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Association Between Text Neck and Neck Pain in Adults

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Neck pain (NP) is the fourth cause of disability in the world and has continued to grow considerably over the past decade.[1–3] It has been hypothesized that the flexed posture of the neck and head adopted for reading and typing while using smartphones is related to the increased prevalence of NP and other physical symptoms.[4,5] In his alarming 2014 study, Hansraj[6] estimated that while in a neutral position the head weighs a relative 10 to 12 lbs, compared to 27 lbs at 15°, 40 lbs at 30°, 49 lbs at 45°, and 60 lbs at 60°. Lee *et al*[7] showed that smartphone users maintain head flexion of 33° to 45° when using smartphones. In 2017, Cuéllar *et al*[8] claimed that text neck was an epidemic of the modern era of cell phones. The term text neck has arisen, being defined as the "detrimental" posture of cervical flexion adopted while using smartphones.[8–11]

Nevertheless, a cross-sectional study of Damasceno *et al*[10] did not find an association of text neck with NP or frequency of NP. However, there were some limitations, such as a subjective photographic assessment of smartphone posture, a small sample (n = 150) of participants, and restricted age range (18- to 21 years' old).[11] Gustafsson *et al*[12] reported no association between smartphone use duration and new episodes of NP in a longitudinal study; moreover, the authors did not evaluate the posture adopted during the smartphone use. Therefore, we sought to investigate the association of text neck by the cervical flexion angle during smartphone use with NP in a larger number of individuals with a broader age range.

MATERIAL AND METHODS

This is a cross-sectional study enrolling 582 volunteers aged between 18 and 65 years, who had a smartphone and were willing to participate in research. Data were collected by the

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researchers under a tent located in a busy area on the university campus from November 2018 to November 2019. Commuters were invited to participate through advertising signs beside the tent. Exclusion criteria were spinal surgery or any diseases that prevented the individual from adopting the unsupported orthostatic position. Individuals with significant cognitive impairment to the point of not understanding the self-completion questionnaire were excluded as well as individuals who did not own smartphones. The study protocol followed the recommendations of The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement.[13]

The study was previously approved by the Ethics Committee of the Augusto Motta University Center (approval number 3.030.275), in accordance with national resolution 466/2012. All participants signed an informed consent term after being informed about the nature of the study and the protocol to be performed.

Self-completion Questionnaire

Participants answered a self-reported questionnaire with sociodemographic (name, age, and sex) and anthropometric (body mass and height) questions. Daily smartphone usage duration was assessed with the following question: "On a typical weekday, how many hours per day do you spend reading, texting and playing games on your smartphone?" Nine response options were offered, the first started with "I only use the smartphone to talk" and then the responses ranged from "less than 1 hour per day" to "About 7 or more hours per day". Regarding possible visual problems: "Do you have vision problems?", with answer options "yes" or "no" and also "Do you have sight problems and wear glasses or contact lens?", the response options were: "yes," "no," or "I wear them, but I forgot them." Regarding posture concern, we asked: "Do you worry about your body posture?", "Do you think your posture is appropriate when typing text on a cell phone?" and "Do you worry about your posture while using your cell phone when you type a text?" the answer options followed a five-level Likert item "very often," "often," "occasionally," "rarely," and "never.".

Two questions were used to assess the point prevalence and frequency of NP: "Have you had NP today?" With the following "yes" or "no" answer options and "How often do you have neck pain?", the response options were "very often," "often," "occasionally," "rarely," and "never." For the multivariable analysis, a dichotomized variable was created: "very often"/"often"/"occasionally" *versus* "rarely"/"never." Maximum pain intensity was assessed with a 0 to10 numerical rating scale, and the instruction: "Mark (with an x) the highest pain you have ever had in your neck." About the impact of NP, it was asked "Have you ever missed work due to neck pain?", "Has neck pain taken you out of a sport?", and "Have you ever visited a doctor or physical therapist because of neck pain?" For all these questions, the following five-level Likert-type items were: "very often," "often," "occasionally," "rarely," and "never."

The smartphone dependence was investigated using the short version of the Smartphone Dependency Scale (SDS), translated into Portuguese. The total score ranges from 10 (minimum) to 60 (maximum), with the higher score indicating a higher chance of dependence on smartphone use.[14]

The variables anxiety, social isolation, and depression were assessed by applying the short psychosocial questionnaire, based on the validation by Kent *et al*.[15] There were four questions as follows: anxiety—"Do you feel anxious?", social isolation—"Do you feel socially isolated?" Answer options ranged from 0 ("no, not at all") to 10 ("fairly"). Depression was assessed by the following two questions: "During the past month, have you often been bothered by feeling down, depressed, or hopeless?" and "During the past month, have you often been bothered by little interest or pleasure in doing things?" with response options ranging on a scale from 0 ("never") to 10 ("all the time"). We included a fifth question about stress: "Do you feel stressed?" With response options ranging from 0 ("no stress") to 10 ("very stressed").

Lifestyle was assessed through the short-form International Physical Activity Questionnaire (IPAQ) that classifies the individual as sedentary, insufficiently active, active, or very active.[16] Smoking habits were assessed by asking, "In the last 30 days, how many days did you smoke?" With eight response options ranging from "never smoked" to "every day for the last 30 days." Based on the Subjective Health Complaints,[17] sleep quality was assessed with the following question: "Did you have trouble sleeping in the last month?" with four answer options "nothing, a little, some, or seriously."

Evaluation of Cervical Flexion Angle

The Cervical Range of Motion (CROM) inclinometer (Deluxe model, Performance Attainment Associates, Roseville, MN) was used to measure the flexion angle of the cervical region while typing on the smartphone, assuming that the greater the cervical flexion angle, the greater the text neck. As Damasceno *et al*,[10] we assumed that text neck is excessive neck flexion posture, regardless of whether the person has NP complaints or not. Besides the excellent criterion validity of CROM when compared to an optoelectronic system, the reliability of this device was previously tested and showed an intraclass correlation coefficient of 0.92 for cervical flexion.[18–20]

The participant was instructed to stand on a cross marked on the floor. In the orthostatic position, the CROM device was placed as if putting on a pair of glasses. The velcro straps were fastened snuggly in line with the bows. The participant was asked to send a text message to someone via their smartphone, simulating everyday use (Figure 1). The same orientation was given in the seated position in a chair without armrests. The measurement of the cervical angle with the CROM inclinometer was registered with the participant in an orthostatic and seated position. The assessor was blind to the participants' answers regarding NP outcomes.

Figure 1. The measure of cervical flexion angle using the CROM device while the participant was texting on the smartphone. The left participant yielded a cervical flexion angle of 56° and the right one 20°.

Sample Size

The required sample size for this study was 565 participants, considering prevalence of NP of 22%[21] to detect a mean difference of 4.6° of neck flexion between participants with and without NP, assuming a standard deviation of 13° with an alpha of 5% and a power of 80%. The minimal detectable change value of CROM for neck flexion ranges from 6.5° to 9.6°.[22,23]

Statistical Analysis

All analyses were performed using RStudio version 0.99.486. Sample characteristics were described using proportions, means, and standard deviations. Logistic regression models were analyzed to investigate the association between the cervical flexion angle during texting—herein an objective measure of text neck—and the point prevalence and frequency of NP outcomes. Linear regression models were used to investigate the association between the cervical flexion angle during texting and maximum pain intensity. Potential confounders (age, sex, height, body mass, cell phone use time, visual problems, smoking, dependence on smartphone use, physical activity level, anxiety, depression, sleep quality, and social isolation) with a $P < 0.2$ in the univariate analysis were also included in the logistic regression models or linear regression models. The significance level adopted in the study was 95%.

RESULTS

Our sample was comprised of 71.6% women (n = 417), with a mean age of 27.4 (SD = 8.8) years (Table 1). Most participants (67.8%, n = 395) reported at least 4 hours per day of smartphone use. More than half of participants (53.9%, n = 314) reported some visual problem, and 45.9% (n = 267) wore glasses or contact lenses. Almost half of the sample (46.2%, n = 269) reported worrying about posture occasionally and 36.4% (n = 212) during smartphone use.

Regarding lifestyle, 9.4% (n = 55) of the participants were classified as sedentary, followed by insufficiently active (22.1%, n = 129), active (41%, n = 239), and very active (27.3%, n = 159). Additionally, only 15.1% (n = 89) of participants reported smoking habits and 11.3% (n = 66) reported serious problems with sleep.

Prevalence of NP was 21.4% (n = 125). Regarding frequency of NP, 7% (n = 41) complained very often, 15.6% (n = 91) often, 35.9% (n = 209) occasionally, 32.1% (n = 187) rarely, and 9.2% (n = 54) never complained. The mean of maximum NP intensity was 4.54 (SD = 2.30). Of the total sample, 85.9% (n = 500) never missed school or work, 70.6% (n = 413) never missed sports, and 78.3% (n = 456) never visited a doctor or physiotherapist due to NP. The mean of cervical flexion angle during the use of smartphones while standing was 34.3° (SD = 12.2) and sitting 36.3° (SD = 14.1).

Multiple logistic regression analyses showed that the angle of cervical flexion while standing was not associated with NP (odds ratio [OR] = 1.00; 95% confidence interval [CI] 0.98–1.02; $P = 0.66$), or frequency of NP (OR = 1.01; 95% CI 1.00–1.03; $P = 0.056$) (Table 2). The cervical flexion angle while sitting was not associated with the prevalence of NP (OR = 0.99; 95% CI 0.98–1.01; $P = 0.89$), or frequency of NP (OR = 1.01; 95% CI 0.99–1.02; $P = 0.13$) (Table 3).

Multiple linear regression analyses showed that the angle of cervical flexion while standing was not associated with the maximum NP intensity (beta coefficient = -5.195×10^{-5}; 95% CI: −0.01 to 0.01; $P = 0.99$) (Table 4). The cervical flexion angle while sitting was not associated with the maximum NP intensity (beta coefficient = 0.002; 95% CI: −0.01 to 0.01; $P = 0.71$) (Table 5).

The only potential confounders that remained associated with prevalence of NP in the multivariate model were age (OR = 1.04; 95% CI 1.01–1.06; $P = 0.001$) and sleep quality (OR = 1.28; 95% CI: 1.01–1.61; $P = 0.035$). For the NP frequency outcome, none of the potential confounders remained associated with NP frequency. For the maximum pain intensity outcome, the three variables that remained associated with maximum NP were sleep quality (beta coefficient = 0.30; 95% CI: 0.10–0.51; $P = 0.003$), smartphone use time (beta coefficient = 0.11; 95% CI: 0.01–0.21;

TABLE 1. Characteristics of the Participants (n = 582)

Age, y, mean (SD)	27.44 (8.89)	Neck flexion angle (CROM) standing (degrees), mean (SD)	34.34 (12.22)
Sex, female, n (%)	417 (71.64)	Neck flexion angle (CROM) sitted (degrees), mean (SD)	36.30 (14.11)
Body mass, kg, mean (SD)	69.69 (16.1)	Neck pain (point prevalence), n (%)	125 (21.47)
Height, cm, mean (SD)	166.09 (9.58)	Neck pain frequency, n (%)	
Physical activity level, n (%)		Very often	41 (7.04)
Sedentary	55 (9.45)	Often	91 (15.63)
Insufficiently active	129 (22.16)	Occasionally	209 (35.91)
Active	239 (41.06)	Rarely	187 (32.13)
Very active	159 (27.31)	Never	54 (9.27)
Smoking, smokers (%)	89 (15.15)	Maximum neck pain intensity, mean (SD)	4.54 (2.30)
Smartphone use time, n (%)		Missed school due to neck pain, n (%)	
I only use the smartphone to talk	8 (1.37)	Very often	41 (6.01)
<1 h a day	16 (2.74)	Often	3 (0.51)
About 1 h a day	23 (3.95)	Occasionally	14 (2.4)
About 2 h a day	62 (10.65)	Rarely	30 (5.15)
About 3 h a day	78 (13.40)	Never	500 (85.91)
About 4 h a day	84 (14.43)	Missed sports due to neck pain, n (%)	
About 5 h a day	68 (11.68)	Very often	31 (5.32)
About 6 h a day	72 (12.37)	Often	12 (2.06)
About 7 h a day or more	171 (29.38)	Occasionally	43 (7.38)
Visual impairments, n (%)	314 (53.95)	Rarely	83 (14.26)
Glasses or lens use, n (%)	267 (45.95)	Never	413 (70.66)
Worry about posture, n (%)		Went to a doctor or physiotherapist, n (%)	
Very often	61 (10.48)	Very often	36 (6.18)
Often	164 (28.17)	Often	14 (2.4)
Occasionally	269 (46.21)	Occasionally	31 (5.32)
Rarely	68 (11.68)	Rarely	45 (7.73)
Never	20 (3.43)	Never	456 (78.35)
		Smartphone dependence (SAS), mean (SD)	31,68 (9.94)
		Anxiety (0–10), mean (SD)	6.6 (2.73)
Smartphone adequate posture, n (%)			
Very often	10 (1.71)		
Often	49 (8.41))	Social isolation (0–10), mean (SD)	2.46 (2.73)
Occasionally	203 (34.87)	Depression (0–10), mean (SD)	4 (3.24)
Rarely	197 (33.84)	Stress (0–10), mean (SD)	5.79 (2.04)
Never	123 (21.13)	Sleep problems, n (%)	
Worry about smartphone posture, n (%)		Nothing	166 (28.57)
Very often	10 (3.61)	A little	198 (34.07)
Often	49 (12.56)	Some	151 (25.98)
Occasionally	212 (36.48)	Seriously	66 (11.35)
Rarely	175 (30.12)		
Never	100 (17.21)		

CROM indicates cervical range of motion SD, standard deviation.

$P = 0.025$), and age (beta coefficient = 0.027; 95% CI: 0.004–0.05; $P = 0.017$).

Model diagnosis based on variance inflation factor (VIF) showed no presence of collinearity or multicollinearity in any of the tested models (all VIFs <1.97).

DISCUSSION

The present study showed that the angle of cervical flexion, an objective measure of text neck while standing and sitting in adults, was not associated with the prevalence of NP, frequency of NP, or maximum NP intensity. Our results

TABLE 2. OR for the Association Between Text Neck While Standing—Assessed by Cervical Flexion Angle—With Prevalence of Neck Pain (Model 1) and Frequency of Neck Pain (Model 2), Considering Potential Confounders for Each Model

	Prevalence of Neck Pain (Model 1)			
	OR-adjusted	95% CI	*P*	VIF
Cervical flexion angle (CROM*), standing	1.00	0.98–1.02	0.669	1.01
Age	1.04	1.01–1.06	0.001	1.20
Sex (male)	0.70	0.39–1.24	0.229	1.35
Body mass	1.00	0.98–1.01	0.707	1.33
Smartphone use time	1.11	0.98–1.25	0.089	1.41
Smartphone dependence	1.00	0.98–1.03	0.515	1.30
Anxiety	1.01	0.92–1.11	0.721	1.10
Social isolation	1.06	0.98–1.16	0.121	1.16
Depression	1.01	0.93–1.10	0.723	1.25
Sleep quality	1.28	1.01–1.61	0.035	1.10
	Frequency of Neck Pain (Model 2)			
	OR-adjusted	95% CI	*P*	VIF
Cervical flexion angle (CROM*), standing	1.01	1.00–1.03	0.056	1.10
Height	0.99	0.96–1.01	0.408	1.82
Sex (male)	0.64	0.38–1.07	0.089	1.83
Sleep quality	1.12	0.92–1.36	0.250	1.16
Smartphone use time	1.02	0.93–1.11	0.660	1.21
Smartphone dependence	1.02	0.99–1.04	0.077	1.27
Anxiety	1.05	0.97–1.13	0.164	1.13
Social isolation	1.05	0.97–1.13	0.197	1.13
Depression	0.99	0.92–1.07	0.961	1.22

CI indicates confidence interval; CROM, cervical range of motion; OR, odds ratio; VIF, variance inflation factor.
**Cervical range of motion instrument.*

reinforce the findings of the study by Damasceno *et al*,[10] in which the association between text neck and NP was also not found after subjective assessment of smartphone posture performed by experienced musculoskeletal physiotherapists and the self-perception of the research participants.

Our findings contradict the hypothesis raised by the aforementioned Hansraj[6] study. At the average value found in the standing position (34° *vs.* Hansraj 60°), the simulated load would be much lower (around 40 lb or 18 kg, *vs.* 60 lb or 27 kg). Besides that, data from mechanical load on the necks of cadavers showed a resistance of up to 540 lb or 244.94 kg, nine times higher than mentioned by Hansraj.[6] Moreover, the authors state that in living people the resistive and adaptive capacity of the cervical spine would be even higher.[24] These are aspects of structural biomechanics, but given that pain is multidimensional, it is possible that NP would be influenced by other biopsychosocial factors.[25]

Our sample showed a high level of smartphone dependence, but even this variable was not associated with NP. Alsalameh *et al*[26] who used the same dependency scale, identified that 60% of medical students were dependent on smartphones and that such dependency was correlated with musculoskeletal dysfunction. High levels of smartphone use may lead to physical inactivity associated with musculoskeletal disorders in young adults.[27,28] The high proportion of individuals who use the smartphone for >4 hours daily in our study, as well as the work of Damasceno *et al*,[10] is a concern due to the possibility of physical inactivity and an increased risk of hand and finger symptoms.[12]

In the present study, we evaluated the cervical flexion adopted during texting through the CROM inclinometer, thus translating a quantitative text neck measure. Therefore, both the subjective analysis[10] and the quantitative analysis of the present study did not associate text neck with NP or frequency of NP.

There were some potential confounders associated with NP outcomes in the present study. Participants with NP were 1.9 years older than asymptomatic subjects. However, the large sample size made it possible to identify small statistically significant differences as for age, physical activity, and smartphone use time. Sleep quality was associated with NP and maximum pain intensity. Increasing the ordinal scale by one level toward poorer sleep quality increased the chance of NP about 28%. Aili *et al*[29] showed that sleep disturbance was a predictor of time off work in individuals with cervical or low back pain in a longitudinal study.

TABLE 3. OR for the Association Between Text Neck While Sitting—Assessed by Cervical Flexion Angle—With Prevalence of Neck Pain (Model 1) and Frequency of Neck Pain (Model 2), Considering Potential Confounders for Each Model

	Prevalence of Neck Pain (Model 1)			
	Adjusted OR	95% CI	*P*	VIF
Cervical flexion angle (CROM*), sitting	0.99	0.98–1.01	0.892	1.08
Age	1.04	1.01–1.06	0.001	1.28
Sex (male)	0.72	0.41–1.27	0.271	1.32
Body mass	1.00	0.98–1.01	0.709	1.33
Smartphone use time	1.11	0.98–1.25	0.088	1.42
Smartphone dependence	1.01	0.98–1.03	0.457	1.31
Anxiety	1.01	0.92–1.11	0.717	1.10
Social isolation	1.06	0.98–1.16	0.128	1.16
Depression	1.01	0.93–1.10	0.705	1.26
Sleep quality	1.28	1.01–1.61	0.035	1.10
	Frequency of Neck Pain (Model 2)			
	OR-adjusted	**95% CI**	***P***	**VIF**
Cervical flexion angle (CROM*), sitting	1.01	0.99–1.02	0.130	1.06
Height	0.99	0.96–1.01	0.518	1.79
Sex (male)	0.65	0.39–1.09	0.105	1.81
Sleep quality	1.12	0.91–1.36	0.261	1.06
Smartphone use time	1.02	0.93–1.12	0.637	1.22
Smartphone dependence	1.02	0.99–1.04	0.073	1.28
Anxiety	1.05	0.98–1.13	0.156	1.10
Social isolation	1.05	0.97–1.13	0.192	1.11
Depression	0.99	0.92–1.07	0.961	1.20

CI indicates confidence interval; CROM, cervical range of motion; OR, odds ratio; VIF, variance inflation factor.

*Cervical range of motion instrument.

TABLE 4. Beta Coefficients for the Association Between Text Neck While Standing—Assessed by Cervical Flexion Angle—and Maximum Neck Pain Intensity, Considering Potential Confounders

	Maximum Pain Intensity (0–10)			
	Adjusted Beta Coefficient	95% CI	*P*	VIF
Cervical flexion angle (CROM*), standing	-5.195×10^{-5}	−0.01 to 0.01	0.995	1.12
Age	0.028	5.40×10^{-2}–0.05	0.015	1.24
Height	4.383×10^{-4}	−0.02 to 0.02	0.972	1.84
Sex (male)	−0.249	−0.78 to 0.33	0.427	1.93
Sleep quality	0.308	0.99 to 0.51	0.003	1.30
Smartphone use time	0.116	0.01 to 0.21	0.025	1.48
Smartphone dependence	0.021	-8.24×10^{-4} to 0.04	0.058	1.54
Anxiety	0.034	−0.04 to 0.11	0.398	1.46
Social isolation	0.034	−0.04 to 0.11	0.377	1.37
Depression	0.038	−0.03 to 0.11	0.331	1.97
Physical activity (sedentary)	0.353	−0.04 to 0.74	0.078	1.04
Vision problems	0.297	−0.08 to 0.68	0.127	1.27

Scientific notation was used when the number of zeros exceeded two after the decimal point. CI indicates confidence interval; CROM, cervical range of motion; VIF, variance inflation factor.

*Cervical range of motion instrument.

TABLE 5. Beta Coefficients for the Association Between Text Neck While Sitting—Assessed by Cervical Flexion Angle—and Maximum Neck Pain Intensity, Considering Potential Confounders

	Maximum Pain Intensity (0–10)			
	Adjusted Beta Coefficient	95% CI	*P*	VIF
Cervical flexion angle (CROM*), sitting	−0.002	−0.01 to 0.01	0.713	1.09
Age	0.027	0.004 to 0.05	0.017	1.25
Height	3.53×10^{-4}	−0.02 to 0.02	0.978	1.83
Sex (male)	−0.213	−0.76 to 0.34	0.450	1.92
Sleep quality	0.309	0.10 to 0.51	0.003	1.30
Smartphone use time	0.116	0.01 to 0.21	0.025	1.48
Smartphone dependence	0.022	-1.35×10^{-4} to 0.04	0.051	1.55
Anxiety	0.034	−0.04 to 0.11	0.399	1.46
Social isolation	0.033	−0.04 to 0.11	0.392	1.37
Depression	0.038	−0.03 to 0.11	0.324	1.97
Physical activity (sedentary)	0.356	−0.03 to 0.75	0.075	1.04
Vision problems	0.300	−0.08 to 0.68	0.123	1.13

Scientific notation was used when the number of zeros exceeded two after the decimal point. CI indicates confidence interval; CROM, cervical range of motion; VIF, variance inflation factor.

*Cervical range of motion instrument.

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The strength of the present study is the quantitative evaluation of the text neck through the cervical flexion angle measured by the CROM while standing and sitting. In addition, the larger sample size, a range of potential biopsychosocial confounders and a sample with a higher average age when compared to the study of Damasceno *et al*[10] were also strengths. The main limitation of this study was the cross-sectional design. The question of whether the participants started to adopt a better posture after having NP could only be responded to with longitudinal studies. Another limitation was that we assessed the point prevalence of NP without differentiating between acute and chronic stages. Although participants were on average 10 years older than the ones on Damasceno *et al*'s[10] study, the sample of the present study was still young. In future studies, it would be interesting to investigate whether there is an interaction effect between an objectively measured time spent using smartphones and neck posture with NP in older adults.

Considering the clinical applicability of our findings, there is an evident need for a broader view in the biopsychosocial model and not to focus only on postural changes, in order to always justify a dysfunction or pain through an injury or structural alteration.[30] This belief can harm not only health professionals, with excessive requests of imaging exams and interventions[31] but also the patients, who end up searching for several therapies of low scientific value that often lead to higher chances of developing chronic pain. The results of the present study can help mitigate the impact of negative information regarding text neck and reinforce that the cervical spine is much stronger and resilient than has been claimed in the general media.

Text neck was not associated with NP, frequency of NP, or maximum NP intensity in adults, even when assessed objectively. These results challenge the belief that inadequate neck posture while using smartphones leads to NP.

Key Points

- It has been hypothesized that the flexed posture of the neck and head adopted for reading and typing while using smartphones is related to the increased prevalence of NP and other physical symptoms.
- The aim of this study was to investigate the association between text neck and NP in adults.
- The prevalence of NP was 21.4% and the mean of cervical flexion angle during the use of smartphones while standing was 34.3° (SD = 12.2) and sitting 36.3° (SD = 14.1).
- Text neck was not associated with prevalence of NP, NP frequency, or maximum NP intensity in adults.

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