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Review Article

Physiotherapy Section

# Posture Correction Interventions to Manage Neck Pain among Computer and Smartphone Users- A Narrative Review

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## ABSTRACT

Digital technology has affected practically every aspect of modern life. Sitting is something that humans do for a number of purposes, including work (particularly for those who work in the computer industry), and for enjoyment. Daily computer use causes frequent neck and back pain. Flexed head and neck postures might cause neck pain during work. Pauses and postural modifications help avoid pain and sickness. Recent wearables can sense spinal alignment and provide immediate feedback on improper posture. Posture monitoring can help treat or change a user's posture. In this narrative review, Google Scholar, PubMed, Cross-Ref, Cochrane, and ResearchGate were searched for English-only papers using review-specific keywords and fifty-one items were found. The search was narrowed by using more particular terms, such as "wearable postural correction sensors," "forward head posture," "neck discomfort in smartphone or computer users," and "neck workouts." Only current papers from 2015 onwards were considered. After filtering for relevancy, twenty-five articles were included. Researcher should identify intervention functions, policy categories, and tactics for behaviour change. Researchers have also examined neck discomfort, forward head posture in young individuals while using smartphones and computers, and posture correction using a wearable postural correction sensor. And also appropriate arrangement and support to administering a home and workplace fitness programme that eliminates pain and impairment while enhancing Forward Head Posture (FHP) and endurance. This review aimed to thoroughly examine existing literature for evidence concerning prevalent problems among smartphone and computer users such as neck discomfort and forward head position, postural correction sensor, and impact of exercises on neck discomfort.


**Keywords:** Computer users, Discomfort, Head posture, Posture monitoring sensors

## INTRODUCTION

In this contemporary world, hardly any sphere of life exists where computer technology has not influenced human being. Not only a substantial quantum of time is spent by professionals at work in sitting position for occupational (computer professionals) but also by them during leisure activities [1,2]. Extended sitting combined with an incorrect posture, such as a forward head and increased dorsal spine kyphosis; increase the demands on the vertebral column muscles and joints, hence increasing the risk of vertebral column discomfort in desk-bound professionals [3,4]. Long-term computer use for learning and recreational purposes leads to fairly increase prevalence of cervical and dorsolumbar pain even amongst university level learners [5,6]. Despite commercial availability of so many assistive devices available to assist computer users in maintaining a proper sitting position, problem is persisting in significant proportions. Wearable sensors that employ micro-electro-mechanical technology are meant to offer real-time feedback for enabling active posture adjustment [7].

Neck pain is a fairly common problem among computer professionals and also among those desk-bound professionals whose work life requires spending longer times face their display in a static position. This type of soreness and malaise can be prevented by taking frequent rests and adjusting one's posture [8]. Cervical spine pain is also found as a common deficit in others (i.e., general public), with a stated incidence of 43-66.7% at various stages in their lives [9]. The source of pain may be varying, e.g., arising from a variety of cervical spine structures, which is responsible for the development of chronic neck pain [9]. A greater neck flexion angle increases the gravitational moment on the neck. Compared to neutral posture, flexed posture has a high gravitational moment, which means that the neck muscles have to work harder. This can lead to muscle fatigue and neck pain [10].

Wearable devices include a variety of technologies that are worn on the body and measure metrics such as heart rate, and sleep duration step count, distance travelled. In recent times, different wearable systems have been made that can sense how the spine is positioned and give live biofeedback when bad posture is maintained [11]. Maintaining good posture throughout the day, along with performing activities of daily living, is indispensable for safeguarding spinal health. Considering this, posture monitoring provides a useful basis for facilitating the therapy. It also provides handy mechanism for day-to-day alerts and alarms to remind an aware user to correct and adapt his/her posture in different situations (including while sitting down during work, carrying weights, etc.,)

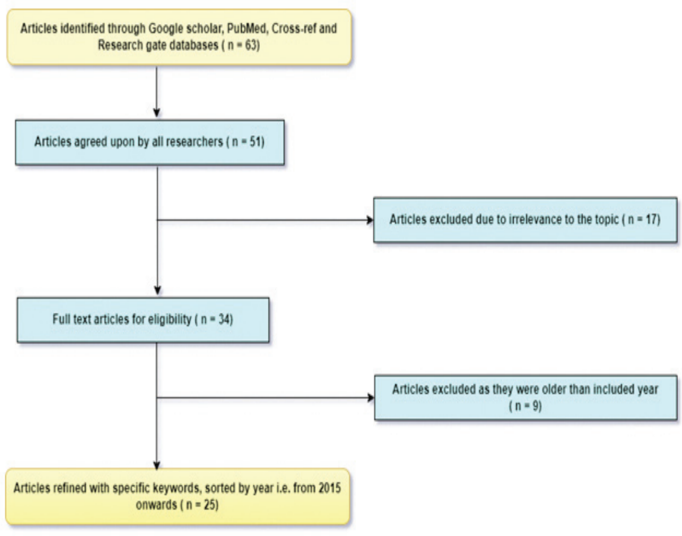
The fundamental objective of this review is to thoroughly examine existing literature for evidence concerning prevalent problems among smartphone and computer such as user's cervical spine pain and forward head posture, postural correction sensor and effect of exercises on neck pain.

## LITERATURE SEARCH

In this narrative review Google Scholar, PubMed, Cross-Ref, Cochrane, and ResearchGate were searched for English-only papers using review-specific keywords. Fifty one items were found. The search was narrowed by using more particular terms, such as "wearable postural correction sensors," "forward head posture," "neck discomfort in smartphone or computer users," and "neck workouts." Only current papers from 2015 onwards were considered. After filtering for relevancy, twenty seven articles were included [Table/Fig-1].

### Prevalent Problems among Smartphone and Computer Users: Neck Pain and Forward Head Posture

According to the results of a cross-sectional survey done by Namwongsa S et al., in the year 2018, that included 779 undergraduate



**[Table/Fig-1]:** Selection of articles.

smartphone users with musculoskeletal problems, the mean age of the population was 18.82.07 years. Musculoskeletal diseases adopted neck flexion of 82.74 percent, shoulder protraction of 56.61 percent, elbow flexion of 65.16 percent, and wrist and hand flexion of 22.40 percent [12]. Abadiyan F et al., in the year 2021, conducted a Randomised Controlled Trial (RCT), which included 60 (female and male office employees suffering from chronic cervical pain) aged 28-48 years. The findings indicated that the GPR+smartphone application improved pain, disability, and FHP [13].

Fathollahnejad K et al., did a random control trial with 60 married women who had neck pain, a rounded shoulder, and FHP. Age ranging from 32-42 years. Results suggested that both intervention groups fared better than the control group in terms of pain, function, FHP, and shoulder posture [14].

Barrett JM et al., studied eight healthy men who had never had neck, shoulder, or dorsal spine pain before; their mean age was 21.3±1.7 years. Hence, it was concluded that in flexion, compression is 1.6 times greater than in neutral (p-value=0.05). In flexion, C1-C2 compresses more than C0-C1. In flexion, C0-C1 had the largest Antero-posterior (AP) shear (p-value=0.05), followed by C2-C3 [15].

## Postural Correction Sensor

A pilot study consisting of six participants (4 females and 2 males) was carried out by Caviedes JE et al., 2020 [16]. A total of 37 years was the age that was considered the norm. When it came to correctness detection, tailored garment-mounted sensors for scoliosis training revealed the highest sensitivity, while strapped sensors only achieved 70% of that.

A clinical trial was carried out by Jeong H and Park W [17]. on 36 participants including 21 males and 15 females. The mean age of males is 26.7±2.0 years, and the mean age of females is 25.0±2.3 years. The mixed sensor system demonstrated a high level of accuracy in terms of overall posture categorisation (0.92). The overall accuracy of the pressure sensor only system is 0.59, while the overall accuracy of the distance sensor only system is 0.82.

## Effect of Exercises on Neck Pain

Mylonas K et al., 2021, did a RCT with 20 women between the ages of 43 and 65 who weighed between 51 and 73 kg and stood between 1.56 m and 1.75 m tall. The results showed that Instrument-Assisted Soft Tissue Mobilization (IASTM) and neuromuscular exercises improved Cerebrovascular Accident (CVA) (Group-A:+7.2% vs. Group-B:+1.1%) and Neck Disability Index (NDI) (Group-A: -25.2% vs. Group-B: -5.8%) more than massage and identical exercises. Group-B: -5.8 percent) less than massage and the same exercises [18]. The researchers Suvarnnato T and associates in the year 2019, carried out a RCT [19]. A total of 54 participants (with chronic mechanical neck pain), when compared to the non-experimental groups, the experimental groups see significant Neck Disability Index (NDI) score improvements after six weeks of training as well as at one and three months into the follow-up studies.

Sheikhhoseini R et al., 2018, carried out a meta-analysis and systematic review [20]. The odds ratios for cranial-vertebral angle and pain were 6.7 (CI=2.53-17.9, p=0.0005), 0.7 (CI=0.43-1.2, p=0.2), and 0.3 (95% CI=0.13-0.42, p=0.001), respectively, across seven RCTs with a total of 627 participants. For each of the three constructs of interest, the review's structure is shown below [Table/Fig-2-4] [7,8,10-18,20-33].

| Author/publication year/type of study | Size/type of population | Age range/average age | Findings |
|---|---|---|---|
| Derakhshanrad N et al., 2021 (report of a cross-sectional cohort study) [21] | 1602 office employees (Had a history of long-term (>4 years) smartphone use) | Above the age of 18 | Neck discomfort=30.1%. Majority of female and younger employees reported neck discomfort. |
| Jaroenrungsup Y et al., in 2021 (Randomised control trial) [22] | 46<br>(Participants had history >1 year and >2.5 hours each day smartphone use on average | 18-25 years | Neck flexion strength, extension strength, flexion endurance, and extension endurance were 17.623.32 N, 23.613.06 N, 40.7222.89 sec, and 128.6250.25 sec, respectively. |
| Rebiero P et al., 2020 [23] | 44<br>(with or without cervical pain) | 18-65 years | Forward head posture's intra-rater reliability was 0.88. Intra-class correlation was 0.83 to 0.89 for inter-rater reliability.<br>Above 0.82 for criterion validity. Intra-rater change was 4.96 and inter-rater change was 5.52. |
| Mahmoud NF et al., 2019 (systematic review and meta-analysis) [24] | 15 cross-sectional studies were included | - | Few studies found negative association between FHP and cervical pain intensity (r=0.55; 95 percent CI=0.69, 0.36) and disability (r=0.42; 95 percent CI=0.54, 0.28) in adults and geriatric people. |
| Kim DH et al., 2018 [25] | 44<br>(FHP in volunteers employed who had CVA of <52°) | 20-40 | The pain group's CVA and cervical flexion and extension ROM were significantly different from the pain-free group (p 0.05). |
| Singla D et al., 2017 (Literature review) [27] | 21 studies included | - | CVA, sagittal head tilt, and sagittal shoulder are reliable posture measurements compared to X-rays. |
| Nejati P et al., 2015 (cross-sectional correlation study) [26] | 101<br>55 with neck pain and 46 without neck pain | mean age: 39.0±8.0 years | High thoracic and CV angles linked with working-position neck discomfort (p 0.05). |
| Markopoulos P et al., 2020 (Iterative user centered design) [8] | 10<br>(Computer work for about six hours each day and had no neck pain or injury) | 18-30 years | Only 5.3% stuck with the programme for more than a week.<br>On a scale from 1 (easy) to 5 (difficult), subjects rated as most challenging finding the time to do cervical exercises. |
| Namwongsa S et al., 2018 (cross-sectional survey study) [12] | 779 (Prevalence of musculoskeletal problems among undergraduate smartphone users) | mean age: 18.82±0.79 years | Musculoskeletal diseases adopted neck flexion=82.74 percent, shoulder protraction=56.61 percent, elbow flexion=65.16 percent, and wrist and hand flexion=22.40 percent. |

| | | | |
|---|---|---|---|
| Abadiyan F et al., 2021 Randomised Controlled Trial (RCT) [13] | 60 (Female and male office employees suffering from chronic cervical pain) | 28-48 years | The GPR+a smartphone app improved pain, disability, FHP. |
| Fathollahnejad K et al., 2019 (RCT) [14] | 60 (Married women with cervical discomfort, rounded shoulder and FHP | 32-42 years | Both intervention groups fared better than the control group in terms of pain, function, FHP, and shoulder posture. |
| Barrett JM et al., 2020 [15] | 8 (The study was done on eight healthy men who had never had neck, shoulder, or dorsal spine pain before.) | mean age: 21.3±1.7 years | In flexion, compression is 1.6 times greater than in neutral (p 0.05). In flexion, C1-C2 compresses more than C0-C1, In flexion, C0-C1 had the largest AP shear (p 0.05), followed by C2-C3. |
| Mylonas K et al., 2021 (RCT) [18] | 20 (Adult females weighing 51 to 73 kg and standing 1.56 to 1.75 m tall with cervical pain FHP | 43-65 years | IASTM and neuromuscular exercises improved CVA (Group-A:+7.2 percent vs. Group-B:+1.1 percent) and NDI (Group-A: -25.2 percent vs. Group-B: -5.8 percent) more than massage and identical exercises. |

**[Table/Fig-2]:** Reviewed studies on prevalent problems among smart phone and computer users: neck pain and forward head posture [8,12-15,18,21-27].

| Author/publication year/ type of study | Size/type of population | Age range/average age | Findings |
|---|---|---|---|
| Chopra S, 2017 (Pilot study) [28] | Single adult test | - | Magnets and magnetometers considerably enhanced posture classification accuracy (89% vs. 47%). Image analysis validated this strategy. |
| Gallego-Izquierdo T, 2020 (Pilot study) -[29] | - | - | Due to employment, many neglect their sitting, standing, and walking posture. This gizmo enables people spend a few minutes on health and posture. |
| Wang Q et al., 2015 (Non clinical pilot study) [30] | (4 female and 3 male, without any related pathology) | - | Smart rehabilitative apparel that employs vibration motors to deliver posture feedback on the jacket and a linked Android smartphone. |
| Kuo YL et al., 2021 (one-group quasi-experimental study) [7] | 21 (Healthy young adults) | 20-25 years | Cervical flexion, cervical, thoracic, and pelvic plane angles showed statistically significant impacts (p 0.05). |
| Ailneni RC et al., 2019 (Clinical trial) [10] | 19 (Nine men and tenwomen who can type at least 30 words per minute) | 24.47±5.32 years | The wearable sensor affected moment-arms at C7-T1 and gravitational moment during standing and sitting position. |
| Simpson L et al., 2019 (comprehensive systematic review) [11] | 37 articles | - | Wearables device assessing spine posture have been proposed for application in postoperative therapeutic intervention of musculoskeletal illnesses, diagnosis of pathological spinal curvature, monitoring of Parkinson's disease postural deviation, fall detection, and comparison of therapeutic intervention. |
| Caviedes JE et al., 2020 (Pilot study) [16] | 6 (4 females and 2 males) | Mean age 37 years | Correctness detection revealed maximal sensitivity with tailored garment-mounted sensors for scoliosis training and 70% with strapped sensors. |
| Jeong H and Park W, 2021 (clinical trial) [17] | 36 (21 male and 15 females) | mean age of male 26.7±2.0 and female 25.0±2.3 | Overall posture categorisation accuracy was good using the mixed sensor system (0.92). The pressure sensor only and distance sensor only systems have overall accuracies of 0.59 and 0.82, respectively. |

**[Table/Fig-3]:** Reviewed studies on postural correction sensor [7,10,11,16,17,28-30].

| Author/publication year/type of study | Size/type of population | Age range/ average age | Findings |
|---|---|---|---|
| Suvarnnato T et al., 2019 (Randomised control trial-RCT) [19] | 54 (with chronic mechanical neck pain) | - | After 6 weeks of training and at 1- and 3-month follow-up studies, NDI scores in the experimental groups significantly improve compared to the non experimental groups. |
| Ha S-Y and Sung YH 2020 [31] | 22 (Healthy adults, female and male) | 21.8±1.78 | The forward head posture group maintained a CVA of 49° when watching a smartphone for 40 minutes. Cervical proprioception differed significantly (p-value=0.05). |
| Jun D et al., 2020 (A prospective cohort study with a one-year follow-up) [32] | 214 (Office employees who work >30 hours per week, including >20 hours per week of computer-intensive work, and who do not experience neck pain) | 18 and above years | Correct thoracic spine sitting posture increased cervical movement and muscle performance, increasing physical activity, which reduced neck discomfort. |
| Sheikhhoseini R et al., 2018 (Meta-analysis and systematic review) [20] | 7 Randomised Controlled Trials (RCT) comprising 627 participants | - | The odds ratios for Cranio vertebral angle, and pain were 6.7 (CI=2.53-17.9, p-value=0.0005), 0.7 (CI=0.43-1.2, p-value=0.2), and 0.3 (95% CI=0.13-0.42, p-value 0.001), respectively. |

**[Table/Fig-4]:** Reviewed studies on effect of exercises on neck pain [19,20,31-32].

## DISCUSSION

The present review acknowledged different types of involvement of pain due to posture such as neck, head, and back etc. among smartphone and computer and postural correction sensor. The prevalence of neck discomfort among office employees was determined to be 30.1% by the results of this investigation as per study done by Derakhshanrad N et al., in 2021. [21]. This review did not examine the correlation between neck discomfort, smartphone use, and neck postures. As a result of extreme head positions, there was no examination of cervical spine stresses and neck forces [21]. (Jaroenrungsup Y et al., 2021) A study suggests that self-postural correction exercise combined with text-neck knowledge acquisition enhanced upper limb muscle performance and decreased neck discomfort symptoms [22]. The researchers had limited time to perform a comparative case study to see whether self-exercising could be employed for an extended length of time to improve forward head position. During the six-week duration of this study inquiry, a number of their actions were seen while monitoring the exercise outcomes, but there was a lack of specific data on the activities of the participants in the two groups [22]. In the study by Ribeiro P et al., in year 2020, forward head posture was found to be viable and dependable application for assessing the CVA in a standing position, and it may be employed in clinical practice. The authors advocate using the FHP app in clinical practice because of its simplicity of use, low cost, and great accuracy [23]. According to the results of a cross-sectional survey conducted by Namwongsa S et al., in year 2018 that included 779 undergraduate smartphone users with musculoskeletal problems the mean age of the population was 18.82.07 years.

Musculoskeletal diseases adopted neck flexion of 82.74 percent, shoulder protraction of 56.61 percent, elbow flexion of 65.16 percent, and wrist and hand flexion of 22.40 percent [12]. This study did not examine a number of smartphone use characteristics examined in other research (e.g., number of text messages and neck postures). This research only involved adolescents, thus no comparisons across age groups were done. To confirm the link, future studies should include people who aren't college students and a group of people who smoke on their smartphones [12]. In a systematic review and meta-analysis done by Mahmoud NF et al., 2019, 15 cross-sectional studies were included. Findings indicated that few studies found negative associations between FHP and cervical pain intensity (r=0.55; 95 percent CI=0.69, 0.36) and disability (r=0.42; 95 percent CI=0.54, 0.28) in adults and geriatric people [24]. Future studies should specify the severity (mild or severe), duration (acute or chronic), and frequency of neck pain, as well as use reliable tools to measure the severity and functional impairment caused by neck pain, as these small factors may affect the link between neck pain and FHP [24]. Kim DH et al., 2018 conducted a study that included 44 participants (FHP in volunteers employed with a CVA of 52°) aged 20-40 years. The CVA and cervical flexion and extension ROM of the pain group were significantly different from the pain-free group (p 0.05). This research was unable to identify whether FHP influenced pain or whether mobility restrictions caused discomfort. In addition, possible predictors of cervical pain (other than CVA and ROM) could not be investigated, preventing the inclusion of many participants. Future research must investigate the elements that influence pain in FHP patients [25]. According to this cross-sectional investigation that smoking and having your neck bent forward are linked to neck problems in smartphone users and also provide crucial proof of a connection between heavy smartphone use and the development of cervical diseases [16]. The study done by authors, Jeong H and Park W, in the year 2021, suggested that the future research using bigger sample sizes and a focus on lumbar postural dysfunctions is required to validate these findings [17]. Sixty female and male office workers with persistent neck pain participated in a study, which revealed that incorporating a smartphone app into GPR for NP may be an appropriate method for providing a home and work exercise programme that lowers pain and disability while enhancing FHP and endurance [19]. The authors Nejati P et al., in year 2015 gave the finding that there was no connection between FHP and the majority of neck pain measurements in teenagers [26]. The authors Singla D et al., in year 2017, also found that when analysing posture in clinical settings, less time is required to determine the anatomical landmarks for each of these angles. High thoracic and CV angles linked with working-position neck discomfort [27]. To evaluate the long-term impact of wearable biofeedback sensors, well-designed, randomised, controlled research is needed. Participants were instructed to remove their T-shirts or tank tops and place skin markers for the evaluation of spine angles using the motion analysis equipment [7].

Future testing should be undertaken by a medical practitioner with an understanding of orthopaedics or ergonomics in order to acquire an anatomically correct evaluation of the device's performance. The future work requires a more extensive validation procedure, including postures confirmed physically by a physician [23]. The researchers adopted a novel sensor array may be built into a custom garment or a light weight harness wirelessly linked to a pattern recognition algorithm implemented in a mobile application. The authors use a new type of triangular stretch sensor array design which can generate a unique signature for a correct spine therapy exercise when performed by a specific subject. The importance of the system was determined by how easy it was to build and train, how it could be tested using simulated signals, and how it could give biofeedback in real time [16]. By investigating various sensor placement options, it may be feasible to develop innovative designs that offer comparable or superior performance with fewer sensors [17]. Due to the participant's static postures, it is anticipated that the sensor's measurement error will be modest [10].

Moreover, before commercialisation and widespread acceptance can be considered, practicality must be enhanced [11]. The study by Chopra S et. al. in the year 2017. Depicted that consequence of the evolution of people's life styles, back problems are becoming more widespread. It supports individuals in adjusting their postures while completing a range of occupations and protects their bodies from a number of back-related illnesses and disorders [28]. Another study examined the development and design of the Smart Rehabilitation Garment (SRG). Initially, the usability and user-friendliness of the SRG's feedback during rehabilitation, as well as its credibility as a treatment aid and stimulating aspects, will be studied [29]. Gallego-Izquierdo T et al., 2020, included 44 people (with or without cervical pain), age ranging from 18 to 65 years. According to the findings, the intra-rater reliability of the forward head posture was 0.88. Intra-class correlation was 0.83 to 0.89 for inter-rater reliability. Above 0.82 for criterion validity. Intra-rater change was 4.96, and inter-rater change was 5.52. As a result of its simplicity, low cost, and high accuracy in measuring cervical position, the FHP app may be ideal for clinical use [29]. Subject-specific metrics were used in this study. This could lead to measurement and selection biases if body markers or measuring equipment were misplaced or results were misinterpreted. These biases can affect camera and mobile application measurements. The results don't apply to those with cervical injuries or other exclusion criteria. This study examines standing spine alignment. The findings cannot be generalised to alignment during functional task performance, especially with moving or laden upper limbs [30].

The study by Suvarnnato T et al., in year 2019, depicted that six weeks of training in both exercise groups improved neck disability, pain severity, CV angle, and neck-muscle strength, according to a RCT. Normal treatment did not work as well as training the semi spinal is cervic is and deep cervical flexors [19]. In addition, there is evidence that individuals with FHP who are given exercise see a slight reduction in neck discomfort. Different exercise regimens may be more beneficial than others, as the degree of improvement in CVA and pain differed substantially between trials. There was wide heterogeneity in the results, suggesting that caution should be applied when generalising the findings to all individuals with FHP and to all forms of exercise [20]. Furthermore, the significance of these risk variables may be modified by the characteristics of other workers and the workplace, as was denoted by study by Ha SY and Sung YH in the year 2020. Therefore, programmes for the prevention of neck discomfort in office workers should combine a number of individual and occupational psychological and physical risk factors, some of which may be more modifiable than others as is denoted by Jun D et al., in the year 2020. In office employees, measurements of postural behavior collected by wearable motion sensors may be able to predict an increased risk of neck discomfort. The FHP used its smartphone for forty-one minutes. Only the deep neck flexor muscles were assessed using ultrasonography. Future research should seek to address these deficiencies [31,32].

These researches were carried out before the Coronavirus Disease (COVID) epidemic. But now that the situation has changed and the pandemic has brought with it previously unimaginable challenges, new areas of study have become available to look into the problems associated with computer use. The work load has shifted from offline to online due to the widespread usage of computers during the pandemic; hence, it is important to determine how the post-computer world will affect computer workers. The long-term use of ergonomic solutions and ergonomic training continue to be difficult problems in the workplace. In order to maintain a straight posture and lessen neck discomfort, future research has been planned to examine the clinical viability of integrating a wearable posture correction sensor with at-home exercises and ergonomic advice for computer workers.

# CONCLUSION(S)

Researchers have identified intervention functions, policy categories, and tactics for behavior change. They have also examined neck discomfort, forward head posture in young individuals who use smartphones and computers, and posture correction using a wearable postural correction sensor. Additionally, they have studied the arrangements and support needed to implement a home and work exercise program that eliminates pain and impairment while enhancing forward headposture and endurance.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