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Original Article

Upper Extremity Dysfunction and Quality of Life in Women with Non-Specific Neck Pain: A Cross-Sectional Study

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Abstract

Objectives: This study aimed to comprehensively evaluate and compare upper extremity functions and health-related quality of life (HRQoL) between Non-specific neck pain (NSNP) patients and healthy controls. **Methods**: This is a cross-sectional descriptive study included 80 individuals. The patient group comprised 40 NSNP patients, while the control group consisted of 40 healthy women. Upper extremity functions were assessed using Nine Hole Peg Test (9HPT), Disabilities of the Arm, Shoulder and Hand (DASH), hand grip and pinch strength, Ruler Drop Test (RDT), Shoulder Position Sense and Single Arm Military Press Test (SAMP). HRQoL was assessed using the Short Form-36 (SF-36). Neck pain was assessed using the Visual Analogue Scale (VAS) and neck disability using the Neck Disability Index (NDI). **Results**: The patient and control groups showed statistically significant differences for 9HPT, SAMP, RDT, DASH scores, and hand grip and pinch strengths ($p<0.05$). All subcategories of HRQoL were statistically significantly lower in patients than in control group ($p<0.05$). **Conclusions**: Compared to healthy controls, women with NSNP demonstrated worse upper extremity function and HRQoL. Assessment of upper extremity function may be considered as part of routine evaluation, and rehabilitation programs could consider incorporating targeted interventions to enhance these functions. **ClinicalTrials.gov ID:** NCT06233006

Keywords: Disability, Hand, Neck, Pain, Women's Health

Introduction

Non-specific neck pain (NSNP) is defined as pain in the posterior and lateral part of the neck between the superior nuchael line and the spinous process of the 1st thoracic vertebrae without neurologic findings and obvious structural pathology. The lifetime prevalence of NSNP in the general population ranges from 12% to 70% and accounts for approximately 25% of physiotherapy referrals, and it is more prevalent in women than in men[1,2].

Patients with neck pain frequently report upper extremity problems[3]. In a study conducted on patients with neck pain but without neurological findings, upper extremity symptoms were observed in 67% of cases[4]. The literature indicates that shoulder problems associated with neck pain are significant determinants of neck disability and predictors of recurrent pain[3].

Several mechanisms have been proposed to explain upper extremity dysfunction in NSNP. Mechanical loading; the upper extremities are biomechanically connected to the neck and shoulder regions through the musculoskeletal system. Increased load on the upper extremity places stress on the neck and shoulder structures, contributing to neck pain and impairing upper extremity functions. Minor peripheral nerve damage; the upper extremity, which is connected to the neck by the brachial plexus, can develop neurogenic pain and loss of function due to minor nerve damage. Deconditioning; restricting the use of the upper extremity due to pain leads to physical deconditioning, impairing strength and endurance, and causing difficulties

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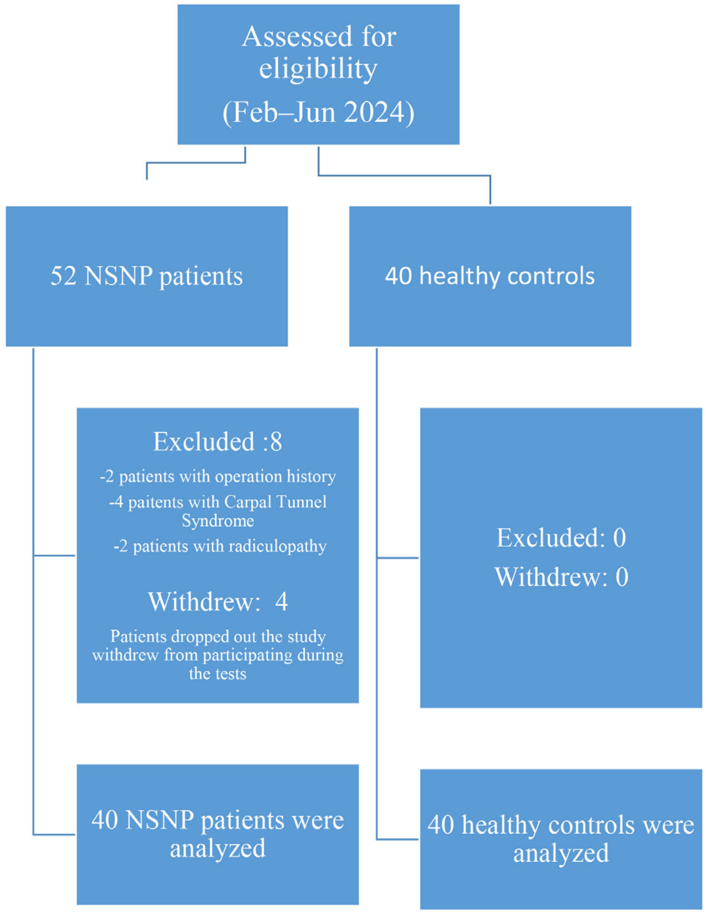

Figure 1. Flow Chart (NSNP: Non-specific neck pain).

with activities requiring these physical capabilities[3,5].

The cervical muscles play a crucial role in stabilizing the head and eyes, maintaining vestibular function, and contributing to postural orientation and proprioception. Altered afferent feedback from the muscles caused by cervical pain is expected to cause significant changes in cervical motor control[6]. Motor activity changes and pain impair sensorimotor integration by negatively affecting proprioceptive inputs in patients with neck pain[7]. Abnormal proprioceptive information leads to delayed responses to stimuli and performance differences in speed and accuracy. Eventually, a decrease in reaction time is observed[8].

Neck pain affects upper extremity functions and limits activities of daily living. Therefore, health-related quality of life (HRQoL) is significantly reduced in patients with NSNP[1,7]. Despite these impacts, studies comparing upper extremity functions between NSNP patients and healthy individuals remain limited, and prior research often lacks a holistic, multi-dimensional assessment approach. This study aimed to comprehensively evaluate and compare upper extremity functions and HRQoL between women with NSNP and healthy controls, using both objective and subjective measures.

Materials and Methods

Study Design

This was a cross-sectional descriptive study conducted at the Clinic of Physical Therapy and Rehabilitation at Tarsus State Hospital between February 2024 and June 2024. The study flow is illustrated in Figure 1.

Study Sample

The minimum sample size was calculated using data from a study by Egwu et al., which compared grip strength between patients with cervical spondylosis and healthy individuals. In that study, the mean grip strength was 23.35±8.5 in the patient group and 29.4±8.1 in the control group[9]. Based on these values, the effect size (Cohen's d) was calculated and used for the sample size estimation.Sample size analysis was performed using the G*Power software. A two-sided independent samples t-test was selected as the statistical test. The analysis was conducted with an alpha level of 0.05, statistical power of 0.85 (1-β), and an allocation ratio of 1:1 between groups. According to this analysis, the minimum required sample size was calculated as 70 participants (35 per group). To account for potential dropouts, a total of 80 participants were included in the study.

The inclusion criteria for the study are divided into two groups: the patient group and the control group. For the patient group, participants must have a diagnosis of non-specific neck pain (NSNP) with neck pain lasting more than 30 days at rest (visual analogue scale >3). Participants must be female, aged 20-65 years, and willing to participate in the study. For the control group, participants must have no underlying medical conditions that would affect the assessment parameters, including neurological, neuromuscular or cardiopulmonary conditions. They should also have no musculoskeletal pain affecting upper extremity functions with a VAS score of less than 3. As with the patient group, participants in the control group must be female, aged 20-65 years and willing to participate in the study.

Exclusion criteria for both groups include the presence of orthopaedic conditions related to the spine, a history of surgery that could affect upper extremity functions, pregnancy or recent childbirth. Participants with serious conditions such as cancer or rheumatoid arthritis, symptoms of cervical stenosis or radicular compression were also excluded. Additionally, participants with a history of whiplash injury, thoracic deformities (e.g., kyphoscoliosis or scoliosis), or a body mass index (BMI) outside the range of 18.5 to 30 kg/m^2 were not eligible to participate.

Procedure

Participants' demographic information was obtained through interviews. The duration of current neck pain and the date of initial diagnosis were asked and recorded in months. Upper extremity functions, health-related quality of life (HRQoL), neck pain, and neck disability were assessed by an experienced physiotherapist who was not blinded to group allocation. All assessments in the NSNP group were performed prior to the initiation of the physiotherapy program. Participants rested for 2–3 minutes between measurements to minimize fatigue.

Assessments

The primary outcomes of this study consisted of measures evaluating upper extremity function. These included the Nine-Hole Peg Test, the Disabilities of the Arm, Shoulder and Hand (DASH) questionnaire, hand grip and pinch strength, the ruler drop test, shoulder position sense, and the single-arm military press test. The secondary outcomes comprised health-related quality of life, pain severity, and neck disability.

Upper Extremity Functions Assessments

Nine Hole Peg Test (9HPT)

Manual dexterity of the participants was assessed using the 9HPT. Participants were instructed and allowed practice before the test. Participants were asked to place pegs on the board with one hand and remove them without pausing as quickly as possible. The time between the participant touching the first peg and releasing the last peg was recorded in seconds (sec). The measurements were repeated 2 times each for dominant and non-dominant sides and averaged[10].

Disabilities of the Arm, Shoulder and Hand (DASH)

Upper extremity disability was assessed using the 30-question DASH questionnaire, scored on a 5-point Likert system (1=no difficulty, 5=unable). Scores range from 0 to 100 (0=no disability, 100=maximum disability). It has been validated in Turkish[11]. DASH Scoring Formula = ([(sum of n responses)/n] -1)(25) where n represents the number of completed items.

Hand grip and pinch strength

Hand grip and pinch strength were measured with 'Baseline Hand Dynamometer' and 'Baseline pinchmeter' respectively. They were given the opportunity to make a trial before the test. The participant sat upright in a back-supported chair. The device was held with the shoulder in adduction, elbow in 90 degrees flexion, forearm in midrotation and hand in neutral position. A total of 3 measurements were taken for each hand at 15 sec intervals. For pinch strength, the participant was asked to squeeze the pinchmeter sensor between thumb and forefinger as hard as possible. Test results were recorded in kg. The average of the three measurements was taken to determine right and left hand grip and pinch strength[12].

Ruler Drop Test (RDT)

Hand reaction time was assessed by RDT. The participant sat with the dominant hand in a neutral position and the forearm supported on the table. The physiotherapist held the ruler vertically, with the lower end of the ruler between the participant's thumb and forefinger, and asked the participant to catch the ruler between the thumb and forefinger when the ruler was released. The distance was measured in centimetres from the top of the participant's thumb at the moment the participant grasped the ruler. From the 5 measurements, the highest and lowest were subtracted, the remaining 3 measurements were averaged and the reaction time was calculated using the formula below[13].

Table 1. Comparison of Demographic and Clinical Characteristics Between Groups.

	Patient Group n=40	Control Group n=40	p
Age, year	42.78±9.18	41.83±7.77	0.619
Height, m	1.61±0.05	1.61±0.05	0.449
Weight, kg	67.15±8.43	63.51±9.65	0.076
BMI, kg/m^2	26.06±3.14	24.34±3.28	0.019*
VAS, score	5.35 (4.58-6.55)	0 (0-0)	<0.001**
Duration of pain, month	12 (4-48)	-	-
NDI, score	21.63 (17-24.75)	3 (1-4)	<0.001**
Duration of Illness, month	48 (12-114)	-	-

*The values, expressed as mean ± standard deviation, were compared by independent groups t-test. The values, expressed as the median (IQR), were compared using the Mann-Whitney U test, * p<0.05, ** p<0.001. BMI: Body Mass Index, VAS: Visual Analog Scale, NDI: Neck Disabilty Index.*

$t = \sqrt{(2d / g)}$
t = reaction time (seconds), d = distance fallen (meters), g = acceleration due to gravity (9.8 m/s^2)

Shoulder Position Sense

Shoulder position sense was assessed with Baseline Digital Inclinometer while the participants were standing with the shoulder in 60° flexion and 60° abduction. Participants were instructed with their eyes open and then asked to replicate the target angle with their eyes closed. The deviation from the target angle was measured for both extremities. Each measurement was performed three times, and the average was calculated[7].

Single Arm Military Press Test (SAMP)

The test was developed to assess upper extremity strength and endurance in NSNP. Participant were asked to hold a 3 kg dumbbell with the dominant hand at shoulder height, with the wrist in a neutral position and the elbow flexed 90°, and to lift the dumbbell upwards by extending the elbow. They were asked to repeat this process for 30 seconds and as many times as possible. Participants were informed that they could stop and restart at any time during this period. The number of correct repetitions was recorded[5,14].

Health Related Quality of Life Assessment

Short Form 36 (SF-36)

HRQoL was assessed with SF-36. SF-36 consists of 36 items assessing 8 categories (physical functioning, social functioning, role limitations due to physical health, role limitations due to emotional problems, emotional well-being, energy/vitality, pain and general health). Each category is scored between 0-100. A higher score indicates better quality of life. The Turkish version of the questionnaire has validity and reliability[15].

Pain Severity Assessment

Visual Analog Scale (VAS)

Neck pain was assessed with VAS. Participants were asked to mark their pain intensity (0= no pain, 10= unbearable pain) on a 10 cm line and the distance was measured. VAS scores of 3 cm or less are considered mild neck pain, 3.1-6.9 cm moderate neck pain and 7 cm or more severe neck pain[16].

Neck Disability Assessment

Neck Disability Index (NDI)

The scale includes 10 questions about pain intensity, weight lifting, concentration, reading, headache, self-management, driving, working, sleeping and daily activities, scored between 0-5. Scores between 0-4 indicate no disability, 5-14 indicate mild disability, 15-24 indicate moderate disability, 25-34 indicate severe disability and 35-50 indicate total disability. The Turkish version of the scale has validity and reliability[17].

Statistical Analysis

Data analysis was performed using SPSS 22.0 for Windows (IBM Corporation). The variables were analysed for normal distribution using Kolmogorov-Smirnov/Shapiro-Wilk tests. To compare the values between the two groups, the Independent Groups t-test (normally distributed) and the Mann-Whitney U test (non-normally distributed) were used. Probabilities of less than 0.05 were considered significant[18]. Effect sizes were calculated to quantify the magnitude of group differences. For parametric variables, Hedges' g was computed based on the pooled standard deviation. For non-parametric variables, effect size (r) was calculated using the formula $r = Z / \sqrt{N}$, where N represents the total sample size. Given the number of outcomes assessed, no formal correction

Table 2. Comparison of Upper Extremity Functions Between Groups.

	Patient Group n=40	Control Group n=40	Mean Difference (95% CI)	Z	Effect Size	p
9HPT-D, sec	19.63±1.95	17.63±1.52	2.00 (1.22 to 2.78)	-	1.13	<0.001
9HPT-ND, sec	21.37±2.38	19.16±1.85	2.21 (1.26 to 3.16)	-	1.02	<0.001
SAMP, score	21.53±6.87	34.58±7.70	-13.05 (-16.3 to -9.8)	-	1.77	<0.001
RDT, sec	0.23±0.02	0.21±0.02	0.02 (0.011 to 0.029)	-	0.99	<0.001
Hand Grip-D, kg	17.83 (15.33-21.33)	21.00 (19.75-23.25)	-	3.29	0.37	0.001
Hand Grip-ND, kg	18.00 (12.75-19.92)	20.67 (19.08-24.33)	-	3.48	0.39	<0.001
Pinch-D, kg	6.70 (4.99-11.07)	8.55 (7.60-10.09)	-	2.41	0.27	0.016
Pinch-ND, kg	6.10 (4.58-8.92)	8.02 (6.73-9.11)	-	2.41	0.27	0.016
DASH, score	45.76 (38.96-54.79)	3.33 (0.83-7.5)	-	3.48	0.39	<0.001
Shoulder Flex-D, degree	4.33 (1.75-7.83)	2 (1.33-3.58)	-	2.61	0.29	0.009*
Shoulder Flex-ND, degree	5.33 (0.87-8.25)	1.67 (1-3.92)	-	2.51	0.28	0.012*
Shoulder Abd-D, degree	3.83 (1.33-7.67)	1.84 (1-3.92)	-	2.43	0.27	0.015*
Shoulder Abd-ND, degree	4 (1.33-7.08)	2.17 (1.08-4.25)	-	1.80	0.20	0.072

*The values, expressed as mean ± standard deviation, were compared by independent groups t-test. The values, expressed as the median (IQR), were compared using the Mann-Whitney U test, * p<0.05, ** p<0.001. Effect sizes were reported as Hedges' g for parametric variables and r for non-parametric variables. IQR: Interquartile Range, 9HPT-D: Dominant Nine Hole Peg Test, 9HPT-ND: Non-dominant Nine Hole Peg Test, SAMP: Single Arm Military Press Test, RDT: Ruler Drop Test, sec: seconds, Hand Grip-D: Dominant Hand Grip Strength, Hand Grip-ND: Non-dominant Hand Grip Strength, Pinch-D: Dominant Pinch Strength, Pinch-ND: Non-dominant Pinch Strength, DASH: Disabilities of the Arm,Shoulder and Hand, Shoulder Flex-D: Dominant Shoulder Flexion, Shoulder Flex-ND: Non-dominant Shoulder Flexion, Shoulder Abd-D: Dominant Shoulder Abduction, Shoulder Abd-ND: Non-dominant Shoulder Abduction.*

for multiple comparisons was applied. Therefore, the results should be interpreted as exploratory.

Results

A total of 52 patients with NSNP were assessed for eligibility; 8 were excluded and 4 withdrew during testing. Therefore, 40 patients were included in the final analysis. In the control group, no participants were excluded or withdrew, and all 40 participants were analyzed. All analyzed participants had complete data for the study outcomes; therefore, a complete-case analysis was performed. The mean age of the patient group was 42.78±9.18 years and the mean age of the control group was 41.83±7.77 years. The mean BMI of the patient group was 26.06±3.14 kg/m^2 and that of the control group was 24.34±3.28 kg/m^2. Participant's demographic and clinical data were presented in Table 1. There were no significant differences between the groups regarding age, height or weight (p>0.05, Table 1). The mean BMI of the patient group was statistically significantly higher (p<0.05, Table 1). VAS and NDI scores were significantly higher in the patient group (p<0.001, Table 1).

Statistically significant differences were found between the patient and control groups for 9HPT, SAMP, RDT, DASH scores and hand grip and pinch strengths (p<0.05, Table 2). Dominant and non-dominant side shoulder flexion position deviation degrees and dominant side abduction position deviation degrees were statistically significantly higher in the patient group compared to the control group (p<0.05, Table 2). Non-dominant side shoulder abduction position deviation degrees were similarly between groups (p>0.05, Table 2). In addition to statistical significance testing, effect sizes were calculated to quantify the magnitude of the differences between groups. Parametric variables demonstrated large effect sizes, particularly for the Nine Hole Peg Test (dominant: g = 1.13; non-dominant: g = 1.02), the Single Arm Military Press test (g = 1.77), and the Ruler Drop Test (g = 0.99). For non-parametric variables, small to moderate effect sizes were observed. Hand grip strength and DASH scores showed moderate effects (r = 0.37–0.39), while pinch strength and shoulder position sense measures demonstrated small-to-moderate effects (r = 0.27–0.29). The comparison of non-dominant shoulder abduction position sense yielded a small effect size (r = 0.20) and did not reach statistical significance. Overall, the effect size analysis indicated that the magnitude of differences between groups ranged from small to large depending on the functional parameter evaluated (Table 2).

All subcategories of HRQoL (physical functioning, role limitations due to physical health, role limitations due

Table 3. Comparison of Health-Related Quality of Life Scores Between Groups.

SF-36	Patient Group median (IQR) n=40	Control Group median (IQR) n=40	p
Physical Functioning	60 (45-70)	90 (80-100)	<0.001*
Role Limitations Due to Physical Health	0 (0-25)	100 (100-100)	<0.001*
Role Limitations Due to Emotional Problems	0 (0-58.34)	100 (75-100)	<0.001*
Energy/Vitality	42.5 (30-50)	70 (55-80)	<0.001*
Emotional Well-Being	60 (49-72)	76 (64-84)	0.001*
Social Functioning	50 (37.5-62.5)	87.5 (75-100)	<0.001*
Pain	32.5 (14.38-45)	100 (90-100)	<0.001*
General Health	37.5 (26.25-45)	80 (66.25-90)	<0.001*

*Mann-Whitney U test, *p<0.05, **p<0.001. SF-36: Short Form-36, IQR: Interquartile Range.*

to emotional problems, energy/vitality, emotional well-being, social functioning, pain and general health) were statistically significantly lower in patients than in controls ($p<0.05$, Table 3).

Discussion

This study aimed to compare upper extremity functions and health-related quality of life (HRQoL) between patients with NSNP and healthy controls. It was found that patients with NSNP had worse outcomes than healthy controls in terms of upper extremity functions and all categories of HRQoL.

Given that female gender has been consistently identified as a strong risk factor for neck pain in the literature, and because our study incorporated upper extremity performance tests alongside self-report questionnaires, we exclusively included female participants to eliminate potential gender-related differences[5]. This methodological choice allowed us to control for gender as a confounding factor and to focus specifically on the female population, which is both clinically relevant and underrepresented in the literature.

The literature has reported an association between BMI and widespread neck pain, with overweight being identified as a potential risk factor[19,20]. In the present study, the mean BMI was higher in the NSNP group compared to controls. Although height and weight did not differ significantly, BMI differed due to its composite nature. Given that BMI may influence musculoskeletal function and health-related quality of life, this difference may have acted as a confounding factor. Therefore, the findings should be interpreted with caution.

Patients with chronic neck pain may experience pain in their upper extremities as well as their neck, and over time this pain may affect their grip strength and their gross and fine motor skills[21]. In line with previous findings, Mahmoud et al. observed that patients with NSNP exhibited reduced grip and pinch strength[22]. Similarly, Yalçinkaya et al. reported significantly lower hand grip strength in women with neck pain compared to controls[23]. Tutar et al. also found a decrease in hand grip strength in both women and men with chronic neck pain in comparison to healthy controls[21]. Our study further supports these findings, as both grip and pinch strength were worse in the patient group compared to healthy controls. Importantly, our study is among the few that simultaneously examined grip, pinch strength, and broader upper extremity functions, thereby providing a more comprehensive understanding of functional impairments in this population.

Upper extremity dysfunction leading to disability is often reported clinically in patients with NSNP. Jang et al. have shown severe upper extremity disability in the DASH scores of NSNP patients with severe pain/disability[24]. In our study, patients' DASH scores were significantly worse than controls'. Patients with NSNP often avoid movement and exercise because they fear that physical activity will make their condition worse. However, avoiding movement or exercise may be associated with physical and functional disability and psychological problems in the long term. Furthermore, these psychological problems may play an important role in the chronicity of the disease and pain. Many studies have shown that depression and pain avoidance behaviours are strongly associated with chronic pain and increased disability[25-27]. Based on all these factors, we believe that increased neck disability may also be associated with greater upper extremity disability. These findings highlight the need for early interventions targeting both physical and psychological domains in order to prevent the vicious cycle of pain, avoidance, and disability.

Neck pain is thought to reduce shoulder proprioception, because changes in motor activity with increasing pain may affect afferent proprioceptive stimuli[7]. Patients with NSNP and upper extremity pain have impaired positional acuity and reduced tracking performance[28]. A study investigating the effect of neck pain on upper extremity position sense in a geriatric population reported that older people with moderate neck pain made more position errors during 60° shoulder flexion and 60° shoulder abduction than those with painless and mild neck pain[7]. Sandlund et al. reported that the sense of proprioception was impaired in both NSNP and traumatic neck pain patients, resulting in a reduction in end-point acuity during target movements[29]. In our study, shoulder position sense was significantly worse in the patient group compared with the control group. This difference may be related to several possible mechanisms. The first possibility is that there may be a reduction in the acuity of the proprioceptive information from the muscle spindle. A second possibility is that an injury or stress to the peripheral nerves may affect the transmission of proprioceptive afferent information and have a negative effect on the control of movement[29]. Lastly, because the muscle groups that provide scapular mobility and stability function simultaneously with the upper limb and cervical spine, neck pain may influence the upper limb's sense of position through the axioscapular joint. Impaired upper extremity proprioception may contribute to functional deficits in patients with NSNP[7]. Our findings suggest that proprioceptive impairments may be associated with upper extremity dysfunction in this population, and therefore proprioception-focused interventions may be beneficial in rehabilitation programs.

Interestingly, there was no significant difference in non-dominant shoulder abduction position sense between groups. This heterogeneous finding may be explained by neuromuscular adaptations related to dominance, lower functional demand on the non-dominant side, or greater measurement variability. Alternatively, the inclinometer-based assessment may lack the sensitivity required to detect subtle proprioceptive asymmetries. Future studies employing more precise motion analysis technologies may clarify this observation.

Patients with neck pain are known to have greater activation of accessory neck muscles during repetitive upper extremity tasks than asymptomatic controls[30]. According to the pain adaptation model, pain can cause a decrease in contractile capacity in agonist muscles and a corresponding increase in activity in antagonist or synergist muscles[31]. Increased disability related to neck pain has been associated with greater auxiliary muscle electromyography amplitude during functional tasks[30]. Sittikraipong et al. found that patients with neck pain had slower hand-foot reaction times and impaired hand-eye coordination compared to healthy controls. They reported that these findings revealed sensorimotor losses associated with neck pain[8]. Heerkens et al reported that patients with chronic non-specific arm, neck and shoulder pain had reduced tactile acuity and faster reaction time in the painful arm. The results should be interpreted with caution, however, as the study group consisted of only seven participants and their pain and disability scores were low, suggesting that this may be due to impaired information processing in sensory and motor feedback[32]. In our study, the NSNP group had longer hand reaction times compared to healthy controls. In patients with NSNP, sensorimotor integration may be altered alongside changes in proprioception, which may in turn influence the preparation process of motor planning[33]. Therefore, delayed reaction time observed in the patient group may be related to altered sensorimotor processing. The results of our study show that hand reaction time may be prolonged due to sensorimotor deficits associated with neck pain. This highlights the potential importance of including reaction time measures in the assessment of patients with NSNP, as delayed sensorimotor responses may be associated with functional disability.

Mclean et al reported that NSNP patients had the greatest problems with heavy housework, gardening, carrying heavy objects and overhead activities, so they developed the SAMP test, which assesses upper extremity strength and endurance, and administered it to 151 NSNP patients. The study reported that women without upper extremity symptoms performed significantly better on the SAMP test than women who reported upper extremity symptoms[5]. Alreni et al. reported that SAMP scores of women with NSNP were significantly lower than healthy women. They also emphasised that the SAMP can be used in clinical and research applications to assess upper extremity functions in women with NSNP and has near perfect reliability and compliance[14]. Patekar et al also reported that SAMP test results were worse in women with neck pain than in healthy controls[34]. Gurav et al also reported that patients with NSNP had worse SAMP scores than healthy controls[35]. The NSNP group was significantly worse than the healthy controls on the SAMP test in our study. This may be associated with loss of physical conditioning and reduced cardiovascular capacity that may occur when patients restrict upper extremity activities due to pain. As cardiovascular capacity decreases, a reduction in upper extremity muscle strength and endurance may also be observed[3,35]. In addition, even if the patients' strength and endurance did not decrease during the SAMP test, which consists of forced flexion-extension movements at the elbow and shoulder with a 3 kg free weight, we think they may have kept the number of repetitions low for fear of increasing neck pain.

Among NSNP patients, 79.6% reported that upper extremity activities made neck pain worse, supporting the view that upper extremity dysfunction is closely related to neck pain[36]. In a study investigating the effect of neck pain on upper extremity functions in older people, Ünlüer et al. reported that there was a significant difference in hand dexterity in older people divided into three groups as no pain, mild pain and moderate pain. This has been interpreted to mean that people with neck pain avoid difficult and painful activities that require the use of the upper extremities, and sometimes even avoid normal activities because they think that movement will cause pain[7]. Similarly, dexterity scores of the NSNP group were significantly worse than healthy controls in our study. This finding may be related to the anatomical proximity of the neck and upper extremities and the fact that nerve roots innervating upper extremities muscles originate from the cervical region. This finding further supports the integration of dexterity assessments into clinical rehabilitation programmes, and suggests that task-specific training may be beneficial for these patients.

The present study also evaluated the magnitude of group differences using effect size measures. The results indicated large effect sizes for several upper extremity performance tests, particularly the Nine Hole Peg Test and the Single Arm Military Press test, suggesting substantial differences in dexterity and upper extremity functional performance between groups. In contrast, grip strength, pinch strength, and proprioceptive measures demonstrated small to moderate effect sizes, indicating that although these parameters differed significantly between groups, the magnitude of the differences was more modest. These findings highlight that impairments in upper extremity function may vary across different domains, with larger differences observed in tasks requiring coordinated motor performance. Reporting effect sizes in addition to p-values provides a clearer understanding of the practical and clinical relevance of the observed differences.

Neck pain, whose prevalence peaks in middle age, the most productive years of life, usually leads to activity limitation and disability. Neck pain is a chronic, recurring condition, with more than a third of the population complaining of persistent neck pain each year[37]. Neck pain not only affects physical health but also mental health[38]. As neck pain increases and quality of life decreases, general health and participation in daily activities are affected, disability increases, and quality of life deteriorates further[1]. Nolet et al. showed that neck pain negatively affects HRQoL[37]. Lin et al. reported that patients with chronic neck pain had worse outcomes in all subcategories of the SF-36 compared with age- and sex-matched Taiwanese normative values[38]. Yalçinkaya et al. also reported that physical health and total SF-36 scores decreased in men, while physical health, mental health and total health scores decreased in women compared with healthy controls[23]. In our study, the patient group had worse scores in all subcategories of the SF-36 compared with the control group, similar to other studies in the literature investigating neck pain and HRQoL. These results suggest that both physical and mental HRQoL may be poorer in patients with NSNP and may be associated with pain and disability. These findings highlight the coexistence of pain, disability, and reduced quality of life in this population. To our knowledge, this is the first study that investigated both upper extremity functions and HRQoL together in patients with NSNP, thus providing a more holistic perspective on how pain and disability may be associated with quality of life.

Limitations

Only female patients were included in the study. Therefore, it is not possible to generalise our findings to all gender groups. It is difficult to generalise the results to the entire NSNP population as this was a cross-sectional study conducted at a single site. No adjusted analyses were performed; therefore, potential confounding factors could not be controlled. In particular, the significant difference in BMI between groups may have influenced the results. In addition, other potential confounders such as physical activity level, psychosocial status, and ongoing treatments were not systematically measured. Assessments were performed by a single physiotherapist who was not blinded to group allocation. Although standardized protocols were strictly followed, assessor expectations may have introduced measurement bias. Future studies should incorporate blinded assessors to reduce this risk. In addition, shoulder position sense and reaction time could have been assessed using computerised systems under laboratory conditions to provide more objective data. Therefore, future studies should include both genders, adopt longitudinal and multicentre designs, and incorporate advanced motion analysis technologies in order to confirm and expand upon our findings.

Conclusions

In conclusion, women with NSNP demonstrated worse upper extremity functions and HRQoL compared to healthy controls. Even in the absence of neurological involvement, upper extremity impairments were observed in patients with neck pain compared with healthy controls. This situation may be associated with reduced quality of life in women with NSNP who are expected to be active. Our findings emphasise the importance of incorporating comprehensive assessments of the upper extremities including strength, proprioception, dexterity and reaction time into routine evaluations of patients with NSNP. Rehabilitation programs should target not only neck pain relief, but also integrate upper extremity training to improve overall HRQoL.

Ethics Approval

The study was approved by the Ethics Committee of Dokuz Eylül University (protocol no. GOA-8033; decision no. 202/14-12) and was conducted in accordance with the Declaration of Helsinki (1964) and its later amendments.

Consent to Participate

Written informed consent was obtained from all participants.

Authors' Contributions

AG: Study conception and design; data collection; formal data analysis and interpretation; drafting of the manuscript. SÖ: Contribution to study design; critical revision of the manuscript for important intellectual content; supervision of the research *process. EG: Methodological development; assistance with data interpretation; review and editing of the manuscript. All authors read, edited, and approved the final version of the manuscript.*

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