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Reliability and validity of text neck questionnaire for assessing neck pain and its associated symptoms due to smartphone use in college going students

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Abstract
Background: These days, text neck syndrome is an alarming problem as more people engage in technology. There are some tools available in the literature which are used for assessing text neck but the reliability and validity of these tools is still questionable. Moreover, the association of neck disability with various behaviors during the use of smartphones is still unclear in the literature. Therefore, this study aims to find out the reliability and validity of TNQ as a screening tool for assessing text neck and its associated factors due to smartphone use in college going students.
Purpose: To examine the Reliability and Validity of Text Neck Questionnaire for assessing text neck and its associated factors due to smartphone use in college going students.
Methodology: Text Neck Questionnaire was developed and Validity was assessed with content validity, analyzed by content validity index (CVI). A total of 111 participants were included in this study according to the inclusion criteria. Scale evaluation was done by assessing internal consistency reliability, inter-rater reliability, concurrent validity and construct validity.
Result: The result of this study demonstrated that the TNQ has good internal consistency (Cronbach's Alpha: 0.814) and good inter-rater (ICC 0.814) reliability as quantified by ICC when used to assess Text Neck due to smartphone use in college going students. The final CVI calculated from the ratings was found to be 1. In the present study, it was also observed that the TNQ scale is moderately correlated with NPAD (Spearman rho = 0.648). Construct validity was estimated using Pearson's correlation coefficient which was found to be 0.603.
Conclusion: The TNQ is a reliable and valid tool for the screening of text neck among smartphone users. It is comprehensive, culturally appropriate and user-friendly instrument for use in clinical settings as well as research purposes.

Keywords: Turtle neck syndrome, mobile phones, texting, reliability, validation, nomophobia, students, pain, disability, text neck questionnaire

Introduction

The most common and frequently used gadget nowadays for tasks like information exchange, internet access, movie viewing, social media use, gaming, and many other tasks is the mobile phone. According to a report, 79% of adults between the ages of 18 and 44 spend the majority of their time on cellphones. A recent survey of 2061 students found that 74.8 percent of respondents had moderate to severe nomophobia and a phone addiction. People who were glued to their phones all the time could develop anxiety, tension, panic attacks, and other psychological issues. The text neck syndrome is one of the most common physical ailments that people can have in addition to these psychological ones. The first person to use the term "TEXT NECK" was a chiropractor from the US named Dean L. Fishman. This phrase refers to neck pain and upper back muscle damage brought on by repeated neck flexion at various angles while looking down at a mobile device, which changes the cervical spine's natural curve. Text neck syndrome should be regarded as "Pain of the Modern Era" because it is brought on by modern technology, including smartphones, computers, and other smart devices, and it results in acute to chronic discomfort in the neck and upper back [1].

Neck pain is a prevalent health problem, largely reported in adult patients. However, very recent data show that new technologies are inducing a shift in the prevalence of this relevant issue from adulthood to all of the pediatric ages. In fact, the precocious and inappropriate use of personal computers and especially cell phones might be related to the development of a complex cluster of clinical symptoms commonly defined as “text neck syndrome. This article’s goal is to examine the recent phenomenon known as “text neck syndrome,” as well as the underlying causes and risk factors of musculoskeletal pain that can be modified by changes in daily routine, in various cultures, and habits. “Text neck syndrome” is defined as increased stresses on the cervical spine that can cause cervical degeneration as well as other developmental, medical, psychological, and social complications [2].

Neck pain is a major public health problem in modern societies. It can originate from any structure in the neck including intervertebral discs, ligaments, muscles, facet joints, dura, and nerve roots. Potential causes can be tumors, infection, inflammatory diseases, and congenital disorders. In most cases, however, no systemic illness can be detected, and the complaint is labeled as musculoskeletal neck pain.

Prevalence data have shown that, in a general population, the 1-year incidence of neck pain can be as high as 40%. The World Health Organization (WHO) has ranked neck pain and other musculoskeletal diseases at 4th and 10th, respectively, among all health conditions for years lived with disability. These conditions were also acknowledged as the key drivers of the increase in years lived with disability over the past 20 years. In addition, data from the WHO Global Burden of Disease study showed that neck pain is the 8th ranked reason for most years lived with disability for 15-19-year-olds of any health condition, which is higher than well-known adolescent public health problems such as asthma, alcohol use, drug use, and road injury [3].

In 2023, reports estimate the total number of global smartphone users to reach 6.8 billion. Given the global population to reach just over 8 billion, 8 in 10 people will be equipped with a smartphone (85%). Recent figures have shown that around 87% of teenagers (14-18 years) in USA and 79% teenagers (12-15 years) in UK own and use smartphones Among adults aged 18-34 years, 92% and 95% reported owing a smartphone in USA and Australia, respective [4].

The Turtle Neck syndrome, often referred to as Text Neck syndrome, is characterized as a neck injury caused by recurrent neck strain or pain by using portable devices too much and for an extended length of time. Text Neck syndrome has a number of detrimental implications on one’s health, including neck pain, shoulder pain, upper back pain, and increasing spinal curvature. Also, it’s cause eye irritation and migraine. The weight of the average head exerts about 10 to 12 lbs. of strain through the neck muscles when you are standing straight and your ears are in line with the middle of your shoulders. The force on the neck, however, increases to 27 lb. when your head is leaned forward at an angle of 15 degrees from this neutral position. This is the same as the typical baby's weight at age 8. Similar to how Text Neck affects the spine when the head is tilted forward at different angles, when the head tilts forward at 15 degrees, the force on the neck increases to 27 lb., at 30 degrees, the force is 40 lb. at 45 degrees, the force is 49 lb. and at 60 degrees, the force is 60 lb. Due to their tendency to use mobile phones and the fact that their heads are larger than their bodies relative to adults, children have a huge problem with this and are at a higher risk of developing text neck syndrome.

Damage caused by untreated text neck can be similar to occupational overuse syndrome or repetitive stress/strain injury [5].

A paper proposed that the most common presentation of Text Neck is neck pain, stiffness and soreness. The main symptoms include

- **Stiff neck:** Soreness and difficulty in moving the neck is usually present when trying to move the neck after long usages
- **Pain:** Can be localized to one spot or may be diffused over an area, usually lower part of the neck. Can be described as dull aching or can also be sharp or stabbing in extreme cases
- **Radiating pain:** There can often be radiation of Sharp or Nagging pain in the neck and shoulders.
- Nerve pain with tingling and numbness in the upper limb.
- **Muscular weakness:** shoulders muscles namely, trapezius, rhomboids and shoulder external rotators are often weak.
- **Headache:** sub-occipital muscle tightness can lead to tension type headaches [6].

There is a hypothesis that the growing use of mobile phones in an inappropriate posture to text and read (text neck) could be a reason for the increasing prevalence of neck pain in the past decade. Before testing if there is an association between text neck and neck pain, it is necessary to develop reliable pragmatic tools appropriate to epidemiological studies [7].

Current literature shows that the tools that has been used to measure text neck are NDI, NPAD & SAS. NPAD and NDI were created to gather information on how neck pain affected ones’ ability to function in everyday life. But both these scales had certain limitations. It may not account for other factors that can contribute to neck pain and disability, such as psychological or social factors. The SAS is a self-reporting scale to assess smartphone addiction. It may not fully capture the individuals unique experience or the full impact of their condition [2, 8, 9].

Findings support the contention that an appropriate approach for an early diagnosis and treatment is crucial to properly evaluate this emerging issue worldwide in children and adolescents who spend a lot of time watching smartphones and computers; additional research with more rigorous study designs and objective measures of musculoskeletal pain are needed to confirm significant relationships. Existing evidence is limited by non-objective measures and the subjective nature of musculoskeletal pain.

Looking at the literature on the association between texting and neck pain, the answer is really muddled, because the studies that have been done on the topic are flawed. Scientific studies don’t appear in a vacuum; they are part of a growing body of evidence. To simply report on a single study is misleading [2].

These days, text neck syndrome is an alarming problem as more people engage in technology. There are some tools available in the literature which are used for assessing text neck but the reliability and validity of these tools is still questionable. Moreover, the association of neck disability

with various behaviors during the use of smartphones is still unclear in the literature. Therefore, this study aims to find out the reliability and validity of TNQ as a screening tool for assessing text neck and its associated factors due to smartphone use in college going students [10].

Methodology

A total of 150 students were screened out of which 111 students who were falling in the category of inclusion criteria were included in the study for analysis. Sample size was calculated from the following tab1e [27].

Table 1: Sample Size Calculation

ICC = 0.7			ICC = 0.8		
m repeated measurements	**95% CI ± 0.1 *n***	**95% CI ± 0.2 *n***	**m repeated measurements**	**95% CI ± 0.1 *n***	**95% CI ± 0.2 *n***
2	100	25	2	50	13
3	67	17	3	35	9
4	56	14	4	30	8
5	50	13	5	28	7
6	47	12	6	26	7

Assuming the value of R (reliability value of Intra-class correlation coefficient) was to be 0.70 or more with 95% confidence interval, a total of 100 students were required for the present study.

The Source of data collection was S.S. Agrawal Institute of Physiotherapy and Medical Care Education, Navsari.

Inclusion Criteria

1. Participants were Indians.
2. Participants were college going students.
3. Participants who were using smartphones.
4. Age: 18-25 years
5. Individuals who are able to understand English language.

Exclusion Criteria

1. Subjects with any other medical cause or known condition which could lead to pain in neck, like congenital cervical problems and traumatic and pathological cervical problems.
2. Visual or auditory loss.

After screening, all subjects were given explanation about the present study in detail and a consent was taken digitally by each subject as a formality towards their willingness to participate. Subjects used smart phone for completing both their questionnaires through google forms.

Procedure

- There are three phases to creating a rigorous scale-item development, scale development, and scale evaluation. These can be further broken down into nine steps (Figure 1).

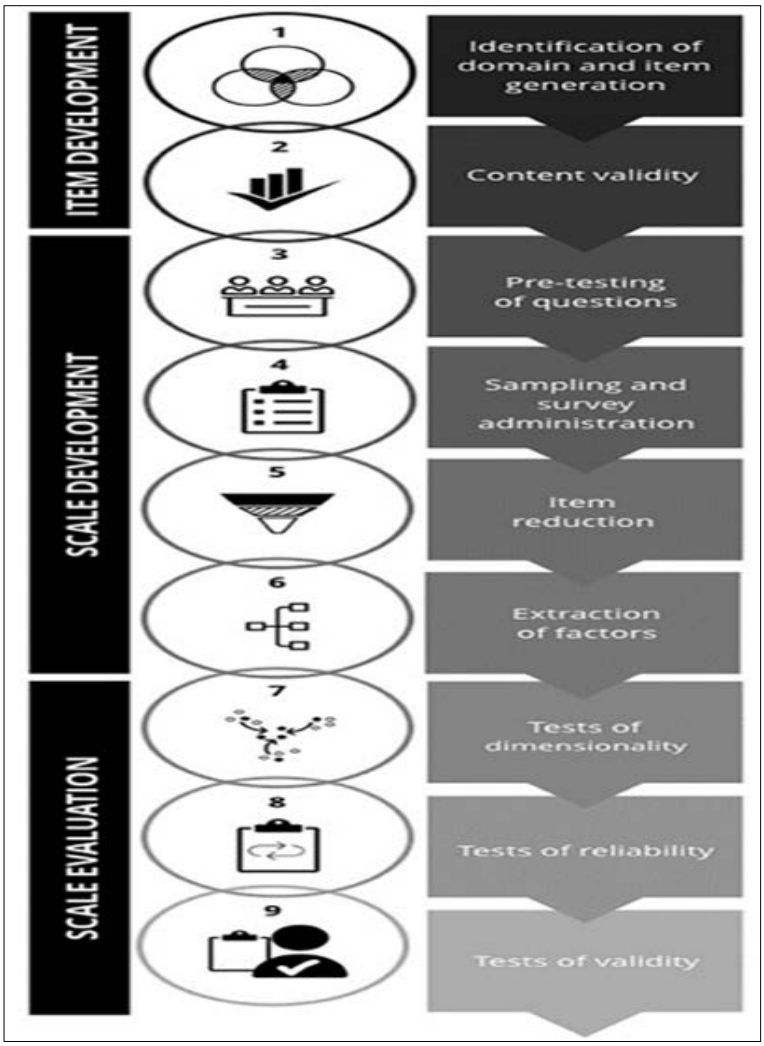


Fig 1: An overview of the three phases and nine steps of scale development and validation

Phase 1: Item development

- The main aim of this study is to develop a questionnaire for Text Neck. So, the main domain was text neck. After the identification of domain, items were generated regarding that particular domain. A questionnaire was created consisting of 20 items in English language.
- Content validity, commonly referred to as "theoretical analysis," describes how well a measure evaluates the domain of interest. If the items are to measure what they are supposed to measure, they must have adequate content. Content relevance and content representations are also defined by content validity, which means that the items must accurately reflect the relevant experience of the target population being studied.
- The content validity was examined by an expert panel consisting of 1 Physiotherapist, 1 physician, 1 M.S orthopedic, 1 student and 1 MA B. Ed in English who evaluated the translated text. Content validity index (CVI) was used for the validation of content validity. The suggestion of the experts was used for last modification of the questionnaire when necessary.

Phase 2: Scale development

- In phase 2, pre-testing of the newly developed scale is done with the help of small sample size and its application to the target population.
- Pre-final English version of TNQ was tested on 30 participants. The participants were asked to complete the questionnaires and were additionally interviewed with open questions to find the differences between the meaning of the items and their actual responses. They were asked to rate their understanding of all the 20 items of TNQ on a 10-point numeric rating scale (where 0 is not at all understandable and 10 is completely understandable). The responses on all the items were further discussed in the expert committee along with proportion of missing responses.
- The present study was initiated, where a total of 111 subjects were included who were found to be satisfying all the inclusion criteria. A detailed explanation regarding the complete procedure was done for each subject and as a formality towards their willingness to be a part of this study, they were asked to give their consent digitally. Demographic characteristics and assessment of the participants were taken before filling scale.
- The scale was prepared digitally using google form and a common link was shared to all the participants for filling both the scales (TNQ & NPAD). For finding out the inter-rater reliability two different forms were created.
- The TNQ is made up of 20 items and a 5-point rating scale. There were twenty questions in this section, each of which had five options with a score ranging from 0 to 4. The TNQ questionnaire was created to gather information on how texting affects one's ability to function in everyday life. The TNQ questionnaire contains subsections consisting of usage of mobile phone, severity of pain and disability, psychological factor and postural behavior.

Phase 3: Scale evaluation

- This phase consists of Reliability and Validity testing of the final version of TNQ scale.
- Reliability measures how consistently a measurement gives the same results when repeated under the exact same conditions. Various established statistics exist to evaluate the reliability of a scale.
- Scale validity refers to how well an instrument accurately measures the specific concept it was designed to assess. The process of validation is ongoing, starting with defining the study's domain and extending to assessing how well the instrument relates to other concepts.

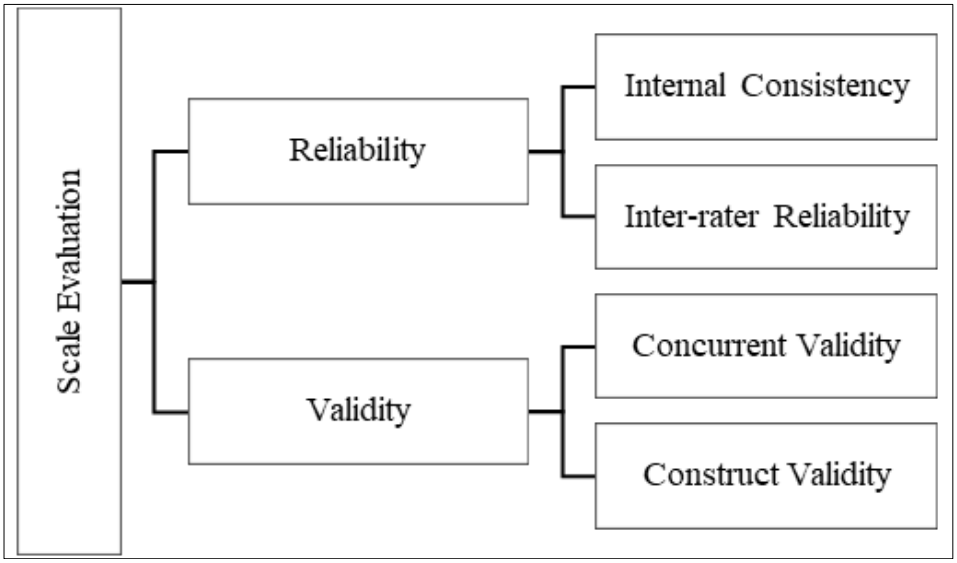


Fig 2: Scale Evaluation

- Cronbach's alpha assesses the internal consistency of the scale items, i.e., the degree to which the set of items in the scale co-vary, relative to their sum score. An alpha coefficient of 0.70 has often been regarded as an acceptable threshold for reliability; however, 0.80 and 0.95 is preferred for the psychometric quality of scales.
- Another way to evaluate reliability is through test-retest reliability, also known as the stability coefficient. It checks how consistently participants' scores remain the same over time. Inter-rater reliability was assessed by incorporating a qualified 2nd rater to score separately apart from rater 1. The recording sheets used by rater 2

were totally separate from rater 1 sheets. Care was taken towards observation of proper blinding between the 2 raters to rectify any bias.

- Concurrent validity assesses how well a test score correlates with another relevant measure at the same time or shortly after. The concurrent validity was assessed by correlating the TNQ scale with the NPAD which is already established valid tool for assessing text neck.
- Construct validity refers to how well an instrument measures the specific concept it's designed for and how it relates to other concepts and real-world criteria. Convergent validity assesses whether different ways of measuring a construct yield similar results. It's best evaluated through techniques like the multi-trait multi-method matrix, latent variable modeling, or Pearson correlation. Strong correlations with similar measures support convergent validity [28].

Data Analysis

Data analysis is done using the SPSS software version 23.0. Results are considered significant at $p<0.05$ and confidence interval of 95%. Data analysis is done by:

- Cronbach's alpha for finding the internal consistency which is considered as an important factor for reliability.
- Intra class correlation coefficient for inter rater reliability which is regarded as a key indicator of reliability.
- Bland -Altman limits of agreement analysis for assessing the agreement between rater's scores.
- Standard error of measurement (SEM) to calculate the variability in measurement of same individual. The true measurement can be calculated as 1.96*SEM.
- Smallest real difference (SRD) is the smallest change that can be interpreted as a real difference. It is calculated as SRD=1.96*2*SEM.
- Content Validity Index for calculating content validity.
- Spearman's Rank correlation for finding out the concurrent validity.

Pearson's correlation for measuring the convergent validity.

Table 2: Descriptive statistics of TNQ and NPAD for all the students

	N	Min	Max	Mean	Std. Deviation
TNQ (rater 1)	111	0	50	18.89	10.654
TNQ (rater 2)	111	0	47	15.39	9.785
NPAD	111	0	53	5.77	9.457

The above-mentioned tabular description of the descriptive statistics of TNQ and NPAD, describes the mean and standard deviation for different recorded scoring done for all the students included in this study. The data reveals that there was not much difference in the mean score of TNQ for rater 1 and rater 2.

Internal Consistency reliability

To calculate internal consistency reliability, Coefficient of Cronbach's Alpha can be used as per the following guidelines: [29].

No	Coefficient of Cronbach's Alpha	Reliability Level
1	More thin 0.90	Excellent
2	0710-0.89	Good
3	0.70 0.79	Acceptable
4	0.6-.69	Questionable
5	0.5-0.59	Poor
6	Les than 0.59	Unacceptable

Table 3: Coefficient of Cronbach's Alpha for the Internal Consistency reliability of the total score of TNQ scale

	Cronbach's Alpha	Cronbach's Alpha based on Standardized items
TNQ total	0.814	0.816

The ICC value for total TNQ score is 0.814 which according to the above-mentioned guidelines indicates good internal consistency reliability.

Inter-rater reliability

To calculate reliability coefficients for ordinal data Intra-Class correlation coefficient (ICC) can be used as per the following table:

Reliability	Continuous scale	Ordinal scale	Nominal scale
	ICC	ICC or weighted kappa	unweighted kappa
Measurement error / agreement	SEM or limits of agreement	% agreement	% agreement

The TNQ scale is an ordinal scale. Therefore, to calculate inter-rater reliability coefficients ICC can be used [27].

To evaluate the value of reliability following guideline can be used:

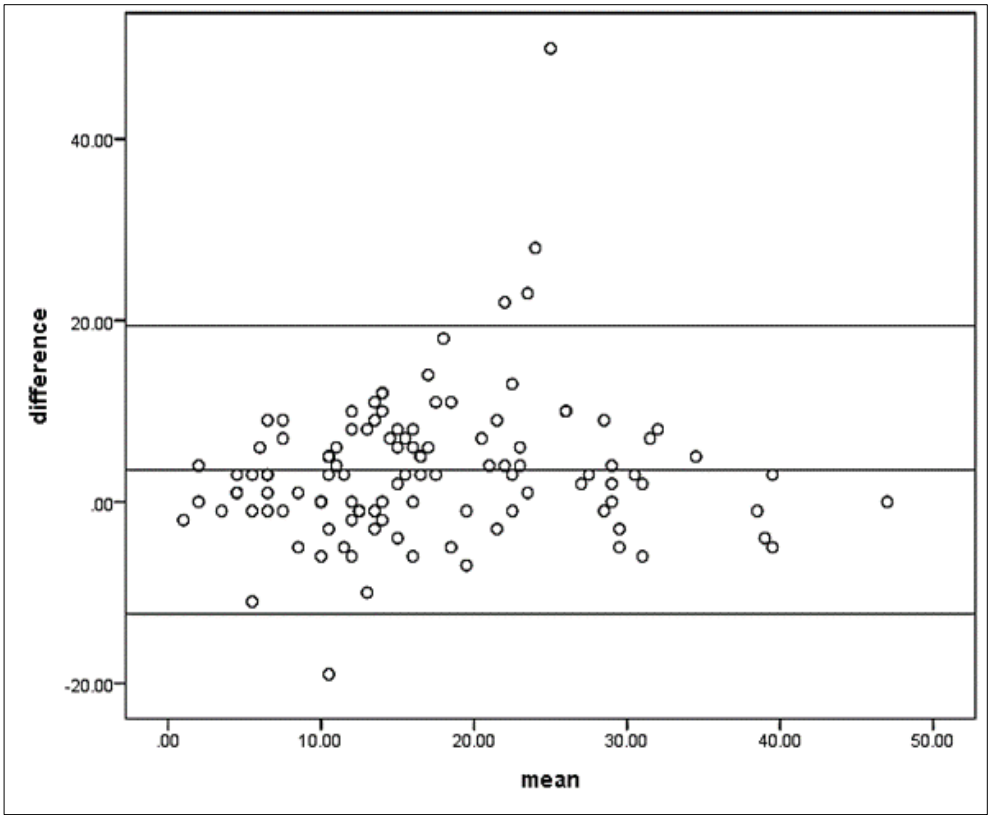
- < 0.5 - poor Reliability
- 0.5 to 0.75 - moderate Reliability
- 0.75 to 0.9 - good Reliability
- > 0.90 - excellent Reliability (17)

Table 4: Intra-class Correlation Coefficient (ICC) for the Inter-rater reliability of the total score of TNQ scale

	ICC	CI (lower)	CI (upper)
TNQ total	0.814	0.730	0.872

The ICC value for total TNQ score is 0.814 which according to the above-mentioned guidelines indicates good inter-rater reliability.

ICC values for inter-rater reliability shows correlation between the 2 raters. Apart from correlation, limits of agreement need to be evaluated. Limits of agreement can be evaluated by Bland Altman limit of agreement plot. For plotting Bland Altman limit of agreement plot the average mean of rater 1 and rater 2 readings is plotted on the *x*-axis, against the average difference between rater 1 and rater 2 readings on the *y*-axis. 3 horizontal lines are superimposed on the plot. 1 line at the center represents average difference between the 2 measurements. 2 lines above and below the midline represents the limit of agreement drawn at M ± 1.96 SD.



Graph 1: Bland Altman limit of agreement between rater 1 and rater 2

The Bland Altman limits of agreement between 2 raters for TNQ shows that most of the values fall in M ± 1.96SD (p<0.05). It indicates good reliability. Limits of agreement represents of how much the score can vary in stable data. Change in score within the limits of agreement (known as Smallest Real Difference) can be attributed to measurement error and only if the score falls outside the limits of error, it can be said that there are statistically significant changes. Therefore, we need to calculate SRD/MDC for which standard error of measurement needs to be calculated first.
SEM (Standard Error of Measurement) value of variability has been calculated by the following formula:

SEM = SD* √1-ICC.

Therefore, the SEM value for variability between 2 raters is:
SEM = 3.49

The true SEM value for variation in measurements between the 2 raters is 1.96*0.81 = 6.84, which suggests that any individual value lies within the range of ± 6.84 of TNQ measured value.
MDC (Minimal Detectable Change) also known as SRD (Smallest Real Difference) can be calculated by following formula:
MDC = 1.96*√2*SEM
MDC = 5.18
Therefore, the SRD/MDC value for variation between 2 raters is 5.18.

Table 5: SEM and MDC value between 2 raters

	Rater 1 - Rater 2
SEM	3.49
MDC/SRD	5.18

Content Validity
The Content Validity Index (CVI) was calculated as an empirical measurement analysis to validate the validity of the instrument. [30] The suggested formula and procedures to determine the CVI is illustrated in Table 7.

Table 6: Determining the Content Validity Index (CVI)

No.	Matter		
1	Scale	Ordinal	
2	Formula	$CVI = \frac{n}{N}$ Divide the ordinal scale into my groups for example for scales 1, 2, 3, 4: I and 2: a group for "not agreed". 3 and 4: a group for -agreed" and vice versa n -numbers of evaluator agreed sum of evaluator Mean CVI is a mean of all CVI each item	
3	Range accepted	**N**	**Value**
		2-4	1.00
		5	> 0.83
		6	> 0.86
		7-10	> 0.78

Table 7 shows the method of determining content validity using CVI. There were 5 evaluators who were asked for the validation of TNQ. Using the CVI method, the acceptable standard for index of average congruity recommended by M. R. Lynn [17] is >0.83 for 5 evaluators. In this case, CVI for content validity is 1.00. Therefore, it is in acceptable range.

Concurrent Validity
Concurrent validity for TNQ scale was assessed by correlating the values of TNQ scale with that of NPAD of all the students. Both are ordinal scales.

Table 7: Statistical test used to assess concurrent validity

Level of Measurement		Same units	Statistical parameter
Gold standard	**Measurement instrument**		
Dichotomous	Dichotomous	Yes	Sensitivity and specificity
	Ordinal	NA	ROC
	Continuous	NA	ROC
Ordinal	Ordinal	Yes	Weighted kappa
		No	Spearman's r^a or other measures of association
Continuous	Continuous	NA	ROCs^b / Spearman's *r*
	Continuous	Yes	Bland and Altman limits of agreement or ICC^C
		No	Spearman's r or Pearson's r

According to the above table if the gold standard scale and measuring instrument both are ordinal the statistical test used to assess concurrent validity is spearman rank correlation coefficient [27]. Therefore, to assess the concurrent validity of TNQ scale spearman rank correlation coefficient can be used. The rule of thumb for interpreting the size of correlation coefficient is as follows: [31].

Size of correlation	Interpretation
.90 to 1.00 (-.90-1.00)	Very high positive (negative) Correlation
.70 to 90 (-.70-.90)	High positive (negative) Correlation
.50 to .70 (-.50-.70)	Moderate positive (negative) Correlation
.30 to 50 (-.30-.50)	Low positive (negative) Correlation
.00 to .30 (1(-.00-.30)	Negative Correlation

Table 8: Spearman's correlation coefficient between TNQ and NPAD

	TNQ - NPAD
Spearman's rho	0.648**

**correlation is significant at the 0.01 level

The Spearman's correlation coefficient between TNQ and NPAD is 0.648. Therefore, according to the thumb rule there is moderate correlation between the scores of TNQ and NPAD.

Convergent Validity

Convergent validity was used for measuring the construct between TNQ and NPAD.

Construct validity		
Convergent V	To examine if the same concept measured in different ways yields similar results	Estimate the relationship between scale scores and similar constructs using a multi-trait multi-method matrix, latent variable modeling, or Pearson's coefficient: higher/stronger correlation supports for validity

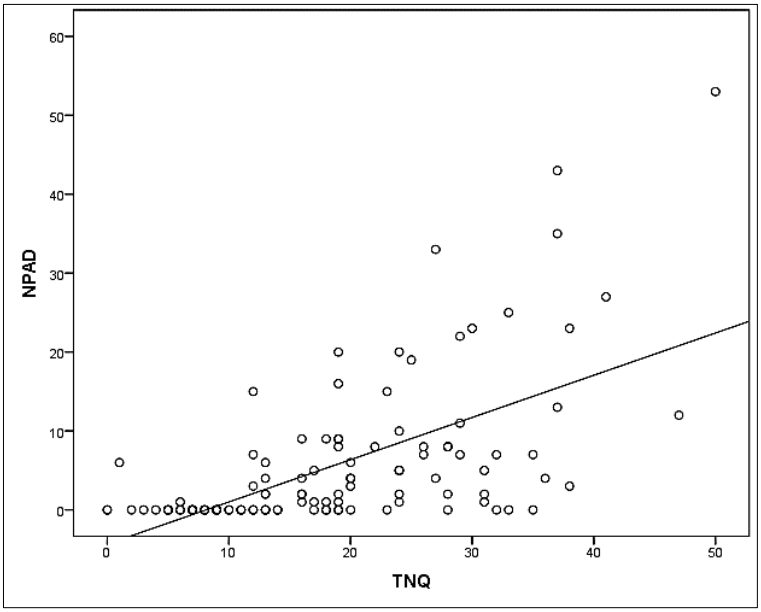
According to above mentioned guidelines, convergent validity can be estimated by using Pearson's correlation coefficient and if its value is greater than 0.5 then it can be considered as an adequate correlation [32].

Table 9: Pearson's correlation coefficient between TNQ and NPAD

	TNQ - NPAD
Pearson Correlation	0.603**

**correlation is significant at the 0.01 level

The Pearson's correlation coefficient between TNQ and NPAD is 0.603. Therefore, according to above mentioned guidelines, the coefficient is greater than 0.5. Thus, the convergent validity of TNQ is well established.



Graph 2: Scatter plot for correlation between TNQ and NPAD

The points in scatter plot are moderately scattered and there is linear association between the 2 variables. This indicating moderately positive linear correlation between the scores of TNQ and NPAD.

Discussion

For valid decision making in clinical practice, high-quality outcome measures that meet rigorous measurement standards are required. The present study was conducted to determine TNQ has good reliability and validity for the evaluation of Text Neck due to smartphone use in college going students.

In this study mean and SD of TNQ for both the raters are: The mean and SD of TNQ are 18.89 and 10.654 for rater one and the mean and SD of TNQ are 15.39 and 9.785 for rater two.

The TNQ takes about 10 minutes to complete and tests multiple domains of text neck along with its associated factors. The TNQ is made up of 20 items and a 5-point rating scale. There were twenty questions in this section, each of which had five options with a score ranging from 0 to 4. The TNQ questionnaire was created to gather information on how texting affects one's ability to function in everyday life. The TNQ questionnaire contains subsections consisting of usage of mobile phone, severity of pain and disability, psychological factor and postural behavior.

Current literature shows that the tools that has been used to measure text neck are NDI, NPAD & SAS. NPAD and NDI were created to gather information on how neck pain affected ones' ability to function in everyday life. But both these scales had certain limitations. It may not account for other factors that can contribute to neck pain and disability, such as psychological or social factors. The SAS is a self-reporting scale to assess smartphone addiction. It may not fully capture the individuals unique experience or the full impact of their condition. On the other hand, TNQ includes the psychological factors and it also captures the individuals unique experience of using smartphone by including questions related to postural behavior and their way of using smartphone.

Reliability

The result of this study demonstrated that the TNQ has good internal consistency (Cronbach's Alpha: 0.814) and good inter-rater (ICC 0.814) reliability as quantified by ICC when used to assess Text Neck due to smartphone use in college going students. The results of this study are found to be reliable and are in line with the results of NPAD. In original validation study of NPAD, test-retest reliability (ICC = 0.93) was shown to be significant. Paula Goolkasian *et al.* [33] published the study validating NPAD in 2002 with test-retest reliability of (ICC = 0.93). In a study done in 1999, NPAD was developed and its internal consistency was found to be 0.93. Our result was very much similar to the literature with ICC value of around of 0.814 along with internal consistency of 0.814.

SEM (standard error of measurement) and SRD (smallest real difference)

To assess the reliability in more detail SEM and MDC values were calculated. No previous studies have been reported for the SEM and MDC values as this is the first time TNQ scale has been validated. Previously done studies shows that there were many self-administered questionnaires used for assessing text neck but no one has ever tried to find out the reliability and validity of this tool. From the present study SEM value for inter-rater is 3.49. MDC value for inter-rater is 5.18. The value of MDC represents the minimal difference that would reflect a real change in the TNQ total score, hence having found from the present study, this value can now be used as reference value to compare the outcomes and results of studies to be done hence forth using TNQ tool.

Bland Altman limits of agreement

In this study, SEM value is from corresponding variability in measurements of both the raters. The finding of Bland Altman limits of agreement showed good inter-rater agreement between rater one (R1) and rater two (R2).

Validity

In this study, the content validity was calculated by using Content Validity Index (CVI). There were 5 experts chosen for getting the validation of TNQ. The ratings of all the raters were favorable and the final CVI calculated from the ratings was found to be 1. Therefore, the developed TNQ could be considered as having good content validity, indicating that the TNQ for checking text neck due to smartphone use in college going students have satisfactory validity.

In the present study, it was also observed that the TNQ scale is moderately correlated with NPAD (Spearman rho = 0.648). Thus, the concurrent validity of TNQ is established. The construct between the TNQ and NPAD was measured with the help of convergent validity. It was estimated using Pearson's correlation coefficient which was found to be 0.603. Hence, it can be said that the construct between TNQ and NPAD is well established and the results are in line with the study done by Wheeler *et al.* [34] in 1999 for the development of NPAD.

The TNQ has advantages over NPAD in assessing text neck. Firstly, NPAD lacks the psychological components which has been added in the newly developed TNQ scale. Secondly, TNQ includes pictorial presentation of the postural behavior which is easy for the participants to answer. Another important thing is the area of interest of both these tools. TNQ is specifically designed for assessing text neck while NPAD is used to measure neck pain due to any of the underlying problem.

Conclusion

The TNQ is a reliable and valid tool for the screening of text neck among smartphone users. It is comprehensive, culturally appropriate and user-friendly instrument for use in clinical settings as well as research purposes. The availability of this measure will encourage and facilitate decision making and further researches.

Limitations of the study

1. Psychometric properties like specificity and sensitivity was not evaluated.
2. Factor analysis was not done. Instead of that Pearson correlation was used for construct validity.
3. Results were limited to smartphone users in college going students.

Future recommendations

1. A detailed construct validation can be done using confirmatory factor analysis.
2. The study can be done by taking different age group as well as different occupation.
3. TNQ can be correlated with physical dimensions of the participants by assessing different parameters and finding out the association between them.

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References

1. Kumari S, Kumar R, Sharma D. Text neck syndrome: the pain of modern era. International Journal of Health Sciences and Research. 2021 Nov;11(11):161-5.
2. David D, Giannini C, Chiarelli F, Mohn A. Text neck syndrome in children and adolescents. International journal of environmental research and public health. 2021 Feb;18(4):1565.
3. Fares J. Ergonomics-not just for grown-ups! Ergonomics; c2020 Oct 7.
4. Ghosh D, Foong PS, Zhao S, Liu C, Janaka N, Erusu V. Eyeditor: Towards on-the-go heads-up text editing using voice and manual input. In Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems; c2020 Apr 21. p. 1-13.
5. Fiebert I, Kistner F, Gissendanner C, DaSilva C. Text neck: An adverse postural phenomenon. Work. 2021 Jan 1;69(4):1261-70.
6. Mousavi-Khatir R, Talebian S, Maroufi N, Olyaei GR. Effect of static neck flexion in cervical flexion-relaxation phenomenon in healthy males and females. Journal of bodywork and movement therapies. 2016 Apr 1;20(2):235-42.
7. Damasceno GM, Ferreira AS, Nogueira LA, Reis FJ, Lara RW, Meziat-Filho N. Reliability of two pragmatic tools for assessing text neck. Journal of bodywork and movement therapies. 2018 Oct 1;22(4):963-7.
8. Abbasi AH, Aslam M, Ashraf T, Malik AN. Evaluation of the Forward Head Posture, its association with Neck Pain & Quality of life of Female DPT Students: JRCRS. Journal Riphah College of Rehabilitation Sciences. 2016 Nov 1;4(2):59-64.
9. Alsiwed KT, Alsarwani RM, Alshaikh SA, Howaidi RA, Aljahdali AJ, Bassi MM. The prevalence of text neck syndrome and its association with smartphone use among medical students in Jeddah, Saudi Arabia. Journal of Musculoskeletal Surgery and Research. 2021 Nov 13;5(4):266-72.
10. Jorritsma W, Dijkstra PU, De Vries GE, Geertzen JH, Reneman MF. Detecting relevant changes and responsiveness of neck pain and disability scale and neck disability index. European Spine Journal. 2012 Dec; 21:2550-7.
11. Ahmed S, Akter R, Pokhrel N, Samuel AJ. Prevalence of text neck syndrome and SMS thumb among smartphone users in college-going students: a cross-sectional survey study. Journal of Public Health. 2021 Apr;29:411-6.
12. Kamalakannan M, Rakshana R. Estimation and prevention of text neck syndrome among smart phone users. Biomedicine. 2020 Nov 9;40(3):372-6.
13. Czępińska A, Zawadka M, Wójcik-Załuska A, Rzezak-Siwiec A, Gawda P. Association between pain intensity, neck disability index, and working conditions among women employed in horticulture. Annals of Agricultural and Environmental Medicine: AAEM. 2023 Mar 23;30(3):531-5.
14. Joseph LR, Palappallil DS. Neck disability index, Visual analog scale, and Likert scale in patients receiving pharmacotherapy for neck pain: How good do they correlate?. National Journal of Physiology, Pharmacy and Pharmacology. 2017;7(3):328.
15. Liang Z, Thomas L, Jull G, Treleaven J. The neck disability index reflects allodynia and headache disability but not cervical musculoskeletal dysfunction in migraine. Physical Therapy. 2022 May 1;102(5):pzac027.
16. Pontes-Silva A, Avila MA, Fidelis-de-Paula-Gomes CA, Dibai-Filho AV. The Short-Form Neck Disability index has adequate measurement properties in chronic neck pain patients. European Spine Journal. 2021 Dec;30:3593-9.
17. Khan AF, Gillani SF, Khan AF. Are you suffering pain neck due to smart phone text neck syndrome. Age. 2018 Jul 1;42(58.4):1095-7.
18. Parikh PR, Amarnath TK. To study the relationship between neck pain and anxiety, depression in computer workers-a correlation study. Int J Health Sci Res. 2021;11(6):356-61.
19. Kwon M, Kim DJ, Cho H, Yang S. The smartphone addiction scale: development and validation of a short version for adolescents. PloS one. 2013 Dec 31;8(12):e83558.
20. Arthy CC, Effendy E, Amin MM, Loebis B, Camellia V, Husada MS. Indonesian version of addiction rating scale of smartphone usage adapted from smartphone addiction scale-short version (SAS-SV) in junior high school. Open Access Macedonian Journal of Medical Sciences. 2019 Oct 10;7(19):3235.
21. Wilhelm M, Cleland J, Carroll A, Marinch M, Imhoff M, Severini N, *et al*. The combined effects of manual therapy and exercise on pain and related disability for individuals with nonspecific neck pain: A systematic review with meta-analysis. Journal of Manual & Manipulative Therapy; c2023 Apr 23. p. 1-5.
22. Kim CM. The Effect of Manual Physical Therapy on Neck Disability Index in Myofascial Pain Syndromes: A Systematic Review. Korean Society of Physical Medicine. 2020 Nov 30;15(4):21-8.
23. Atakla HG, Mbaye M, Dakurah TK, Quenum MK, Barry LF, Wague D, *et al*. Tech Neck Syndrome: A global epidemic of the modern era among students at the University of Abomey Calavi in Benin. Interdisciplinary Neurosurgery. 2023 Dec 1;34:101812.
24. Sathya P, Tamboli SA. Prevalence of text neck syndrome in young-adult population. Int J Med Exec Sci. 2020;6:749-59.
25. Sathya P, Tamboli SA. Prevalence of text neck syndrome in young-adult population. Int J Med Exec Sci. 2020;6:749-59.
26. Goolkasian P, Wheeler AH, Gretz SS. The neck pain and disability scale: test-retest reliability and construct validity. The Clinical journal of pain. 2002 Jul 1;18(4):245-50.

27. De Vet HC, Terwee CB, Mokkink LB, Knol DL. Measurement in medicine: a practical guide. Cambridge university press; c2011 Aug 11.
28. Boateng GO, Neilands TB, Frongillo EA, Melgar-Quiñonez HR, Young SL. Best practices for developing and validating scales for health, social, and behavioral research: a primer. Frontiers in public health. 2018 Jun 11;6:149.
29. Arof KZ, Ismail S, Saleh AL. Contractor's performance appraisal system in the Malaysian construction industry: Current practice, perception and understanding. International Journal of Engineering & Technology. 2018;7(3.9):46-51.
30. Lynn MR. Determination and quantification of content validity. Nursing Research. 1986;5:382-385.
31. UzUn MB, Özçelikay G, Gülpınar G. The situation of curriculums of faculty of pharmacies in Turkey. Marmara Pharmaceutical Journal. 2017;21(1):183-9.
32. Doll WJ, Xia W, Torkzadeh G. A confirmatory factor analysis of the end-user computing satisfaction instrument. MIS Quarterly. 1994 Dec 1:453-61.
33. Goolkasian P, Wheeler AH, Gretz SS. The neck pain and disability scale: test-retest reliability and construct validity. The Clinical Journal of Pain. 2002 Jul 1;18(4):245-50.
34. Wheeler AH, Goolkasian P, Baird AC, Darden BV. Development of the Neck Pain and Disability Scale: item analysis, face, and criterion-related validity. Spine. 1999 Jul 1;24(13):1290.