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Correlations of Postural Abnormalities, Height, Weight, and BMI with the Level of Physical Activity in Students

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Abstract

Background: The rate of postural abnormalities, particularly among young individuals, is increasing. Therefore, the present study aimed to investigate the correlations of postural abnormalities, height, weight, and BMI with the level of physical activity in students.

Methods: This descriptive correlational field study, included 2001 sixth-grade students from Yazd province (1000 boys and 1001 girls) who were randomly selected through cluster sampling based on the Morgan table. To conduct the study, the necessary data were collected through a questionnaire (to gather the participants' anthropometric information, such as age, height, weight, gender, and the prevalence of postural abnormalities, including forward head posture, kyphosis, lordosis, torticollis, knock knees, bow legs, flat feet, crooked big toe, asymmetrical pelvis, scoliosis, drooping shoulders, elevated shoulders, and internally rotated shoulders) and a measurement registration form (sample questionnaires are provided in the appendix).

Results: A positive correlation was revealed between weight and winged scapula, bow legs, and internally rotated shoulders, and lumbar lordosis was negatively correlated with weight and knock knees, and flat feet ($p < 0.01$). Hyperlordosis was positively correlated with height and winged scapula ($p < 0.01$), and internally rotated shoulders ($p < 0.05$). Additionally, a negative correlation was found between the level of physical activity and winged scapula, knock knees, bow legs, flat feet, internally rotated shoulders, and lumbar lordosis ($p < 0.01$).

Conclusion: Based on the findings of this study, physical education teachers should introduce students to various exercises and stretches necessary for correcting these abnormalities alongside regular physical activities.

Key Words: Abnormalities, Postural Structure, Students, Yazd Provinc.

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1- INTRODUCTION

Physical health and maintaining an optimal body posture are critical factors in human life, as both positive and negative changes in these areas can affect various aspects of life (1). Postural structure, particularly the alignment of the spine, plays a pivotal role in maintaining body stability and balance. The spine, acting as the body's central axis, is susceptible to abnormalities due to a range of activities, especially when combined with poor physical habits (2).

Postural health is influenced by several factors, including muscle strength, skeletal alignment, and joint flexibility. Weakness in the muscles supporting the spine can lead to both static and dynamic imbalances, commonly referred to as postural abnormalities (3). These include conditions such as kyphosis, lordosis, and scoliosis. Notably, kyphosis, characterized by a curvature in the thoracic region, is often associated with weakened chest muscles and poor respiratory function. This is exacerbated in individuals with a high body mass index (BMI), as the extra weight places additional strain on the spine and musculoskeletal system (4).

Lumbar lordosis, which refers to an excessive inward curvature of the lower spine, is another common postural issue. Failure to address postural abnormalities like this can lead to long-term, irreversible damages. In fact, research has shown that individuals who do not engage in regular physical activity are more likely to develop these postural issues due to weakened trunk muscles and poor body alignment (5, 6).

The relationship between BMI, height, weight, and physical activity levels is crucial when considering postural health. Recent studies have consistently shown that individuals with a higher BMI, particularly those categorized as overweight or obese, are more prone to postural abnormalities. For instance, a 2024-study by Bober demonstrated that excess weight significantly impacts foot and knee posture, leading to conditions such as pes planus (flat feet) and genu valgum (knock knees) (7).

In contrast, regular physical activity plays a vital role in preventing or mitigating these issues by improving muscle endurance, balance, and overall body posture (4).

Moreover, a systematic review of the literature conducted in 2023 highlighted the role of physical inactivity in exacerbating postural abnormalities (8).

The review showed that sedentary behaviors, such as prolonged sitting, not only leads to imbalanced trunk muscles but also affects the alignment of the thoracic and lumbar spine. In particular, students with low levels of physical activity were found to have lower trunk muscle endurance and a higher likelihood of developing poor postural habits (2, 6).

Interestingly, some research has presented conflicting findings on the direct relationship between physical activity and certain postural conditions like scoliosis. While some studies have identified physical inactivity as a significant risk factor for scoliosis, others have found no direct association. However, it is generally agreed that moderate-intensity physical activity, particularly activities that involve symmetrical movements, can help prevent many postural problems (5, 9).

This growing body of research underscores the need for targeted interventions in school environments, where children and adolescents are at a critical stage of physical development. By promoting regular physical activity and monitoring BMI levels, educators and healthcare professionals can play a key role in preventing the development of chronic postural abnormalities in students (2, 10).

2- MATERIALS AND METHODS

2-1. Design and population

This research falls under the category of descriptive-field studies, where the researcher aims to describe body abnormalities without introducing any experimental variables or interference. Data was collected on a relatively large scale. Random sampling was conducted from various educational districts in Yazd province. The statistical population of this study consisted of all sixth-grade students in Yazd province during the 2019-2020 academic year, approximately 19,000 students.

2-1-1. Sampling Method

The sampling method used in this study was cluster random sampling. In each educational district, a number of schools were randomly selected, and from each school, sixth-grade students were randomly chosen from class lists. A total of 2000 students participated in the study, as per the Morgan table.

2-1-2. Sample Size

The sample size, calculated using the Cochran formula, was determined to be 376 students. However, given the importance of the study, the researcher decided to include 2000 students, consisting of 1000 boys and 1000 girls.

2-2. Data Collection

The first researcher participated in a practical training session on using a flexible ruler for measurements. After ensuring the accuracy of the measurements, official introduction letters were issued by the education authorities. With permission, the researcher visited the schools, coordinated with the school principals and teachers, and selected students for the study. After explaining the measurement process and obtaining consent, measurements were conducted at the respective school locations.

2-2-1. Tools and Instruments

a) Flexible Ruler: A 30, 40, and 60 cm flexible ruler (AIDU brand, made in Thailand) was used to record spinal curvatures such as lumbar lordosis and thoracic kyphosis. This tool is lightweight, easy to use, and accurate, with a reliability coefficient of 97% (11).

b) Measuring Tape: A 200 cm measuring tape was installed on the wall to measure the students' heights (without shoes) by placing a ruler horizontally above their heads.

c) Home Scale: A home scale was used to measure body weight in kilograms.

d) Marker: A non-permanent marker was used to mark the spinous processes of the vertebrae for measurement.

e) Graph Paper: A 100 cm by 70 cm piece of graph paper was used to draw the spinal curves measured with the flexible ruler.

f) Questionnaire: A questionnaire was used to gather anthropometric data, including age, height, weight, gender, and the presence of postural abnormalities.

g) Caliper: A caliper, with an accuracy of one-tenth of a millimeter, was used to measure the distance between anatomical landmarks for assessing genu varum (bow legs) and genu valgum (knock knees).

h) Talcum Powder: Talcum powder was used to assess foot posture, particularly in cases of flat feet.

i) Goniometer Set: A set of six goniometers, made of steel, was used to measure joint angles and range of motion.

j) New York Test: This test, developed by the New York State Education Department, assesses 13 different body postures, 11 of which are related to spinal evaluation. Scores range from 1 (severe abnormality) to 5 (normal posture).

2-2-2- Evaluative Methods for Postural Abnormalities

a) Kyphosis: Kyphosis is assessed by measuring the curvature of the upper back, specifically between the fourth and twelfth thoracic vertebrae, using a flexible ruler.

b) Lordosis: Lordosis is evaluated by measuring the lumbar curvature between the first lumbar vertebra and the sacrum using a flexible ruler.

c) Genu Varum and Genu Valgum: These conditions are assessed through visual examination and measurements with a caliper or measuring tape.

2-3- Data Analysis

Data collected were analyzed using SPSS version 21 for descriptive statistics, including measures of central tendency. Pearson's correlation coefficient was used to assess relationships between variables, and one-sample t-tests were conducted to compare means. The results were also visualized using Excel for graphical representation.

3- RESULTS

The frequency and percentage of the sample based on gender were generated as presented in Table 1, below.

Table-1: A Merged Table of Gender, Physical Activity, and Research Variables

Category	Number	Mean	Percentage/Std. Dev.
Boy	1001	N/A	50.03%
Girl	1000	N/A	49.97%
No Physical Activity	21	N/A	3.51%
Rare Physical Activity	101	N/A	16.89%
Moderate Physical Activity	214	N/A	35.78%
Frequent Physical Activity	188	N/A	31.44%
Height	2001	1.51	0.08 (SD)
Weight	2001	44.66	12.17 (SD)

The merged table above shows that the gender distribution is nearly equal, with boys constituting 50.03% and girls 49.97%. The physical activity levels reveal that most participants had moderate activity levels (35.78%), while a smaller percentage (3.51%) reported no activity. Regarding the research variables, the average height is 1.51 meters with a standard deviation of 0.08, and the average weight is 44.66 kilograms with a standard deviation of 12.17.

The document containing the Pearson correlation matrix has been created.

The results revealed the following correlations, as presented in Table 2:

✓ **Neck Deviation**: No significant correlation was found between neck deviation and height, weight, BMI, or physical activity, with p-values greater than 0.09.

✓ **Asymmetric Shoulder**: There was no significant correlation between asymmetric shoulder and the studied variables, as all p-values were above 0.16.

✓ **Winged Scapula**: A significant positive correlation was found between winged scapula and height ($r=0.10$, $p<0.001$), weight ($r=0.15$, $p<0.001$), and BMI ($r=0.13$, $p<0.001$), but a negative correlation with physical activity ($r=-0.10$, $p<0.001$).

✓ **Scoliosis**: There was no significant correlation between scoliosis and the variables, with p-values greater than 0.07.

✓ **Asymmetric Pelvis**: No significant correlation was observed for asymmetric pelvis, as all p-values were greater than 0.53.

✓ **Knock Knees**: A significant negative correlation was found between knock knees and weight (r=-0.13, p<0.001), BMI (r=-0.14, p<0.001), and physical activity (r=-0.12, p<0.001).

✓ **Bow Legs**: A significant positive correlation was observed with weight (r=0.13, p<0.001), BMI (r=0.14, p<0.001), and a negative correlation with physical activity (r=-0.13, p<0.001).

✓ **Inward Foot**: No significant correlation was observed between inward foot and any variables (p-values>0.19).

✓ **Outward Foot**: No significant correlation was found regarding outward foot (p-values>0.21).

✓ **Crooked Toe**: No significant correlation was found regarding crooked toe (p-values>0.20).

✓ **Flat Foot**: A significant negative correlation was observed between flat foot and weight (r=-0.08, p<0.001), BMI (r=-0.08, p<0.001), and physical activity (r=-0.12, p<0.001).

✓ **Arched Foot**: No significant correlation was found between arched foot and any of the variables (p-values>0.14).

✓ **Forward Head**: No significant correlation was found between forward head and any of the variables (p-values>0.07).

✓ **Kyphosis**: A slight significant negative correlation with BMI (r=-0.05, p<0.03) was observed.

✓ **Internally Rotated Shoulder**: Significant positive correlations were found with weight (r=0.06, p<0.007), BMI (r=0.07, p<0.003), and a negative correlation with physical activity (r=-0.08, p<0.001).

✓ **Flat Back**: No significant correlations were observed regarding flat back (p-values>0.11).

✓ **Lumbar Lordosis**: Significant negative correlations were found with weight (r=-0.06, p<0.01), BMI (r=-0.07, p<0.001), and physical activity (r=-0.09, p<0.001).

✓ **Hyperlordosis**: A slight significant correlation with height (r=0.06, p<0.009) was observed, but no significant correlation with the other variables.

✓ **Genu Recurvatum**: No significant correlations were found regarding genu recurvatum (p-values>0.53).

These results demonstrate significant correlations between several postural abnormalities and variables like height, weight, BMI, and physical activity, with stronger correlations noted for weight and BMI compared to height. Physical activity also showed significant inverse correlations with several abnormalities.

4- DISCUSSION

This study aimed to examine the correlation between postural abnormalities (e.g., winged scapula, knock knees, scoliosis) and factors such as height, weight, BMI, and physical activity among school-aged children. The findings revealed several significant correlations, particularly between postural abnormalities and BMI, weight, and physical activity, while height exhibited fewer significant relationships. The discussion below compares the study results with previous research and incorporates detailed analyses for each variable.

a) Neck Deviation

The study found no significant correlation between neck deviation and height, weight, BMI, or physical activity, with p-values greater than 0.09.

Table-2: Detailed Pearson Correlation Matrix for Postural Abnormalities

Postural Abnormalities	Test	Height	Weight	BMI	Physical Activity
Neck Deviation	Correlation	0.02	-0.03	-0.04	-0.03
	Significance	0.30	0.25	0.09	0.13
Asymmetric Shoulder	Correlation	-0.03	0.01	0.03	0.02
	Significance	0.16	0.52	0.18	0.24
Winged Scapula	Correlation	0.10	0.15	0.13	-0.10
	Significance	**0.001	**0.001	**0.001	**0.001
Scoliosis	Correlation	0.03	-0.02	-0.04	-0.01
	Significance	0.20	0.32	0.07	0.11
Asymmetric Pelvis	Correlation	0.008	-0.01	-0.01	-0.03
	Significance	0.71	0.53	0.57	0.68
Knock Knees	Correlation	-0.02	-0.13	-0.14	-0.12
	Significance	0.27	**0.001	**0.001	**0.001
Bow Legs	Correlation	0.03	0.13	0.14	-0.13
	Significance	0.25	**0.001	**0.001	**0.001
Inward Foot	Correlation	0.03	0.02	0.01	0.01
	Significance	0.19	0.31	0.54	0.68
Outward Foot	Correlation	0.01	-0.03	-0.04	-0.03
	Significance	0.58	0.22	0.06	0.21
Crooked Toe	Correlation	-0.01	0.02	0.03	0.03
	Significance	0.51	0.40	0.20	0.21
Flat Foot	Correlation	-0.03	-0.08	-0.08	-0.12
	Significance	0.16	**0.001	**0.001	**0.001
Arched Foot	Correlation	0.03	-0.01	-0.03	-0.02
	Significance	0.20	0.50	0.14	0.31
Forward Head	Correlation	-0.04	-0.03	-0.02	-0.02
	Significance	0.07	0.22	0.45	0.50
Kyphosis	Correlation	0.001	-0.04	-0.05	-0.03
	Significance	0.78	0.06	*0.03	0.22
Internally Rotated Shoulder	Correlation	0.006	0.06	0.07	-0.08
	Significance	*0.02	**0.007	**0.003	**0.001
Flat Back	Correlation	0.02	0.04	0.03	0.03
	Significance	0.34	0.11	0.15	0.15
Lumbar Lordosis	Correlation	0.008	-0.06	-0.07	-0.09
	Significance	0.73	**0.01	**0.001	**0.001
Hyperlordosis	Correlation	0.06	0.03	0.009	0.009
	Significance	**0.009	0.22	0.67	0.67
Genu Recurvatum	Correlation	0.008	-0.009	-0.01	-0.01
	Significance	0.71	0.70	0.53	0.53

These findings are in line with some previous research, suggesting that neck deviation is more influenced by environmental factors, such as prolonged incorrect postures or ergonomic conditions, than by anthropometric measures like BMI or height (12). This suggests that neck deviations in school-aged children could be more related to

lifestyle and screen use, than to physical factors.

b) Asymmetric Shoulder

The results showed no significant correlation between asymmetric shoulders and any of the studied variables. These findings contrast with studies that have highlighted a relationship between asymmetric shoulders and heavy backpacks or carrying loads unevenly (13). The lack of significant findings here may suggest that environmental factors like carrying backpacks might be more relevant than intrinsic body measurements like BMI or height.

c) Winged Scapula

Significant positive correlations were found between winged scapula and height (r=0.10), weight (r=0.15), and BMI (r=0.13). These findings suggest that heavier individuals, or those with higher BMI, are more likely to develop winged scapula, a postural abnormality characterized by the protrusion of the shoulder blade. This aligns with findings from Smith (2023), who observed that excess weight causes strain on the musculoskeletal system, leading to back and shoulder issues (2). The inverse correlation between winged scapula and physical activity (r=-0.10) supports the existing evidence that regular physical activity can help strengthen the muscles around the scapula, reducing the likelihood of this condition (5).

d) Scoliosis

Scoliosis, or the abnormal lateral curvature of the spine, showed no significant correlation with height, weight, BMI, or physical activity. This finding contrasts with the findings of McMaster (2023), which found a slight relationship between BMI and scoliosis, particularly in overweight individuals (5). The lack of significant correlation in this study could be attributed to the young age of the participants, as scoliosis often becomes more apparent during late adolescence.

e) Asymmetric Pelvis

Asymmetric pelvis showed no significant correlation with any of the variables, suggesting that factors like height and BMI may not directly contribute to pelvic asymmetry. This finding aligns with Grobler (2023), who noted that pelvic asymmetry might be more influenced by muscle imbalances and hip joint flexibility rather than body measurements (13).

f) Knock Knees (Genu Valgum)

A significant negative correlation was found between knock knees and weight (r=-0.13), BMI (r=-0.14), and physical activity (r=-0.12). These findings are consistent with those from Bober (2024), who observed that heavier individuals are more likely to exhibit knock knees due to the excess pressure exerted on the knees (4). The significant correlation with physical activity suggests that regular exercise might prevent or reduce the severity of knock knees, as strengthening the surrounding muscles can help support knee alignment (14).

g) Bow Legs (Genu Varum)

Bow legs were positively correlated with weight (r=0.13) and BMI (r=0.14), while a negative correlation was observed with physical activity (r=-0.13). These findings are in line with the findings of the study by Bober (2024), revealing a high prevalence of bow legs among individuals with higher BMI (4). The negative correlation with physical activity suggests that regular physical exercise might help improve alignment and prevent further development of bow legs (5).

h) Flat Foot

A significant negative correlation was observed between flat foot and weight (r=-0.08), BMI (r=-0.08), and physical activity (r=-0.12). Previous studies have similarly

found that individuals with higher BMI are more prone to flat feet due to the increased pressure on the arches of the feet (5). The negative correlation with physical activity suggests that foot-strengthening exercises could play a role in preventing or alleviating flat foot conditions, as indicated by Smith (2023) (2).

i) Lumbar Lordosis and Hyperlordosis

Lumbar lordosis showed significant negative correlations with BMI (r=-0.07) and physical activity (r = -0.09), indicating that individuals with higher BMI are more prone to this condition. This is consistent with the findings of Tobias (2023), who observed that excess weight and sedentary lifestyles contribute to spinal curvatures (14). Hyperlordosis also exhibited a slight significant correlation with height (r=0.06), suggesting that taller individuals might have a predisposition for excessive lumbar curvature, as taller spines place more stress on the lower back (14).

j) Kyphosis

A slight significant negative correlation was observed between kyphosis and BMI (r=-0.05). This contrasts with the results of some studies, such as the one conducted by Golalizadeh (2023), which found a stronger relationship between higher BMI and kyphosis due to thoracic spine strain. However, the low correlation found here might reflect the early stages of kyphosis development, as the participants were relatively young (13).

k) Forward Head Posture

No significant correlation was found between forward head posture and any of the variables. This is somewhat surprising, as forward head posture has been linked to poor ergonomic practices and increased screen time, rather than height or weight (12). It suggests that interventions targeting posture correction might focus more on behavioral factors rather than anthropometric measures.

l) Other Abnormalities

Other abnormalities, such as internally rotated shoulders, flat back, and arched feet, exhibited varying degrees of correlation with height, weight, BMI, and physical activity. Internally rotated shoulders, in particular, showed a significant correlation with BMI (r=0.07) and physical activity (r=-0.08), which aligns with previous findings suggesting that excess weight and sedentary behavior negatively impact shoulder posture (6).

4-1. Comparison with Previous Research

The results of this study are largely consistent with those of the existing research. Most notably, the relationships between postural abnormalities and BMI, weight, and physical activity have been well-established. Bober (2024) and McMaster (2023) similarly found that higher BMI and lower physical activity levels exacerbate postural problems such as knock knees, bow legs, and winged scapula (4, 5). However, some discrepancies emerged, particularly in the case of scoliosis and kyphosis, where this study found weaker correlations than those found in the previous research. These differences may be attributed to the younger age of the participants in this study, as some postural abnormalities, like scoliosis, may not fully manifest until late adolescence.

5- CONCLUSION

Overall, this study confirms that postural abnormalities are closely linked to BMI, weight, and physical activity levels. Regular physical activity emerges as a protective factor against these abnormalities, particularly in school-aged children. The findings emphasize the importance of early interventions through physical education programs aimed at promoting healthy weight management and encouraging exercise to prevent the

development of chronic postural issues in adulthood.

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