Original Article

Prevalence and associated risk factors of Genu valgum and Genu varum in school children of Abbottabad: A cross-sectional study

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Abstract

Objective: This study aimed to determine the prevalence, association and risk factors of genu varum and genu valgum and among school-going children.

Study Design: A Cross sectional study was conducted.

Place and duration of study: A cross-sectional study was conducted among 329 school-going children aged 6–12 years from public and private schools in Abbottabad All Public and Private Universities of Rawalpindi & Islamabad were included in the study.

Material and Methods: A cross-sectional study was conducted among 329 school-going children aged 6–12 years from public and private schools in Abbottabad using non-probability convenient sampling. Data were collected of demographic characteristics, lower limb alignment measurement for genu valgum and genu varum, as well as food intake. Data were analyzed using SPSS version 26 through Spearman correlation, and multivariant ordinal regression.

Results: Prevalence of 3.04% was recorded for lower leg deformities. The categorical variable Spearman correlation analysis revealed a highly significant negative association between age and deformity severity ($\rho = -0.233$, $p<0.01$) and a highly significant positive association with BMI ($\rho = 0.189$, $p<0.01$), while vegetables showed a weak negative significant association ($\rho = -0.122$, $p<0.01$). Ordinal regression indicated that the odds of higher deformity severity increase in BMI (OR = 2.008, 95% CI: 1.288–3.130) reduced odds with increase in age (OR = 0.795, 95% CI: 0.666–0.948). Vegetable showed reduced deformity whereas significantly increased odds was found with soda and unexpectedly with fruits.

Conclusion: Higher BMI significantly increased deformity severity and age showing a negative association (decrease with growth). It was recommended that parents needs to be aware and emphasized on children early screening, weight control, and proper nutrition.

Keywords: Genu varum, Genu valgum, BMI, Cross-sectional Studies

1. Introduction

Lower limb alignment is an important component in normal posture as it maintains locomotion and balance in children. During childhood development, a proper alignment of the lower extremities leads to optimal distribution of mechanical forces across joints that can help in building in children. (1)

The occurrence of the knees that deviate either outward or inward from the normal axis of alignment conditions are considered angular deformities of the knee joint. In children, the lower limb deformities are noticeable genu varum (bow legs) and genu valgum (knock knees). (2) During the school-age period when children are undergoing active skeletal growth, therefore the early detection of genu varum and genu valgum is essential. If not identified and managed appropriately then such abnormalities may compromise joint stability and interfere with normal gait mechanics, potentially leading to long-term musculoskeletal complications. (3) Children of age 3 to 6 are seen to develop genu valgum and genu varus, however stable alignment of the legs are seen as children reach age 7 to 8 years. (4)The deformities limb alignment with pathological conditions can be due to metabolic bone diseases,

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skeletal dysplasia, abnormalities of the growth plate and rickets. [5] These abnormalities if left untreated it can lead to long-term biomechanical complications such as increased risk of musculoskeletal injuries, early degenerative joint changes, altered gait mechanics and patellofemoral instability. [6]

The several environmental and lifestyle factors that influence children alignment in skeletal growth includes sedentary lifestyle and poor nutritional status, as well as additional inappropriate footwear, heavy school bags, inadequate physical activity and exposure to fluoride in drinking water. [7, 8] Unfortunately, information regarding the prevalence and associated risk factors of genu varum and genu valgum among school-going children is limited in Pakistan. [9] Furthermore, lack of epidemiological data has made it difficult for policymakers and healthcare professionals for designing intervention that effectively prevent and manage these deformities. Despite genu varum and genu valgum with important clinical recognition, data of these deformities in Pakistan remain scarce. Addressing this knowledge gap is essential for informing screening initiatives, preventive strategies, and healthcare planning. Therefore, this study aims to determine the prevalence, association and risk factors associated with genu varum and genu valgum among school-going children

2. Materials & Methods

Cross sectional study design ,Public and private schools in Abbottabad School going children aged 6-12 years A total of 334 patients was calculated using prevalence sampling formula:

$$N = \frac{Z^2 . p . (1-p)}{d^2}$$

Where, 'Z'-score is confidence (95%=1.96), 'p' prevalence proportion (32%) [10], '1-p' with no proportion and 'd' is margin of error (0.05). However the final estimate Non probability convenient sampling method was used. The final estimate of sample size after data collection was 329.

Inclusion criteria:

Gender: male and female (children) Age group: 6 to 12 years. They must be able to walk independently, Children from diverse socio economics backgrounds (to study the influence of socio economics status).

Exclusion criteria: Students with the major history of fracture and recent surgeries of lower limbs, Individuals who have neuromuscular problems like cerebral palsy and muscular dystrophy and who have congenital problems like clubfoot are often excluded, Children with developmental delays that impair physical examination reliability and with previous or current use of orthotic devices or braces for lower limb deformities

Data Collection Tools: After ethical approval (RSC/WIRS-25/210), data was collected from school-going children who fulfilled the inclusion criteria for the study. After obtaining informed consent from parents or guardians, each participant underwent a self-structured questionnaire to evaluate lower limb alignment including demographic characteristics, Intercondylar Distance (ICD), Intermalleolar Distance (IMD), physical activity and food frequency questionnaire. For assessment of genu varum, participants were instructed to stand with the medial malleoli touching each other. The ICD (distance between the medial femoral condyles) was measured; where space greater than 6 cm was considered indicative of genu varum. For genu valgum, the IMD (distance between the medial malleoli) greater than 8 cm was considered indicative of genu valgum. Tibiofemoral angle was measured by goniometer, where above 12° deviation was marked abnormal. Measurements were taken trice and average value was reported for each participant. The average severity index for ICD, IMD and TFA was taken in account and on which bases the limb alignment deformity was categorized as no (normal), mild, moderate and severe.

Statistical analysis: Analysis for the collected data wasperformed through SPSS Version 26. Data entry was performed manually and then further organized into percentage and frequency. Association between deformities and nutrition was assessed using spearman correlation and prediction of risk factors was calculated using multivariant ordinal regression analysis for leg severity deformities (no, mild, moderate and severe). $P \leq 0.05$ was considered significant.

3. Results

Table 1: Demographic distribution of study participants .

Demographic characteristics		Frequency (%)
Gender	Female	159 (48.33)
	Male	170 (51.67)
BMI	Underweight	63 (19.15)
	Normal	225 (68.39)
	Overweight	41 (12.46)

Table 1 shows demographic information of participants. The number of male (51.67%) was slightly higher than female (48.33%) children. The number of participants with normal BMI (68.39%) was highest followed by underweight (19.15%) and overweight (12.46%).

Table 2: Lower limb alignment clinical assessment

Measurements			Frequency (%)
ICD		Normal	280 (85.11)
		Abnormal	49 (14.89)
IMD		Normal	329 (100)
		Abnormal	-
TFA	Right	Normal	227 (69)
		Abnormal	102 (31)
	Left	Normal	247 (75.08)
		Abnormal	82 (24.92)

According to the study findings shown in table 2, the number of normal cases for ICD (85.11%) was higher than abnormal cases. The IMD measurements were taken for all participants and all cases were found to not surpass thrashhold range for genu valgum. The TFA of both legs was also measured, wherein the right leg the normal cases (69%) were higher than abnormal cases (31%). Similar trend was observed in left leg, were normal cases(75.08%) exceeded than abnormal cases(24.92%).

Table 3: Deformities severity of children participated in the study.

Measurements		Frequency (%)
Limb alignment deformity severity	No	195 (59.27)
	Mild	124 (37.69)
	Moderate	8 (2.43)
	Severe	2 (0.61)
Physical activity / Week	No activity	37 (11.25)
	Less (1-2 times)	57 (17.33)
	Few (3-4 times)	115 (34.95)
	Often (5-6 times)	54 (16.41)
	Daily (7 times)	66 (20.06)

Table 3 results show the frequency of different levels of severity in genu valgum and genu varum.The highest numbers of individuals showed no deformities (59.27%), followed by (37.69%) with mild deformity alignments. The least number of participants were recorded for the moderate (2.43%), followed by severe (0.61%) deformities. The total prevalence of lower limb deformity thus recorded normal (no and mild deformity) was 96.96% and abnormal deformity (moderate and severe) was overall 3.04%. Regard to physical activities per week, results showed that higher number of children were doing physical activity 3 to 4 times a week (34.95%) followed by those which were on daily basis (20.06%) doing physical activities. Whereas, 16.41% children were doing often (5-6 times) a week physical activities, and 17.33 % children response with 1 to 2 times, less physical activities.

Table 4. Correlation and odd risk factors of lower limb deformities.

Study variables		Lower limb deformities severity			
		Correlation	Odd Ratio	95% Confidence Interval	
				Lower Bound	Upper Bound
Demographic Characteristics	Age	-0.233**	0.795*	0.666	0.948
	Gender	-0.03 ^{ns}	0.225 ^{ns}	0.047	1.075
	BMI	0.189**	2.008*	1.288	3.130
Physical Activities		0.031^{ns}	0.890 ^{ns}	0.734	1.078
Nutritional factors	Juice	0.110*	1.377 ^{ns}	0.988	1.921
	Soda	0.170**	1.610*	1.140	2.273
	Milk	-0.043 ^{ns}	0.828 ^{ns}	0.585	1.173
	Meat	-0.108^{ns}	0.630 ^{ns}	0.337	1.179
	Candies	0.136*	1.173 ^{ns}	0.760	1.811
	Eggs	0.157**	0.778 ^{ns}	0.519	1.164
	Vegetables	-0.122*	0.291*	0.136	0.623
	Fruits	0.161**	1.626*	1.149	2.302
	Junk food	0.178**	3.857*	1.779	8.354

(*=$p<0.05$, **=$p<0.01$, ns=$p>0.05$)

The correlation and risk factors associated with deformities severity is presented in table 4. Results showed that there was highly significant weak negative association (ρ = -0.233, p<0.01) of leg deformities with age, and highly significant weak positive association (ρ = 0.189, p<0.01) with BMI. Physical activities, showed non-significant association (p>0.05) with deformities severity. Among the nutritional factor, juice, soda, candies, eggs, cook/fried food, fruits, and junk food were found with significant weak positive (p<0.05) association with lower limb deformities severity. Only, vegetables was found significantly negatively weak associated (ρ = -0.122, $p<0.01$) with severity. Results showed that the odd ratio for age was found to significantly decrease (OR = 0.795, 95% CI: 0.666-0.948, $p<0.05$) and increase for BMI (OR=2.008, 95% Cl: 1.288-3.130, $p<0.05$). As for nutritional factors, significant increase in OR with soda (OR=1.610, 95% Cl: 1.140-2.273, $p<0.01$) and unfortunately with fruits (OR=1.626, 95% Cl: 1.149-2.302, $p<0.05$) was found whereas highly significant decrease in OR was found with vegetables (OR=0.291, 95% Cl: 0.136-0.623, $p<0.01$).

4. Discussion

The present study showed that a small number of subjects had mild to severe deformity, and the majority of participants had normal alignment in their lower limbs. Body Mass Index (BMI) and dietary practices were among the demographic variables that showed a strong relationship with severity, which can be explained by biochemical loading mechanisms. Individuals with higher body weight increases compressive and shear forces across knee joint which impact standing and gait. This mechanical load alters excess stress on plates and lower limb axis which adversely affect skeletal development and contribute to the development and progression of lower limb deformities, likely increase risk of anterior cruciate ligament (ACL) injuries. [11] Over time, it may contribute to progression of coronal plane malalignment (genu valgum). These findings show that, in Pakistani individuals, both biological factors, such as growth and BMI, and modifiable lifestyle factors, such as nutrition and eating habits, have an important influence on the development of genu varum and genu valgum in school-aged children. Previous studies demonstrate that during childhood the knee alignment is affected by various reasons such as body weight, nutrition, growth patterns, and environmental factors, suggesting that overweight and obese children are exposed to greater mechanical demands that may influence lower limb alignment. [12] Similar demographic patterns were found in a previous study that looked at knee alignment in Brazilian students. [13] Another study identified the overweight children were found to be highly correlated with genu valgum. The difference observed in these studies can be due to variation in eating habits, socioeconomic status and financial stability. [14] Recent studies showed that children with genu valgum often have less stability in their lower limbs, and also the biomechanics of the hip muscles were also altered. [15] This proves that exercise has a marked effect on building muscle strength and is also beneficial for improving nerve-muscle coordination in order to maintain stability in growing children. Additionally, musculoskeletal complaints and postural abnormalities were higher in those kids which have high screen time and sedentary lifestyle. [16]

Physical activity adequately contributes to musculoskeletal development by enhancing dynamic joint stability, balance, neuromuscular control and muscle strength. Individuals, particularly children that are inactive may exhibit reduced muscular support around the hip and knee thereby decreasing athletic performance and potentially increasing the risk of knee injuries. [17] Decrease in physical activity may result in decreased muscle strength and change in biomechanical alignment, which indirectly contribute to knee deformities. These findings are steady with preceding studies indicating that moderate versions in knee alignment are not unusual at some point of youth however have a tendency to frequently grow. [18] The majority of genu valgum cases in school children reported in the literature were mild and did not necessitate medical attention. [19]

Studies found that in populations with a higher prevalence of nutritional deficiencies have found greater severity of deformities. Children who were deficient in vitamin D had a higher rate of significant genu varum and genu valgum. [20] The same tendencies have been observed in some studies, with children often eating processed snacks with a high amount of calories and little necessary nutrients. [21] Past research have indicated overweight and obese children being predisposed to develop genu valgum because they expose the knee joints to higher mechanical load. [22]

Other dietary factors were found to have weakly positive relationships with the severity of deformity, with vegetables having a weak negative relationship. The findings indicate that dietary habits might have an impact on the musculoskeletal development, but the correlations are quite low. [23, 24]

Studies have also established the need to utilize early musculoskeletal screening programs in schools in order to screen orthopedic abnormalities at an early stage. Screening programs in schools enable medical practitioners to identify the deformities at earlier stages before they advance to more serious levels. Study refer to the importance of early detection with the help of school health programs as per the effectiveness of conservative management techniques, such as physiotherapy and corrective exercises. [25]

The results indicated that deformity severity tended to decrease with increasing age, whereas higher BMI was associated with greater severity of deformities. Regarding nutritional factors, soda and unexpectedly fruit was associated with increased odds of deformity severity. On the other hand, vegetable intake was significantly associated with reduced odds of severe deformities. However, some variables did not show significant predictive values suggested that the factors not included in the model also contribute to development of knee deformity. The importance of comprehensive preventive strategies that combine nutritional interventions, physical activity promotion, musculoskeletal screening and early clinical management were also highlighted. The prevented strategies may reduce the prevalence of knee deformities and promote optimal musculoskeletal health among school going children .

Conclusion

It was concluded that small proportion of school children had deformities. The higher BMI and eating habits of vegetable, particularly vegetable intake tend to decrease these deformities. Clinical reliable measurements including intercondylar distance (ICD), intermalleolar distance (IMD), and tibiofemoral angle (TFA) proved as cost-effective tools can be used for identification of these deformities. These results highlight the importance of maintaining healthy BMI and dietary intake, as well as recommends early musculoskeletal screening in reducing progression of deformities and reduce long-term functional complications in children.

Limitations

The cross-sectional design allows identification of associations but does not establish causal relationships between the examined risk factors and lower limb deformities. In addition, the use of non-probability convenience sampling may limit the generalizability of the results to the wider population of school-aged children. Furthermore, the study was conducted only in selected public and private schools of Abbottabad, which may not fully represent children from other regions or backgrounds.

Disclosure /Conflict of interest:

Authors declare no conflict of interest.

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