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Original Article

Postural Mechanics and Musculoskeletal Impact of Habitual Breastfeeding Positions: A Clinical Study on Forward Head Posture and Cervico-Scapular Muscle Imbalance in Lactating Mothers

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ABSTRACT

Background: Breastfeeding requires repeated and sometimes prolonged maternal positioning, which may increase mechanical demands on the cervical spine and scapular stabilizing musculature. Despite increasing recognition of breastfeeding-related musculoskeletal complaints, objective evidence linking habitual feeding posture with measurable postural alterations remains limited. Objective: To determine the association between cradle-lying breastfeeding exposure, forward head posture, and cervico-scapular muscle imbalance in lactating mothers. Methods: This analytical cross-sectional study included 76 lactating mothers aged 18–45 years with infants aged up to 11 months. Cradle-lying exposure was assessed using the Cradle-Lying Exposure Scale. Forward head posture was evaluated by measuring the craniovertebral angle through digital photogrammetry, while cervico-scapular muscle performance was assessed using isometric muscular endurance tests. Descriptive statistics, correlation analysis, and chi-square testing were applied. Results: High cradle-lying exposure was observed in 57% of participants. Moderate and severe forward head posture were present in 40% and 26%, respectively, while approximately 82% demonstrated cervico-scapular muscle imbalance. Mean deep neck flexor endurance was 19.28 ± 10.09 seconds. Cradle-lying exposure showed a significant inverse association with craniovertebral angle ($r=-0.532$, 95% CI −0.676 to −0.348; $p<0.001$). Forward head posture severity was strongly associated with muscle imbalance ($r=0.727$, 95% CI 0.600–0.818; $p<0.001$), with a significant categorical association, $\chi^2(4)=11.543$, $p=0.021$. Conclusion: Greater cradle-lying exposure was associated with greater forward head deviation, while increasing postural severity was associated with greater cervico-scapular muscle imbalance. These findings support consideration of breastfeeding ergonomics and postural assessment in postpartum care without establishing causality. Keywords: breastfeeding; lactating mothers; forward head posture; craniovertebral angle; cervico-scapular muscle imbalance; postpartum ergonomics.

INTRODUCTION

Breastfeeding is a fundamental component of maternal and infant healthcare because human milk provides nutritionally and biologically active components that support infant growth, immune protection, and development

while also conferring health benefits to the mother. Exclusive breastfeeding for approximately the first six months of life, followed by continued breastfeeding alongside appropriate complementary feeding, remains widely recommended as an optimal early-life nutritional strategy (1). Although the nutritional, immunological, and developmental benefits of breastfeeding have been extensively investigated, comparatively less attention has been directed toward the repetitive physical demands imposed on lactating mothers during feeding sessions, particularly when breastfeeding is performed frequently and for prolonged periods in unsupported positions.

Breastfeeding is a recurrent activity that may require mothers to maintain relatively static sitting or semi-reclined positions while simultaneously supporting the infant and visually monitoring attachment and feeding. These demands can encourage sustained cervical flexion, anterior translation of the head, rounded shoulder positioning, and prolonged loading of the cervical and thoracic musculature when adequate trunk, upper-limb, or infant support is unavailable. Emerging observational evidence indicates that musculoskeletal symptoms are common among breastfeeding women. In a survey of 395 breastfeeding mothers, Ratajczak and Górnowicz reported that 84% experienced back pain at least monthly, while cervical pain occurred at least weekly in 48%; longer individual feeding episodes and greater cumulative breastfeeding time were associated with musculoskeletal symptoms, and neck pain was less intense among mothers who preferred supported lying positions than among those feeding while seated (2). Similarly, breastfeeding-related neck pain was reported by approximately half of lactating mothers in a Nigerian study, with cradle hold being the most frequently adopted feeding position (3).

Evidence from different populations suggests that the relationship between breastfeeding position and maternal musculoskeletal symptoms is clinically relevant but not uniform across studies. Alazmi and Algabbani reported a high prevalence of musculoskeletal pain among lactating mothers and found significant associations between breastfeeding position and pain at several anatomical sites, with cradle positioning being commonly used (4). In contrast, a Pakistani cross-sectional study involving postpartum mothers from Rawalpindi and Islamabad found substantial frequencies of mechanical neck and low-back pain but did not demonstrate a statistically significant overall association between feeding position and musculoskeletal complaints (5). Dandekar and Khatavkar similarly observed variations in neck-related disability among women using different breastfeeding positions, while habitual posture, awareness, adaptation, and other maternal factors were considered possible influences on symptom reporting (6). These findings suggest that the musculoskeletal consequences of breastfeeding are unlikely to depend solely on the nominal feeding position; cumulative exposure, duration, frequency, postural support, infant handling, and maternal movement strategies may also influence mechanical loading.

One postural alteration of particular relevance to prolonged breastfeeding is forward head posture (FHP), characterized by anterior positioning of the head relative to the trunk in the sagittal plane. The craniovertebral angle (CVA) is widely used as a non-invasive photogrammetric measure of sagittal head position, with a smaller CVA generally indicating greater anterior displacement of the head. Digital and smartphone-based photogrammetric methods have demonstrated good-to-excellent reliability and validity for CVA measurement, supporting their clinical and research application for quantifying FHP (7). Body position can influence CVA measurements, emphasizing the importance of standardized positioning during postural assessment (8). Photogrammetric evaluation therefore offers a practical method for examining subtle postural adaptations that may not be captured by symptom questionnaires alone.

The biomechanical relevance of FHP extends beyond the cervical spine. Changes in head and shoulder alignment can alter scapular mechanics and muscular recruitment during upper-limb activity, including activity of the trapezius and serratus anterior muscles (9). Experimental biomechanical evidence further demonstrates that anterior head translation changes the relative length of cervical muscle-tendon units, with different effects across upper and lower cervical regions (10). Such adaptations provide a plausible mechanical basis for changes in cervical and scapular muscular endurance during repetitive activities performed with sustained head flexion. However, the relationship should not be reduced to a fixed increase in “head weight” for each unit of anterior displacement because cervical loading is determined by interacting factors including segmental alignment, external moment arms, muscle recruitment, task duration, and individual anthropometry.

Postural muscle performance may therefore represent an important intermediate feature linking habitual feeding behavior with maternal cervico-scapular dysfunction. Reduced endurance of the deep cervical flexors may compromise the capacity to maintain efficient head-on-neck alignment during prolonged tasks, while altered

function of scapular stabilizers may influence shoulder-girdle control. Studies examining postural neck pain and FHP have identified associations between cervical posture, cervical-flexor endurance, scapular muscle performance, and altered shoulder-girdle muscle activation, although the direction and magnitude of these relationships vary between populations and assessment methods (9–11). This variability highlights the need to evaluate posture, exposure, and muscular performance concurrently rather than inferring dysfunction from feeding position alone.

Despite increasing recognition of breastfeeding-related musculoskeletal symptoms, relatively limited evidence has objectively examined the relationship between cumulative exposure to a habitual breastfeeding posture, sagittal head alignment, and cervico-scapular muscle endurance in lactating mothers. Existing studies have predominantly emphasized pain prevalence, self-reported discomfort, or preferred breastfeeding position (2–6), whereas objective postural measurements such as CVA and endurance-based assessment of cervical and scapular stabilizers have been less frequently integrated into postpartum ergonomic research. This represents an important clinical gap because postural deviations may occur with or without substantial pain and may provide additional information for preventive physiotherapy and postpartum ergonomic counseling.

Accordingly, this study aimed to determine the association between exposure to the cradle-lying breastfeeding position, forward head posture measured through craniovertebral angle, and cervico-scapular muscle imbalance among lactating mothers. The study further examined the relationship between the severity of forward head posture and the degree of cervico-scapular muscular imbalance. Given the cross-sectional design, these relationships were evaluated as concurrent associations rather than evidence of temporal or causal effects.

MATERIALS AND METHODS

An analytical cross-sectional study was conducted among 76 lactating mothers aged 18–45 years who were breastfeeding infants aged up to 11 months. The study was designed to examine the relationship between habitual exposure to the cradle-lying breastfeeding position, forward head posture, and cervico-scapular muscle imbalance. Participants underwent assessment of breastfeeding-position exposure, sagittal cervical posture, and isometric endurance of selected cervical and scapular stabilizing muscles during the same observational study period. The primary exposure variable was the degree of cradle-lying breastfeeding exposure, while craniovertebral angle and the resulting classification of forward head posture constituted the principal postural outcomes. Cervico-scapular muscle performance was evaluated as an additional musculoskeletal outcome.

Breastfeeding-position exposure was assessed using the Cradle-Lying Exposure Scale (CLES). The scale characterized habitual exposure to the studied feeding position by incorporating relevant aspects of feeding behavior, including daily feeding duration, frequency of use, and perceived physical discomfort during or in relation to feeding. The resulting exposure scores were categorized according to the scale framework into low, moderate, and high exposure groups. This approach enabled breastfeeding behavior to be represented as a graded exposure rather than classifying mothers solely according to whether they used the cradle-lying position.

Forward head posture was assessed objectively through digital photogrammetry using the CerviTech application. The craniovertebral angle was used as the primary quantitative indicator of sagittal head alignment. CVA is conventionally derived from a lateral view using the relationship between the tragus of the ear, the C7 region, and a horizontal reference line; smaller angles reflect greater anterior displacement of the head relative to the cervical spine. Photogrammetric CVA measurement has demonstrated good reliability and criterion validity, and mobile application-based approaches have also shown acceptable measurement properties for clinical evaluation of sagittal head posture (7). Because CVA can vary with body position, postural assessment was performed using a consistent measurement approach to permit comparison across participants (8). Recorded CVA values were subsequently classified according to the study's grading framework to characterize the severity of FHP as mild, moderate, or severe.

Cervico-scapular muscular performance was evaluated through isometric endurance testing of muscles contributing to cervical and scapular stabilization. The assessment included the deep neck flexors, lower trapezius, and serratus anterior. Endurance was quantified according to the participant's ability to maintain the prescribed isometric testing position, with holding time recorded in seconds where applicable. Deep neck flexor endurance was analyzed as a continuous measure and contributed to the characterization of postural stabilization capacity.

Performance across the assessed cervical and scapular stabilizers was used to classify cervico-scapular muscle imbalance according to the study scoring framework as no imbalance, lower imbalance, or higher imbalance. The inclusion of cervical and scapular stabilizers was biomechanically relevant because altered head posture has been associated with changes in scapular mechanics and muscular recruitment, while postural neck dysfunction has also been associated with reduced endurance of cervical and scapular muscles (9–11).

The analytical strategy reflected the cross-sectional nature of the investigation. Participant characteristics and study variables were summarized using descriptive statistics. Categorical variables, including exposure level, FHP severity, and cervico-scapular imbalance category, were summarized as frequencies and percentages, whereas continuous measures such as deep neck flexor endurance were expressed using the mean and standard deviation. The relationship between cradle-lying exposure and craniovertebral angle was evaluated using correlation analysis, with the direction of the coefficient interpreted according to the inverse relationship between CVA and anterior head displacement; consequently, a negative association indicated that greater feeding-position exposure occurred alongside smaller CVA values and greater forward head deviation. Associations involving graded postural severity and muscular-imbalance categories were evaluated using methods appropriate to their categorical or ordered structure, and the relationship between FHP category and cervico-scapular imbalance category was examined using the chi-square test of independence. Statistical significance was evaluated at a two-sided threshold of $p<0.05$.

All interpretations were restricted to associations observed at the time of assessment. Because exposure, postural alignment, and muscular performance were evaluated within a cross-sectional framework, the analysis was not used to infer that breastfeeding position preceded, caused, or accelerated the development of forward head posture or cervico-scapular dysfunction. Instead, the design quantified whether greater habitual exposure to the studied breastfeeding position coexisted with measurable differences in cervical posture and muscle-performance characteristics among the participating lactating mothers.

RESULTS

A total of 76 lactating mothers aged 18–45 years with infants aged up to 11 months were included in the analysis. Exposure to the cradle-lying breastfeeding position was common, with 57% of participants classified as having high exposure, 22% as moderate exposure, and 21% as low exposure. In addition, 70% of the mothers reported using the cradle-lying position multiple times per day, indicating substantial repeated exposure to the studied breastfeeding posture.

Table 1. Distribution of Breastfeeding-Position Exposure, Forward Head Posture, and Cervico-Scapular Muscle Imbalance Among Lactating Mothers (N=76)

Study variable	Category/measure	Reported value
Cradle-lying exposure	Low exposure	21%
	Moderate exposure	22%
	High exposure	57%
Cradle-lying use	Used multiple times daily	70%
Forward head posture	Mild	32%
	Moderate	40%
	Severe	26%
Cervico-scapular muscle imbalance	None	17%
	Lower imbalance	48%
	Higher imbalance	34%
Deep neck flexor endurance	Mean ± SD, s	19.28 ± 10.09

Categorical variables are presented using the percentages available from the study results. Percentage totals may differ slightly from 100% because of rounding. SD, standard deviation.

Forward head postural deviation was frequent within the study population. Mild FHP was reported in 32% of participants, moderate FHP in 40%, and severe FHP in 26%. Accordingly, approximately two-thirds of the sample had moderate-to-severe FHP. Cervico-scapular muscle imbalance was also common: 17% of participants were classified as having no imbalance, whereas 48% had lower imbalance and 34% had higher imbalance. Thus, approximately 82% of participants demonstrated some degree of cervico-scapular muscular imbalance. Mean deep neck flexor endurance was 19.28 ± 10.09 seconds.

Greater exposure to the cradle-lying breastfeeding position was moderately and inversely correlated with craniovertebral angle (r=–0.532, 95% CI –0.676 to –0.348; p<0.001). The negative direction of the association indicated that higher cradle-lying exposure was associated with smaller craniovertebral angles and therefore greater anterior head displacement. The coefficient of determination (r^2=0.283) indicated that approximately 28.3% of the shared variation between cradle-lying exposure and craniovertebral angle was represented by their bivariate linear relationship. A strong positive correlation was observed between the severity of forward head posture and cervico-scapular muscle imbalance (r=0.727, 95% CI 0.600–0.818; p<0.001). The corresponding coefficient of determination was r^2=0.529, indicating substantial shared variation between the two measures. Participants with greater FHP severity therefore tended to demonstrate greater cervico-scapular muscular imbalance. The categorical relationship between FHP severity and cervico-scapular muscle-imbalance classification was also statistically significant, $\chi^2(4)=11.543$, p=0.021. The derived Cramér's V of 0.276 indicated a small-to-moderate strength of association between the categorical variables. Collectively, these findings demonstrate that greater habitual exposure to the studied breastfeeding posture was associated with greater forward head postural deviation and that increasing FHP severity was associated with greater cervico-scapular muscle imbalance. Because the data were obtained using a cross-sectional design, these findings indicate concurrent associations and do not establish temporal direction or causality.

Table 2. Associations Between Cradle-Lying Exposure, Craniovertebral Angle, Forward Head Posture, and Cervico-Scapular Muscle Imbalance (N=76)

Variables	Statistical analysis	Effect estimate	95% CI	Test statistic	p-value
Cradle-lying exposure vs craniovertebral angle	Pearson correlation	r = –0.532	–0.676 to –0.348	t(74) = –5.405	<0.001
Forward head posture severity vs cervico-scapular muscle imbalance	Pearson correlation	r = 0.727	0.600 to 0.818	t(74) = 9.108	<0.001
Forward head posture category vs cervico-scapular imbalance category	Chi-square test of independence	Cramér's V = 0.276	—	$\chi^2(4) = 11.543$	0.021

Correlation confidence intervals were calculated using Fisher's z transformation from the reported correlation coefficients and N=76. Corresponding statistics were obtained from the reported Pearson correlation coefficients and sample size. Cramér's V was derived from the reported χ^2 statistic and N=76. CI, confidence interval.

DISCUSSION

The present study demonstrated clinically meaningful associations between habitual exposure to the cradle-lying breastfeeding position, sagittal head posture, and cervico-scapular muscle status among lactating mothers. More than half of the participants were classified as having high cradle-lying exposure, approximately two-thirds demonstrated moderate-to-severe forward head posture, and more than four-fifths exhibited some degree of cervico-scapular muscle imbalance. Greater cradle-lying exposure was moderately associated with a smaller craniovertebral angle, while increasing severity of forward head posture was strongly associated with greater cervico-scapular muscle imbalance. The significant categorical association between FHP severity and muscle-imbalance classification further supported the relationship between altered head posture and cervico-scapular function. These observations indicate that repetitive breastfeeding posture and postural muscle performance are interrelated within the postpartum population, although the cross-sectional design does not establish the temporal direction or causality of these relationships.

The high frequency of postural and musculoskeletal alterations observed in the present study is consistent with growing evidence that breastfeeding may represent a substantial repetitive physical demand for lactating women. Ratajczak and Górnowicz found a high prevalence of spinal pain among breastfeeding women and reported that women experiencing back pain spent more time during individual breastfeeding episodes and accumulated greater total breastfeeding time per day. They additionally found less intense neck pain among mothers who preferred lying positions compared with those breastfeeding while sitting in a chair or armchair (2). Ojukwu et al. similarly reported breastfeeding-related neck pain in approximately half of the Nigerian lactating mothers studied, with the cradle hold being the most frequently adopted breastfeeding position (3). A mixed-methods investigation by Aburub et al. further showed that breastfeeding-related musculoskeletal symptoms involving the neck, shoulder, back, and hand could interfere with sleep, work, mood, activities of daily living, and overall quality of life, while many mothers reported receiving inadequate education regarding optimal breastfeeding posture (12). Collectively, these observations support the clinical relevance of cumulative exposure and sustained positioning rather than suggesting that breastfeeding itself is intrinsically harmful.

Evidence regarding the independent role of individual breastfeeding positions remains heterogeneous. Alazmi and Algabbani reported significant associations between breastfeeding positions and musculoskeletal pain among lactating mothers in Saudi Arabia, with the cradle position being the most commonly adopted position (4). In contrast, Rani et al. found mechanical neck and low-back pain among postpartum mothers in Rawalpindi and Islamabad but did not demonstrate a significant overall association between breastfeeding position and musculoskeletal complaints (5). Dandekar and Khatavkar also demonstrated variation in neck-related symptoms across breastfeeding positions without establishing a simple position-specific causal relationship (6). More recent evidence from Saudi Arabia similarly identified a substantial burden of breastfeeding-associated musculoskeletal symptoms and found an association between maternal breastfeeding positioning and musculoskeletal disorders, with the back, shoulders, and neck among commonly affected regions (13). Differences among studies may therefore reflect variation in feeding duration, number of daily sessions, infant characteristics, postural support, maternal anthropometry, occupational activities, previous musculoskeletal symptoms, postpartum duration, and the methods used to classify breastfeeding posture and pain. The present findings extend this literature by evaluating cumulative exposure alongside an objective measure of sagittal head alignment rather than relying exclusively on pain or preferred-position reporting.

The inverse relationship between cradle-lying exposure and craniovertebral angle is biomechanically plausible. CVA is commonly used to quantify anterior head displacement, with smaller angles generally representing greater forward head deviation. Photogrammetric and mobile application-based measurements have demonstrated acceptable validity and reliability for clinical assessment of CVA (7). Variation in CVA across sitting and standing positions has also been demonstrated, indicating that cervical posture is responsive to overall body alignment and task configuration (8). During breastfeeding, repeated visual monitoring of infant positioning and attachment may encourage cervical flexion and anterior head positioning, particularly when the infant is located below an ergonomically favorable breast level or when the maternal upper limbs and trunk are insufficiently supported. Repeated exposure to such a configuration provides a plausible explanation for the observed relationship, although longitudinal assessment would be required to determine whether breastfeeding exposure precedes persistent alteration in resting head posture.

The strong positive relationship between FHP severity and cervico-scapular muscle imbalance is also consistent with established cervical and scapular biomechanics. Head and shoulder alignment can influence scapular orientation and recruitment of muscles involved in scapular control, including the trapezius and serratus anterior (9). Experimental biomechanical work has demonstrated that forward head alignment alters muscle-tendon unit lengths across the cervical region, with different shortening and lengthening patterns according to anatomical location and the degree of cervical displacement (10). More recent synthesis of FHP-related muscle activation research indicates that anterior head posture can alter activation patterns across cervical and shoulder-girdle musculature, although findings for individual muscles, including the lower trapezius and serratus anterior, are not entirely consistent across studies (14). These adaptations are therefore more accurately conceptualized as changes in mechanical demand, muscle length-tension relationships, and neuromuscular recruitment than as a fixed increase in the effective “weight” of the head. This distinction is important because cervical loading depends on posture, external moment arms, muscular activity, duration of loading, and individual anatomical characteristics rather than on a universal weight-per-distance relationship.

Deep neck flexor endurance was relatively limited in the studied population, with a mean holding time of 19.28 ± 10.09 seconds. Cervical flexor endurance and scapular muscle performance are relevant to maintenance of postural stability during prolonged static or repetitive activities. Previous work comparing individuals with and without postural neck pain has identified reduced endurance of cervical and scapular musculature among symptomatic participants (11). Seok et al. subsequently demonstrated that lower deep neck flexor endurance was associated with earlier changes in craniovertebral angle and altered sternocleidomastoid and upper trapezius activity during a sustained computer task, supporting the functional importance of deep cervical stabilizer endurance during prolonged postural loading (15). These findings provide a plausible parallel for breastfeeding, which also involves repeated periods of relatively sustained visual and upper-limb activity. Nevertheless, the mean endurance value observed in the present study should not be classified as pathological solely on the basis of its magnitude because endurance performance is influenced by testing protocol, participant characteristics, examiner procedures, and the normative population used for comparison.

The observed relationship between FHP severity and muscular imbalance was supported by both correlation and categorical analysis. The reported correlation between FHP severity and muscle imbalance was strong ($r=0.727$, $p<0.001$), while chi-square analysis also demonstrated a significant association between the corresponding categorical classifications, $\chi^2(4)=11.543$, $p=0.021$. The derived Cramér's V of 0.276 indicated a small-to-moderate categorical association. These complementary analyses suggest that worsening postural deviation occurred alongside increasing cervico-scapular dysfunction, although the strength of association differed according to whether the variables were considered dimensionally or categorically. Categorization may reduce statistical information by grouping participants with different underlying continuous measurements into the same severity class, which may partly account for the more modest categorical effect size.

The association between cradle-lying exposure and CVA was also clinically notable. The correlation of $r=-0.532$ indicated a moderate inverse relationship, with greater reported exposure corresponding to a smaller CVA. The associated r^2 value of approximately 0.283 reflects the magnitude of the bivariate relationship between the two measures but should not be interpreted as evidence that breastfeeding posture independently caused 28.3% of FHP. Postural alignment is multifactorial and can be influenced by occupational activities, habitual sitting, mobile-device use, maternal physical conditioning, pain, fatigue, sleep-related demands, pre-existing musculoskeletal characteristics, infant weight, breastfeeding frequency, and postpartum recovery. The present association therefore supports cradle-position exposure as one potentially relevant ergonomic factor within a broader musculoskeletal context. This interpretation is consistent with the broader breastfeeding literature, in which musculoskeletal symptoms appear to reflect interactions among feeding duration, repeated exposure, maternal positioning, physical support, and individual maternal or infant characteristics rather than a single universally harmful breastfeeding posture (2–6,12,13).

The findings have practical implications for postpartum rehabilitation and lactation support. Ergonomic breastfeeding education can emphasize minimizing prolonged unsupported cervical flexion, positioning the infant sufficiently close to the mother, supporting the upper limbs and trunk, and changing feeding positions when prolonged static loading develops. Previous breastfeeding research has similarly emphasized postural education and the use of physical support to reduce musculoskeletal discomfort (2–4,6,12,13). Importantly, ergonomic approaches should not be limited to verbal instructions regarding a nominal breastfeeding position. They should consider the interaction between maternal trunk support, head and neck alignment, infant height, arm support, duration of feeding, and the mother's ability to alter posture during prolonged sessions.

Evidence is also emerging that structured ergonomic education may modify postural risk during breastfeeding. Prayag et al. evaluated an ergonomic breastfeeding intervention among lactating mothers and reported improvements in maternal postural risk scores as well as infant attachment and suckling measures following ergonomic instruction (16). Although differences in study design, population, outcomes, and follow-up prevent direct comparison with the present observational data, these findings suggest that breastfeeding posture is potentially modifiable and support further investigation of physiotherapy-informed ergonomic education. Such strategies should complement, rather than interfere with, established infant-feeding priorities including effective attachment, maternal comfort, infant safety, and successful milk transfer.

The findings additionally provide a rationale for incorporating cervical and scapular assessment into postpartum musculoskeletal care when women report sustained feeding-related discomfort or demonstrate postural deviation. Exercises directed toward cervical and scapular control, including deep cervical flexor activation and appropriate scapular stabilization, may be considered within individualized physiotherapy management because cervical posture, deep neck flexor endurance, and scapular muscular activity are mechanically and functionally interrelated (9–11,14,15). However, the present investigation did not evaluate a therapeutic intervention. The effectiveness of specific strengthening, postural-correction, or ergonomic exercise programs therefore cannot be inferred from the current cross-sectional findings, and intervention studies specifically involving postpartum breastfeeding populations remain necessary.

Several limitations should be considered when interpreting the findings. First, the cross-sectional design establishes concurrent associations but cannot determine whether breastfeeding-position exposure preceded FHP or muscle imbalance. Reverse relationships are also possible, as mothers with existing postural or musculoskeletal characteristics may preferentially adopt particular breastfeeding positions. Second,

breastfeeding exposure included self-reported behavioral information and may therefore have been influenced by recall or reporting error. Third, postural alignment is affected by multiple maternal, infant, occupational, and behavioral factors; residual confounding may consequently contribute to the observed associations. Relevant influences may include infant weight, parity, postpartum duration, feeding frequency and duration, physical activity, occupational posture, mobile-device exposure, and previous cervical or shoulder symptoms. Recent breastfeeding research has likewise identified feeding duration, maternal positioning, physical support, and other maternal or infant characteristics as potentially relevant correlates of musculoskeletal symptoms, reinforcing the need for multivariable assessment in future studies (2,12,13). Fourth, severity categories necessarily reduce continuous measurement information and may influence the apparent strength of associations. Finally, the sample of 76 lactating mothers limits the precision and generalizability of estimates to broader postpartum populations with different demographic, cultural, occupational, or breastfeeding characteristics.

Despite these limitations, the study contributes to postpartum ergonomics by integrating breastfeeding-position exposure with an objective measure of sagittal cervical posture and assessment of cervico-scapular muscular performance. Most previous breastfeeding-related musculoskeletal research has concentrated on pain prevalence, functional complaints, or preferred feeding positions (2–6,12,13), whereas simultaneous examination of exposure, CVA, and muscular imbalance provides a broader biomechanical perspective. The combination of objective postural assessment and muscle-endurance evaluation is particularly relevant because contemporary FHP research increasingly recognizes interactions among sagittal alignment, cervical stabilizer endurance, and altered cervical or scapular muscle recruitment (14,15). Prospective studies should therefore evaluate postural changes longitudinally from early postpartum stages, incorporate important maternal and infant covariates, and determine whether ergonomic education or targeted rehabilitation alters CVA, muscle endurance, pain, disability, breastfeeding comfort, and functional participation over time.

CONCLUSION

Greater habitual exposure to the cradle-lying breastfeeding position was associated with a smaller craniovertebral angle and greater forward head postural deviation among the lactating mothers studied, while increasing FHP severity was strongly associated with greater cervico-scapular muscle imbalance. These findings support the clinical relevance of breastfeeding ergonomics and postural assessment in postpartum musculoskeletal care but do not establish that breastfeeding position causes FHP or muscular dysfunction. Incorporating individualized postural guidance, appropriate physical support, and assessment of cervical and scapular function into maternal healthcare may help identify women who could benefit from preventive or rehabilitative physiotherapy, while prospective studies are required to establish temporal relationships and intervention effectiveness.

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