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Exploring the Association Between Trunk Asymmetry and Dominance Preference

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ABSTRACT

Background: Trunk asymmetry, an indicator of potential scoliosis, manifests as an uneven distribution in body alignment such as shoulder, head, and hip positions. An individual's inherent preference to use one side of the body over the other, known as laterality, may contribute to such imbalances. This study aimed to explore the correlation between trunk asymmetry and side preference in adults, particularly in relation to hand, foot, ear, and eye dominance.

Methodology: In this cross-sectional study, 164 young adults aged 18-25 were screened using the Adam's forward bend test. Data collection encompassed three phases: demographic and anthropometric data collection (Phase 1), a visual inspection for head tilt, shoulder and pelvic asymmetry, and spinal curvature deviation (Phase 2), and an assessment of side dominance using a 16-item lateral preference inventory questionnaire (Phase 3).

Results: Hand dominance correlated significantly with head tilt ($p < 0.01$), shoulder asymmetry ($p < 0.05$), and ear asymmetry (83.5% concordance), while foot dominance was associated with pelvic tilt (57.3% concordance). Eye dominance showed a 65.9% concordance with ear asymmetry, and ear dominance was linked to head tilt and shoulder asymmetry (81.7% and 94.5% concordance, respectively). Spinal curve deviation displayed a chi-square value of 3.158 ($p < 0.05$) with hand dominance and 4.321 ($p < 0.05$) with foot dominance.

Conclusion: The study establishes a significant association between trunk asymmetry and dominance preference. These findings advocate for the integration of laterality assessments in the clinical evaluation of trunk asymmetry to potentially enhance diagnostic accuracy and inform therapeutic approaches.

Keywords: Scoliosis, Postural Imbalance, Handedness, Laterality, Functional Dominance, Asymmetry, Spinal Deviation

INTRODUCTION

Trunk asymmetry (TA) is clinically recognized as an indication of scoliosis, a condition characterized by a lateral deviation of the spine exceeding 10 degrees (1, 2). While TA, manifesting as uneven shoulders, ears, head, or pelvic alignment, may signal potential progression to scoliosis, it is not a definitive or sensitive marker of the condition. The origins of scoliosis, particularly idiopathic scoliosis, which commonly arises in otherwise healthy individuals, remain largely elusive. Current understanding points to genetic or hereditary influences as significant contributors to its development (3, 4). However, additional factors like neuromuscular anomalies, connective tissue disorders, hormonal imbalances, and varied growth patterns have been observed in certain cases (5, 6). Some research posits that the developmental and functional aspects of the cerebral cortex might play a role in initiating TA, potentially leading to scoliosis. In older adults, studies indicate a widespread presence of some degree of scoliosis and TA (7). Another human characteristic, the marked preference for using one hand over the other for tasks is side dominance (SD) (8), the general predilection for using one side of the body (12). A 2019 cross-sectional study by Chiara Arienti, Riccardo Buraschi, Sabrina Donzelli, Fabio Zaina, Joel Pollet, and Stefano Negrini involving 1029 children explored the connection between TA and dominance preference (9). The study found a higher prevalence of thoracic and thoracolumbar curves in left-sided dominance, although right-sided preference was also noted. Another research in 2022 indicated some trends in lateralization and scoliosis, but the findings weren't statistically significant, underlining the complexity of the relationship between scoliosis and laterality (10). However, the study by Zahra Vahedi, Adel Mazloumi, and others in 2020 observed a significant link between dominance preference and trunk asymmetry (11).

The existing literature suggests that exploring various dimensions of laterality alongside trunk asymmetry could enhance our understanding of their intricate interplay. There is a potential correlation that implicates the function of the cerebral cortex in the etiopathogenesis of surface trunk asymmetry (12). As such, examining hand, foot, eye, and ear laterality becomes crucial to validate this hypothesis (13). Therefore, this study aims to investigate the association between trunk asymmetry and side preference in adolescents, focusing on hand, foot, ear, and visual laterality.

MATERIAL AND METHODS

The methodology for the study was a cross-sectional approach utilizing non-probability sampling, and the focus was on a university population in Lahore, Pakistan. Subjects were recruited through direct approaches and their informed consent was obtained. Physical evaluations were conducted in a private, secluded area to ensure the comfort of the participants. The inclusion criteria were young adults aged between 18-25 years, capable of maintaining a standing position unassisted, able to follow instructions, and with intact limbs and fingers (14). Excluded from the study were individuals with any physical or cognitive disabilities, such as spinal cord injuries, post-surgical conditions of the spine or joints, extensive burns, cerebral palsy, autism, hearing disorders, as well as those with bone growth disorders like Paget's disease, osteomalacia, rickets, bone cancer, or tumors, and any vision disorders (15).

The data collection process was divided into three distinct phases. The first phase involved the gathering of subjective data, which included participants' names, ages, genders, heights, and weights, recorded on individual data forms (16). The second and third phases focused on objective data. In the second phase, trunk asymmetry (TA) was assessed through a visual inspection process. Participants were asked to stand straight with their arms by their side, and were inspected for signs of head tilt, shoulder and hip asymmetry, ear alignment, and deviations in spinal curvature (16). Any observed anomalies were marked as present. Additionally, the Adam's forward bend test, known for its sensitivity of 67.9% and accuracy of 71.8% (17), was performed. This test required participants to bend forward until horizontal, with feet together, knees straight, and arms by their sides, while the researchers observed from behind for any rib hump indicative of asymmetry (18).

The third phase was dedicated to determining the dominance preference of the participants. This was achieved using the Lateral Preference Inventory Questionnaire, a specially designed 16-item questionnaire that assessed hand, foot, eye, and ear laterality (19). This phase was critical in understanding everyone's preference for using their right or left side, or both, in performing specific tasks (20).

For the analysis of the collected data, SPSS version 21 was employed (21). The demographic and anthropometric data, including height, weight, and age, were expressed as mean ± SD, alongside minimum and maximum values. Frequency and percentages for variables were represented through various forms such as tables, pie charts, and histograms. The association between variables was analyzed using Pearson's chi-square statistics at a 5% significance level (21).

In terms of operational definitions, in the first phase, height was measured in inches, age was within the 18–25-year range, and weight was recorded in kilograms, with gender specified as male, female, or other. During the visual inspection of the second phase, the presence or absence of head tilt, ear asymmetry, shoulder asymmetry, pelvic tilt, and spinal curve deviation was noted, specifying the affected side as either right or left. In the third phase, the Lateral Preference Inventory assessed dominance preference, categorizing hand, foot, eye, and ear laterality based on the participants' preference for using their right side, left side, or both for specific tasks (22).

RESULTS

The demographic analysis of participants yielded an average age of 5.05 years (SD = 1.68), an average height of 1.67 meters (SD = 0.09), and an average weight of 60.95 kilograms (SD = 9.95).

The prevalence of asymmetry types and their lateralization were as follows: head tilt was present in 137 participants (83.5%), with 89 (54.3%) exhibiting right-side and 48 (29.3%) left-side tilt. Shoulder asymmetry occurred in 155 participants (94.5%), with a right-side preference in 106 (64.6%) and left-side in 49 (29.9%). Pelvic tilt was noted in 94 participants (57.3%), with 66 (40.2%) on the right and 28 (17.1%) on the left. Ear asymmetry was found in 135 participants (81.7%), with 88 (53.7%) displaying right-side and 47 (28.7%) left-side asymmetry. Spinal curve deviation was the least common, present in 16 participants (9.8%), with a right-side deviation in 10 (6.7%) and left-side in 6 (4.3%).

Table 1 Demographics

Variable	Mean	Std. Deviation
Age (Years)	5.05	1.68
Height (Meters)	1.67	0.09
Weight (Kilograms)	60.95	9.95

Table 2 Asymmetry Type

Asymmetry Type	Frequency (Percentage)	Right Side (%)	Left Side (%)
Head Tilt	137 (83.5%)	89 (54.3%)	48 (29.3%)
Shoulder Asymmetry	155 (94.5%)	106 (64.6%)	49 (29.9%)
Pelvic Tilt	94 (57.3%)	66 (40.2%)	28 (17.1%)
Ear Asymmetry	135 (81.7%)	88 (53.7%)	47 (28.7%)
Spinal Curve Deviation	16 (9.8%)	10 (6.7%)	6 (4.3%)

Table 3 Associational Statistics

		Dominant Hand				Pearson Chi-Square	P- Value
		Left	Right	Mixed	Total		
Side of Head Tilt	Right	0	89 (100%)	-	89	145.374a	.000
	Left	48 (100%)	0	-	48		
	N/A	5 (19%)	22 (81%)	-	27		
Side of Shoulder Asymmetry	Right	2 (2%)	104 (98%)	-	106	147.917a	0.000
	Left	49 (100%)	0	-	49		
	N/A	2 (22%)	7 (78%)	-	9		
Side of Ear Asymmetry	Right	2 (2%)	86 (98%)	-	88	131.672a	0.000
	Left	46 (98%)	1 (2%)	-	47		
	N/A	5(17%)	24(83%)	-	29		
Side of Spinal Curve Deviation	Right	5 (45%)	6 (55%)	-	11	3.158a	0.206
	Left	4 (57%)	3 (43%)	-	7		
	N/A	44 (30%)	102 (70%)	-	146		
Dominant Foot							
Side of Pelvic Tilt	Right	0	63 (95%)	3(5%)	66	85.927a	0.000
	Left	26 (93%)	0	2(7%)	28		
	N/A	22 (31%)	44 (63%)	4(6%)	70		
Side of Spinal Curve Deviation	Right	5 (45%)	5 (45%)	1(10%)	11	4.321a	.364
	Left	3 (43%)	3 (43%)	1(14%)	7		
	N/A	40 (27%)	99 (68%)	7(5%)	146		
Dominant Eye							
Side of Ear Asymmetry	Right	2 (2%)	84 (96%)	2 (2%)	88	124.557a	.000
	Left	40 (85%)	1 (2%)	6 (13%)	47		

		Dominant Hand				Pearson Chi-Square	P- Value
		Left	Right	Mixed	Total		
		4 (14%)	23 (79%)	2 (7%)	29		
Dominant Ear							
Side of Head Tilt	Right	0	82 (92%)	7 (8%)	89	139.337a	.000
	Left	44 (92%)	0	4 (8%)	48		
	N/A	3 (11%)	20 (74%)	4 (15%)	27		
Side of Shoulder Asymmetry	Right	2 (2%)	96 (91%)	8 (76%)	106	131.424a	.000
	Left	43 (88%)	0	6 (12%)	49		
	N/A	2 (22%)	6 (67%)	1 (11%)	9		

Pearson Chi-Square analyses revealed significant associations between dominance preference and corresponding asymmetry. Hand dominance showed significant correlations with head tilt (χ^2 = 145.374, p < .000), shoulder asymmetry (χ^2 = 147.917, p = .000), and ear asymmetry (χ^2 = 131.672, p = .000). Foot dominance was significantly associated with pelvic tilt (χ^2 = 85.927, p = .000). However, no significant association was found between spinal curve deviation and either hand or foot dominance (hand: χ^2 = 3.158, p = .206; foot: χ^2 = 4.321, p = .364). Eye and ear dominance demonstrated significant associations with ear asymmetry (eye: χ^2 = 124.557, p = .000) and head tilt and shoulder asymmetry (ear: head tilt χ^2 = 139.337, p = .000; shoulder asymmetry χ^2 = 131.424, p = .000), respectively.

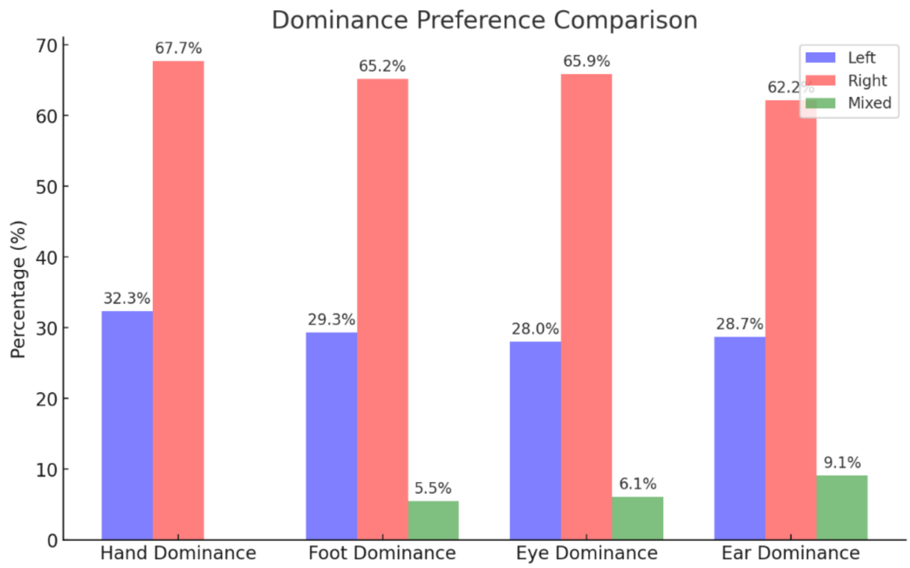

Figure 1 Dominance Preference Comparison

The bar chart visually represents dominance preferences across four categories: Hand, Foot, Eye, and Ear. Hand dominance shows a clear preference for right-handedness at 67.7%, with left-handedness at 32.3%. Foot dominance is similar, with 65.2% right and 29.3% left, alongside a small proportion of mixed dominance at 5.5%. Eye dominance also leans towards right-eye dominance at 65.9%, left-eye at 28.0%, and mixed at 6.1%. Ear dominance exhibits a slightly more balanced distribution, with right-ear dominance at 62.2%, left-ear at 28.7%, and mixed at 9.1%. The chart uses color-coded bars (blue for left, red for right, green for mixed) to differentiate these preferences, providing a clear comparative overview of dominance patterns.

DISCUSSION

In the investigation of the relationship between trunk asymmetry and dominance preference, the current study identified a significant association. The analysis revealed that right-handed individuals predominantly exhibited right-sided asymmetries, such as head tilt and shoulder and ear asymmetry. This pattern was also observed in right-footed individuals with pelvic tilt, right-eyed individuals with ear asymmetry, and right-eared individuals with head tilt and shoulder symmetry, and the inverse was noted for left-sided preferences.

Contrasting with Arienti et al. (2019), who documented a prevalence of trunk asymmetry in left-side dominance in thoracolumbar curves without significant findings in right-sided dominance, the current study did not find a notable association between spinal curve deviation and dominance preference (9). This discrepancy highlights the complexity of factors that influence trunk asymmetry and the potential for dominance preference to impact these factors differently.

Vahedi et al. (2020) explored the prevalence of lateral head tilt among smartphone users, noting a tendency for increased left lateral bending during one-handed use in a standing posture among right-handed individuals (11). This suggests that handedness is one of several factors influencing head tilt. Similarly, Tanaka et al. suggested an association between the dominant hand and ear, with the right ear demonstrating higher accuracy in stimuli response, which supports the hypothesis that dominance preference relates to asymmetry (23).

The present study posits that habitual behaviors, such as prolonged lateral head tilt while using a phone or computer, or the tendency to lean to one side during conversations or while carrying heavy loads, can contribute to the development of asymmetries. Chen et al. supported this by demonstrating that carrying heavy backpacks on one shoulder leads to increased trunk flexion and shoulder elevation, which can result in permanent asymmetries (24).

However, it must be noted that the spine is influenced by multifaceted mechanical factors. Lateral trunk shifts can precipitate spinal deviation, suggesting that handedness and dominance patterns could contribute to such shifts (25). Persistent postures that favor the dominant side may promote trunk imbalance, potentially leading to asymmetries that require clinical attention to prevent the progression into conditions like scoliosis (26, 27).

The study is not without limitations. Notably, quantitative measurements of asymmetries were not recorded, and the observation was limited to the coronal plane, omitting potential asymmetries in other planes. Additionally, the focus on young adults restricts the generalizability of the findings to other age groups.

For future research, it is recommended that objective measures of asymmetry, such as those obtained from a scoliometer, be utilized. Consideration of asymmetries in the sagittal and transverse planes, and an expanded age range, would also be beneficial to comprehensively understand the relationship between dominance preference and trunk asymmetry.

CONCLUSION

The findings of this study underscore a significant positive correlation between dominance preference and trunk asymmetry, specifically linking hand dominance to asymmetries in head, shoulder, and ear alignment; foot dominance to pelvic tilt; eye dominance to ear asymmetry; and ear dominance to asymmetries in head and shoulder positioning. These associations suggest that dominance preference plays a role in the development of asymmetrical postures and may contribute to the progression of structural imbalances. Consequently, the evaluation of trunk asymmetry in clinical settings should consider an individual's dominance preference to enable a more holistic understanding and approach to treatment and prevention strategies.

The implications of this research are multifaceted, impacting both clinical practice and public health awareness. Clinicians should be cognizant of the relationship between dominance preference and trunk asymmetry when assessing patients, as this could influence both diagnosis and intervention strategies. Public health messages could educate on the importance of balanced postural habits, particularly in settings prone to asymmetry development, such as schools and workplaces. Additionally, the evidence may guide ergonomic designs in technology and furniture to mitigate the risk of developing trunk asymmetry, particularly in dominant body regions. Further research could extend these findings to tailor preventive measures across various age groups and activities.

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