GMR
The Original

PREVALENCE OF JOINT HYPERMOBILITY IN ADOLESCENTS AND ITS ASSOCIATION WITH INJURIES AROUND THE JOINT

Dr. G. V. Shashanka Reddy[1], Dr. Koteeswar Rao. R. G[2*], Dr. Venkataram. V[3], Dr. Chakravarthi. M[4]

[1]Post Graduate, Department of orthopaedics, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry. Email id: shashankareddy339@gmail.com ORCID iD : 0009-0009-9337-8531
[2]Associate professor, Department: Orthopaedics, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry. Email id : koteeswarrg@gmail.com ORCID iD: 0009-0004-6602-6104
[3]Associate professor, Department of Orthopaedics, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry. Email id : venro89@gmail.com ORCID iD: 0000-0003-1236-9350
[4]Assistant professor, Department of orthopaedics, Mahatma Gandhi Medical College and Research Institute, Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry. Email id: chakravarthim18@gmail.com ORCID iD : 0009-0006-5647-4821
Corresponding author*
Dr. Koteeswar Rao. R. G
Associate professor, Department of Orthopaedics, Mahatma Gandhi Medical College and Research Institute,
Sri Balaji Vidyapeeth (Deemed to be University), Pondicherry. Email id : koteeswarrg@gmail.com ORCID iD: 0009-0004-6602-6104

ABSTRACT

Background: Joint hypermobility is common in adolescents and may predispose them to musculoskeletal injuries, yet Indian data, especially for both sexes, are limited, prompting this study to estimate GJH prevalence and its association with injuries. **Methods:** A cross-sectional study was conducted among 356 adolescents aged 13–15 years from three schools in Puducherry, India. Two independent evaluators assessed joint hypermobility using the Beighton (≥4/9) and Hospital del Mar (HDM) (≥4/11) criteria. Demographic details, nutritional status, and medically confirmed injuries in the past 12 months were also recorded. Data were analysed using chi-square tests, with significance set at $p < 0.05$. **Results:** The majority of participants were 15 years old (57.9%) and male (60.7%). Hypermobility was identified in 11.5% of adolescents using the Beighton score and in 11.0% using the Hospital del Mar score, with 6.2% meeting criteria on both scales. Overall, 12.1% of participants reported musculoskeletal injuries, most commonly involving the knee. Injury prevalence was significantly higher among hypermobile adolescents than non-hypermobile peers (Beighton, p = 0.009; Hospital del Mar, p = 0.036). Males sustained more injuries than females (p = 0.049), and adolescents who were overweight or underweight had higher injury rates compared with well-built participants (p = 0.010). No significant associations were observed between injury occurrence and age, socio-economic status, or urban–rural residence. **Conclusion:** A clinically relevant proportion of adolescents exhibited joint hypermobility, which was significantly associated with an increased risk of knee and ankle injuries, highlighting the importance of early screening, preventive strategies, and the promotion of a balanced diet to support musculoskeletal health and reduce injury risk.
Keywords: Adolescents, Beighton score, Hospital del Mar score, joint hypermobility, musculoskeletal injuries, knee injuries, ankle injuries, nutrition, body mass index, and injury risk.

Introduction

Joint hypermobility (JH) occurs when joints move beyond the normal range expected for a person's age, sex, or body type. Many children and adolescents are naturally flexible because their connective tissues are more elastic than those of adults [1]. In some cases, this flexibility is harmless and even beneficial in activities such as dancing, gymnastics, and sports [2]. However, when flexibility is combined with weak joint control or reduced tissue stability, it can result in pain, fatigue, and a greater risk of musculoskeletal injury [3].
Hypermobility lies on a spectrum, ranging from normal flexibility to more complex medical conditions, such as hypermobile Ehlers-Danlos syndrome and hypermobility spectrum disorders [4]. Distinguishing between normal

flexibility and clinically significant hypermobility is especially important during adolescence, a period marked by rapid growth and high physical activity levels [5]. Therefore, identifying adolescents with generalised joint hypermobility (GJH) is important for both clinical care and public health.

Epidemiological studies have reported widely varying rates of GJH in young populations, ranging from less than 5% to more than 50% [6]. This variation arises mainly from differences in assessment methods, age and sex composition, and ethnic backgrounds of the study groups. Overall, GJH is more common in girls, tends to peak before puberty, and is seen more frequently in Asian and African populations than in European groups [7]. In India, only a few small studies, mostly involving schoolgirls, have been published, and their findings are inconsistent [8]. Reliable community-based data, including both boys and girls, remains limited.

The Beighton score is the most commonly used method for assessing GJH. However, debate continues regarding the most suitable cutoff point for children and adolescents. Currently, a score of six or more out of nine is recommended for this age group [9]. The Hospital del Mar (HDM) criteria provide an alternative system for evaluating a broader set of joints. The use of both measures may offer a clearer picture of hypermobility in adolescents and strengthen prevalence estimates [10]. There is increasing evidence that JH is associated with musculoskeletal problems. Adolescents with hypermobility are more likely to experience joint pain, fatigue, and sports-related injuries than their peers [3].

Research on athletes also suggests that ligamentous laxity increases the likelihood of sprains and dislocations and slows recovery after injuries [7]. However, most of this evidence comes from Western countries, and data from India are limited [8]. This study aimed to fill this gap by measuring the prevalence of JH in Indian adolescents using both Beighton and HDM criteria. This study will also examine the relationship between hypermobility and joint injuries.

Materials and Methods

The study is a cross-sectional analytical study, based at schools, that was carried out in three schools in Puducherry, South India between October 2023 and 2025. A population of 356 adolescents between the ages of 13 and 15 years was used. The Institutional Ethics Committee gave an ethical approval, and before consent was granted, the concerned authorities were notified. Informed consent was taken, in writing, before participant assessment, both of which were school authorities and parents/guardians.

Sample size estimation was based on data reported by Öhman et al., who observed a prevalence of generalized joint hypermobility of 34% using the Hospital del Mar (HDM) score and 12% using the Beighton score, yielding an estimated absolute risk difference of 22%. Assuming a two-sided α of 0.05, 80% power, and equal group allocation, the minimum required sample size was calculated as 56 participants using the formula:

$$n = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \times [p_1(1 - p_1) + p_2(1 - p_2)]}{(p_1 - p_2)^2}$$

To improve external validity and permit subgroup analyses, the target sample size was pragmatically increased to 300 adolescents. Ultimately, 356 adolescents were enrolled in the study.

The inclusion criteria included adolescents aged between 13 and 15 years old with an informed consent given by the parents or guardians. The exclusion criteria comprised of the adolescents who had neurological or syndromic conditions in their past, a history of non-sport-related injuries, and the adolescents who undertook gymnastics because it is known to be associated with physiological hypermobility.

Upon measurement of anthropometric measures, two independent examiners measured the joint hypermobility of participants using Beighton score and Hospital del Mar (HDM) score. These two tests were administered on the same day separated by a 10-minute rest period between tests. Case-report forms contained the scores that were documented on standardized case-report forms and later inputted into a secure REDCap database. What is being measured in the Beighton score is the nine joint movements, such as passive dorsiflexion of the fifth metacarpophalangeal joint, passive opposition of the thumb to the forearm, the hyper extension of elbows and knee more than 10 degrees, and the forward flexion of the trunk with the palms flat on the floor. The range of the scores is between 0 and 9 with a cutoff of 4 being applied in determining hypermobility in this research. The Hospital del Mar scale evaluates the passive mobility of several joints arranged in a finger, elbow, shoulder, hip, knee, patella, ankle, metatarsophalangeal, and trunk mobility, with the highest amount of 11. The cutoff point was 4 and above which was taken to be hypermobility. Though in some cases, higher cutoffs are advised in adolescent populations, a threshold of 4 and above was used in both systems of scoring to ensure consistency and comparability.

There were two groups of the participants: the generalized joint hypermobility (GJH) group, which included adolescents who fulfilled the criteria of hypermobility on either the Beighton or the Hospital del Mar (HDM) scale, and a non-GJH group, including adolescents who failed to fulfil hypermobility criteria on both scales. All the participants were then interviewed on whether they had any medically proven joint injuries in the past 12 months during organized or recreational sports activities and the frequency of the injuries was contrasted between the two groups.

Data were double-entered and cross-validated prior to analysis. Continuous variables were summarized as mean ± standard deviation, while categorical variables were expressed as frequencies and percentages. Associations between joint hypermobility, demographic variables, nutritional status, and injury occurrence were examined using the Chi-square test. Agreement between assessors was evaluated using Cohen's kappa (κ). Statistical significance was set at $p < 0.05$. All analyses were performed using IBM SPSS Statistics for Windows, version 17.0.

Results

The study included 356 adolescents aged 13–15 years, with 16 adolescents (4.5%) aged 13 years, 134 (37.6%) aged 14 years, and 206 (57.9%) aged 15 years. The mean age was 14.53 ± 0.58 years, and the mean BMI was 21.38 ± 4.675 kg/m². The gender distribution comprised 140 females (39.3%) and 216 males (60.7%) (Figure 1). Most adolescents resided in urban areas (265, 74.4%), while 91 (25.6%) were from rural areas. Regarding socio-economic status, 4 adolescents (1.1%) belonged to the lower class, 342 (96.1%) to the middle class, and 10 (2.8%) to the upper class. Nutritional assessment showed that 11 adolescents (3.1%) were lean built, 41 (11.5%) were underweight, 96 (27.0%) were overweight or at risk, and 207 (58.1%) were well built. Based on BMI classification, 260 adolescents (73.0%) were in the normal/underweight category, while 96 (27.0%) were classified as overweight or at risk (Table 1).

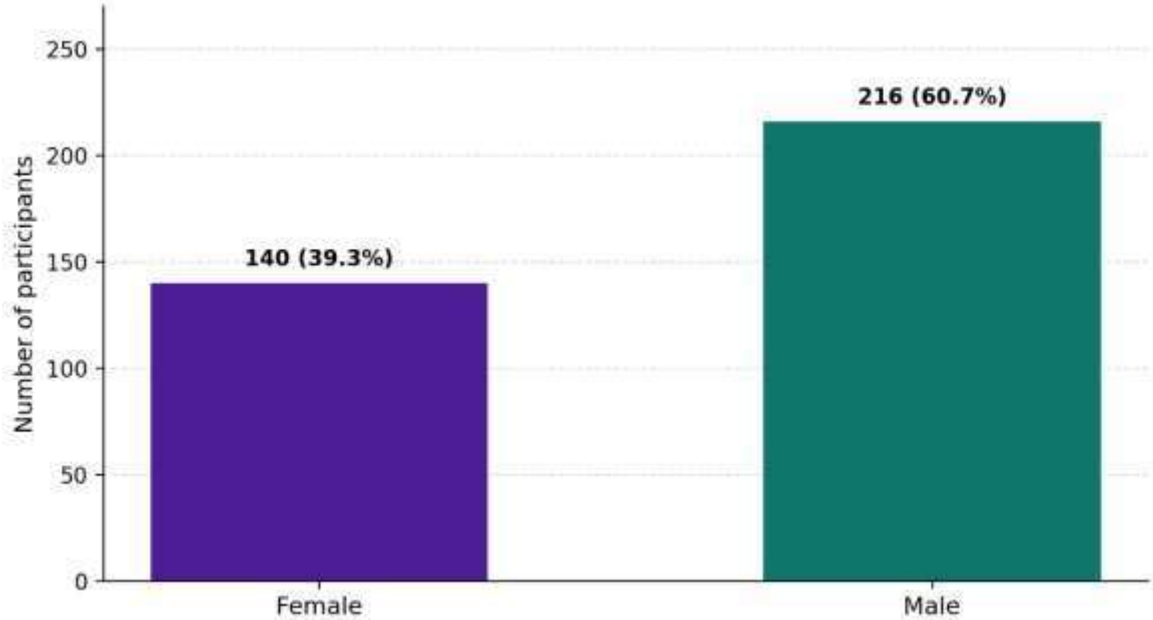

Figure 1: Gender Distribution of the Study Population

Table 1: Demographic and Baseline Characteristics of the Study Population (n = 356)

Variable	Category	Frequency (%)
Age (years)	13	16 (4.5%)
	14	134 (37.6%)
	15	206 (57.9%)
Gender	Female	140 (39.3%)
	Male	216 (60.7%)
Location	Urban	265 (74.4%)
	Rural	91 (25.6%)
Socio-economic status	Lower class	4 (1.1%)
	Middle class	342 (96.1%)
	Upper class	10 (2.8%)
Nutritional status	Lean built	11 (3.1%)
	Underweight	41 (11.5%)
	Overweight / Risk	96 (27.0%)
	Well built	207 (58.1%)
BMI category	Normal / Underweight	260 (73.0%)
	Overweight / Risk	96 (27.0%)

The mean Beighton score was 2.04 ± 1.78, and the mean Hospital del Mar (HDM) score was 1.78 ± 1.47. Based on the Beighton scoring system, 315 adolescents (88.5%) were classified as non-hypermobile (scores 0–3), while 41 (11.5%) were identified as hypermobile (scores 4–9). Using the HDM score, 317 adolescents (89.0%) were non-hypermobile (scores 0–3), and 39 (11.0%) were hypermobile (scores 4–11). When both scoring systems were considered concurrently, 298 adolescents (83.7%) did not meet hypermobility criteria on either scale, 19 (5.3%) were positive only on the Beighton score, 17 (4.8%) were positive only on the HDM score, and 22 (6.2%) were positive on both scales, representing dual-positive cases of generalized joint hypermobility (Table 2).

Table 2: Distribution of Joint Hypermobility According to Beighton and Hospital del Mar Scores (n = 356)

Scoring system	Category	N (%)
Beighton score	Non-hypermobile (0–3)	315 (88.5%)
	Hypermobile (4–9)	41 (11.5%)
Hospital del Mar score	Non-hypermobile (0–3)	317 (89.0%)
	Hypermobile (4–11)	39 (11.0%)
Combined scores	Neither ≥4	298 (83.7%)
	Beighton only ≥4	19 (5.3%)
	HDM only ≥4	17 (4.8%)
	Both ≥4 (dual positive)	22 (6.2%)

Among the adolescents, 313 (87.9%) reported no injury, while 43 (12.1%) sustained at least one musculoskeletal injury. The knee was the most commonly affected site, with injuries involving the right knee in 13 participants (3.7%) and the left knee in 10 participants (2.8%). Left ankle injuries were reported in 2 participants (0.6%). Overall, lower limb injuries were infrequent, and the majority of the study population remained injury-free (Table 3, Figure 2).

Table 3: Distribution of Injuries by Status and Anatomical Location (n = 356)

Variable	Category	N (%)
Injury status	No	313 (87.9%)
	Yes	43 (12.1%)
Site and location of injury	Right knee	13 (3.7%)
	Left knee	10 (2.8%)
	Left ankle	2 (0.6%)

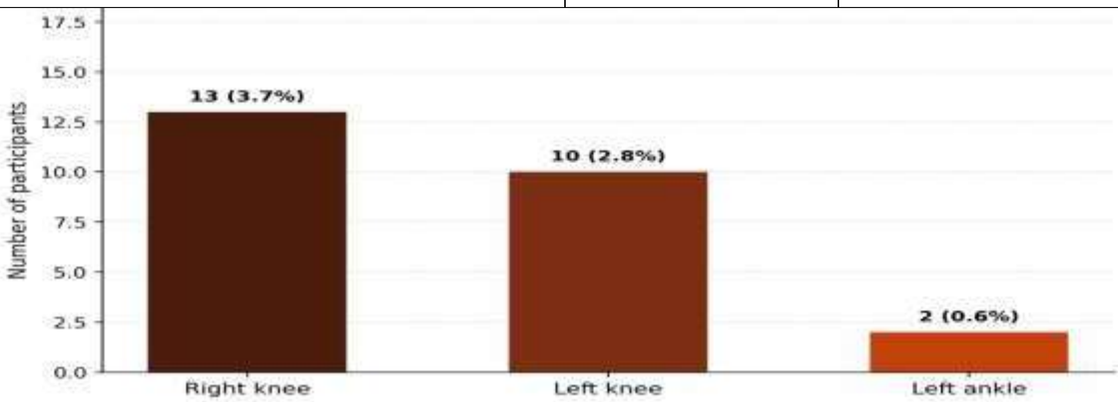

Figure 2: Distribution of Musculoskeletal Injuries by Anatomical Location

Significant associations with injury occurrence were observed for gender, Beighton score, Hospital del Mar (HDM) score, nutritional status, and BMI ($p < 0.05$). Injury prevalence did not differ significantly across age groups, with injuries reported in 12.5% of 13-year-olds, 14.2% of 14-year-olds, and 10.7% of 15-year-olds ($p = 0.625$). Males experienced a significantly higher proportion of injuries compared with females (14.8% vs. 7.9%, $p = 0.049$). Adolescents with a Beighton score ≥4 had a higher injury prevalence than those with scores of 0–3 (22% vs. 10.8%, $p = 0.009$), and similarly, those with an HDM score ≥4 showed greater injury occurrence compared with lower scores (23.1% vs. 10.7%, $p = 0.036$). All injuries occurred among adolescents belonging to the middle socioeconomic class; however, this association was not statistically significant ($p = 0.368$). Although injury rates were numerically higher among rural adolescents (14.3%) than urban adolescents (11.3%), the difference was not significant ($p = 0.454$). Nutritional status demonstrated a significant association, with overweight or at-risk adolescents showing higher injury rates (15.6%) than well-built individuals (9.7%, $p = 0.010$). BMI classification similarly revealed a higher injury prevalence among overweight or at-risk adolescents compared with those with normal or underweight BMI (15.6% vs. 10.8%, $p = 0.002$) (Table 4).

Table 4: Association Between Demographic Characteristics, Hypermobility Scores, and Injury Occurrence (n = 356)

Variable	Category	Injury – Yes (%)	Injury – No (%)	PValue
Age (years)	13	2 (12.5%)	14 (87.5%)	0.625
	14	19 (14.2%)	115 (85.8%)	
	15	22 (10.7%)	184 (89.3%)	
Gender	Female	11 (7.9%)	129 (92.1%)	0.049*
	Male	32 (14.8%)	184 (85.2%)	
Beighton score	0–3	34 (10.8%)	281 (89.2%)	0.009*
	≥4	9 (22.0%)	32 (78.0%)	
HDM score	0–3	34 (10.7%)	283 (89.3%)	0.036*
	≥4	9 (23.1%)	30 (76.9%)	
Socio-economic status	Lower	0 (0%)	4 (100%)	0.368
	Middle	43 (12.6%)	299 (87.4%)	
	Upper	0 (0%)	10 (100%)	
Location	Urban	30 (11.3%)	235 (88.7%)	0.454
	Rural	13 (14.3%)	78 (85.7%)	
Nutritional status	Overweight/Risk	15 (15.6%)	81 (84.4%)	0.010*
	Lean/Underweight	8 (15.1%)	45 (84.9%)	
	Well built	20 (9.7%)	187 (90.3%)	
BMI category	Normal/Underweight	28 (10.8%)	232 (89.2%)	0.002*
	Overweight/Risk	15 (15.6%)	81 (84.4%)	

P value < 0.05*

Discussion

The purpose of this study was to determine whether joint hypermobility was a predisposing factor to musculoskeletal injuries in adolescents. The study population consisted of adolescents aged between 13 and 15 years and mostly 15-year-olds and a higher percentage of males than females. This distribution can be a school enrolment, sampling, or more involvement in physical activities by men. Past studies have reported age- and sex-related differences in joint mobility. Ituen et al. have indicated that the prevalence of hypermobility was the greatest in the younger children and decreased with age with significant differences in the gender patterns of mobility, and the active nature of joint laxity in growth and development [11].

Both Beighton and Hospital del Mar (HDM) criteria were used to assess the subjects, and it was easy to see that the majority of adolescents in the current study were non-hypermobile with a smaller percentage exhibiting hypermobility on either scale. This observation aligns with previous research which had found lesser prevalence of generalized joint hypermobility in older children and adolescents. According to Ohman et al., hypermobility was found prevalent at 12 per cent with Beighton score and 34 per cent with HDM criteria in younger children, which highlights why HDM system is more sensitive in the detection of joint laxity [12]. Even though the suggestion of higher Beighton cut-offs in adolescents has been suggested, equal cut-offs of 4.0 in both scoring systems were used in this research not only to ensure consistency but also comparability with current literature.

Most of the adolescents in the current research did not record musculoskeletal injury, which represents a healthy group of adolescents. Knee and ankle were the most affected areas among those who were injured implying that weight bearing joints were more vulnerable. Such tendencies have been observed in the past Junge et al. have also described knee overuse injury to be frequent among children with generalized joint hypermobility and knee and ankle injuries were also found to be the most common locations of musculoskeletal trauma in adolescents by Reuter et al. [13,14]. These results help to suggest that alterations in joint biomechanics and susceptibility of these sites to injuries can be caused by joint laxity.

As nutrition assessment revealed, the majority of adolescents were well-built, but a significant number of them were overweight or at risk. Although the general nutritional status was found to be appropriate, the deviation on ideal body composition was linked to the occurrence of injury. Similar results were obtained in earlier works. Bozkurt reported mean values of BMI in the normal range in school children, and Perera et al. reported that BMI and hypermobility of the joints had significant relationships, which is the result of the complicated interdependence of the nutritional condition and the musculoskeletal state [15,16]. In the current study, an analysis by age established no significant difference in the prevalence of injuries between the 13 to 15-year age groups indicating relatively homogeneous exposure to risk of injuries in the early adolescence stages. It is consistent with the results of Blajwajs et al. who found a different age-related effect of a reduction in hypermobility prevalence but no stable age-related effect on injury occurrence [17]. There were some gender disparities where the prevalence of injuries was higher among the male gender as compared to the female gender. It can be a manifestation of increased involvement in risk-prone or high-intensity physical activities in males. Quatman et al., on the other hand, found more females had suffered a ligamentous and ankle injury, and higher rates of injury could be dependent on the type of activity, biomechanics, and characteristics of the population [18]. One of the main results of this study was that the prevalence of injuries in adolescents with joint hypermobility is much higher than that of non-hypermobile adolescents measured by the Beighton and HDM scores. This confirms this hypothesis that joint hypermobility is a relevant risk factor of musculoskeletal injury among adolescents. Russek and Errico have also reported similar associations and noted that more people were injured because of generalized joint hypermobility and joint hypermobility syndrome [19]. The increased count of injuries according to the HDM criteria also contributes to its application in the field of detecting clinically relevant hypermobility [11]. Even though all of the injuries in the current research involved adolescents whose socioeconomic status was in the middle socioeconomic group, there was no statistically significant correlation between socioeconomic status and the occurrence of injuries, probably because other classes were not represented well. In a comparable manner, the urban-rural residence was not a significant predictor of injury risk, indicating that hypermobility and nutritional influences might have a more significant role than the environment. Other past research has also indicated incongruous relationships between socioeconomic factors and sports-related injuries [20]. Altogether, the results of this paper show that joint hypermobility among adolescents is connected with the greater vulnerability to musculoskeletal injuries, in particular, the knee and ankle [21]. Injury risk was also increased by gender of males and nutritional imbalance [22]. These findings emphasize the significance of early diagnosis of joint hypermobility, gender-sensitive injury prevention programs, and encouraging balanced nutrition as the means of promoting muscle-related health and lowering the risk of injuries in adolescence.

Limitations of the Study

This cross-sectional study design does not permit the establishment of causal relationships between joint hypermobility and injury risk. The findings are based on a single regional sample and therefore may not be generalizable to all adolescent populations. The reliance on self-reported injury history introduces the possibility of recall bias, which may influence the accuracy of the reported outcomes. Additionally, the exclusion criteria applied in the study could have affected the estimated prevalence of joint hypermobility. Variability between the two assessment scoring systems used to identify joint hypermobility also limits standardization and may influence diagnostic consistency across different settings.

Conclusion

Joint hypermobility in adolescents is significantly associated with an increased risk of musculoskeletal injuries, particularly involving the knee and ankle. Male gender and nutritional imbalance further contribute to injury susceptibility, whereas age, socio-economic status, and place of residence do not appear to exert a significant influence. These findings underscore the importance of early identification of joint hypermobility and the implementation of targeted preventive strategies that emphasise joint stability, appropriate physical activity, and the promotion of a balanced diet to support optimal musculoskeletal health and reduce injury risk during adolescence.

Acknowledgement

The authors acknowledge the Institutional Ethics Committee, the administrative authorities, school principals, participating adolescents and their parents, and all individuals who supported data collection and assessment for their cooperation and assistance in conducting this study.

Funding
This study received no external funding.
Conflict of Interest
The authors declare no conflict of interest.

References

1. Castori M, Tinkle B, Levy H, Grahame R, Malfait F, Hakim A. A framework for the classification of joint hypermobility and related conditions. Am J Med Genet C Semin Med Genet. 2017;175(1):148-57. doi: 10.1002/ajmg.c.31539. PMID: 28145606.
2. Pacey V, Nicholson LL, Adams RD, Munn J, Munns CF. Generalized joint hypermobility and risk of lower limb joint injury during sport: a systematic review with meta-analysis. Am J Sports Med. 2010;38(7):1487-97. doi: 10.1177/0363546510364838.
3. Tofts LJ, Simmonds J, Schwartz SB, Richheimer RM, O'Connor C, Elias E, et al. Pediatric joint hypermobility: a diagnostic framework and narrative review. Orphanet J Rare Dis. 2023;18(1):104. doi: 10.1186/s13023-023-02717-2. PMID: 37143135.
4. Yew KS, Kamps-Schmitt KA, Borge R. Hypermobile Ehlers-Danlos syndrome and hypermobility spectrum disorders. Am Fam Physician. 2021;103(8):481-92. PMID: 33856167.
5. Dhankher P, Yadav JS, Devgan A. Hypermobility in adolescent females: Prevalence data from India and Europe. Int J Sci Adv. 2021;Special Issue:1-6. doi: 10.51542/ijscia.spi1.06.
6. Williams CM, Welch JJ, Scheper M, Tofts L, Pacey V. Variability of joint hypermobility in children: a meta-analytic approach to set cut-off scores. Eur J Pediatr. 2024;183(8):3517-29. doi: 10.1007/s00431-024-05621-4. PMID: 38801562.
7. Malek S, Reinhold EJ, Pearce GS. The Beighton Score as a measure of generalised joint hypermobility. Rheumatol Int. 2021;41(10):1707-16. doi: 10.1007/s00296-021-04832-4. PMID: 33738549.
8. Black WR, DiCesare CA, Wright LA, Thomas S, Pfeiffer M, Kitchen K, et al. The effects of joint hypermobility on pain and functional biomechanics in adolescents with juvenile fibromyalgia: secondary baseline analysis from a pilot randomised controlled trial. BMC Pediatr. 2023;23(1):557. doi: 10.1186/s12887-023-04353-y. PMID: 37932711.
9. Tobias JH, Deere K, Palmer S, Clark EM, Clinch J. Joint hypermobility is a risk factor for musculoskeletal pain during adolescence: findings of a prospective cohort study. Arthritis Rheum. 2013;65(4):1107-15. doi: 10.1002/art.37836. PMID: 23450628.
10. Liaghat B, Pedersen JR, Young JJ, Thorlund JB, Juul-Kristensen B, Juhl CB. Joint hypermobility in athletes is associated with shoulder injuries: a systematic review and meta-analysis. BMC Musculoskelet Disord. 2021;22(1):389. doi: 10.1186/s12891-021-04249-x. PMID: 33902511.
11. Ituen OA, Anieto EM, Ferguson G, Duysens J, Smits-Engelsman B. Prevalence and demographic distribution of hypermobility in a random group of school-aged children in Nigeria. Healthcare (Basel). 2023;11(8):1092. doi: 10.3390/healthcare11081092. PMID: 37107934.
12. Öhman A, Westblom C, Henriksson M. Hypermobility among school children aged five to eight years: the Hospital del Mar Criteria gives a higher prevalence for hypermobility than the Beighton score. Clin Exp Rheumatol. 2014;32(2):285-90. PMID: 24143889.
13. Junge T, Larsen LR, Juul-Kristensen B, Wedderkopp N. The extent and risk of knee injuries in children aged 9-14 with Generalised Joint Hypermobility and knee joint hypermobility - the CHAMPS-study Denmark. BMC Musculoskelet Disord. 2015;16:143. doi: 10.1186/s12891-015-0611-5. PMID: 26065679.
14. Reuter PR, Fichthorn KR. Prevalence of generalized joint hypermobility, musculoskeletal injuries, and chronic musculoskeletal pain among American university students. PeerJ. 2019;7:e7625. doi: 10.7717/peerj.7625. PMID: 31565567.
15. Bozkurt S, Kayalar G, Tezel N, Güler T, Kesikburun B, Denizli M, et al. Hypermobility frequency in school children: relationship with idiopathic scoliosis, age, sex and musculoskeletal problems. Arch Rheumatol. 2019;34(3):268-73. doi: 10.5606/ArchRheumatol.2019.7181. PMID: 31598591.
16. Perera R, Rajakanthan N, Bulkees N, Perera N. Analysis of the association between generalised joint hypermobility and categories of malnutrition in a cohort of school children in Sri Lanka. Arch Dis Child. 2023;108(Suppl 2):A237-A238. doi: 10.1136/archdischild-2023-rcpch.377.
17. Blajwajs L, Williams J, Timmons W, Sproule J. Hypermobility prevalence, measurements, and outcomes in childhood, adolescence, and emerging adulthood: a systematic review. Rheumatol Int. 2023;43(8):1423-44. doi: 10.1007/s00296-023-05338-x. PMID: 37149553.
18. Quatman CE, Ford KR, Myer GD, Paterno MV, Hewett TE. The effects of gender and pubertal status on generalized joint laxity in young athletes. J Sci Med Sport. 2008;11(3):257-63. doi: 10.1016/j.jsams.2007.05.005. PMID: 17597005.

19. Russek LN, Errico DM. Prevalence, injury rate and symptom frequency in generalized joint laxity and joint hypermobility syndrome in a “healthy” college population. Clin Rheumatol. 2016;35(4):1029-39. doi: 10.1007/s10067-015-2951-9. PMID: 25930211.
20. Nathan JA, Davies K, Swaine I. Hypermobility and sports injury. BMJ Open Sport Exerc Med. 2018;4(1):e000366. doi: 10.1136/bmjsem-2018-000366. PMID: 30364440.
21. Hasija RP, Khubchandani RP, Shenoi S. Joint hypermobility in Indian children. Clin Exp Rheumatol. 2008;26(1):146-50. PMID: 18328164.
22. Sobhani-Eraghi A, Motalebi M, Sarreshtehdari S, Molazem-Sanandaji B, Hasanlu Z. Prevalence of joint hypermobility in children and adolescents: a systematic review and meta-analysis. J Res Med Sci. 2020;25:104. doi: 10.4103/jrms.JRMS_983_19. PMID: 33824669.