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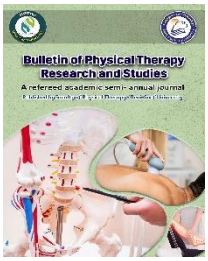

Association between Foot Posture and Neck Posture in Non-Specific Neck Pain

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Running Title: Association between Foot Posture and Neck Posture in Non-Specific Neck Pain.

Abstract

[Purpose] The objective of this study was to assess if there is any correlation between posture of the foot, neck pain, function, and head posture in non-specific neck pain (NSNP). **[Patients and Methods]** Eighty-four participants, aging between18 and 29 years, diagnosed with chronic NSNP were included. Patients were recruited from the orthopedic clinic and student population of the physical therapy faculty, Beni Suef University. It was conducted from May 2024 to August 2024. The neck function, neck pain intensity, head posture, and foot posture were evaluated using neck disability index, visual analogue scale, cranio-vertebral angle using a photographic posture analysis, and foot posture index, respectively. **[Study design]** A Cross-sectional study. [Results] Our findings showed a non-significant association between the posture of the foot, neck pain, function, and head posture ($P < 0.05$).

[Conclusion] There is no association between the posture of the foot, neck pain, function, and head posture in NSNP.

Key words: Non-specific neck pain (NSNP), forward head posture (FHP), foot posture.

Introduction

Neck pain can be regarded as one of the most prevalent musculoskeletal conditions all over the world. It has a high prevalence in young adults, ranging from 42% to 67%[1]. Also, it imparts a significant financial cost that includes medical expenses, lost productivity, and work-related issues. Pain in the neck and lower back accounted for the highest spending in the health section in the United States in 2016, totaling about $134.5 billion[2]**.** Non-specific neck pain (NSNP) is a subcategory of neck pain that is not associated with a specific underlying disease or pathology[3,4]**.** This pain is commonly described as a discomfort in the cervical region in any location from the nuchal line to the 1st thoracic vertebra and to the lateral edges of the neck[5]. It has been related to several interrelated factors such as kinetic, postural, work-related, and sports-related factors[6].

One of the commonly recognized forms of faulty positions in individuals with painful neck in the sagittal plane is forward head posture (FHP). FHP is described as a postural malalignment in which the external auditory meatus is placed in front of a vertical line passing through the acromion process of the shoulder [7]. It has found that FHP is common among university students, with a prevalence ratio of 63.96%[8]. Also, it has been suggested by several studies that FHP may be related to tension headaches, neck pain, and cervical pain. It has not been related only to the head and neck, but also it has been found to be related to muscle tension and exhaustion in the shoulders[9]. That's why we need to examine if this connection can extend more distally, to the lower limb and foot.

Foot posture can be normal, high, and low- arched foot, based on the shape of the medial longitudinal arch (MLA)[10,11]. Recently, the human body has been viewed as a kinetic chain that is connected anatomically and mechanically, with any abnormality in one part of the chain would affect the other parts[12]**.** Several studies found a relation between foot posture and spinal malalignments and pathologies, specifically, in the pelvis, lumbar, and thoracic regions[13,14]**.**

Up to the author's knowledge, limited research aimed to relate foot posture to cervical spine pathologies. They found there might be a relation between flatfoot posture, chronic tension headache, and trigger points in the subo-ccipital region[15]. Also, it has been proved that experimentally induced flatfoot alignment caused increased electromyographic (EMG) activity of the temporalis and masseter muscles[16]. None of these researches investigated if there is a relation between foot posture and NSNP

or FHP. Investigating the possible correlation between the cervical spine and the feet may help in more understanding of the kinetic chain. Furthermore, it would help in more effective management of NSNP by addressing other related risk factors.

Materials and Methods

Study design

This study is an observational cross-sectional one. It had the approve of the Ethical Committee for Scientific Research of the Faculty of Physical Therapy, Cairo University, Egypt **(P.T.REC/012/005348)**, 2024.

Patients

Eighty-four patients diagnosed with chronic NSNP of both genders, aging between 18 and 29 years were included[17]. Participants were recruited from the orthopedic clinic and student population of the faculty of physical therapy, Beni Suef University from May 2024 to August 2024. They were diagnosed with chronic NSNP based on the following criteria; pain in the cervical region in any location from the nuchal line to the 1st thoracic vertebra, until the lateral edges of the neck, neck pain duration of more than 12 weeks and less than one year[18], body mass index (BMI) from 18 to 30 kg/m^2[19]**.** The exclusion criteria included any of the following: signs of red flags including; malignancy, infection, traumatic fractures, signs of cerebrovascular insufficiency, neck pain associated with whiplash injury, cervical radiculopathy, fibromyalgia syndrome, or if the patient received any interventions to control the neck pain in the last 6 months. All patients were asked to sign informed consents before participation after explaining the study procedures to them.

Sample size calculation:

Sample size calculation was obtained using the G*Power software (version 3.0.10), developed It has been conducted with a correlation model of 80% power, 0.05 type one error (2 tailed) and effect size of 0.3. The estimated minimum proper sample size was 82 subjects.

Assessment procedures:

The outcome measures assessed were neck pain intensity, neck-related disability, cranio-vertebral angle (CVA) as a representative for head posture, and foot posture.

1- Neck pain intensity was assessed with the visual analogue scale (VAS)[20]: The VAS is a reliable and valid instrument that measures the pain severity[21]. The patients were asked to put a mark on a specific point on a line measuring 10 cm long, indicating their pain in the last 24 hours. They were explained that (0) means no pain, while (10) means the highest possible pain.

2- Neck-related disability was evaluated using the Neck disability index- Arabic version (NDI-AR)[22]: The NDI-AR Questionnaire is considered reliable and valid, which allows the patients with neck pain to rate their disability[22]. It assesses the following domains in daily life; pain severity, personal care, lifting, reading activities, headaches, focus, employment, operating a vehicle, sleeping, and leisure activities. The patients were instructed to choose a score for every item on a scale of 5, with 0 denoting the absence of disability and 5 being complete disability. The highest total score is 50. The total patient score was transferred into a percentage of disability using the following equation; ((Patient total score) / (N. of answered sections x 5)) x 100 = _____ % disability

3- Head posture was assessed by measuring the CVA using photographic posture analysis[23]: The sagittal position of the head was assessed by measuring the CVA using photographic posture analysis system[24]. The CVA can be defined as the angle made by a line that goes from the tragus of the ear to the spinous process of C7 and a horizontal line that intersects the C7 spinous process. [23]. At first, we palpated the C7 spinous process and tragus and skin adhesive markers were applied over them. The Patient performed head flexion and extension to allow better palpation of the spinous process of C7. Then the patient was asked to attain a relaxed standing position on a specific mark on the ground for standardization, with equal weight bearing on both feet. The right side of the patient was beside the wall with the camera placed on the other side. A 13-megapixel camera (mobile OPPO A54, china) was used and put up on a tripod, 150 cm away from the subject, with the camera base at the shoulder level. The patients were given instructions to direct their visual attention to a fixed target on the wall directly in front of them at eye level with their hands hanging by their sides, and the photos were taken[25]. The photos were used to calculate the CVA using a computer program, kinovea software, by measuring the angle between the 2 marked points and the horizontal line **(Figure 1**). Subjects having angles less than 49° were considered as FHP [26].

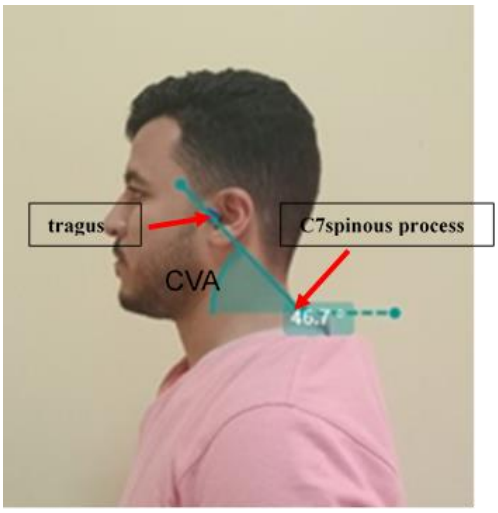

Figure 1: *Measurement of CVA by kinovea software.*

4- The foot position was evaluated using Foot Posture Index-6 (FPI-6)[27]: The FPI-6 is considered a reliable and valid instrument for evaluating foot posture[28]. Six anatomical evaluations were assessed: Talar head palpation, supra- and infra-lateral malleolar curvature, calcaneal frontal plane position, prominence in the region of talonavicular joint, congruence of the medial longitudinal arch, and abduction/adduction of forefoot on the rearfoot. The participants were asked to take several steps and then to stand still in a relaxed position, barefoot, with double limb support, and their arms by their side. The patients were instructed to look straight ahead and not to try to look at their feet during the assessment, as this may affect the foot posture. In this position, the feet were evaluated by observation and palpation. Each anatomical evaluation received a score ranging from -2 to +2, with the overall score between -12 and +12. Based on the oveall score, the foot posture was categorized into: 0 : +5 is considered normal foot; +6 +9 is considered pronated foot; +10 to +12 is considered highly pronated foot; -1 : -4 is considered supinated foot; and -5 : -12 is considered highly supinated foot.

Statistical testing:

- Descriptive statistics to present the outcome measures.as; mean, standard deviation, frequency, minimum, and maximum

- Fisher's Exact test was conducted to investigate the association between foot posture and neck pain, functional disability, and head position in individuals with NSNP.

- The level of significance was determined at $p < 0.05$.

- The statistical package for social sciences (SPSS) version 25 for windows was used to perform all the statistical analysis (IBM SPSS, Chicago, IL, USA).

Results

Eighty-four participants with chronic NSNP participated in this study, with an equal distribution of males (42, 50%) and females (42, 50%). The mean ± SD age and BMI of the study group were 21.73 ± 2.08 years and 23.83 ± 3.08 kg/m², respectively. Regarding foot posture, 53 (63%) was having a normal foot posture, 21 (25%) was having a pronated foot posture, 6 (7.14%) was having a supinated foot posture, 3 (3.57%) was having a highly pronated foot posture, and 1(1.19%) was having a highly supinated foot posture. The characteristics of participants are presented in Table 1.

Table 1: Descriptive statistics of the characteristics of participants.

	Mean ± SD	**Minimum**	**Maximum**
Age (years)	**21.73 ± 2.08**	**18**	**28**
BMI (kg/m²)	**23.83 ± 3.08**	**18.5**	**29.6**
gender distribution, N (%)			
Males	**42 (50%)**		
Females	**42 (50%)**		
Foot posture, N (%)			
Normal	53 (63%)		
Pronated	21 (25%)		
Supinated	6 (7.14%)		
Highly pronated	3 (3.57%)		
Highly supinated	1 (1.19%)		

Clinical characteristics of participants: The clinical characteristics of participants showed that the mean ± SD VAS score was 5.54 ± 1.83, CVA was 49.83 ± 5.93 degrees, and NDI was 27.02 ± 10.08%. Pain levels were categorized as mild in 13 (15.5%) participants, moderate in 44 (52.4%), and severe in 27 (32.1%). Regarding head posture, 44 (52%) participants had a normal posture, while 40 (48%) exhibited FHP. Disability levels were classified as mild in 49 (58.3%) participants, moderate in 33 (39.3%), and severe in 2 (2.4%) participants. These features are presented in Table 2.

Table 2: Descriptive statistics of the clinical features of participants.

	Mean ± SD	Minimum	Maximum
VAS	**5.54 ± 1.83**	**2**	**10**
CVA (degrees)	**49.83 ± 5.93**	**35.1**	**64.9**
NDI (%)	**27.02 ± 10.08**	**4.40**	**60**

Pain level, N (%)	Neck posture, N (%)	Disability levels, N (%)
Mild 13 (15.5%)	**Normal 44 (52%)**	**Mild 49 (58.3%)**
Moderate 44 (52.4%)	**FHP 40 (48%)**	**Moderate 33 (39.3%)**
Sever 27 (32.1%)		**Sever 2 (2.4%)**

Association between foot posture (NDI), neck pain (VAS), head posture (CVA) and neck disability (NDI) in individuals with NSNP: There was no significant association between foot posture and pain levels (p = 0.45), head posture (p = 0.55) and neck disability levels (p = 0.45) (Table 3).

Table 3: Association between foot posture, neck pain, neck posture, and neck disability levels.

	Foot posture			Fisher's Exact Test	p -value
	Normal	**Pronated**	**Supinated**		
Pain level					
Mild	(%11.3) 6	5 (20.8%)	2 (28.6%)	**3.57**	**0.45**
Moderate	30 (56.6%)	12 (50%)	2 (28.6%)		
Sever	17 (32.1%)	7 (29.2%)	3 (42.9%		
Neck posture					
Normal	28 (52.8%)	11 (45.8%)	5 (71.4%)	**1.39**	**0.55**
FHP	25 (47.2%)	13 (54.2%)	2 (28.6%)		
Disability levels					
Mild	31 (58.5%)	12 (50%)	6 (85.7%)		
Moderate	20 (37.7%)	12 (50%)	1 (14.3%)	**3.83**	**0.45**
Sever	2 (3.8%)	0 (0%)	0 (0%)		

Discussion

Our research aimed to examine the association between foot posture, neck pain, functional disability, and head posture in individuals with NSNP. The results found that there weren't any significant associations between foot posture and the studied variables.

Foot posture and neck pain

The current study showed no statistically significant association between foot posture and neck pain. This result contrasts with a previous study that suggested a biomechanical link between foot posture, specifically the flat foot posture, and trigger points in the suboccipital region in tension type headache. They explained that association by the compensatory changes in the postural alignment to the flat foot posture, which can occur from the lower limb to the spine proximally. These postural adaptations can be linked to the formation of trigger points in tension headaches [15]. This discrepancy can be due to that all of their sample was having already trigger points as a structural change and most of them was having flat foot while more than half of our sample was of normal foot posture. Also, the foot assessment was different as they used the navicular drop test.

In the same context, another study reported significant correlations between pes-planus and trigger points in the cervicothoracic region and upper limbs. This can be attributed to the continuous myofascial chain extending throughout the body, any disorder in one part of the fascia would cause changes in other parts of the body [29]. Also, this study included only females and used different tool in assessing the foot posture**;** the feiss line test.

Foot posture and neck related disability

Our research didn’t find any significant association between foot posture and neck related disability. Moreover, we found that despite 56.6% of our patients with normal foot posture were having moderate pain, the greater percentage of them (58.5%) were having only mild functional disability. These results match with findings of another research that investigated the association of different factors to pain and functional disability in patients with NSNP [30]. They found that the neck disability was correlated mainly to neck range of motion, which suggests that patients with NSNP can find adaptive mechanisms to do their function despite their pain and posture. Other factors have been correlated also to functional limitation, such as the psychological status of the patient, which was proved to be associated to disability level in NSNP [31]. Conversely, it was found that increased pes planus severity led to reduced postural stability, potentially contributing to altered postural alignment and function [32]. The disagreement may be related to the severity of postural malalignment and its consequences as impaired balance.

Foot Posture and Neck Posture

Although, some studies suggested that abnormal foot posture can influence whole-body alignment, potentially affecting the spine alignment[33,34], our study found non-significant relation between foot posture and neck posture. These findings align with the finding of a study conducted on children and concluded that flat foot posture doesn't affect the cervical spine alignment. They explained the absence of correlation by the adaptive capacity and developmental variability in young people, and that compensatory alignment strategies may occur later in life [35]. Similarly, a study conducted recently on children with flat foot posture, this study found no correlation between foot posture and sagittal spinal alignment but malalignment was found in lower limb. They assumed that, if already compensatory changes occurred in the lower limbs to restore the balance without compensatory changes in the pelvis, then compensatory changes in the spinal alignment won't occur[36]. This may suggest that postural compensatory deformities require a longer time to develop, and therefore might not be detectable in younger populations. Another possible explanation for this lack of association is that the corrective mechanism through the body chain linked to the improper foot posture may not have necessarily to be extended to the cervical spine and may have stopped at any point below the cervical point of the body chain.

In contrast, other studies approved the link between body malalignments and foot posture. For example, foot pronation as an improper foot posture can result in increasing the spinal curvature angels ; thoracic kyphosis, lumbar lordosis, sacral angle, pelvic inclination, and considering this as compensatory phenomenon at each one of them[33]. But this study included mainly males with a smaller sample size than our study. Also, another study found that FHP may affect the planter pressure[37], which can affect the foot posture [38]. Only 48% of our sample were FHP while the remaining were having normal CVA.

Conclusion

Our study suggests that there is a non-significant correlation between foot posture, neck pain, function and head posture in NSNP.

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Conflict of interest:

The authors declare that they have no conflicting interests.

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