Original Article

ANATOLIAN CURRENT MEDICAL

DOI: 10.38053/acmj.1817061

Anatolian Curr Med J. 2026;8(2):187-193

Association between computer and technological device usage and cervical proprioception and dynamic balance in young adults: a cross-sectional study

Erdi Kayabınar*, Zeynep Şahin, Ebrar Atak, Büşra Kayabınar, Fatma Mutluay

Department of Physiotherapy and Rehabilitation, Faculty of Health Sciences, Yalova University, Yalova, Turkiye

Cite this article as: Kayabınar E, Şahin Z, Atak E, Kayabınar B, Mutluay F. Association between computer and technological device usage and cervical proprioception and dynamic balance in young adults: a cross-sectional study. *Anatolian Curr Med J.* 2026;8(2):187-193.

Received: 04.11.2025 ◆ **Accepted**: 20.01.2026 ◆ **Published**: 10.03.2026

ABSTRACT

Aims: This study aimed to investigate the relationship between the duration of computer and visual display terminal (VDT) use and cervical proprioception and dynamic balance performance in healthy young adults.

Methods: A cross-sectional study was conducted with 125 healthy university students aged 18-25 years. Participants' age, sex, body mass index (BMI), and weekly durations of computer and technological device use were recorded. Cervical proprioception was assessed using the Cervical Joint Position Error Test (CJPET), and dynamic balance was measured with the Y Balance Test (YBT). Multiple linear regression and Pearson correlation analysis were performed to investigate the associations between computer and technological device usage duration, cervical joint position error, and dynamic balance performance.

Results: The mean age of the participants was 21.46±1.94 years, consisting of 99 females (79.2%) and 26 males (20.8%). The regression models for CJPET flexion, extension, right rotation, and left rotation were nonsignificant (F=0.812, 0.400, 0.869, and 0.393; Adjusted R^2=0.046, 0.036, 0.023, 0.007, respectively). Similarly, the YBT composite models for right and left limbs were not significant (F=0.475 and 0.574; Adjusted R^2=0.040 and 0.032, respectively). In addition, Pearson correlation analysis revealed no significant associations between computer or technological device usage duration and cervical joint position error or YBT composite scores ($p>0.05$).

Conclusion: Prolonged computer and technological device use, within non-symptomatic limits, is not associated with impaired cervical joint position sense or dynamic balance performance in healthy young adults. These findings suggest that young, healthy individuals may maintain effective proprioceptive and postural control potentially through adaptive neuromuscular mechanisms. Ergonomic education, regular posture correction, and periodic movement breaks are recommended to prevent long-term sensorimotor strain associated with sustained screen exposure. Further studies including symptomatic populations and ergonomic, postural, or psychosocial variables are recommended to clarify the multifactorial effects of prolonged digital device exposure.

Keywords: Cervical joint position sense error, computer usage, physiotherapy, Y balance test, young adults

INTRODUCTION

Prolonged computer use has become an essential part of modern life, particularly among young adults in academic and professional settings. However, extended periods of visual display terminals (VDTs) exposure are associated with increased risk of neck pain, musculoskeletal discomfort, and postural imbalance due to sustained static postures and repetitive head–neck movements.[1,2] Continuous screen fixation and reduced postural variability can alter neuromuscular control of the cervical region, potentially leading to deficits in cervical proprioception, a key sensory mechanism for maintaining head and postural stability.[3]

Cervical proprioception is mediated by mechanoreceptors located in the deep cervical muscles, joints, and ligaments, and plays a crucial role in head orientation and postural control through its integration with the visual and vestibular systems.[4,5] Owing to the high density of muscle spindles in the cervical region, even subtle alterations in cervical sensorimotor function may influence joint position sense accuracy and balance performance.[4-6] Impairments in this system, often associated with sustained postures or musculoskeletal symptoms, have been linked to increased cervical joint position errors (CJPE) and reduced postural stability.[6,7] Previous studies have demonstrated that individuals with chronic neck pain or fibromyalgia exhibit increased cervical joint position errors and impaired dynamic balance performance compared to healthy individuals.[6,8]

***Corresponding Author:** Erdi Kayabınar, erdikayabinar@gmail.com

This work is licensed under a Creative Commons Attribution 4.0 International License.

With the rapid growth of digital technology, numerous studies have explored the effects of smartphone overuse on cervical proprioception and postural control.[9-11] However, despite the similar postural demands between computer and smartphone use, few studies have examined the specific association between computer usage duration and cervical proprioception in asymptomatic young adults.[12] The visual distance, posture, and ergonomic demands of computer work differ substantially from smartphone use, suggesting that computer-based exposure may have unique neuromuscular implications.[3]

In the literature, the number of studies evaluating CJPE and balance together in computer users appears to be quite limited. For example, Sahu[3] examined cervical proprioception and dynamic balance in prolonged computer users, and Lin et al.[13] reported that prolonged tablet use may influence cervical joint position sense and balance control; similar approaches have also been used in smartphone users.[7,13] However, evidence remains scarce regarding asymptomatic young adults and the extent to which computer and VDT exposure duration is associated with both cervical proprioception (CJPET) and dynamic balance performance (YBT) when potential demographic influences are considered. Therefore, this cross-sectional study aimed to investigate the association between computer and technological device usage duration and cervical proprioception and dynamic balance performance in healthy young adults using multivariable regression analyses. This study hypothesized that computer and technological device usage duration would be independently associated with cervical joint position error and dynamic balance performance in young adults, after controlling for relevant demographic variables. Based on previous evidence indicating that demographic factors such as age, body mass index, and sex may influence cervical proprioception and balance performance, these variables were planned to be considered as control variables within the scope of the present study.[4,5,14]

METHODS

Study Design and Ethical Approval

This study was designed as a cross-sectional investigation. Ethical approval was obtained from the Non-interventional Clinical Researches Ethics Committee of Yalova University (Date: 07.05.2025, Decision No: 2025/183). Data collection was carried out between May 2025 and June 2025 in labs of Yalova University, Department of Physiotherapy and Rehabilitation. All participants provided written informed consent. All procedures were carried out in accordance with the ethical rules and the principles of the Declaration of Helsinki.

Participants

It was estimated that a maximum of nine independent variables would be included in the planned regression analyses. Based on a medium effect size (f^2=0.15), a significance level of 5% (α=0.05), and a statistical power of 80% (1-β=0.80), an a priori power analysis performed using the G*Power 3.1.9.7 software indicated that at least 114 participants would be required to ensure reliable analyses. Considering possible data loss, this number was increased by 10%, and it was decided to complete the study with 125 participants.

Inclusion criteria were voluntary participation, not having pain or musculoskeletal disorders and being within the 18-25 age range. Individuals with a recent history of surgery, trauma, neurological or inflammatory diseases, pain, musculoskeletal disorders (e.g., symptomatic postural disorders such as cervical anterior tilt) or vestibular system disorders were excluded from the study. Exercise habits or habitual physical activity levels were not considered as inclusion or exclusion criteria during participant selection.

Participants' age, gender, BMI, and weekly durations of computer and other technological device use were recorded.

Computer and Technological Device Use Assessment

Weekly durations of computer and other technological device use were obtained via a structured self-administered questionnaire completed at the time of assessment. The self-assessment questionnaire used to record computer and technological device usage was developed by the authors based on commonly used self-reported screen-time assessment approaches described in previous studies,[2,15,16] rather than adapted from a single standardized questionnaire. Participants were asked to report their average daily hours spent on academic/work-related and recreational activities, and weekly totals were calculated accordingly. The self-assessment questionnaire included items addressing the average daily duration of computer and technological device use for academic/work-related and recreational purposes. Participants were asked to estimate their typical usage patterns over the previous week. Sample items included: "On average, how many hours per day do you use a computer for academic or work-related activities?" or "On average, how many hours per day do you use technological devices (e.g., tablet, smartphone) for non-academic or recreational purposes?" Weekly usage durations were calculated based on these self-reported responses. Screen-time data were also supported by device-based tracking applications; however, no external validation was performed to ensure complete objectivity. This limitation has been acknowledged and discussed in the corresponding section.

Cervical Proprioception Assessment

Cervical proprioception was evaluated using the CJPET. Participants were seated on a fixed chair positioned approximately 90 cm from a vertical wall on which a central target was placed at eye level. A lightweight headband with a laser pointer was affixed to the participant's head and aligned with the central target in the self-selected neutral head position. With eyes closed (blindfolded), participants sequentially performed maximal active flexion, extension, right rotation, and left rotation in randomized order, and then attempted to return their head to the starting (neutral) position. Ten repetitions were performed for each movement direction; the first four repetitions were considered practice trials and were excluded from analysis, and the average of the last six repetitions was used for the outcome measure. The linear deviation of the laser spot from the target on the

wall was recorded in centimeters and expressed as an absolute value. The global error is defined as the difference between the position to which the head returns and the neutral point. An increase in global error is associated with neck proprioception deterioration. To minimize the effect of movement order, a rest interval of approximately 30 seconds was provided between trials for each movement direction.[6] The CJPET has been shown to be a valid and reliable method for assessing cervical proprioception. Previous studies have reported good to excellent test–retest reliability (intraclass correlation coefficients ranging from 0.72 to 0.96) and acceptable measurement validity in both asymptomatic individuals and populations with neck pain.[6,8]

Balance Assessment

Dynamic balance was assessed using the YBT. This test, derived from the Star Excursion Balance Test, is a highly valid and reliable assessment method. Prior to the test, the participant's lower limb length (distance between the anterior superior iliac spine and the medial malleolus) was measured to normalize reach distances. Participants stood barefoot on the stance limb with hands on hips and reached as far as possible with the contralateral limb in the anterior, posteromedial, and posterolateral directions.

Three trials were performed for each direction, and the best values were recorded and used in analyses. Trials were invalidated if the participant lost balance, lifted the stance foot, removed hands from hips, or touched the ground with the reach foot for support. For all directional assessments, the formula (best value (BV)/lower limb length×100) was used in the calculations. The composite score was also calculated using the following formula: (BVAnterior+BVPosteromedial+BVPosterolateral)/(3×lower limb length)×100.[17,18]

All assessments were conducted by physiotherapists who were experienced and specialized in the relevant measurement procedures.

Statistical Method

The data obtained in the study were entered into and analyzed using IBM SPSS Statistics 26 (IBM Corp., Armonk, NY, USA). Numerical data were presented as mean±standard deviation, while categorical variables were expressed as number (percentage). The Kolmogorov-Smirnov test was used to assess normality and homogeneity of variance was confirmed with Levene's test. For all data, normal distribution was met and multiple linear regression analyses (enter method) was applied to assess relationships. Multicollinearity was assessed through the variance inflation factor (VIF), with values below 10 indicating acceptable tolerance levels. For the regression analyses, two separate models were constructed. In the first model, dynamic balance was set as the dependent variable, while age, BMI, sex, computer use duration, VDT use duration, and CJPET scores in flexion, extension, right rotation, and left rotation (a total of nine independent variables) were included as predictors. In the second model, CJPET scores was defined as the dependent variable, and age, BMI, sex, and YBT composite scores for the right and left sides (a total of seven independent variables) were entered as predictors. Age, BMI, and sex were included in the regression models as covariates to control for potential confounding effects. Even within a young and relatively homogeneous sample, these factors may influence proprioceptive accuracy and balance performance; therefore, their inclusion was intended to improve the internal validity of the multivariable analyses. Since gender was a categorical variable, it was coded as a dummy variable before inclusion in the regression models. In addition to the regression analyses, Pearson correlation analysis was performed to explore the bivariate relationships between computer and technological device usage duration, cervical joint position error measures, and dynamic balance outcomes. A significance level of $p<0.05$ was accepted.

RESULTS

Following the announcement for the study, 129 individuals volunteered to participate. Of these, 3 were excluded for not meeting the age criteria, and 1 withdrew from the study after enrollment due to unwillingness to continue. The study was completed with the participation of 125 university student volunteers, with a mean age of 21.46 ± 1.94 years. Among these 125 participants, 99 (79.2%) were female and 26 (20.8%) were male.

The demographic characteristics and test results of the entire study population are presented in **Table 1**.

Table 1. Demographics

	Total (n=125)
Age	21.46±1.94
BMI	23.49±5.26
Computer usage duration (hour/week)	6.34±8.23
VDTs usage duration (hour/week)	34.85±14.65
CJPET-flexion	8.27±4.50
CJPET- extension	7.84±5.27
CJPET-right rotation	8.14±5.01
CJPET-left rotation	7.80±3.90
YBT-anterior right	103.53±16.22
YBT-anterior left	102.38±15.54
YBT-posteromedial right	94.89±17.93
YBT-posteromedial left	95.71±14.71
YBT-posterolateral right	101.12±15.20
YBT-posterolateral left	101.77±14.39
YBT-composite right	99.95±12.07
YBT- composite left	99.85±12.60

BMI: Body mass index, VDTs: Visual display terminals, CJPET: Cervical joint position error test, YBT: Y balance test

Multiple linear regression analyses were performed to examine whether age, BMI, sex, computer use duration, VDT use duration, and YBT composite scores (right and left) predicted cervical joint position error (CJPET) scores. The results showed no significant relationships between these independent variables and CJPET outcomes. The regression models for flexion ($F=0.812$, Adjusted $R^2=0.046$), extension ($F=0.400$, Adjusted $R^2=0.023$), right rotation ($F=0.869$,

Adjusted R^2=0.007), and left rotation (F=0.393, Adjusted R^2=0.036) were all nonsignificant (p>0.05) (Table 2).

Table 2. Multi linear regression analysis for CJPETs

				%95 CI	
		Beta	p	Lower	Upper
CJPET-flexion	Age	-0.017	0.854	-0.473	0.392
	BMI	0.090	0.355	-0.087	0.241
	Computer usage duration (hour/week)	0.011	0.913	-0.101	0.113
	VDTs usage duration (hour/week)	0.117	0.232	-0.023	0.095
	YBT-composite right	0.124	0.494	-0.087	0.180
	YBT-composite left	-0.196	0.280	-0.198	0.058
	Sex	-0.189	0.070	-4.352	0.175
CJPET-extension	Age	0.029	0.761	-0.434	0.592
	BMI	0.020	0.837	-0.175	0.215
	Computer usage duration (hour/week)	0.048	0.633	-0.096	0.158
	VDTs usage duration (hour/week)	0.113	0.255	-0.030	0.111
	YBT-composite right	0.037	0.841	-0.143	0.175
	YBT-composite left	-0.086	0.638	-0.188	0.116
	Sex	0.012	0.906	-2.523	2.845
CJPET-right rotation	Age	-0.113	0.232	-0.773	0.189
	BMI	0.030	0.755	-0.154	0.212
	Computer usage duration (hour/week)	0.104	0.295	-0.056	0.182
	VDTs usage duration (hour/week)	0.096	0.327	-0.033	0.099
	YBT-composite right	0.069	0.703	-0.120	0.177
	YBT- composite left	-0.153	0.399	-0.203	0.081
	Sex	-0.160	0.125	-4.484	0.551
CJPET-left rotation	Age	-0.077	0.421	-0.535	0.225
	BMI	0.034	0.728	-0.119	0.170
	Computer usage duration (hour/week)	0.015	0.881	-0.087	0.101
	VDTs usage duration (hour/week)	0.064	0.520	-0.035	0.069
	YBT-composite right	0.134	0.466	-0.074	0.161
	YBT-composite left	-0.203	0.269	-0.175	0.049
	Sex	-0.006	0.956	-2.042	1.931

BMI: Body mass index, VDTs: Visual display terminals, CJPET: Cervical joint position error test, YBT: Y balance test

Similarly, when dynamic balance performance was analyzed as the dependent variable, including age, BMI, sex, computer use duration, VDT use duration, and CJPET scores (flexion, extension, right and left rotation) as predictors, no significant associations were found. For the YBT composite scores, the models for the right and left sides were not significant (F=0.475, Adjusted R^2=0.040; F=0.574, Adjusted R^2=0.032, respectively; p>0.05) (Table 3). Pearson correlation analysis revealed no significant correlations between computer or technological device usage duration and CJPET or YBT composite scores (p>0.05). Detailed correlation coefficients are presented in Table 4.

These findings indicate that neither demographic nor screen-exposure variables had measurable associations with cervical proprioception or balance in this cohort of healthy young adults.

Table 3. Multi linear regression analysis for dynamic balance

				%95 CI	
		Beta	p	Lower	Upper
YBT-composite right	Age	-0.042	0.663	-1.446	0.923
	BMI	-0.010	0.920	-0.402	0.182
	Computer usage duration (hour/week)	-0.075	0.456	-0.402	0.182
	VDTs usage duration (hour/week)	0.172	0.083	-0.019	0.303
	CJPET-flexion	-0.028	0.814	-0.702	0.552
	CJPET- extension	0.008	0.954	-0.588	0.624
	CJPET-right rotation	-0.062	0.634	-0.775	0.474
	CJPET-left rotation	0.009	0.946	-0.810	0.867
	Sex	0.002	0.988	-6.344	6.443
YBT-composite left	Age	0.017	0.863	-1.125	1.340
	BMI	0.017	0.864	-0.426	0.507
	Computer usage duration (hour/week)	-0.105	0.296	-0.465	0.143
	VDTs usage duration (hour/week)	0.154	0.119	-0.035	0.300
	CJPET-flexion	-0.074	0.531	-0.859	0.445
	CJPET-extension	0.049	0.711	-0.512	0.749
	CJPET-right rotation	-0.063	0.631	-0.807	0.491
	CJPET-left rotation	-0.041	0.766	-1.004	0.741
	Sex	0.034	0.755	-5.602	7.700

BMI: Body mass index, VDTs: Visual display terminals, CJPET: Cervical joint position error test, YBT: Y balance test

Table 4. Correlations between computer and technological device use and test results

		CJPET-flexion	CPJET-extension	CPJET-right rotation	CPJET-left rotation	YBT–composite right	YBT–composite left
Computer usage duration (hour/week)	p*	0.947	0.317	0.474	0.799	0.612	0.564
	r	-0.006	0.090	0.065	0.023	-0.046	-0.052
VDTs usage duration (hour/week)	p*	0.528	0.173	0.484	0.510	0.094	0.133
	r	0.057	0.123	0.063	0.060	0.151	0.135

VDTs: Visual display terminals, CJPET: Cervical joint position error test, YBT: Y balance test. *Pearson correlation analysis.

DISCUSSION

This study investigated the relationship between the duration of computer and VDT use and cervical proprioception and dynamic balance performance in healthy young adults. The findings indicated that neither computer use nor VDT exposure duration was significantly associated with cervical joint position sense or dynamic balance parameters. These results contrast with some studies reporting impaired proprioception and balance after prolonged screen exposure but are consistent with others that found no measurable neuromuscular deficits in healthy populations.

The lack of significant associations in the present study between computer or VDT use duration and CJPET and YBT scores may be interpreted in the context of several factors. First, all participants were asymptomatic young adults, which likely reduced variability in sensorimotor performance and limited the statistical power to detect subtle differences. Second, the range of daily VDT exposure times in this sample was relatively narrow, as most participants were university students with similar academic routines. Third, adaptive neuromuscular responses that have been discussed in relation to long-term exposure to digital devices may help maintain postural control even during extended screen use. Previous studies have suggested that such adaptations in sensorimotor integration may mitigate the negative effects of sustained visual and postural demands, especially in younger individuals with higher physical activity levels. The absence of a significant relationship between computer use and cervical proprioception in this study aligns with recent evidence suggesting that young adults may develop adaptive postural control strategies that mitigate the neuromuscular consequences of prolonged screen exposure.[4,19,20] From a developmental perspective, early and continuous exposure to technological devices has been discussed as a potential factor related to adaptive neuroplastic changes in sensorimotor organization. Excessive screen time has become a global behavior among children and adolescents.[15] In young individuals, increased screen use from early childhood has been reported to be associated with both static and dynamic postural control. For instance, among adolescents, computer use was associated with increased neck flexion in males and greater lumbar lordosis in females.[21] Frequent screen interaction from childhood may lead to differentiated development of proprioceptive calibration and visuomotor integration, potentially altering tolerance to postural challenges induced by sustained screen use. However, these adaptations might also obscure direct linear relationships between device-use duration and cervical proprioceptive performance.

Conversely, several studies have reported that extended use of technological devices may be associated with adverse changes in proprioception and balance. Alshahrani et al.[22] found that prolonged smartphone use impaired neck proprioception and dynamic balance, while Kang et al.[23] demonstrated that forward head posture reduced balance ability in long-term computer users. Cheragh et al.[24] also reported that maintaining a slump-sitting posture during computer use increased neck discomfort and decreased proprioceptive accuracy and postural stability. Similarly, Bisen et al.[25] found that individuals with neck pain exhibited greater CJPE and scapular dyskinesis compared with asymptomatic controls. In contrast, the absence of significant findings in our study aligns with research indicating that asymptomatic young adults may develop adaptive postural and neuromuscular strategies that buffer against the negative consequences of screen exposure. Depreli et al.[16] likewise observed no meaningful relationship between device use and proprioceptive function among healthy students. Reddy et al.[5] similarly reported that proprioceptive deficits are more pronounced in individuals with chronic neck pain or reduced cervical endurance than in asymptomatic participants. Taken together, these findings suggest that cervical proprioceptive impairment may be more evident in populations with musculoskeletal symptoms or postural dysfunction, rather than in young, healthy individuals. In such asymptomatic groups, proprioceptive systems may exhibit sufficient neuroplastic adaptability to maintain sensorimotor accuracy despite long-term digital device use. This interpretation is supported by recent evidence showing that repeated visual–postural interactions during daily screen-based activities may be related to sensorimotor integration mechanisms in younger individuals.

From a practical standpoint, the results highlight the importance of early ergonomic education and postural awareness strategies to preserve neuromuscular health in the digital era. Although prolonged computer use within non-symptomatic limits may not lead to immediate proprioceptive or balance deficits, long-term exposure combined with poor posture or physical inactivity may be related to subclinical sensorimotor changes over time. Therefore, implementing posture correction exercises, regular movement breaks, and ergonomic adjustments may be considered preventive strategies to minimize potential adverse effects associated with continuous screen use. Future longitudinal studies incorporating ergonomic, postural, and psychosocial factors are warranted to clarify these multifactorial associations.

Limitations

This study has several methodological limitations that should be carefully considered. First, although screen-time data were obtained using device-based tracking applications, external validation procedures were not implemented to ensure full objectivity of exposure measurement. Second, potential confounding variables such as physical activity level, and exercise habits, ergonomic conditions, and psychosocial influences were not controlled, even though each could independently affect proprioceptive and postural outcomes. Third, our study sample consisted of 99 female and 26 male volunteers. The predominance of female participants resulted from a greater number of women expressing interest in joining the study following the announcement. This led to a lack of homogeneity in the gender distribution of the sample and was considered one of the study's limitations. Therefore, the study was not designed to support sex-based group comparisons, and sex-specific interpretations were not emphasized. Moreover, because all participants were healthy university students, the external validity of the findings is restricted, and the results may not be generalizable to older adults or individuals with musculoskeletal disorders.

Despite these constraints, the present study provides a meaningful contribution by indicating that prolonged computer use alone does not necessarily impair cervical proprioception or balance in healthy young adults. Given these limitations, future research should include detailed ergonomic assessments, collect comprehensive behavioral and neuromuscular data, and use longitudinal designs to examine long-term postural and sensorimotor adaptations associated with digital device use.

CONCLUSION

In conclusion, prolonged computer and VDT use within non-symptomatic limits does not appear to be significantly associated with cervical joint position sense or dynamic balance performance in healthy young adults. These findings suggest that, in the absence of musculoskeletal symptoms, young individuals may maintain effective postural and proprioceptive control potentially through adaptive neuromuscular mechanisms. From a preventive and ergonomic perspective, promoting regular movement breaks, posture correction exercises, and proper workstation ergonomics remains important to support neuromuscular health during prolonged sedentary screen exposure. Future studies should employ longitudinal and interventional designs with objective assessments of screen exposure, postural alignment, and neuromuscular activity to clarify the long-term implications of digital device use on cervical proprioception and balance.

ETHICAL DECLARATIONS

Ethics Committee Approval

Ethical approval was obtained from the Non-interventional Clinical Researches Ethics Committee of Yalova University (Date: 07.05.2025, Decision No: 2025/183).

Informed Consent

Written informed consent was obtained from all individual participants prior to their inclusion in the study. Participants were fully informed about the study's aims, procedures, potential risks and benefits, and their rights-including the right to withdraw at any time without consequence. All participants voluntarily signed a written informed consent form.

Peer Review Process

This manuscript was subject to external peer review.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

Financial Disclosure

The authors received no financial support for the conduct or publication of this research.

Author Contributions

Concept: EK, ZŞ, FM; Design: EK, ZŞ, EA, BK; Control: EA, BK, FM; Data Collection and/or Processing: EK, ZŞ, EA, BK; Analysis and/or Interpretation: EK, ZŞ; Literature Review: EK, ZŞ; Article writing: EK, ZŞ, EA, BK; Critical Review: All authors.

REFERENCES

1. García-Remeseiro T, Gutiérrez-Sánchez Á, Taboada-Iglesias Y, Alonso-Fernández D. Physical activity, sitting time, neck disability and posture in workers using visual display terminals (VDT). *Work*. 2023;74(2):733-742. doi:10.3233/WOR-205194
2. Cheng X, Song M, Kong J, et al. Influence of prolonged visual display terminal use and exercise on physical and mental conditions of internet staff in Hangzhou, China. *Int J Environ Res Public Health*. 2019;16(10):1829. doi:10.3390/ijerph16101829
3. Sahu PK. Cervical proprioception and dynamic balance in computer users: a comparison between male and female healthy adults. *Indian J Public Health Res & Development*. 2020;11(12):263-269. doi:10.37506/ijphrd.v11i12.13247
4. Özüdoğru A, Canlı M, Kuzu Ş, Aslan M, Ceylan I, Alkan H. Muscle strength, balance and upper extremity function are not predictors of cervical proprioception in healthy young subjects. *Somatosensory & Motor Research*. 2023;40(2):78-82. doi:10.1080/08990220.2023.2183832
5. Reddy RS, Tedla JS, Alshahrani MS, Asiri F, Kakaraparthi VN. Comparison and correlation of cervical proprioception and muscle endurance in general joint hypermobility participants with and without non-specific neck pain-a cross-sectional study. *PeerJ*. 2022;10:e13097. doi:10.7717/peerj.13097
6. Peng B, Yang L, Li Y, Liu T, Liu Y. Cervical proprioception impairment in neck pain-pathophysiology, clinical evaluation, and management: a narrative review. *Pain Ther*. 2021;10(1):143-164. doi:10.1007/s40122-020-00230-z
7. Alshahrani MS, Reddy RS. Mediation effect of kinesiophobia on the relationship between cervical joint position sense and limits of stability in individuals with fibromyalgia syndrome: a cross-sectional study using mediation analysis. *J Clin Med*. 2023;12(8):2791. doi:10.3390/jcm12082791
8. Gucmen B, Kocyigit BF, Nacitarhan V, Berk E, Koca TT, Akyol A. The relationship between cervical proprioception and balance in patients with fibromyalgia syndrome. *Rheumatol Int*. 2022;42(2):311-318. doi:10.1007/s00296-021-05081-1
9. Lee J, Seo K. The comparison of cervical repositioning errors according to smartphone addiction grades. *J Phys Ther Sci*. 2014;26(4):595-598. doi:10.1589/jpts.26.595
10. AlAbdulwahab SS, Kachanathu SJ, AlMotairi MS. Smartphone use addiction can cause neck disability. *Musculoskeletal Care*. 2017;15(1):10-12. doi:10.1002/msc.1170
11. Ahmed S, Mishra A, Akter R, Shah MH, Sadia AA. Smartphone addiction and its impact on musculoskeletal pain in neck, shoulder, elbow, and hand among college going students: a cross-sectional study. *Bulletin of Faculty of Physical Therapy*. 2022;27(1):5. doi:10.1186/s43161-021-00067-3
12. Szucs KA, Cicuto K, Rakow M. A comparison of upper body and limb postures across technology and handheld device use in college students. *J Phys Ther Sci*. 2018;30(10):1293-1300. doi:10.1589/jpts.30.1293
13. Lin C-C, Hua S-H, Lin C-L, Cheng C-H, Liao J-C, Lin C-F. Impact of prolonged tablet computer usage with head forward and neck flexion posture on pain intensity, cervical joint position sense and balance control in mechanical neck pain subjects. *J Med and Biological Engineering*. 2020;40(3):372-382. doi:10.1007/s40846-020-00525-8
14. Plisky P, Schwartkopf-Phifer K, Huebner B, Garner MB, Bullock G. Systematic review and meta-analysis of the Y-balance test lower quarter: reliability, discriminant validity, and predictive validity. *Int J Sports Phys Ther*. 2021;16(5):1190. doi:10.26603/001c.27634
15. Qi J, Yan Y, Yin H. Screen time among school-aged children of aged 6–14: a systematic review. *Glob Health Res Policy*. 2023;8(1):12. doi:10.1186/s41256-023-00297-z

16. Depreli O, Iyigun G, Angın E, et al. The relationship between proprioception, physical activity level, muscle endurance, posture, sitting time, smartphone and computer usage in healthy young adults. *Sağlık ve Toplum*. 2024;34(3):166-176.
17. Zheng Y, Feng R, Hu W, Huang P. Investigation of inter-rater and test-retest reliability of Y balance test in college students with flexible flatfoot. *BMC Sports Sci Med Rehabil*. 2024;16(1):40. doi:10.1186/s13102-024-00819-3
18. Shaffer SW, Teyhen DS, Lorenson CL, et al. Y-balance test: a reliability study involving multiple raters. *Military Med*. 2013;178(11):1264-1270. doi: 10.7205/MILMED-D-13-00222
19. Saraiva M, Vilas-Boas JP, Castro MA. Postural control and muscle activity during dual-task in young adults. *Behav Sci (Basel)*. 2024;14(5): 403. doi:10.3390/bs14050403
20. Hua A-K, Bai J-Y, Wang G-Z, Hao Z-M, Meng J, Wang J. Adaptive changes in balance control strategies under continuous exposure to visual-somatosensory conflicts. *J Neurophysiol*. 2025;133(3):765-774. doi:10.1152/jn.00350.2024
21. Straker LM, O'Sullivan PB, Smith A, Perry M. Computer use and habitual spinal posture in Australian adolescents. *Public Health Rep*. 2007;122(5):634-643. doi:10.1177/003335490712200511
22. Alshahrani A, Aly SM, Abdrabo MS, Asiri FY. Impact of smartphone usage on cervical proprioception and balance in healthy adults. *Biomedical Research*. 2018;29(12):2547-2552. doi:10.4066/biomedicalresearch.29-18-594
23. Kang J-H, Park R-Y, Lee S-J, Kim J-Y, Yoon S-R, Jung K-I. The effect of the forward head posture on postural balance in long time computer based worker. *Ann Rehabil Med*. 2012;36(1):98. doi:10.5535/arm.2012.36.1.98
24. Cheragh ZA, Degens H, Sakinepoor A. Effect of a slump posture on pain, proprioception, and electrical activity of the muscles in office workers with chronic non-specific neck pain. A retrospective study. *J Bodyw Mov Ther*. 2024;38:100-105. doi:10.1016/j.jbmt.2023.12.006
25. Bisen RR, Kadam PD, Varghese A, Bisen R, Bisen R, Kadam P. The correlation between cervical proprioception and scapular dyskinesis in patients with neck pain: a case-control study. *Cureus*. 2024;16(10): e70869 doi:10. 7759/cureus.70869