Postural education program for adolescent Basketball athletes: a quasi-experimental study

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Abstract

To evaluate the effects of a postural education program (PEP) regarding body posture, back pain, dynamic balance, and quality of life (QoL) adapted for adolescent athletes. This was a quasi-experimental study with a convenience sample composed of male adolescent basketball athletes. Ten meetings were held, once a week for 90 min. Eight sessions comprised theoretical-practical interventions of PEP; two were pre- and post-intervention assessments and static posture (biophotogrammetry), dynamic balance (Star Excursion Balance Test-Y SEBT) and questionnaires (BackPEI, WHOQOL-bref) were applied. For data analysis, the paired t-test or Wilcoxon's test was used for normal distribution ($p \leq 0.05$). Twelve athletes (mean age:13.9 ± 0.73 years, body mass: 60.04 ± 10.07 kg, height: 1.72 ± 0.06 m, and BMI 20.01 ± 2.63 kg/m2) were included in the study. The postural evaluation presented a statistically significant difference for the frontal angles of the left lower limb (-1.4 °± 2.8° vs. -0.8°± 2.6°), right tibio-tarsal (83.9± 2.5° vs. 85.5± 2.9°), and vertical head alignment in the left side view (15.9 °± 10.2° vs. 7.7°± 10.1°). In the analysis of the presence of self-reported back pain in the three months prior to the assessment, approximately 17% of athletes reported pain, reducing to 8% after PEP. A significant improvement was also observed for normalized relative distances regarding bilateral dynamic balance (right, $p=0.01$ and left, $p=0.02$) and quality of life (psychological domain, $p=0.04$). As a result, PEP was an effective intervention, improving balance, posture and aspects of the quality of life of the adolescent athletes. Similar programs should be used in adolescent athletes in order to improve sports performance and other aspects of daily life, such as items in the psychological domain.

Keywords: Adolescent; Photogrammetry; Basketball; Health education; Back school.

Introduction

Basketball athletes are subjected to intense training with varied movements requiring high levels of endurance. Depending on the intensity of the workout, athletes are more susceptible to traumatic injuries, with the lower limbs and lumbar spine being the most overloaded regions[1,2]. Some compensations related to strength, coordination, balance, and flexibility can arise and influence the growth process, leading to postural changes[1,3]. Postural misalignments and the presence of persistent low back pain in adolescence may have negative effects on physical and social activities, mental health, and quality of life (QoL) as well as become predisposing factors for degenerative conditions of the spine in adulthood[4,5]. The development of postural changes and pain have multifaceted causes, such as the use of heavy backpacks and asymmetric transport[6], long periods in the sitting position, using chairs and tables that are not ergonomically friendly[7], use of electronic devices in inappropriate postures for long periods[8], adopting a stance or posture without maintaining the physiological

curvatures of the spine during the execution of activities of daily life (DLA's)[7,9].

There is a report that biomechanical and anatomical changes such as an increase in the difference in the Q angle, hindfoot valgus, and weight distribution are considered risk factors for lower limb injuries in basketball players[10]. In addition, the degree of postural alteration may generate some inability to perform activities of daily living, further impacting the individual's QoL[11]. In this context, it is important to include postural education programs (PEP) for young athletes to decrease these challenges and to improve the QoL in adolescence, as well as in adulthood[12,13].

The Back School Program (BSP), created by the Swedish physiotherapist Mariane Forssell[14], expanded worldwide and became widely applied as an educational program that aims to reduce the frames of postural dysfunction in adults through theoretical-practical meetings about ergonomics and exercises to stimulate the practice of postural care in DLA's[15]. The approaches vary for different audiences (adults, elderly, children, and adolescents) and structures of the same program[15,16] are found in Brazil, differing in the amount and duration of BSP classes[16,17]. The application of postural promotion and prevention programs for adolescent athletes can provide alignment and maintenance of body posture and postural habits, reduce and prevent musculoskeletal pain and injuries, and improve sports performance[18].

Although some studies have reported on the application of postural education programs in children and youth in Brazil[16,17,19] and worldwide[20,21], no studies have been conducted on adolescent athletes. This study aimed to evaluate the effects of a longitudinal PEP in adolescent basketball athletes using the principles of the BSP and its influence on body posture, back pain, dynamic balance, and QoL. This study hypothesizes is that a Postural Education Program (PEP) adapted to junior federated basketball athletes will improve body posture, back pain, dynamic balance, and quality of life.

Methods

This is a quasi-experimental study[22] with a convenience sample, with assessments before and immediately after the PEP. The sample comprised male adolescent basketball players, federated and from the under-15 age category, who participated in PEP intervention, and their respective guardians. This study followed the statement for non-randomized studies proposed by Rivees and Gaus[23].

Adolescents were selected in an unintentional and non-probabilistic manner. The inclusion criteria were adolescent athletes, training at least three times per week, with or without diagnosed postural alterations who understood the proposed protocol and parents or guardians who completed the weekly questionnaire about assistance in changing postural habits. The exclusion criteria was: adolescents failure to attend the intervention three times or more, the presence of related neurological diseases, and osteomyoarticular disorder and illiterate parents and/or guardians. The parents and/or guardians of the participants signed the informed consent form, the consent form for photographs, videos, and recordings, and the adolescent signed the consent form. This study was approved by the Ethics Committee (CAAE: 73447617.6.0000.0118).

To evaluate the static posture of adolescents, Biophotogrammetry was used using the Postural Evaluation Software (SAPO v.0.69). Individuals were asked to wear suitable for the placement of spherical markers in the selected anatomical points, as previously described24. A digital camera (SONY Cybershot, model DSC-S950) was positioned parallel to the floor with a tripod at a height of 90 cm, at a horizontal distance of 3 m from the bank of 20 cm in which the adolescent was positioned, in its preferential support base. This bench was 28 cm from the wall and positioned in front of the symmetrograph in FIGURE 1, A. The positioning of the support base was the same for all the images. For image calibration, a plumb wire was used for further analysis of the photographs in the software. Four photographs

were analyzed according to the SAPO protocol[24] and a free-angle measurement (posterior superior iliac spine angle) was added. The angles and distances analyzed were based on the study by Miranda et al.[25].

The dynamic balance was evaluated using the Star Excursion Balance Test-Y SEBT (FIGURE 1, B) because, when compared to the SEBT, less time is required for execution and there is greater applicability, as well as a standard protocol with high inter-and intra-validator reliability[26].

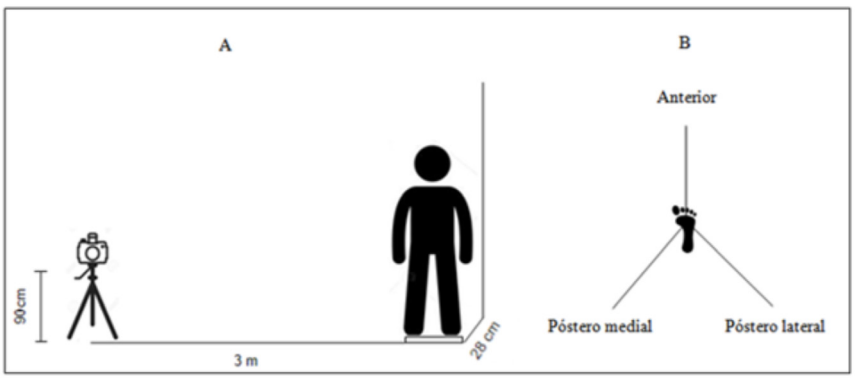

FIGURE 1 - Pre and post-intervention methods for photogrammetry (A) and Y SEBT (B).

The Back Pain and Body Posture Evaluation Instrument (BackPEI) was used to evaluate self-reported back pain and postural habits in school and home environments, and to assess the QoL of young athletes using the *World Health Organization Quality of Life Assessment* (WHOQOL-bref), both validated for Portuguese[27,28]. A visual analog scale (VAS) scoring system for back pain was applied, with zero representing no pain and 10 representing the worse possible pain.

The Postural Education program was developed at the athletes' training center, carried out over a period of ten weeks, consisting of ten meetings, once a week. The first meeting was the assessment, followed by eight theoretical-practical postural education interventions and the reevaluation. In the evaluation and reevaluation, the same data collection instruments were applied, by the same trained researcher (FIGURE 2). In the evaluation and reevaluation, the same trained researcher was responsible for data collection. Each intervention lasted 90 minutes, consisting of educational approach and practice of physical exercises for body training. Several educational topics were addressed entertainingly along, with emphasis on postural exercises, practical ergonomics, and stimulus for postural correction through body awareness. The content covered included general notions about the skeleton and the seated position, body awareness and posture, mechanisms of postural compensation and adequate walking, transport of school material, ideal weight of the backpack, importance of physical activities, sitting and lifting correctly, squatting, and proper lifting of heavy objects, eating habits, the importance of shoulder and pelvis in daily activities, ideal sleep position, lying down, and lifting correctly. At the ninth meeting, a review of the contents addressed during the PEP was conducted.

After each theoretical intervention, physical exercise practices were carried out, with varied executions of stretching, joint mobilization, balance, muscle strengthening, respiratory control and relaxation, focusing on important musculoskeletal structures to maintain better body posture.

At the end of each intervention, the participating athletes received printed materials such as a folder and summary card of the theme addressed, and a weekly diary to direct exercise and regular home practice guided by the program, and a weekly questionnaire for parents/guardians. The questionnaires to the parents/guardians aimed to verify their participation as stimulators in the execution of physical exercises and changes in the postural habits of adolescents, guided by PEP. It consisted of simple questions about the

practice of domestic activities within the family during the week and gave parents/guardians the opportunity to write comments about the experience. The participation of parents and family members was considered important in the learning process and in helping with postural adjustments, solidifying what was taught and strengthening family ties. Printed versions of the questionnaire were distributed to the guardians.

The data were processed using the Statistical Package for Social Sciences (version 20.0). The statistical significance level was set at $p \leq 0.05$. The Shapiro-Wilk test was applied for data distribution, followed by paired t-test for parametric data and Wilcoxon test for non-parametric data.

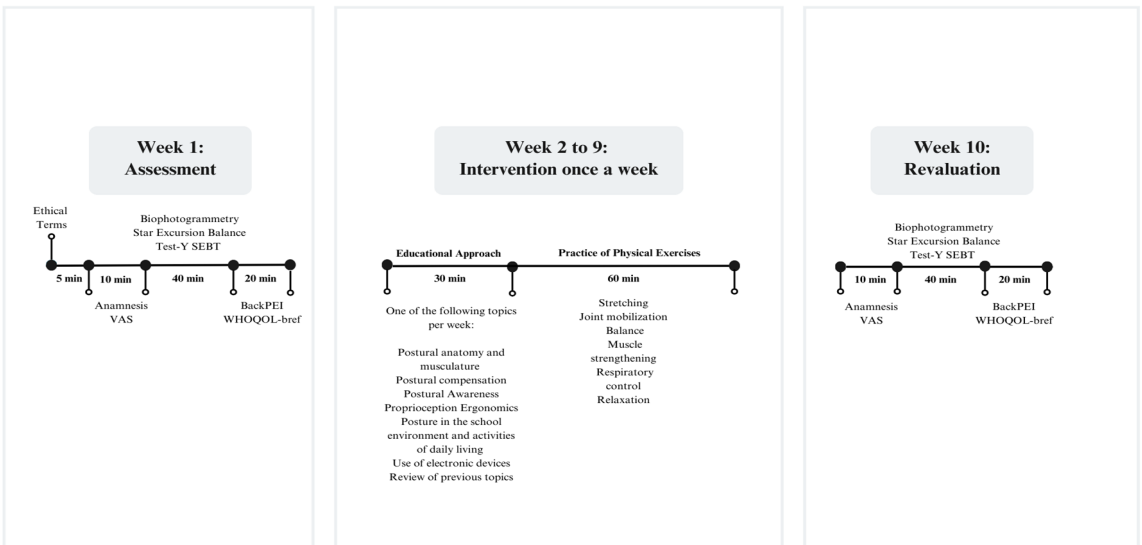

FIGURE 2 - Protocol timeline.

Results

FIGURE 3 shows a flow diagram of the participants' enrollment until analysis. Adherence to PEP in athletes was 66.7%. Twelve study participants were evaluated (average age: 13.90 ± 0.73 years, average body weight: 60.04 ± 10.07 kg, average height: 1.72 ± 0.06 m, and average BMI: 20.01 ± 2.63 kg/m^2. The postural evaluations before and after PEP for basketball athletes are presented in TABLE 1.

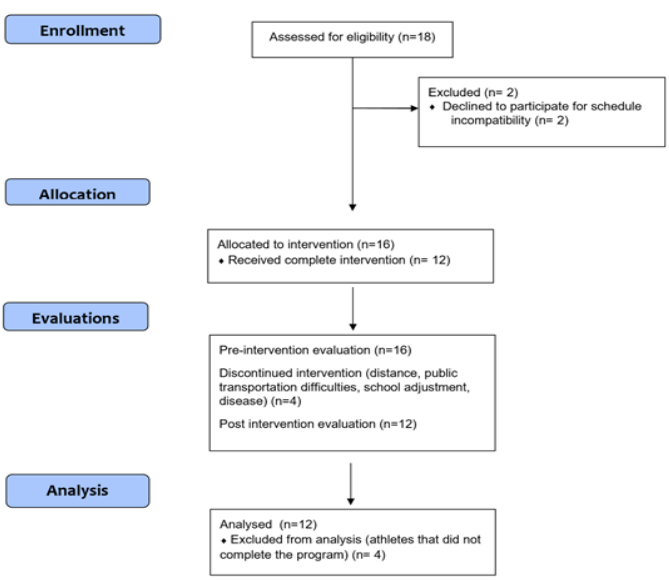

FIGURE 3 - Flow diagram of the enrollment, allocation, evaluations and analysis of the studied participants.

TABLE 1 - Angular measurements (°) of postural evaluation in the anterior, right and left and posterior lateral views before and after the intervention of the Postural Education Program (PEP) (n=12).

VIEW Variables	BEFORE M±SD	AFTER M±SD	p
Anterior Lateral View			
Horizontal alignment of the head	0.01±2.01	-0.33±2.16	0.71
Horizontal alignment of the shoulders	1.57±1.44	1.93±1.58	0.34
Frontal angle of the right lower limb	-1.73±3.15	-1.22±3.53	0.15
Frontal angle of the left lower limb	-1.39±2.81	-0.84±2.57	0.04*
Horizontal alignment of the tibial tuberosities	1.20±1.97	1.47±1.86	0.62
Q angle of the right lower limb	14.86±4.18	14.21±4.70	0.71
Q angle of the left lower limb	12.37±9.17	9.38±10.65	0.40
Right Lateral View			
Horizontal alignment of the head (C7)	56.87±3.37	58.11±4.28	0.16
Vertical alignment of the head	8.73±7.92	5.88±8.96	0.30
Vertical alignment of the trunk	-1.06±1.63	-0.45±2.82	0.52
Hip angle (trunk and lower limb)	-2.38±4.89	-3.01±4.63	0.80
Tibio-tarsal angle	83.96±2.52	85.50±2.94	<0.001*
Left Lateral View			
Horizontal alignment of the head (C7)	57.08±4.86	56.55±4.17	0.59
Vertical alignment of the head	15.99±10.21	7.67±10.11	<0.001*
Vertical alignment of the trunk	-2.01±1.81	-0.14±3.08	0.09
Hip angle (trunk and lower limb)	-6.33±3.80	-4.38±4.92	0.33
Tibio-tarsal angle	86.18±2.42	86.12±2.69	0.87
Posterior Lateral View			
Scapula lower angle and T3 spinous process	9.66±12.60	2.63±18.92	0.15
Left leg-hindfoot angle	10.76±7.61	11.32±5.63	0.82
Right leg-hindfoot angle	11.53±5.46	15.02±5.57	0.19
PSIS angle	1.93±1.19	2.41±2.39	0.390

ASIS: anterosuperior iliac spine;
C7: seventh cervical vertebra;
T3: third thoracic vertebra;
PSIS: posterosuperior iliac spine;
Negative sign (-): left shift;
Positive (+): right shift;
*: (p ≤0.05).;
Values are presented as mean±standard deviation (M±SD).

TABLE 2 shows the results concerning the dynamic balance, where there was a statistical difference in the relative bilateral normalized distances, between before and immediately after the intervention.

In relation to the BackPEI questionnaire results, after the intervention there was an improvement in the self-report of changes in postural habits, in which adolescents reported that they were performing postures more adequately, such as: in the sitting position in the classroom, before the intervention none of the participants maintained postural alignment when sitting and after the intervention, 50% of the adolescents reported sitting on their ischial bones, with spinal alignment, knees flexed at 90 degrees and feet supported. When sitting in front of the computer there was an increase from 25% to 75% of the sample who reported sitting with a more appropriate posture, with the computer screen aligned with their eyes and their spine supported by the back of the chair. Regarding the way of picking up a heavy object from the floor, there was an increase of 8.3% to 58.3% pre and post-intervention, respectively, in the execution of postures that do not overload the spine. Regarding how to transport school supplies, everyone reported using a backpack with two straps, fully supported on their shoulders. This questionnaire does

not specify the height of the handles or the mass of the school supplies.

An analysis of the questions related to the presence of self-reported back pain in the three months preceding the evaluation, comparing pre-and post-intervention, a decrease of 8% was found after PEP. Approximately 17% of the athletes reported back pain during daily activities in the pre-intervention period, which was reduced to 8.3% after PEP. The median intensity of pain before PEP was 2.25 (range: 0-7) before and 0 (range: 0-4) after PEP, with no significant difference (p=0.16).

TABLE 2 - Distance and asymmetry measurements (cm) of the evaluation of the dynamic balance before and after the intervention of the Postural Education Program (PEP) (n=12).

VIEW Variables	BEFORE M±SD	AFTER M±SD	p
Normalized Relative Distance R	89.55±6.55	97.49±5.58	0.01*
Normalized Relative Distance L	91.72±5.95	98.73±6.10	0.02*
Previous Asymmetry	4.87±3.52	4.37±3.11	0.73
Medial Poster Asymmetry	6.00±4.19	6.38±3.81	0.83
Lateral Poster Asymmetry	8.65±5.60	5.12±4.57	0.11

R: right; L:left; *: (p ≤0.05); Values are presented as mean±standard deviation (M±SD).

FIGURE 4 illustrates the results of QOL in adolescents after PEP with its different domains. There was a significant improvement in the psychological domain (p=0.04).

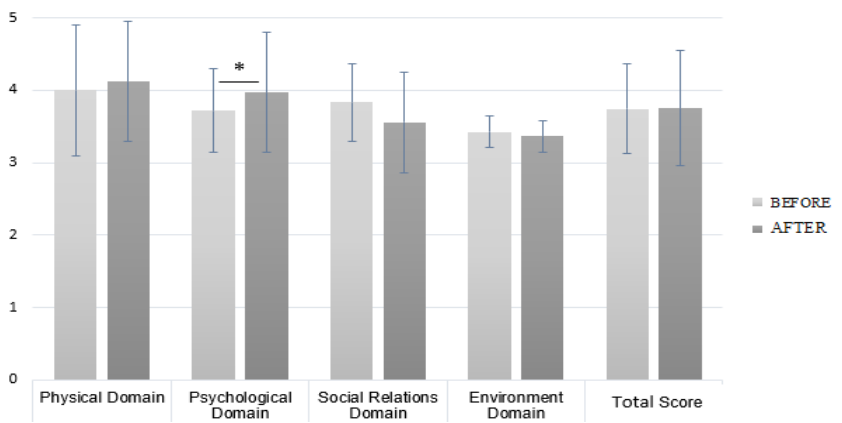

FIGURE 4 - Quality of life (WHOQOL-bref) before and after the intervention of PEP in adolescent basketball athletes presented in mean values and standard deviation according to the respective domains. Paired T-test values for comparisons between pre- and post-intervention *(p ≤0.05).

Through the application of the weekly questionnaire of the parents/guardians on the perception of adolescents' behavior and their assistance as stimulators in the changes of postural habits and practice of home physical exercises, it was observed that during the weeks, this questionnaire was answered (66.7% vs. 83.3%), and they reported reading the educational material with the family. In general, parents (41.7% vs. 66.7%) perceived that their adolescents practiced their exercise and exhibited greater care in daily activities (41.7% vs. 75%).

It was also confirmed that, although the parents sought to encourage exercising, family participation was low (16%). Parents justified their lack of adherence to exercising with their children, to be a result of work responsibilities. Analysis of comments revealed *"Monitoring is not 100%, because I work out all day. This makes this assessment difficult"*. Therefore, although the participation of the parents was low, most of the comments were positive, such as *"It was great because it helped my son's posture"*, and *"He*

dedicates himself to the exercises. He is dedicated and we care about him performing well without harming himself, and these lessons are assisting in that respect".

Regarding the exercise diaries that the adolescents received after each PEP intervention, the percentage of answered diaries declined from 100% (1st week) to 58.3% in the last week, with an average of 69.4% in the intervening weeks. These findings were comparable to the performance of the home exercises.

Discussion

The hypothesis of this study was partially accepted, considering the main results of the study indicated that there was a general improvement in postural angulation and alignment, dynamic balance, and the psychological domain of QoL. Although the difference was not statistically significant, life habits improved after PEP. Studies related to the practice of basketball are still scarce, particularly regarding posture and health promotion[28]. Posture analysis is relevant to understanding the origin, evolution, and trends that can influence the QoL of adolescent athletes and the practice of sports[29,30]. The development of a PEP for this public has the potential benefits for musculoskeletal problems prevention and decrease and postural changes that can compromise the sports careers of adolescent basketball players[29,30], Candotti et al.[19] obtained similar results after the BSP protocol was conducted out with male and female non-athlete adolescents, in which they reported a positive and significant effect in the intervention group regarding postural evaluation and dynamic posture during daily activities. However, in another 8-month follow-up longitudinal study[17] there was no difference in the static posture, but there was an improvement in the posture during daily activities shortly after the intervention, but the intervention gains were not maintained.

Santos et al.[13] found that the BSP had a positive effect immediately after its completion in the execution of DLA's and that there was the maintenance of these effects and the level of theoretical knowledge in the 5-month follow-up after the reinforcement of learning. However, Dolphens et al.[21] performed a follow-up study of 1- and 8 years after the PEP intervention and found that although the knowledge about postural education increased and pain decreased over the years, the intervention did not change the behavior and self-efficacy of these individuals. These divergences in the results of long-term studies suggest that the cultural and environmental issues of interventions during childhood or adolescence can greatly influence the outcomes of studies, making it easier or more difficult to incorporate new habits.

The trunk flexor pattern in the seated posture of children and adolescents is considered inadequate[11]. In this study, before the intervention, most adolescents acquired this posture while sitting, but in the re-evaluation, they had acquired the appropriate posture. Sedrez et al.[11] suggested that the time spent sitting in a particular posture may be a risk factor for the development of postural changes. In addition, Sullivan et al.[31] demonstrated in one study the characterization of two subgroups of male adolescents concerning the adopted seated posture, in which the first group was characterized by developing lordotic postures associated with patterns of pain provocation in extension, and the other group obtained inclined postures when sitting, which were associated with patterns of pain provocation during flexion movement. These findings suggest that both lordotic and kyphotic postural changes triggered by inappropriate sitting posture may be associated with chronic low back pain in adolescents.

There was also an improvement after the intervention of PEP, considering the manner of picking up objects from the ground. Similar to the results obtained by Candotti et al.[19], good effects were observed in the dynamic posture of daily activities, such as picking up an object from the ground. Sedrez et al.[11] did not find an association between the practice of physical exercise and postural changes, but reported divergence as physical activity is a protective factor or risk factor for the appearance of

postural modifications. They suggest that the type of modality, volume of training, time of practice of the sport, and how the activity is developed can influence postural issues.

Regarding the use of backpacks, all participants wore shoulder straps, as did most children and adolescents (71.9%) in the study by Preto et al.[32] and 75.9% in the study by Candotti et al.[33]. Good practices are observed in the transport of school materials, but if the backpacks are overweight, postural changes could develop, since they are in the growth phase[34]. Yamato et al.[35], in a systematic review, reported that backpack use is a risk factor for back pain in children and adolescents.

The participants in this study reported back pain that decreased in both frequency and intensity after PEP, although the differences were not statistically significant. Studies report that several factors may be associated with the presence of back pain, such as growth[36], alteration of lumbar lordosis[37], physical inactivity, incorrect postures maintained for long periods[37], backpack weight[6], and psychological factors[37]. Jordá Llona et al[20] reported a reduction in pain after three months of BSP, both in terms of the number of cases and intensity. Dolphens et al[21]. demonstrated that the prevalence of pain decreased in the intervention group of postural education when compared to the control group, after 8 years of the postural program[21].

By comparing the results of the dynamic balance in our study, we observed a statistically significant difference in the bilateral normalized distances after the intervention, with an increase in the range distances, and consequently an improvement in the ability to balance. Among the three asymmetries, there was a 41% reduction in the lateral postures. Plisky et al.[26] reported that anterior asymmetry values greater than 4 cm were 2.5 times more likely to develop lower limb injury among basketball athletes. Another study found a similar relationship with the predictive injury index[36]. In general, all the asymmetries in the present study remained high, both before and after PEP, but with a significant reduction after the intervention.

Overall, the QoL improved mainly in the physical and psychological domains, although the results were only significant in the psychological domain. The findings of the systematic review on BSP with non-athlete school children[16], revealed an improvement in the overall health status concerning physical, social, and emotional aspects, after a short-term evaluation of the efficacy of BSP. It is worth noting that the sample in our study comprised physically active adolescents, since they practiced basketball at least three times per week, and thus had a good QoL initially; thus, the gains were insipient in most domains. Family participation in the gains of the benefits obtained in PEP is another factor that deserves to be highlighted. The difficulty in the participation of parents as mentioned was the fact that they could not spend the time they wanted with their adolescents, due to the need to perform other duties, such as work activities. Moreover, it is assumed that there was no requirement on the part of the parents for the athletes to practice the activities, as well as on the part of the adolescents, who did not frequently encourage the participation of the parents. However, it is noteworthy that the family is primarily responsible for the education of healthy habits and behaviors for children and adolescents[32] should serve as examples for the children.

The main limitations of this study were adherence to the program and the inadequate completion of athletes' diaries and parents' questionnaires, although there were reminders throughout the intervention period for better family participation. Also, we did not have an independent evaluator in the pre- and post-intervention evaluations.

In conclusion, after the PEP for adolescent athletes of basketball, significant improvements related to dynamic balance, posture, and the psychological domain of QoL were observed. Regarding self-reported back pain complaints, 17% of athletes reported feeling pain in the last three months, and although there was no statistically significant difference, it reduced to 8% after PEP. This program also provided opportunities for teaching positive attitudes to minimize the risks of possible postural alterations and musculoskeletal injuries to the athletes through the responsibility to promote their health and that of the family. It is noteworthy that programs of this kind should be integrated with the physical training of athletes with different modalities to improve sports performance and aspects of daily life.

Acknowledgments

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Conflicts of interest

None of the authors have any conflicting interests.

Resumo

Programa de educação postural para atletas de basquetebol adolescentes: um estudo quase-experimental.

Avaliar os efeitos da aplicação do programa Escola de Postura (EDP) adaptado para atletas adolescentes, em relação à postura corporal, dores nas costas, equilíbrio dinâmico e qualidade de vida (QV). Trata-se de estudo quase-experimental de perspectiva quantitativa. Amostra foi composta por adolescentes atletas de basquetebol e do sexo masculino. Foram realizados dez encontros de 90 minutos, 1x/semana. Oito encontros foram teórico-práticos do programa EDP e dois encontros foram avaliações pré e pós-intervenções, da postura estática (biofotogrametria), dor nas costas, do equilíbrio dinâmico (Star Excursion Balance Test-Y SEBT) e aplicação de questionários (BackPEI, WHOQOL-bref). Para a análise dos dados, o teste t pareado ou teste de Wilcoxon foi usado para os dados com distribuição normal. Diferença estatística foi considerada se p valor ≤0,05. Dezoito atletas, (média±DP de idade 13,9±0,73 anos, massa corporal de 60,04±10,07, estatura 1,72±0,06 m e IMC 20,01±2,63 kg/m2) foram incluídos no estudo. Na avaliação postural houve diferença estatisticamente significativa para os ângulos frontal do membro inferior esquerdo (-1,39°±2,81 vs. -0,84°±2,57), tíbio-társico direito (83,96°±2,52 vs. 85,50°±2,94) e alinhamento vertical da cabeça na vista lateral esquerda (15,99°±10,21 vs. 7,67°± 10,11). Na análise da presença de dor nas costas autorreferida aproximadamente 17% dos atletas relataram dor, reduzindo para 8% após a PEP. Observou-se também melhora significativa para as distâncias relativas normalizadas quanto ao equilíbrio dinâmico bilateral (direito, p=0,01 e esquerdo, p=0,02) e qualidade de vida (domínio psicológico, p=0,04). Com isso, a EDP mostrou-se uma intervenção efetiva, melhorando equilíbrio, postura e aspectos da qualidade de vida dos adolescentes atletas. Programas semelhantes devem ser utilizados em atletas adolescentes, a fim de melhorar o desempenho esportivo e outros aspectos da vida diária, como itens do domínio psicológico.

Palavras-chave: Adolescente; Fotogrametria; Basquete; Educação em Saúde; Escola de postura.

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