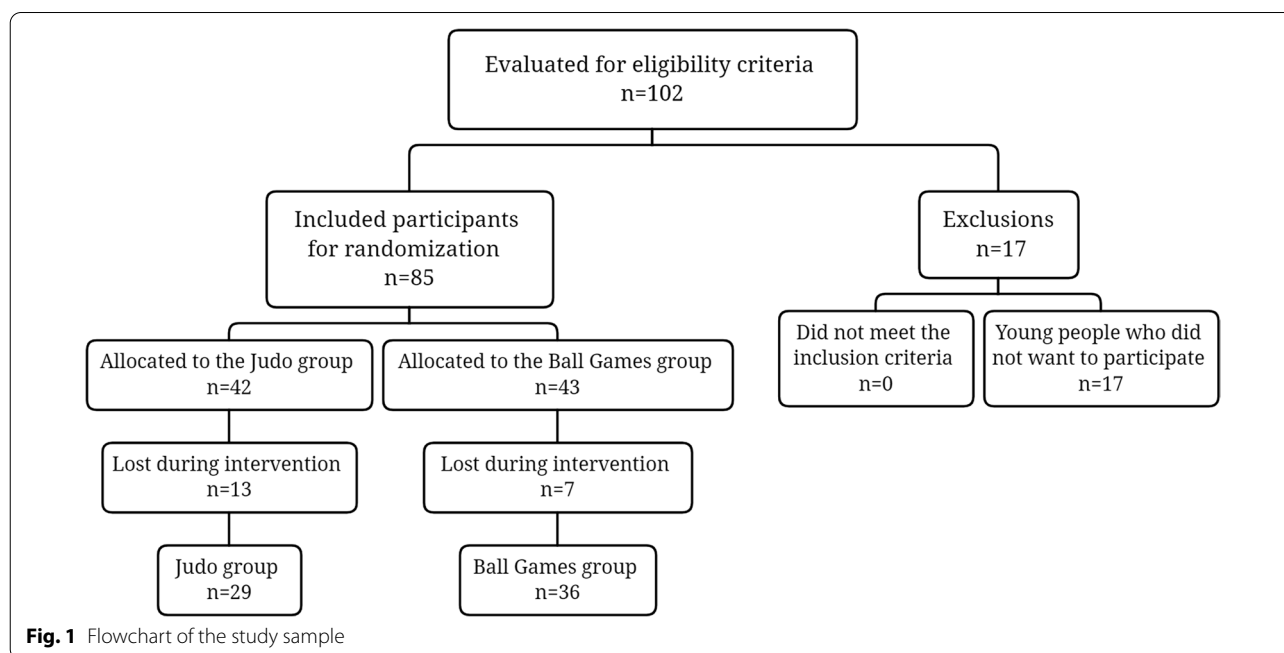


Fig. 1 Flowchart of the study sample

into general exercises, beginning with a warm-up and specific stretching with a ball, for approximately ten minutes. Subsequently, specific exercises of the modality were performed: fundamentals of sport with ball, exercises with ball. At the end of each session, specific games were given for each modality performed in that session, followed by a return to calm with relaxation exercises.

Application of Questionnaires

As the sample of the present study consisted of children aged 6 years and over and adolescents aged up to 15 years, some precautions were taken for the application of the questionnaires. In a classroom provided by the philanthropic institution where the study was carried out, three researchers stayed to apply the questionnaire to a maximum of six children. In case there was any difficulty in understanding the questionnaire by the child, the assessment was carried out face to face.

Sleep Quality

Sleep quality was assessed using the “Mini-Sleep Questionnaire” developed by Zomer et al. [22], which evaluates aspects related to sleep pattern, as well as the frequency with which these aspects can occur. The total score of the scale ranges from 0 to 60, being, respectively: (0–9 points) very good sleep; (10–24) good sleep; (25–27) slightly altered sleep; (28–30) moderately altered sleep; and (over 30) very altered sleep. This instrument has been validated for the Brazilian population [23] and has good reproducibility indices [24].

Quality of Life

Quality of life was assessed using the KIDSCREEN-52 questionnaire. This instrument was developed in European countries to assess the quality of life in young people [25]. The questionnaire consists of 52 questions that are directed to the perception of ten dimensions related to quality of life.

The answers to the questions are attributed on a scale similar to Likert, which varies from one to five points, to assess and identify the frequency of the behavior/feelings, or the intensity of specific attitudes, in the pre- and post-intervention evaluation. The score of each dimension was computed, using a syntax that considers the answers of each group of questions that compose the dimension, with the questions being weighted equally. In the dimensions, the equivalent final scores are recorded on a measurement scale, between 0 and 100, where 0 is the lowest and 100 the highest in relation to the perception of quality of life. This instrument was translated and validated for use in Brazilian children and adolescents [26].

Somatic Maturation

Somatic maturation was used to assess biological development, through the Peak of Growth Velocity (PGV) analysis [27], which uses anthropometric measures of weight, height, and trunk-head height. The formula for females is: $-9.376 + 0.0001882 \times (TL \times TC) + 0.0022 \times (I \times TL) + 0.005841 \times (I \times TL) - 0.002658 \times (I \times W) + 0.07693 \times (W/H)$, where TL corresponds to trunk length, TC to trunk-cephalic height, and W (weight) and H (height). In males, the formula is: $-9.236 + 0.0002708 \times (TL \times TC) - 0.001663 \times (I \times TL) + 0.007216 \times (I \times TC) + 0.02292 \times (W/H)$.

Statistics Analysis

In the statistical analysis, analysis of variance (ANOVA) was used for repeated measures in which the possible differences between the groups were determined. Precision measures for differences between groups were also adopted by presenting the mean and standard deviation values, measures determined by CONSORT to be used in studies of randomized clinical trials. An intention-to-treat analysis was also carried out in which an attempt was made to evaluate all participants at baseline and after the intervention, regardless of their number of absences during the training session, thereby preserving the benefit of the process of randomization [28]. Sex, age, and peak growth velocity were used as adjustment variables for comparison of post- vs. pre-differences according to group (judo vs. ball games). Effect sizes were calculated to estimate the magnitude of differences between groups [29]. The level of statistical significance adopted was 5%. The statistical software used was SPSS (version 15.0).

Results

Eighty-five children/adolescents were randomized, 42 to the judo group and 43 to the ball games group. Of the 85 initially randomized participants, 20 did not complete all sessions or evaluations and were considered to be sample losses (23.5%). Table 1 shows the characteristics of the sample at the baseline moment. No statistically significant differences were observed at baseline in any of the variables investigated.

Figure 2 presents information on the effectiveness of training in the quality of sleep of children and adolescents participating in the project. Significance main effect was observed for time ($P=0.007$), while there was no significant group by time interaction ($P=0.612$). Significant decreases of 2.5 points ($P=0.032$) and 3.6 points ($P=0.005$) in the sleep quality scores for judo and ball games between pre–post-assessments, respectively, demonstrated the benefits of both interventions, since on the scale of the mini-sleep questionnaire, the higher the

Table 1 Characteristic of the sample at baseline

Variables	Judo (n = 42)	Ball games (n = 43)	P
	Male (n = 22)	Male (n = 30)	
	Female (n = 20)	Female (n = 13)	
	Mean (SD)	Mean (SD)	
Age (years)	9.90 (1.56)	9.96 (1.51)	0.885
Weight (kg)	38.81 (14.57)	43.55 (19.60)	0.239
Height (cm)	136.57 (27.01)	141.97 (13.40)	0.278
PGV	-3.44 (1.03)	-3.60 (1.42)	0.655
Sleep quality	24.71 (9.20)	27.02 (10.21)	0.306
<i>Dimensions of quality of life</i>			
Health and Physical Activity	72.07 (25.53)	65.30 (22.84)	0.243
Feelings	76.67 (21.49)	78.79 (26.06)	0.639
Emotional state	45.79 (25.99)	52.00 (15.99)	0.263
Self-perception	48.84 (23.66)	50.57 (26.43)	0.720
Autonomy	71.02 (27.53)	67.05 (19.69)	0.487
Family Environment	78.09 (21.83)	78.80 (18.58)	0.881
Financial Aspect	55.48 (29.71)	47.68 (26.54)	0.239
Friends and Social Support	70.37 (26.98)	64.89 (24.73)	0.384
School environment	73.98 (27.11)	69.27 (26.21)	0.437
Provocation / Bullying	43.80 (32.92)	51.57 (31.10)	0.294

PGV peak of growth velocity. The score for each quality of life domain ranges from 0 to 100

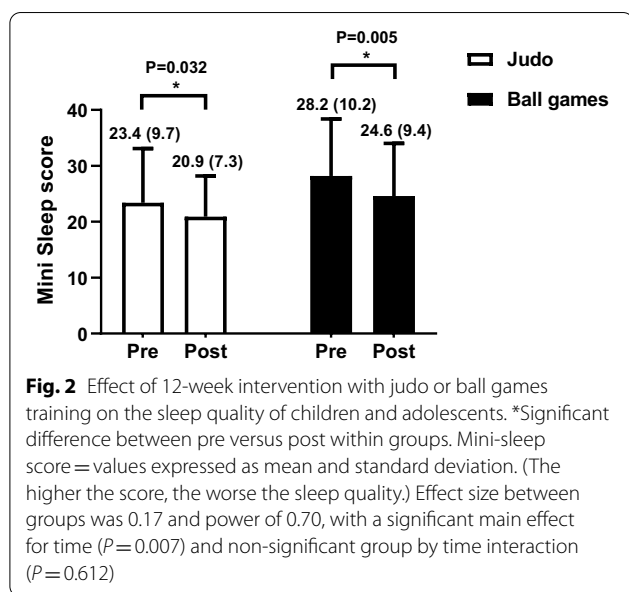


Fig. 2 Effect of 12-week intervention with judo or ball games training on the sleep quality of children and adolescents. *Significant difference between pre versus post within groups. Mini-sleep score = values expressed as mean and standard deviation. (The higher the score, the worse the sleep quality.) Effect size between groups was 0.17 and power of 0.70, with a significant main effect for time ($P=0.007$) and non-significant group by time interaction ($P=0.612$)

score, the worse the quality of sleep. Effect size between groups was 0.17 and power of 0.70. Furthermore, the marginally non-significant main effect for group ($P=0.071$) supports a trend for a moderately better sleep quality in the judo group (good sleep) compared with ball

games (altered sleep) across the whole study period, but with a relatively low effect size.

Table 2 presents information on the effects of three months of training in judo and ball games on the quality of life of children and adolescents. There was a significant improvement in the domain of health and physical activity (power 0.31) over time in both types of training, with 8.3% of increase in judo and 12.2% of increase in ball games group. No significant differences were observed in the quality of life domain of feelings (power 0.05), emotional state (power 0.98), family environment (power 0.17), financial aspects (power 0.41), and school environment (power 0.99) in any of the groups after the intervention. A significant interaction between group and time ($P=0.018$) was observed in the self-perception of children and adolescents (power 0.99), where those who trained ball games decreased the score in 12.7%, while those who trained judo increased the same score in 1.1% ($P=0.009$ for post-vs. pre-difference comparison between group). Considering the autonomy domain (power 0.07), there was improvement in both the judo group (7.3%) and the ball games group (6.9%). In the domain of friends and social support (power 0.99), both training types contributed to improving quality of life, with increases of 3.8% in the judo group and 15.9% in the ball games group. Finally, there were also significant improvements in the domain of provocation/bullying (power 0.99) after the interventions, by increasing 18.1% in judo group and 4.1% in ball games group.

Discussion

The main findings of the present study showed that the practice of different sports (judo and ball games) for 12 weeks was effective in improving the sleep quality of the children and adolescents. Both sports practices were also effective in improving some quality of life domains such as physical activity and health, autonomy, social interaction with friends, and provocation and bullying.

In our study, both types of sports collaborated to improve sleep quality over a 12-week period, with no interaction between the groups, although the effect size was small. A study [30] with German adolescents also observed that leisure sports were associated with better sleep quality in this population. One of the possible reasons for this improvement can be derived from the benefits of sports practice, including changes in neurotransmitters and biochemical processes that could be associated with better sleep quality [31]. Another factor is that sports practice in adolescence was associated with better mental health [32], which could successively contribute to the quality of sleep, since better mental health

Table 2 Effect of 12-week intervention with two types of training on the quality of life of children and adolescents

	Judo (n = 29)	Difference Post versus Pre	Ball games (n = 36)	Difference Post versus Pre	Effect	P
Health and physical activity					Group	0.061
Pre-intervention	76.44 (4.38)	6.89 (3.40)	63.87 (4.23)	8.91 (3.72)	Time	0.002
Post-12-week intervention	83.33 (3.48)	8.3%	72.78 (3.27)	12.2%	Group × Time	0.688
Effect size between groups	0.10					
Feelings					Group	0.179
Pre-intervention	79.13 (4.21)	0.18 (3.68)	77.90 (2.90)	0.22 (3.49)	Time	0.453
Post-12-week intervention	79.31 (4.18)	0.2%	78.12 (2.62)	0.3%	Group × Time	0.190
Effect size between groups	0.01					
Emotional state					Group	0.671
Pre-intervention	48.14 (5.17)	3.04 (2.95)	50.46 (2.91)	− 2.19 (3.41)	Time	0.457
Post-12-week intervention	51.19 (5.62)	5.9%	48.27 (4.53)	− 4.3%	Group × Time	0.080
Effect size between groups	0.29					
Self-perception					Group	0.686
Pre-intervention	48.10 (4.31)	0.52 (4.71)*	50.59 (2.86)	− 6.47 (2.79)*	Time	0.594
Post-12-week intervention	48.61 (3.42)	1.1%	44.12 (2.32)	− 12.7%	Group × Time	0.018
Effect size between groups	0.34					
Autonomy					Group	0.003
Pre-intervention	73.39 (4.85)	5.81 (4.24)	66.91 (3.37)	5.00 (4.23)	Time	0.005
Post-12-week intervention	79.19 (4.00)	7.3%	71.91 (3.32)	6.9%	Group × Time	0.376
Effect size between groups	0.03					
Family Environment					Group	0.328
Pre-intervention	81.40 (4.06)	3.57 (2.60)	77.97 (3.09)	2.38 (3.29)	Time	0.332
Post-12-week intervention	84.97 (3.97)	4.2%	80.36 (3.27)	2.9%	Group × Time	0.597
Effect size between groups	0.07					
Financial Aspect					Group	0.331
Pre-intervention	57.78 (5.40)	0.27 (6.05)	47.22 (4.29)	4.39 (5.82)	Time	0.313
Post-12-week intervention	58.05 (5.19)	0.4%	51.62 (4.59)	8.5%	Group × Time	0.196
Effect size between groups	0.12					
Friends and Social Support					Group	0.202
Pre-intervention	71.00 (5.19)	2.83 (5.04)	63.89 (4.50)	12.08 (5.64)	Time	0.029
Post-12-week intervention	73.81 (4.70)	3.8%	75.97 (3.67)	15.9%	Group × Time	0.692
Effect size between groups	0.30					
School environment					Group	0.179
Pre-intervention	81.32 (3.87)	− 7.33 (3.71)	70.18 (3.95)	0.13 (3.72)	Time	0.410
Post-12-week intervention	73.99 (4.54)	− 9.0%	70.31 (3.61)	0.2%	Group × Time	0.696
Effect size between groups	0.36					
Provocation/Bullying					Group	0.972
Pre-intervention	46.00 (6.41)	10.21 (3.84)	50.24 (5.08)	2.14 (2.71)	Time	0.009
Post-12-week intervention	56.18 (5.75)	18.1%	52.38 (5.34)	4.1%	Group × Time	0.262
Effect size between groups	0.45					

Bold values indicate statistically significant results ($P < 0.05$)

*Statistical significance in analysis of variance adjusted for sex, age, and somatic maturation for comparison of post- versus pre-difference between groups

has been associated with better sleep quality in children and adolescents [33, 34].

Another important finding of our study was to verify the influence of judo and ball games on the quality of life of children and adolescents participating in

the intervention. Judo and ball games (composed of ball sports, soccer, volleyball, handball, and basketball) were chosen because they are a good reflection of popular Brazilian sports. Judo is an Olympic sport with a long tradition in Brazil, and team sports with a

ball are the most commonly played games in Physical Education classes in Brazilian schools. Other studies observed positive results in the quality of life after the intervention through sports practice. Aguilar-Cordero et al. [35], in a clinical trial with obese Spanish children, observed improvements in physical and mental components related to quality of life (using the SF-10 questionnaire). A 22-week intervention in aerobic and resistance training groups of adolescents showed significant increase in quality of life when compared to controls, being quality of life assessed by Pediatric Quality of Life questionnaire [36]. Another intervention using concentric and eccentric cycling training program in obese adolescents showed significant increases in the health-related quality of life scores in both groups after a 12-week period of training, assessed by The Vécu et Santé Percue de l'Adolescent (VSP-A) questionnaire [37]. However, the different modalities, period of interventions, and instruments assessing quality of life precluded broader comparisons with the present study.

In judo, we highlight the positive effects in the domains of self-perception, in which the young people participating in this study presented self-knowledge about issues related to their own personal satisfaction and in relation to their friends and colleagues, and autonomy in which they pointed out the frequency with which they were able to have free time to carry out their activities and freedom to choose what they would do in their free time. One of the reasons for the observed results is perhaps motivated by the characteristic of this sport. Judo is a martial art modality originating in the East, which works on philosophical principles, discipline, self-control, and mental and physical balance [38]. This could contribute to a better perception of young people about themselves, as well helping them to be more autonomous in their choices. On the other hand, ball games could develop greater socialization due to their collective aspect, also contributing to the development of autonomy. This fact may also explain the improvements in timing for the “provocation/bullying” dimension in favor of Judo.

In both modalities, significant increases were observed in the score related to physical activity and health. This dimension measures how children and adolescents consider their physical health to be and their conditions to perform daily activities. A randomized, cluster-controlled clinical trial conducted with school children in Switzerland [39] identified that after three years of a multi-component physical activity program, including sports, the young people showed improvement in aerobic fitness and motor coordination, with increased scores for quality of life mainly in the health domain. Complementing to these findings, another study reported that better

physical fitness was associated with a greater perception of health in children and adolescents [40].

Judo and ball games were also related to better social interaction with friends, considering the domain of friends and social support. This dimension quantifies how often the participants are able to be in the presence of friends and how safe they feel to talk about private matters with them. Improvements were observed in the score of this domain over the three months in both judo and ball games. Similar results were observed by Urzeala et al. [41] in a study with Romanian children with type 1 diabetes who underwent an interdisciplinary health intervention, which included sports. The authors found improvements in social relationships and socializing among friends. Sports practice tends to strengthen interpersonal relationships, as it can promote greater interactions and sharing of ideas among children and adolescents.

Regarding the provocation and bullying dimension, an improvement was observed in the score of both groups. However, this was more evident in children and adolescents who practiced judo; that is, children and adolescents who were threatened or were victims of some discriminatory situation realized that, after the intervention, they felt safer and more confident about negative attitudes from other people [42]. A study investigating more than four thousand Italian adolescents observed that the practice of sports was an ally against bullying, with a reduction in these situations in adolescents who practiced sports and who were victims of bullying [43]. A study with 283 high school students observed that the practices of martial arts promoted benefits in relation to bullying when compared to the control group. The martial arts, especially those of oriental origin include respect, loyalty, and solidarity in their principles [44] and such factors could be responsible for the improvement in this domain of quality of life in the sample of the present study. In ball games, we emphasize that team sports can develop solidarity aspects among the participants, with respect to being part of a team [45].

Considering the dimensions: feelings, which reports and quantifies the intensity with which they feel “important” and satisfied with life, as well as the emotional state, which measures the frequency with which mood changes occur; family environment, which also verifies the frequency of the type of relationship and trust with parents; financial aspects that quantify the financial and economic conditions to carry out activities or buy something they want, and finally; a school environment which measures whether the participants were satisfied with the school environment and their performance, in the present study no significant results were found. One of the hypotheses is that the results

are dependent on these environments; therefore, the family context and the economic conditions in which they are inserted, have a greater influence on the lives of these children and adolescents than the sport itself.

Among the limitations to be considered in this study is the sample loss greater than 15%, considered as one of the qualitative aspects of clinical trial studies. However, we emphasize that the study was carried out in partnership with a philanthropic institution that serves children and adolescents from the periphery and with low socioeconomic conditions, who often have difficulty participating assiduously in the activities. Another factor was the absence of a control group that did not practice sports for comparison purposes with the sports in this study. The sample size calculation was based on a previous study by our group that had cardiovascular indicators as an outcome, which may have affected the power of the analyses. Finally, the absence of assessment of physical activity outside the practice of sports offered in the philanthropic institution and sedentary behavior are possible variables that could influence the results and should be considered as a limitation. Despite this limitation, we emphasize the possible benefits evidenced in the quality of sleep and life in children and adolescents with low economic conditions. Another positive aspect is the randomization of the sample and the longitudinal design of the study, making it possible to verify the cause and effect relationship.

With regard to the practical applicability of this study, although the effect size in most of the indicators was small, we observed that the practice of sports in different modalities, whether collective modalities with a ball or martial arts modalities, is essential for quality of sleep and life for children and adolescents. In this sense, health promotion actions aimed at increasing the quality of sleep and life of children and adolescents must prioritize incentives to practice sports, especially considering several government programs (whether carried out in schools, philanthropic institutions, or public squares).

Conclusions

In summary, judo and ball games were effective in improving the quality of sleep and some life domains of children and adolescents. Health promotion actions for children and adolescents should aim to increase sports practice by young people.

Abbreviations

ANOVA: Analysis of variance; PVC: Peak of growth velocity; TL: Trunk length; TCH: Trunk-cephalic height.

Acknowledgements

The authors thank the members of the Research Group GEAFS (Grupo de Estudos em Atividade Física e Saúde). We gratefully thank all the staff involved in the collection of data.

Authors' contributions

CCR and BTCS contributed to conceptualization; data curation; formal analysis; methodology; and visualization; CCR, CBSO, and DGDC were involved in project administration; CCR, BTCS, and DGDC contributed to methodology; WRT and BQF were involved in investigation; JC and DGDC contributed to formal analysis; DGDC was involved in supervision; and CBSO, WRT, BQF, JC, and DGDC contributed to writing—review and editing. All authors read and approved the final manuscript.

Funding

CCR received a Masters scholarship from the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (Finance Code 001).

Availability of data and materials

Data from this study may be available from the corresponding author on reasonable request.

Declarations

Ethical approval and consent to participate

This study was approved by the Research Ethics Committee of Universidade Estadual Paulista (CAAE: 26702414.0.0000.5402). All procedures are in accordance with the 1964 Helsinki Declaration. All participants gave their consent to participate in the study.

Consent for publication

Not applicable.

Competing interests

CCR, WRT, CBSO, BQF, JC, BTCS, and DGDC declare that they have no potential conflicts of interest that might be relevant to the contents of this manuscript.

Author details

¹Department of Physical Education, School of Technology and Sciences, São Paulo State University (UNESP), Roberto Simonsen Street, n° 305, Presidente Prudente, São Paulo 19060-900, Brazil. ²Universidade do Oeste Paulista (UNOESTE), Presidente Prudente, SP, Brazil. ³Universidade Federal Rural de Pernambuco, Recife, PE, Brazil. ⁴Universidade do Norte do Paraná (UNOPAR), Londrina, PR, Brazil.

Received: 10 August 2021 Accepted: 2 November 2021

Published online: 17 November 2021

References

1. Telama R, Yang X, Viikari J, Välimäki I, Wanne O, Raitakari O. Physical activity from childhood to adulthood: a 21-year tracking study. *Am J Prev Med.* 2005;28(3):267–73. <https://doi.org/10.1016/j.amepre.2004.12.003>.
2. Silva EMB, Simões PAD, Macedo MCSA, Duarte CJ, Silva MD. Parents' perception of the sleep habits and quality of preschool-aged children. *Rev Enferm Ref.* 2018;17(4):63–72.
3. Raman KM. Neurodegenerative disorders and sleep. *Sleep Med Clin.* 2018;13(1):63–70. <https://doi.org/10.1016/j.jsmc.2017.09.006>.
4. Zhang X, Dimitriou D, Halstead EJ. Sleep, anxiety, and academic performance: a study of adolescents from public high schools in China. *Front Psychol.* 2021;12:678839. <https://doi.org/10.3389/fpsyg.2021.678839>.
5. Umlauf MG, Bolland AC, Bolland KA, Tomek S, Bolland JM. The effects of age, gender, hopelessness, and exposure to violence on sleep disorder symptoms and daytime sleepiness among adolescents in impoverished neighborhoods. *J Youth Adolesc.* 2015;44(2):518–42. <https://doi.org/10.1007/s10964-014-0160-5>.
6. Master L, Nye RT, Lee S, Nahmod NG, Mariani S, Hale L, Buxton OM. Bidirectional, daily temporal associations between sleep and physical

- activity in adolescents. *Sci Rep*. 2019;9:1. <https://doi.org/10.1038/s41598-019-44059-9>.
7. Riiser K, Helseth S, Christophersen KA, Haraldstad K. Confirmatory factor analysis of the proxy version of Kidscreen-27 and relationships between health-related quality of life dimensions and body mass index and physical activity in young schoolchildren. *Prev Med Rep*. 2020. <https://doi.org/10.1016/j.pmedr.2020.101210>.
 8. Moeijes J, Van BJT, Wieringa TH, Kone J, Bosscher RJ, Twisk JWR. Characteristics of sports participation and psychosocial health in children: results of cross-sectional study. *Eur J Sport Sci*. 2019;19(3):365–74. <https://doi.org/10.1080/17461391.2018.1510988>.
 9. Poitras VJ, Gray CE, Borghese MM, Carson V, Chaput J-P, Janssen I, et al. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab*. 2016;41(6):S197–239. <https://doi.org/10.1139/apnm-2015-0663>.
 10. Chaput JP, Gray CE, Poitras VJ, Carson V, Gruber R, Olds T, et al. Systematic review of the relationships between sleep duration and health indicators in school-aged children and youth. *Appl Physiol Nutr Metab*. 2016;41(6 Suppl 3):S266–82. <https://doi.org/10.1139/apnm-2015-0627>.
 11. Carson V, Hunter S, Kuzik N, Gray CE, Poitras VJ, Chaput J-P, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth: an update. *Appl Physiol Nutr Metab*. 2016;41(6):S240–65. <https://doi.org/10.1139/apnm-2015-0630>.
 12. Pedišić Ž. Measurement issues and poor adjustments for physical activity and sleep undermine sedentary behaviour research: the focus should shift to the balance between sleep, sedentary behaviour, standing and activity. *Kinesiology*. 2014;46(1):135–46.
 13. Chastin SFM, Palarea-Albaladejo J, Dontje ML, Skelton DA. Combined effects of time spent in physical activity, sedentary behaviors and sleep on obesity and cardio-metabolic health markers: a novel compositional data analysis approach. *PLoS ONE*. 2015;10(10):e0139984. <https://doi.org/10.1371/journal.pone.0139984>.
 14. Costa PC, Franchini E, Saraiva BTC, Gobbo LA, Casonatto J, Fernandes RA, Christofaro DGD. Effect of grappling and striking combat sports on pre-adolescent bone mineral. *Med dello Sport*. 2018;71(1):65–74. <https://doi.org/10.23736/S0025-7826.18.03215-5>.
 15. Suetake VYB, Franchini E, Saraiva BTC, da Silva AKF, Bernardo AFB, Gomes RL, Vanderlei LCM, Christofaro DGD. Effects of 9 months of martial arts training on cardiac autonomic modulation in healthy children and adolescents [Internet]. *Pediatr Exerc Sci*. 2018;30(4):487–94. <https://doi.org/10.1123/pes.2017-0083>.
 16. Glinkowska B, Glinkowski WM. Association of sports and physical activity with obesity among teenagers in Poland. *Int J Occup Med Environ Health*. 2018;31(6):771–82. <https://doi.org/10.13075/ijom.1896.01170>.
 17. Sampasa-Kanyinga H, Colman I, Goldfield GS, Janssen I, Wang J, Podinac I, et al. Combinations of physical activity, sedentary time, and sleep duration and their associations with depressive symptoms and other mental health problems in children and adolescents: a systematic review. *Int J Behav Nutr Phys Act*. 2020;17(1):72.
 18. Wu XY, Han LH, Zhang JH, Luo S, Hu JW, Sun K. The influence of physical activity, sedentary behavior on health-related quality of life among the general population of children and adolescents: a systematic review. *PLoS ONE*. 2017;12(11):e0187668. <https://doi.org/10.1371/journal.pone.0187668>.
 19. Kelley GA, Kelley KS. Exercise and sleep: a systematic review of previous meta-analyses. *J Evid Based Med*. 2017;10(1):26–36. <https://doi.org/10.1111/jebm.12236>.
 20. Marquez DX, Aguiñaga S, Vásquez PM, Conroy DE, Erickson KI, Hillman C, Stillman CM, Ballard RM, Sheppard BB, Petruzzello SJ, King AC, Powell KE. A systematic review of physical activity and quality of life and well-being. *Transl Behav Med*. 2020;10(5):1098–109. <https://doi.org/10.1093/tbm/ibz198>.
 21. Moher D, Schulz KF, Altman D. The CONSORT statement: revised recommendations for improving the quality of reports of parallel-group randomized trials. *BMC Med Res Methodol*. 2001;1:2. <https://doi.org/10.1186/1471-2288-1-2>.
 22. Zomer J, Peled AH, Rubin E, Lavie P. Mini-sleep questionnaire (MSQ) for screening large populations for EDS complaints. In: Koella WP, Rütger E, Schulz H, editors. *Sleep 84*. Stuttgart: Gustav Fischer Verlag; 1985. p. 467–70.
 23. Falavigna A, de Souza Bezerra ML, Teles AR, Kleber FD, Velho MC, et al. Consistency and reliability of the Brazilian Portuguese version of the mini-sleep questionnaire in undergraduate students. *Sleep Breath*. 2011;15(3):351–5. <https://doi.org/10.1007/s11325-010-0392-x>.
 24. Fabbri M, Beracci A, Martoni M, Meneo D, Tonetti L, Natale V. Measuring subjective sleep quality: a review. *Int J Environ Res Public Health*. 2021;18(3):1082. <https://doi.org/10.3390/ijerph18031082>.
 25. Ravens-Sieberer U, Gosch A, Abel T, Auquier P, Bellach BM, Bruil J, Dür W, Power M, Rajmil L, European KIDSCREEN Group. Quality of life in children and adolescents: a European public health perspective. *Soz Präventivmed*. 2001;46(5):294–302. <https://doi.org/10.1007/BF01321080>.
 26. Guedes PD, Guedes PREJ. Translation, cross-cultural adaptation and psychometric properties of the kidscreen-52 for the Brazilian population. *Rev Paul Pediatr*. 2011;29(3):364–437. <https://doi.org/10.1590/S0103-0582011000300010>.
 27. Mirwald RL, Baxter-jones AD, Bailey DA, Beunen GP. An assessment of maturity from anthropometric measurements. *Med Sci Sports Exerc*. 2004;34(4):689–94. <https://doi.org/10.1097/00005768-200204000-00020>.
 28. Montori VM, Guyatt GH. Intention-to-treat principle. *CMAJ*. 2001;165(10):1339–41.
 29. Cohen J. *Statistical power analysis for the behavioral sciences*. Hilldale: Erlbaum; 1988.
 30. Negele L, Flexeder C, Koletzko S, Bauer CP, Von Berg A, Berdel D, Schikowski T, Standl M, Peters A, Schulz H. Association between objectively assessed physical activity and sleep quality in adolescence. Results from the GINIplus and LISA studies. *Sleep Med*. 2020;72:65–74. <https://doi.org/10.1016/j.sleep.2020.03.007>.
 31. Basheer R, Strecker RE, Thakkar MM, McCarley RW. Adenosine and sleep-wake regulation. *Prog Neurobiol*. 2004;73(6):379e96. <https://doi.org/10.1016/j.pneurobio.2004.06.004>.
 32. Appelqvist-Schmidlechner K, Vaara J, Häkkinen A, Vasankari T, Mäkinen J, Mäntysaari M, Kyröläinen H. Relationships between youth sports participation and mental health in young adulthood among Finnish males. *Am J Health Promot*. 2018;32(7):1502–9. <https://doi.org/10.1177/0890117117746336>.
 33. Tafoya SA, Aldrete-Cortez V. The interactive effect of positive mental health and subjective sleep quality on depressive symptoms in high school students. *Behav Sleep Med*. 2019;17(6):818–26. <https://doi.org/10.1080/15402002.2018.1518226>.
 34. Van DTR, Becker SP, Byars KC. Rates of mental health symptoms and associations with self-reported sleep quality and sleep hygiene in adolescents presenting for insomnia treatment. *J Clin Sleep Med*. 2019;15(10):1433–42. <https://doi.org/10.5664/jcsm.7970>.
 35. Aguilar-Cordero MJ, León Ríos XA, Rojas-Carvajal AM, Latorre-García J, Expósito-Ruiz M, Sánchez-López AM. Effects of physical activity on quality of life in overweight and obese children. *Nutr Hosp*. 2021;38(4):736–41.
 36. Goldfield GS, Kenny GP, Alberga AS, et al. Effects of aerobic or resistance training or both on health-related quality of life in youth with obesity: the HEARTY Trial. *Appl Physiol Nutr Metab*. 2017;42(4):361–70.
 37. Julian V, Thivel D, Miguet M, et al. Eccentric cycling training improves health-related quality of life in adolescents with obesity. *Obes Facts*. 2020;13(6):548–59.
 38. Trusz RA, Dell'Aglio DD. The practice of judo and the moral development of children. *Rev Bras Psi Esp*. 2010;3(9):117–35.
 39. Meyer U, Schindler C, Zahner L, Ernst D, Hebestreit H, Mechelen WV, Rocca HPBL, Probst-Hensch N, Puder JJ, Kriemler S. Long-term effect of a school-based physical activity program (KISS) on fitness and adiposity in children: a cluster-randomized controlled trial. *PLoS ONE*. 2014;9:2. <https://doi.org/10.1371/journal.pone.0087929>.
 40. Padilla-Moledo C, Fernández-Santos JD, Izquierdo-Gómez R, Esteban-Cornejo I, Rio-Cozar P, Carbonell-Baeza A, Castro-Piñero J. Physical fitness and self-rated health in children and adolescents: cross-sectional and longitudinal study. *Int J Environ Res Public Health*. 2020;17(7):2413. <https://doi.org/10.3390/ijerph17072413>.
 41. Urzeală C, Bota A, Teodorescu S, Vlaiculescu M, Baker JS, The Kidscreen Group Europe. Quality of life in Romanian children with type 1 diabetes: a cross-sectional survey using an interdisciplinary. *Healthcare (Basel)*. 2020;8(4):382. <https://doi.org/10.3390/healthcare8040382>.
 42. Holbrook HM, Voller F, Castellini G, Silvestri C, Ricca V, Cassioli E, Ivanova MY, Hudziak J. Sport participation moderates association between

- bullying and depressive symptoms in Italian adolescents. *J Affect Disord.* 2020;271:33–8. <https://doi.org/10.1016/j.jad.2020.03.142>.
43. Moore B, Woodcock S, Dudley D. Developing wellbeing through a randomised controlled trial of a martial arts based intervention: an alternative to the anti-bullying approach. *Int J Environ Res Public Health.* 2018;16(1):81. <https://doi.org/10.3390/ijerph16010081>.
44. Santos SG. *Judo: seeking the smooth path*. Florianópolis: Duplic Gráfica e Editora; 2014.
45. Nazareth EF. Action and experience in collective sports. *Braz J Social Sci.* 2015;30(87):59–78.

Publisher's Note

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Submit your manuscript to a SpringerOpen[®] journal and benefit from:

- ▶ Convenient online submission
- ▶ Rigorous peer review
- ▶ Open access: articles freely available online
- ▶ High visibility within the field
- ▶ Retaining the copyright to your article

Submit your next manuscript at ▶ [springeropen.com](https://www.springeropen.com)
