

FORWARD HEAD POSTURE IN SPORTS-INVOLVED CHILDREN

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ABSTRACT

Purpose: Forward head posture (FHP) is the most common cervical postural fault in the sagittal plane that can cause various issues and conditions. The purpose of this study is to determine the prevalence of FHP among sports-involved children and to examine the differences in craniovertebral angle (CVA) with regard to gender, age, neck pain, and the sports in which they participate.

Methods: A cross-sectional study was conducted among 154 sports-involved children (76 males and 78 females), aged 11–14, participating in various sports (basketball, football, volleyball, and athletics). After obtaining signed consent, photography of the sagittal view was performed in a standing position, which was then used to measure the CVA using the Web Plot Digitizer software. A questionnaire was used to gather data about gender, age, sports in which a participant is involved, presence of neck pain, and pain scale.

Results: Among the 154 children, 37 (24.03%) exhibited FHP (15 males, 22 females). The mean CVA for the entire sample was $51.30^\circ \pm 6.20^\circ$. Female participants had a significantly lower CVA ($p = .021$) compared to male participants. No significant differences were found with regard to age, presence of neck pain, or engagement in a specific sport.

Conclusion: FHP is present in sports-involved children, with a higher prevalence among females.

Keywords: forward head posture, craniovertebral angle, children, physical activity, sport, ages 11–14

ANTERIORNA DRŽA GLAVE PRI OTROCIH, KI SE UKVARJAJO S ŠPORTOM

POVZETEK

Namen: Anteriorna drža glave je najpogostejša vrsta napačne drže vratu v sredinski ravnini, ki lahko povzroči različne težave in stanja. Z raziskavo smo želeli določiti pojavnost anteriorne drže glave pri otrocih, ki se ukvarjajo s športom, in preučiti razlike pri kraniovertebralnem kotu glede na spol, starost, bolečine v vratu in sport, s katerim se ukvarjajo.

Metode: Med 154 otroki (76 moškega in 78 ženskega spola), starimi med 11 in 14 let, ki se ukvarjajo z različnimi športi (košarka, nogomet, odbojka in atletika), smo izvedli presečno študijo. Ko smo prejeli pisna soglasja, smo posneli fotografije sredinske ravnine v stoječem položaju, ki smo jih nato uporabili za merjenje kraniovertebralnega kota s pomočjo programske opreme Web Plot Digitizer. Z vprašalnikom smo zbrali podatke o spolu, starosti, izbranem športu, prisotnosti bolečin v vratu in lestvici bolečine.

Rezultati: Anteriorno držo glave smo odkrili pri 37 (24,03 %) od 154 otrok, in sicer pri 15 otrocih moškega in 22 otrocih ženskega spola. Povprečen kraniovertebralni kot za celoten vzorec je bil $51,30^\circ \pm 6,20^\circ$. Pri subjektih ženskega spola smo odkrili znatno manjši kraniovertebralni kot ($p = .021$) v primerjavi s subjekti moškega spola. Starost, prisotnost bolečin v vratu in udeleževanje v različnih športih niso dali statistično pomembnih razlik.

Zaključek: Anteriorna drža glave je prisotna med otroki, ki se ukvarjajo s športom, pri čemer je večja pojavnost značilna za ženski spol.

Ključne besede: anteriorna drža glave, kraniovertebralni kot, otroci, fizična aktivnost, šport, 11–14 let

INTRODUCTION

Good posture is defined as a musculoskeletal balance that creates a minimal amount of stress and strain on the body (Yip, Chiu & Poon, 2008). Good posture in the sagittal plane implies that a vertical posture line passes slightly in front of the ankle joint and the center of the knee joint, slightly behind the center of the hip joint, through the shoulder joint, and through the external auditory meatus (Haughie et al., 1995, as cited in Yip et al., 2008). While desirable, many people do not possess good posture (Shaghayeghfard, Ahmadi, Maroufi, & Sarrafzadeh, 2016). Inadequate posture leads to shortening and tension in the muscles, which leads to difficult movements in the joints (Westcott, 1997, as cited in Ruivo, Pezarat-Correia, & Carita, 2014), and it is often accompanied by pain (Ruivo et al., 2014).

FHP is the most common cervical postural fault in the sagittal plane (Mahmoud, Hassan, Abdelmajeed, Moustafa, & Silva, 2019). Prevalence data indicate that the incidence of FHP can be as high as 63% in elementary school students (Verma, Shaikh, Mahato, & Sheth, 2018). FHP is defined as “any alignment in which the external auditory meatus is positioned anterior to the plumbline through the shoulder joint” (Peterson-Kendall, 2005, as cited in Shaghayeghfard et al., 2016). It is characterized by the hyperextension of the upper part of the cervical spine (C1–C3) and flexion of the lower part of the cervical spine (C4–C7) (Ruivo, Pezarat-Correia, & Carita, 2017). Considering its location and the fact that the head constitutes 6% of total body weight, disrupting its position can result in various musculoskeletal problems, most often in the neck, shoulder joint, chest, and upper extremities (Szczygieł, Waśniowski, Chmiel, & Golec, 2022).

FHP can cause various issues and conditions. Neck pain due to FHP is a frequently researched problem, with several studies proving that increased FHP leads to neck pain in adults (Kim, Yi, Kwon, Cho, & Yoo, 2008; Mahmoud et al., 2019; Yip et al., 2008); whereas, in the review study by Mahmoud et al. (2019), no connection was found between FHP and neck pain in adolescents. FHP affects muscles around the head and shoulders, including the trapezius, sternocleidomastoideus, suboccipital, and temporal, which can cause persistent pressure in the muscles, fascia, and nerves of the neck and shoulders (Lee, 2016). It also leads to limited neck mobility (Fernández-de-las-Peñas, Alonso-Blanco, Cuadrado, & Pareja, 2006; Sarig Bahat, Levy, & Yona, 2023).

Furthermore, persistent tension in the head and posterior neck muscles can lead to tension headaches (Lee, 2016). A systematic review by Elizagaray-Garcia, Beltran-Alacreu, Angulo-Díaz, Garrigós-Pedró and Gil-Martínez

(2020) demonstrated that individuals with chronic primary headaches exhibit greater FHP. FHP is also associated with changes in the thoracic shape and reduced respiratory function (Koseki, Kakizaki, Hayashi, Nishida, & Itoh, 2019), decreased cervical proprioception (Ha & Sung, 2020), increased muscle activity (Alowa & Elsayed, 2021; Nishikawa et al., 2022), and increased muscle fatigue (Nishikawa et al., 2022).

It was found that even professional athletes tend to have postural disturbances and/or spinal curvature disorders (Zwierzchowska, Gawęł, Maszczyk, & Rocznik, 2022). A study conducted by Grabara (2020) found that volleyball training affects the alignment of the pelvis, shoulder girdle, and scapulae. Furthermore, Xing and Popik (2020) reported that both volleyball and basketball could negatively impact the body posture of adolescents. Certain sports pose risks to children, such as football, where head impacts may affect cognitive function in adolescents (Zhang, Red, Lin, Patel, & Sereno, 2013). In the United States, regulations prohibit heading the ball for children under 11 years old, while those aged 12–13 are limited to 15–20 headers per week (US Club Soccer, 2016). However, there are no studies on the impact of repetitive movements associated with heading the ball on the development of FHP.

Assessing upright posture in children and adolescents might be an effective tool for identifying and preventing the early development of musculoskeletal issues (Lafond, Descarreaux, Normand, & Harrison, 2007). One objective way to assess FHP is by measuring the CVA. It is the angle between a horizontal line passing through the spinous process of the 7th cervical vertebra and a line from the spinous process of the 7th cervical vertebra through the tragus of the ear. It can be measured while the subject is sitting or standing, with research recommending measurement while the subject is standing (Shaghayeghfard et al., 2016). CVA values below 48° – 50° indicate the presence of FHP (Shaghayeghfard et al., 2016).

Although studies on FHP in children have been carried out, most focused on samples of schoolchildren (Batistão, Moreira, Coury, Salazar, & Sato, 2016; Chandoliya, Chorsiya, & Kaushik, 2021; Dolphens et al., 2012; Ruivo et al., 2014, 2017; Szczygieł et al., 2022; Verma et al., 2018; Wiguna et al., 2019), with only one study examining FHP in children that participate in sports (Guedes & Amado João, 2014). Sports are important for children and young adults to achieve their recommended level of physical activity. The World Health Organization (2020) states that children and youth aged 5–17 should accumulate at least 60 minutes per day of moderate to vigorous intensity, mostly aerobic physical activity, across the week, including activities that strengthen the

muscles and bones, at least three times per week. Alongside all the benefits of participating in sports, studies have shown that children who engage in sports have better posture than those who do not (Kasović, Štefan, Piler, & Zvonar, 2022).

The purpose of this study was to determine the prevalence of FHP among children participating in sports and to examine differences in CVA values concerning gender, age, presence of neck pain, and sports they engage in.

METHODS

Sample

A total of 154 sports-involved children (76 males and 78 females) were included in this cross-sectional study, aged between 11–14 (12.42 ± 1.06 years old), from Novi Sad, Serbia. All participants were involved in sports: 55 (35.7%) football players, 43 (27.9%) basketball players, 28 (18.2%) volleyball players, and 28 (18.2%) track and field athletes. All participants had at least three training sessions per week. Thirty-two participants (20.80%) reported neck pain, with a neck pain score of 4.22 ± 1.77 on a scale of 1–10. Signed consent from parents was required for each participant to take part in the study.

Sample of measuring instruments

Head posture was measured using CVA. The CVA is the angle between the horizontal line passing through the 7th cervical vertebra (C7) and a line extending from the tragus of the ear to C7. A lower CVA indicates a greater degree of head protrusion, with a value below 48° – 50° signifying the presence of head protrusion (Shaghayeghfard et al., 2016). In this study, participants with a CVA of 48° or less are identified as having FHP. For photographing the athletes, a mobile phone was mounted on a tripod at a height corresponding to the participant's shoulder level. The mobile phone was mounted at a distance of 1.5 meters from the participants. A marker (a sticky, reflective ball) was placed on the participant's skin at the level of the 7th cervical vertebra. The participants were asked to stand sideways with their feet just wider than hip distance. To achieve a neutral, self-balanced neck posture, participants were asked to perform three movements of flexion and extension of the head and neck with

a full range of motion, after which they were asked to assume the most natural position for the head and neck (Shaghayeghfard et al., 2016). After that, a photograph of the participant's right side was taken. Photographs were transferred to a PC and analyzed using *Web Plot Digitizer* software, which was used to measure the CVA. The use of this software for clinical analysis of the CVA was assessed as an effective, simple, and accessible method (Mani, Sharma & Singh, 2018), with excellent intra-rater reliability with ICCs ranging from 0.92 to 0.99 (Muniandy, Singh, Mani, & Omar, 2019).

Also, a questionnaire was used to gather the following data about participants: gender, age, sport in which they are involved, presence of neck pain, and pain scale.

Study design

This cross-sectional study was conducted from August to September 2023. Measurements were taken in sports facilities where athletes train, during training sessions, by a kinesiologist trained to perform this procedure.

Statistical analysis

The statistical analysis was done using SPSS software (SPSS 26.0, IBM Inc., Chicago, IL, USA). The Shapiro-Wilk test of normality was performed to assess the distribution of the data. An independent-sample t-test was conducted to examine the differences in CVA based on gender in different sports, between genders regardless of engagement in sports, and between participants with and without neck pain. A one-way ANOVA was used to assess differences in CVA concerning the participants' ages and the sports they engage in.

RESULTS

The results of the Shapiro-Wilk test indicated that all the variables, except for the CVA, were not normally distributed.

The prevalence of FHP according to different sports is shown in Figure 1. Among the 154 participants observed, 37 (24.03%) exhibited FHP. Specifically, FHP was observed in 9 basketball players (6 males and 3 females), 16 football

players (6 males and 10 females), 8 volleyball players (2 males and 6 females), and 4 track and field athletes (1 male and 3 females).

Table 1. CVA according to gender and engagement in different sports

Sport	Male		Female		<i>p</i>
	<i>n</i>	CVA (°) (mean ± SD)	<i>n</i>	CVA (°) (mean ± SD)	
Basketball	23	50.60 ± 6.02	20	52.16 ± 4.14	.335
Football	31	53.32 ± 7.43	24	48.41 ± 5.39	.009
Volleyball	15	55.20 ± 7.17	13	47.80 ± 5.09	.005
Athletics	7	48.96 ± 6.87	21	51.74 ± 4.10	.203

Legend: *n* – number; CVA – craniovertebral angle; *p* ≤ 0.05

The mean CVA for the entire sample was 51.30° ± 6.20°. Table 1 presents the results of the independent-sample t-test for CVA according to gender in different sports. Among male participants, track and field athletes had the lowest mean CVA of 48.96° ± 6.87°, followed by basketball players with 50.60° ± 6.02°, football players with 53.32° ± 7.43° and volleyball players with the highest CVA of 55.20° ± 7.17°. On the other hand, among female participants, volleyball players had the lowest CVA of 47.80° ± 5.09°, followed by football players with 48.41° ± 5.39°, track and field athletes with 51.74° ± 4.10° and basketball players with the highest CVA of 52.16° ± 4.14°. There was a significant difference between male and female participants in football (*p* = .009), and volleyball (*p* = .005), with female participants showing lower CVA values.

The findings from the independent-sample t-test for CVA, according to gender and the presence of neck pain, are presented in Table 2. A statistically significant difference was observed in CVA between male participants (52.47° ± 7.08°) and female participants (50.16° ± 5.00°) (*p* = .021). However, no significant difference was found concerning neck pain (*p* = .986). Participants with neck pain had a mean CVA of 51.32° ± 4.68°, while those without neck pain had a mean CVA of 51.30° ± 6.55°.

Table 2. CVA according to gender and presence of neck pain

		CVA (°) (mean ± SD)	<i>p</i>
Gender	Male (n=76)	52.47 ± 7.08	.021
	Female (n=78)	50.16 ± 5.00	
Neck pain	No (n=122)	51.30 ± 6.55	.986
	Yes (n=32)	51.32 ± 4.68	

Legend: n – number; CVA – craniovertebral angle; $p \leq 0.05$

Table 3. CVA according to engagement in different sports and age

		CVA (°) (mean ± SD)	<i>p</i>
Sport	Basketball (n=43)	51.32 ± 5.23	.974
	Football (n=55)	51.18 ± 7.00	
	Volleyball (n=28)	51.76 ± 7.23	
	Athletics (n=28)	51.04 ± 4.94	
Age	11 (n=38)	51.84 ± 6.70	.437
	12 (n=43)	50.00 ± 5.56	
	13 (n=44)	51.98 ± 5.56	
	14 (n=29)	51.48 ± 7.29	

Legend: n – number; CVA – craniovertebral angle; $p \leq 0.05$

The results of the one-way ANOVA for CVA, according to engagement in different sports and the age of the participants, are shown in Table 3. No significant differences in CVA with regard to sport were found ($p = .974$). Track and field athletes exhibited the lowest CVA ($51.04^\circ \pm 4.94^\circ$), followed by football players ($51.18^\circ \pm 7.00^\circ$) and basketball players ($51.32^\circ \pm 5.23^\circ$), while volleyball players had the highest CVA ($51.76^\circ \pm 7.23^\circ$).

No significant differences were found concerning the age of the participants ($p = .437$). Participants aged 12 years had the lowest CVA ($50.00^\circ \pm 5.56^\circ$), followed by those aged 14 years ($51.48^\circ \pm 7.29^\circ$) and participants aged 11 years

($51.84^\circ \pm 6.70^\circ$), while the participants aged 13 years had the highest CVA ($51.98^\circ \pm 5.56^\circ$).

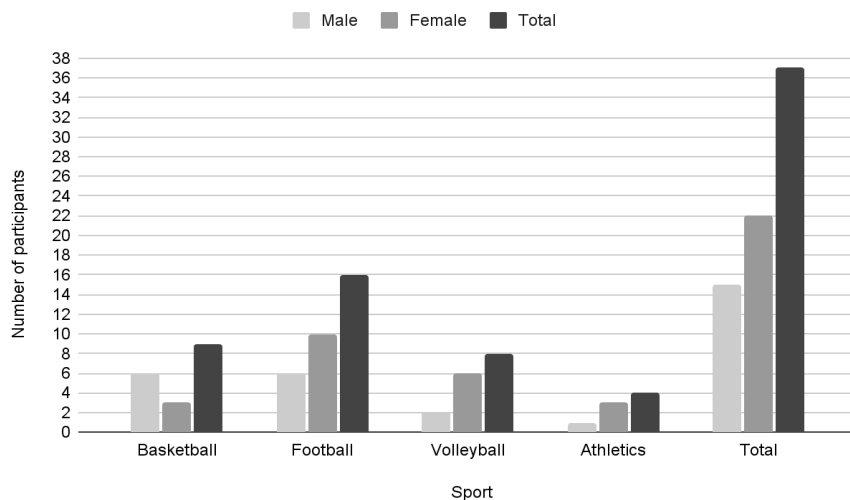


Figure 1. Prevalence of FHP according to engagement in different sports

DISCUSSION

The purpose of the current study was to determine the prevalence of FHP in children involved in sports. Additionally, the study aimed to examine differences in CVA based on gender, age, presence of neck pain, and the sports in which they participate. The results indicated that the mean CVA for the total sample was $51.30^\circ \pm 6.20^\circ$, while 24.03% of participants exhibited FHP. Studies by Kang and Lin (2023) and Veseta, Upeniece, Onzevs, Liepina, and Lice (2020) concluded that a low level of physical activity has no effect on head posture in young adults. However, the results of the present study significantly differ from those reported in previous studies on the population of schoolchildren. In these studies, it was found that 53.5% (Batistão et al. 2016), 63% (Verma et al. 2018), and 51.78% (Wiguna et al. 2019) of participants exhibited FHP. This could be due to the frequency and intensity of their physical activity. Children who are involved in sports have more intense and regimented physical activity compared to those who only participate in physical education classes or engage

in free play. This assumption is confirmed by the study of Guedes and Amado João (2014), who found that adolescent basketball players have a significantly higher CVA than adolescents who only participate in curricular physical activities up to twice a week.

Generally, female participants exhibited significantly lower CVA compared to males ($p = .021$). Specifically, female football players and volleyball players showed significantly lower CVA values than their male counterparts ($p = .009$ and $p = .005$, respectively). Additionally, a greater number of females (22) exhibited FHP compared to males (15). These results confirm the findings of Verma et al. (2018), who found that FHP is more prevalent among female students (71.1%) compared to male students (55.7%). Studies by Ruivo et al. (2014) and Anand, Singhal, Kulshrestha, and Raj (2021) also found that females had a lower CVA. Ruivo et al. (2014) attribute that to psychosocial problems, such as stress, or the development of secondary sex characteristics in females.

No significant differences were observed in CVA concerning the age of the participants ($p = .437$). Shaheen and Basuodan (2012) also did not find significant differences in CVA regarding the age of the participants, with CVA being nearly the same for children aged 7 to 8 years and those aged 8 to 9 years. A study conducted by Batistão et al. (2016) found that the prevalence of FHP was higher in the 13–15 age group compared to the 6–9 and 10–12 age groups. Although there was a study that found that FHP progresses with age, it was conducted on elderly women (Nemmers, Miller, & Hartman, 2009).

There were no significant differences in CVA based on the presence or absence of neck pain ($p = .986$). Interestingly, the neck pain group showed higher CVA ($51.32^\circ \pm 4.68^\circ$ in the neck pain group, compared to $51.30^\circ \pm 6.55^\circ$ in the group without neck pain), but it is not significant ($p = .986$). These findings correspond to the findings of Cheung, Shum, Tang, Yau, and Chiu (2010), who also found that adolescents with neck pain have higher CVA values ($60.03^\circ \pm 9.05^\circ$) compared to adolescents without neck pain ($57.10^\circ \pm 5.00^\circ$). Contrary to this, Ruivo et al. (2014) found lower CVA values in adolescents with neck pain ($46.46^\circ \pm 5.60^\circ$) compared to those without neck pain ($47.96^\circ \pm 4.79^\circ$). However, a systematic review by Mahmoud et al. (2019) confirms the findings of the present study that there is no association between FHP and neck pain in adolescents. It is worth mentioning that an increase of 1° in CVA has a 9.5% decrease in the odds of needing medical help for neck pain (Dolphens et al., 2012).

There were no significant differences in CVA relating to the sports in which participants were involved ($p = .974$). A recent study by Snodgrass, Ryan, Miller, James, and Callister (2021) examining football players aged 18.3 ± 3.3 years reported that 60.3% of players exhibited FHP, a finding somewhat consistent

with the present study. The relatively lower CVA value and a higher number of participants with FHP observed in football players may be attributed to their frequent downward gaze at the ball, particularly among youth players, leading to neck flexion. Conversely, volleyball players demonstrated the highest CVA values, possibly due to the predominantly overhead nature of volleyball, where players direct their gaze forward or upward at the ball. Basketball players had similar results (51.32 ± 5.23) to what Guedes and Amado João (2014) found (51.45 ± 5.33 on the right and 52.54 ± 5.79 on the left side) for CVA values in male adolescent basketball players. However, the existing research does not provide sufficient evidence to establish whether head posture varies across different sports or if sports participation significantly impacts head posture.

Study limitations and future research

The study did not consider the duration of children's engagement in sports. Additionally, data regarding the height and weight of the participants were not collected. Furthermore, the participants' posture may have been influenced by the awareness that they were being watched, but this problem seems to be difficult to avoid. Future research endeavors may consider incorporating longitudinal designs to capture the dynamic nature of postural changes over time, and collect comprehensive anthropometric data, including height and weight, to provide a more nuanced understanding of the relationship between body composition and head posture.

CONCLUSIONS

The study revealed that FHP was observed in 24.03% of children engaged in sports, with a higher prevalence among females. Furthermore, no significant differences were identified in CVA based on the specific sports in which participants were involved. Regular posture assessments and active participation in sports are crucial factors in cultivating good posture among children. These insights, particularly the higher susceptibility of females to head and neck postural disorders, underscore the importance of targeted interventions and awareness campaigns. Future research endeavors should explore tailored interventions aimed at enhancing posture in children, taking into consideration gender-specific factors and the impact of different sports.

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