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Research Article

# Investigating Anxiety, Mobility, Disability and Proprioception in Adults with Mild Neck Pain: A Cross-Sectional Study

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## ABSTRACT

**Introduction:** Studies on subclinical neck pain (SCNP), known as mild pain lack proper literature. This study examines the differences in anxiety, neck movement, disability, and proprioception in people with chronic SCNP (12 females and 4 males, age = 28.1±4.0 years) and people without neck pain (17 females and 6 males, age = 25.8±3.1 years).

**Materials and Methods:** A cross-sectional study with 39 participants was conducted. The participants were instructed to score their pain using the visual analog scale (pain group: < 4/10 and normal group: 0/10), anxiety level with the state-trait anxiety inventory, and neck disability with the neck disability index. In addition, active range of motion and joint position errors were assessed in participants of both groups.

**Results:** There was no significant difference in mean baseline characteristics between the two groups. The participants in the pain group reported significantly higher median neck disability index (P≤0.001) and higher mean current state-trait anxiety inventory state (P=0.032) scores compared to participants with no pain. No significant differences in mean flexion, extension, lateral flexion right, lateral flexion left, rotation right, or rotation left were found between groups (P=0.95, P=0.68, P=0.29, P=0.59, P=0.70, and P=0.17, respectively). In addition, there were no significant differences in mean cervical spine joint position error flexion, extension, rotation right, and rotation left by the study group (P=0.65, P=0.33, P=0.26, and P=0.23, respectively).

**Conclusion:** SCNP can substantially influence functional ability and anxiety levels, especially among students in higher education institutions dealing with additional stressors. The interaction between pain intensity, disability, and anxiety underscores the potential for a detrimental feedback loop, underscoring the significance of early intervention.

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## Introduction

According to the Global Burden of Diseases, Injuries, and Risk Factors study, neck pain affected approximately 203 million people worldwide in 2020 [1]. By 2050, there will be an estimated 32.5% increase in neck pain cases affecting 269 million people [1]. Neck pain was one of the most expensive conditions treated in the United States in 2016 costing more than 134 billion US dollars. In 2017, the global prevalence and incidence rate of neck pain were 3551.1 and 806.6 per 100 000 people, respectively, impacting approximately 15% of the global population [2, 3]. Pain is an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage [4]. Neck pain is a complex disorder [2] that can affect individuals physically and emotionally, leading to movement avoidance behaviors and anxiety [5, 6]. Subclinical neck pain (SCNP) is a disorder that does not typically prompt people to seek medical treatment [7-9]. SCNP has been categorized as mild pain, subacute or chronic, with a visual analog scale (VAS) score of ≤3.4/10 cm, with 10/10 cm meaning the worst pain, that is generally left untreated [7, 8, 10]. SCNP has the potential to increase anxiety, increase disability, decrease neck mobility, and decrease neck proprioception [8, 11, 12]. SCNP and its potential effects on neck and upper limb joint position awareness can lead to impaired integration of sensory input [13].

Chronic neck pain is one of the most common societal problems negatively impacting daily activities and well-being [14]. Chronic pain is defined as pain lasting longer than three months and can persist after the healing process has been completed [15, 16]. According to the literature, causes for neck pain are multifactorial and evidence has demonstrated that psychological factors can affect the musculoskeletal system similarly as physical factors will [1, 17]. These psychological factors also have the potential to influence the way people perceive pain [17]; assuming that this influence can continue after the healing process is completed. More specifically, Alghamdi et al.'s [17] findings show that anxiety affects and can increase neck pain symptoms. Managing chronic pain can become a difficult task with a potential increase in the patient's anxiety and functional disability often affecting personal and professional behaviors [5, 6, 14, 18]. Although SCNP is a common disorder, its impact on the combined musculoskeletal and sensory systems has not been studied extensively [13]. This study examines the differences in anxiety, neck movement, disability, and proprioception in people with chronic SCNP and people without neck pain.

## Materials and Methods

### Study design

A cross-sectional study design was used. This study utilized one pain group and one normal group. This study was conducted at the Loma Linda University Department of Physical Therapy.

### Study participants

A total of 43 participants signed the informed consent. Four participants from the normal group were excluded because they reported a VAS score above zero. Thus, 39 participants with a Mean±standard deviation (SD) age of 25.8±3.1 years and body mass index (BMI) of 26.7±6.0 kg/m$^2$ enrolled in this study. Most participants were females (n=29, 74.4%). Participant recruitment was conducted using emails, flyers, and word of mouth. The inclusion criteria were adults between 20-40 years of age currently enrolled as students, with reports of neck chronic subclinical pain or no pain for the normal group. The participants who reported perceived pain intensity of greater than 4/10 on the VAS were excluded from the study as this was considered greater than subclinical pain [17]. Additionally, participants were also excluded if they were receiving clinical treatment for their pain, had taken pain medication six hours before data collection, had acute pain of fewer than three months of duration, and/or reported contraindications for electrotherapy, were unwilling to receive a daily text message to their phones. The exclusion criteria were assessed based on self-report.

### Procedures and data collection

A total of 39 participants were recruited for this study. There was a total of 23 participants in the subclinical neck pain group and 16 participants in the no pain group as shown in Figure 1. All participants signed the consent form to participate in the study and were educated on the questionnaires to be administered and completed before assessments. First, the participants in the pain group were instructed to score their pain and complete the VAS [19]. The pain score was determined by measuring the distance in centimeters (cm) from "no pain" to the participant's mark on the VAS [20]. The VAS has moderate reliability as a tool for self-reporting for people with neck pain, with an intraclass correlation coefficient (ICC)= 0.72 (95% confidence interval [CI], 0.08-0.90]) [21]. In the pain group scores were required to be < 4/10. Participants in the normal group completed the VAS for pain assessment. A score of 0/10 was required to be in-

**Figure 1.** Noraxon myoMotion Sensor Placement



cluded in the no-pain group. Next, all participants (pain and normal group) completed 2 questionnaires: The state-trait anxiety inventory (STAI) form "Y" for a clinical measure of state (how they feel at the moment) and trait (how they felt in general) anxiety in adults [22, 23]. Form Y (short form) has 10 items for assessing trait anxiety and 10 for state anxiety. Higher scores in the STAI indicate greater anxiety [22-24]. The STAI-specific reliability with a focus on people with neck pain has not been investigated; however, STAI shows excellent reliability, with correlation coefficients ranging from 0.87 to 0.93 in studies with subjects with other anxiety disorders [25]. Then, all participants completed the neck disability index (NDI) questionnaire consisting of 10 sections (pain intensity, personal care, lifting, work, headaches, concentration, sleeping, driving, reading, and recreation) with a 6-point scale from 0 (no disability) to 5 (full disability) to measure neck disability. The NDI scores were recorded as percentages [26]. The NDI has excellent reliability with an ICC=0.92 (95% CI, 0.46-0.97) [21]. The participants in both groups were educated with the Noraxon myoMotionTM system instrument that was used to measure degrees and angles of cervical spine motion to record an active range of motion (AROM) [27]. Also, the Noraxon myoMotionTM system instrument was used to measure the joint position error (JPE) to determine cervical spine proprioception [27]. The MyoMotionTM system (Figure 2) shows a concurrent validity with an excellent agreement (XCORR >0.880) when compared to the gold standard system for human movement [28], a correlation coefficient of 0.99 [29], and good repeatability and reliability [30].

## Outcome measures

### Pain intensity test

The subjective assessment of the participant's pain intensity was recorded on the VAS which consisted of a 10-cm line [19] with the left (0 cm) end of the line meaning no pain and the worst pain imaginable on the right end (10 cm). A measurement was taken from the 0 cm point on the scale to the marking made by the participant, which was interpreted as the pain level [20]. In this study, neck or upper quadrant subclinical mild pain was defined as a VAS score of <4/10.

### Disability test

The NDI instrument considers several factors of daily living: Pain intensity, personal care, sleeping lifting, reading, driving, headaches, concentration, work, and recreation. Scores are based on the impact that neck pain has on ten activities in the NDI which uses a 6-point Likert scale with a range from no impact to worst imaginable [26]. The NDI displays 5 items taken from the Oswestry lower back pain index with an additional 5 new items [31, 32]. These items are assessed through questions utilizing a 6-point scale from 0 (no disability) to 5 (full disability) [31]. The range in the scores is from 0 to 50 [31, 32]. These scores can be recorded as percentages with the following interpretation: 0-4 (0%-8%), no disability; 5-14 (10%-28%), mild disability; 15-24 (30%-48%), moderate disability; 25-34 (50%-64%), severe disability; and >35 (70%-100%), complete disability [33]. This study utilized percentages for the NDI scores.

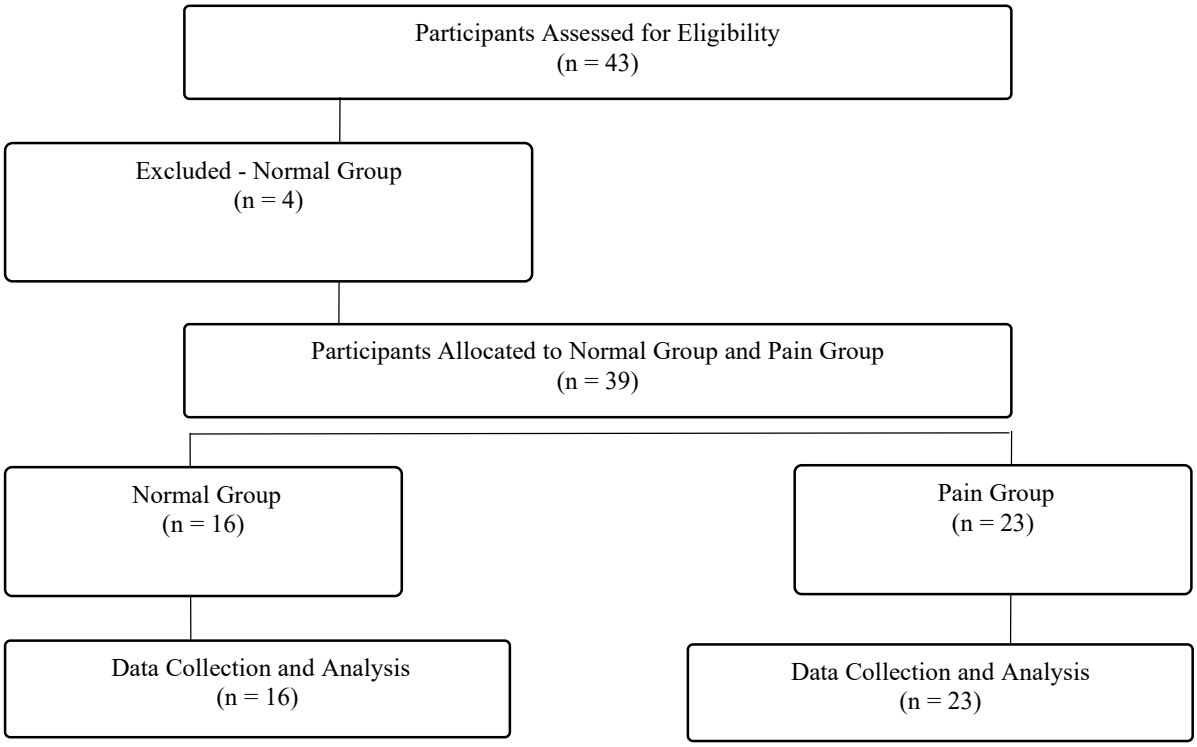


**Figure 2.** Study diagram recruitment and assessment

### State-trait anxiety inventory

The STAI provides a measure of the anxiety level of "normal" adults who are experiencing it at the moment or the tendency to feel anxious utilizing a self-report questionnaire [22, 23]. The STAI contains 2 subscales. The first one is the state anxiety scale (S-Anxiety), which measures the current state of the participant's anxiety and feelings. The second subscale, the trait anxiety scale (T-Anxiety), measures the frequency of anxiety feelings and evaluates the "anxiety proneness" [22, 24]. The STAI has 20 items for each subscale, S-Anxiety and T-Anxiety [22, 24]. Scores range from 20-80; a higher score indicates greater anxiety [22, 24]. For this study, the STAI short form was utilized.

### Active range of motion and joint position error

The MyoMOTIONTM 3D Motion Analysis System, (Noraxon U.S.A Inc., Scottsdale, Arizona- Manufacturer) - Research PRO system (Model 680 MyoMOTIONTM Research Receiver/Model 610 MyoMOTIONTM sensor; Noraxon MR3, 3.16.88 software version), was utilized to measure cervical spine AROM and JPE by placing two sensors utilized to measure degrees of motion in joints [27]. Two sensors (inertial measurement units) from this system we used to measure degrees of motion and joint position error [27]. Sensors were placed on the back of the participant's head with a fixation strap; the second sensor was attached below the C7 vertebra in line with the spinal column with double-sided tape [27].

### Data analyses

The data were analyzed using SPSS software version 28.0. Assuming a moderate effect size of 0.7, a power of 0.80, and an $\alpha$=0.05, the estimated sample size was 46 participants. The data were summarized using frequency (%) for qualitative variables, Mean±standard deviation (SD) for continuous variables, and median (minimum, maximum) when the distribution was not approximately normal. The normality of the outcome variables was examined using the Shapiro-Wilk test and boxplots. The frequency distribution of gender between the two study groups was compared using the chi-square test of independence. Mean baseline characteristics and outcome variables by study group were examined using an independent t-test. Median VAS, NDI, and JPE rotation right were compared between the pain and normal groups using the Mann-Whitney U test. The level of significance was set at $P \leq 0.05$.

## Results

Forty-three participants signed the informed consent. Four participants from the normal group were excluded because they reported a VAS score above zero. Thus, 39

participants with a Mean±SD age of 25.8±3.1 years and BMI of 26.7±6.0 kg/m$^2$ enrolled in this study. The majority were females (n=29, 74.4%). There was no significant difference in mean age and BMI between the two study groups (P=0.06 and P=0.37). Changes in pain, disability, anxiety, cervical spine AROM, and JPE by study group are displayed in Table 1. The results of the independent t-test in Figure 3 show that participants in the pain group reported higher mean STAT-S scores than those in the normal group (18.0±7.0 vs 13.5±4.8, P=0.032; Cohen d=0.72), but no significant changes in STAI-T were detected between the two study groups (P=0.23). The participants in the pain group reported significantly higher median (minimum, maximum) NDI scores (Figure 4) than normal participants (16[0, 22] versus 1[0, 12], P<0.001 [d=0.70]). In terms of cervical spine AROM, there was no significant difference in mean flexion, extension, lateral flexion right, lateral flexion left, rotation right, and rotation left between the study groups (P=0.95, P=0.68, P=0.29, P=0.59, P=0.70, and P=0.17 respectively). In addition, there were no significant differences in mean cervical spine JPE flexion, extension, rotation right, or rotation left by the study group (P=0.65, P=0.33, P=0.26, and P=0.23 respectively) (Table 1).

**Table 1.** Baseline characteristics and outcome variables by group (n=39)

| Variables | No. (%)/Mean±SD | | P (d) | Power |
|---|---|---|---|---|
| | Normal ($n_1$=16) | Pain ($n_2$=23) | | |
| Female | 12(41.4) | 17(58.6) | 0.62 (0.01) [W] | 0.10 |
| Age (years) | 28.1±4.0 | 25.8±3.1 | 0.06 (0.65) | 0.70 |
| BMI (kg/m$^2$) | 25.1±4.2 | 26.7±6.0 | 0.37 (0.30) | 0.25 |
| VAS* | 0 (0, 0) | 2.0 (0.1, 3.8) | <0.001 (0.87) [Y] | 0.85 |
| NDI*(%) | 1 (0, 12) | 16 (0, 22) | <0.001 (0.70) [Y] | 0.80 |
| STAI-S | 13.5±4.8 | 18.0±7.0 | 0.032 (0.72) | 0.80 |
| STAI-T | 18.3±4.4 | 20.3±5.6 | 0.23 (0.40) | 0.35 |
| Flexion | 51.5±12.5 | 53.3±9.6 | 0.95 (0.02) | 0.10 |
| Extension | 38.0±11.4 | 39.6±12.7 | 0.68 (0.14) | 0.11 |
| Lateral flexion right | 38.8±5.9 | 36.4±7.2 | 0.29 (0.35) | 0.30 |
| Lateral flexion left | 38.7±6.6 | 37.5±7.1 | 0.59 (0.18) | 0.15 |
| Rotation right | 67.3±7.1 | 66.4±7.5 | 0.70 (0.13) | 0.11 |
| Rotation left | 68.1±5.2 | 64.9±8.0 | 0.17 (0.46) | 0.50 |
| JPE flexion | 4.2±2.3 | 4.7±4.2 | 0.65 (0.15) | 0.15 |
| JPE extension | 4.8±2.8 | 5.8±3.3 | 0.33 (0.32) | 0.26 |
| JPE rotation right* | 2.2 (1.1, 8.5) | 2.9 (0.9, 18.0) | 0.26 (0.18) | 0.15 |
| JPE rotation left | 3.6±2.0 | 2.8±1.6 | 0.23 (0.40) | 0.35 |

JMR

Abbreviations: BMI: Body mass index; VAS: Visual analog scale; NDI: Neck disability index; STAI-S: State-trait anxiety inventory-state; STAI-T: State-trait anxiety inventory-trait; SD: Standard deviation.

Notes: * indicates median (minimum, maximum); [Y] shows the effect size for the Wilcoxon signed rand test; [W] shows the effect size for the chi-square test.

$d=\frac{\text{Mean of the difference}}{\text{SD of the difference}}$, $r=\frac{z}{\sqrt{N}}$, $j=\sqrt{(\frac{c^2}{n})}$

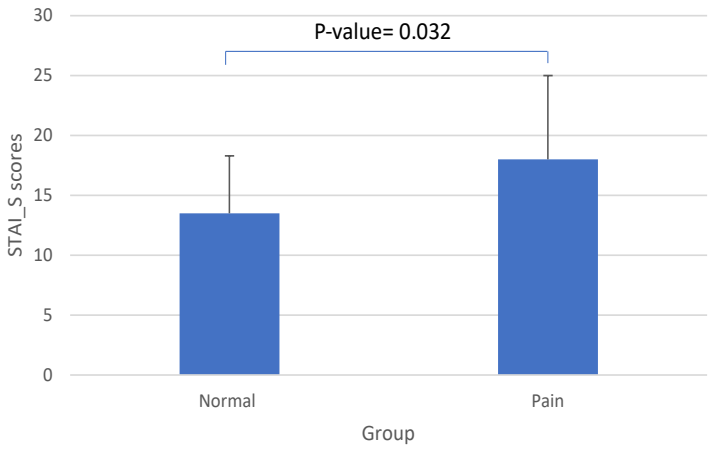


**Figure 3.** The mean of state-trait anxiety inventory state scores by group

JMR

## Discussion

SCNP does not usually prompt people to seek medical treatment; however, their pain may still affect their activities of daily living. Pain has been linked to an interaction between sensory, emotional, and physical factors that influence physical mobility in people [34]. This interaction has not been fully studied to determine the combined effects on movement [34].

In this study, we hypothesized that neck pain, disability, and anxiety results would demonstrate a negative impact on participants with mild neck pain and no major impact on participants without pain. Wlodyka-Demaille et al. suggested two dimensions in the NDI (French version); namely functional disability and pain [35]. The results showed that the pain group had a significantly higher median NDI score of 16% falling between 10%-28% range, considered to be mild disability [33]. In this study, the NDI results (percentage) in subjects with SCNP are clinically higher than the subjects with no pain, considering the clinically meaningful difference of 10 points and a minimum clinically important difference of 7.5 points in the NDI [36].

As mentioned previously, chronic pain can be altered by factors in social life along with anxiety and functional disability [4, 5]. The state of anxiety perceived by participants is described by the STAI-S scores; higher scores indicate higher anxiety at the moment of the test [22, 24]. The results showed that participants in the pain group reported higher mean STAI-S scores when compared to the normal group. Literature has suggested that the expectation of pain alone can cause a cascade of brain activity resulting in anticipatory anxiety [37, 38]. This can explain the higher scores in STAI-S, in Table 1, in the

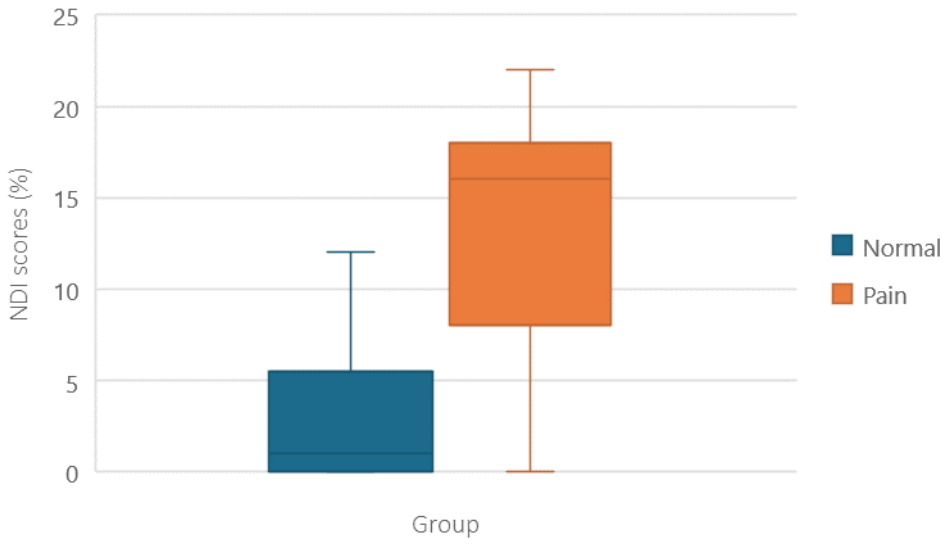


**Figure 4.** Neck disability index scores by group

JMR

pain group compared to the normal group. Anxiety and mild neck pain could be factors students experience in a higher education institution. Poor posture, prolonged periods in a seated position, stress due to academic workload and anxiety could be some of the common responses of students in higher education. The timing of data collection may have been influenced by the timeline of the academic quarter and the various anxiety levels potentially caused by examinations. Our findings for neck JPE in participants with SCNP differ from Quartey et al that showed no differences in neck JPE in participants with neck pain versus no pain [39]. In the present study, cervical JPE was decreased in the pain group in all directions tested, except rotation left. Despite no significant difference in cervical spine AROM in participants with SCNP, there was increased AROM in all directions in the normal group.

As suggested in the literature, the negative correlation between pain intensity (VAS), disability (NDI), and anxiety (STAI) [40] increases the chances of a cycle that starts with pain or anxiety ending with disability and a low quality of life. It is important to point out that interventions for SCNP are likely to be of benefit in avoiding the cycle of pain and low quality of life. The absence of interventions for people with SCNP not seeking medical treatment can also lead to this cycle. In particular, non-pharmacological treatments for pain have been underutilized [41].

## Conclusion

This study shows the frequently overlooked impact of SCNP on individuals' daily lives. While SCNP may not prompt immediate medical attention, it can substantially influence functional ability and anxiety levels, especially among students in higher education institutions dealing with additional stressors. The interaction between pain intensity, disability, and anxiety underscores the potential for a detrimental feedback loop, underscoring the significance of early intervention to enhance the quality of life for individuals experiencing SCNP.

### Study limitations

Limitations of this study included the sampled population. Participants were young students at a higher education institution, and most were females. Also, the academic calendar was not considered (testing weeks vs no testing weeks) when data was collected, which could have impacted anxiety levels.

## Ethical Considerations

### Compliance with ethical guidelines

The study was approved by the Institutional Review Board (IRB# 5220149) at Loma Linda University (Code: NCT05382039). Informed consent was obtained from all subjects before participation in this study. All procedures were applied following the Declaration of Helsinki. The participants had the opportunity to ask questions before deciding to participate and were informed that they could leave the study at any time.

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### Authors' contributions

Conceptualization and Supervision: Pablo Mleziva and Eric G. Johnson; Methodology: Pablo Mleziva; Investigation, Writing – original draft, and Writing – review & editing: All authors; Data collection: Pablo Mleziva, Eric G. Johnson, Madeha Jaber, Lillian Mleziva; Data analysis: Noha Salim Daher; Funding acquisition and Resources: Pablo Mleziva, Eric G. Johnson and Everett B. Lohman.

### Conflict of interest

The authors declared no conflict of interest.

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