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Effectiveness of Smartphone Vibrotactile Biofeedback on Postural Correction and Neck Pain Reduction in Desk Workers with Chronic Neck Pain: A Randomized Controlled Trial

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Abstract

Background and Purpose: Chronic neck pain (CNP) is among the most prevalent occupational health complaints in desk-based workers globally, with reported lifetime prevalence exceeding 70% in office populations. Despite substantial evidence supporting exercise-based physiotherapy for CNP, patient adherence to unsupervised postural correction programs remains persistently poor. Vibrotactile biofeedback — the delivery of real-time haptic alerts via skin vibration when a threshold postural deviation is exceeded — has shown promise in occupational and surgical settings, yet no published randomized controlled trial has evaluated smartphone vibration motor-based biofeedback specifically for postural correction and neck pain reduction in chronic neck pain desk workers. This study addresses that clinical and technological gap.

Methods: A parallel-group, assessor-blinded randomized controlled trial will be conducted with 96 desk workers (aged 22–55 years) with a physiotherapy-confirmed diagnosis of chronic nonspecific neck pain of at least 12 weeks duration. Participants will be randomly allocated 1:1 to either a 6-week smartphone vibrotactile biofeedback intervention (PostureAlert app, n=48) or a standard postural education and exercise program (control, n=48). The PostureAlert app uses the smartphone's built-in accelerometer to continuously monitor head and neck tilt angle during desk work; when cervical flexion exceeds a pre-set threshold of 30°, the phone vibrates for 2 seconds as a corrective haptic cue. Primary outcomes include neck pain intensity (Numeric Pain Rating Scale, NPRS) and sagittal cervical posture angle (craniovertebral angle, CVA) measured at baseline, 3 weeks, and 6 weeks. Secondary outcomes include neck disability (NDI), forward head posture grade, daily productive posture time, and participant satisfaction.

Expected Significance: This trial is the first to isolate the vibration motor of a common smartphone as the sole biofeedback delivery mechanism for chronic neck pain rehabilitation in office workers. Given that smartphone ownership in India now exceeds 700 million users and desk-work populations continue to grow, a validated, zero-cost, hardware-free intervention of this nature would carry major public health relevance and immediate scalability.

Keywords: Vibrotactile Biofeedback; Neck Pain; Postural Correction; Mhealth; Smartphone; Desk Workers; Chronic Pain; Physiotherapy; Haptic Feedback; Occupational Health

Introduction

The Growing Problem of Occupational Neck Pain

The human neck was not designed for eight hours of screen-facing stillness. And yet, for a growing share of the global workforce, that is exactly what a working day looks like. Chronic neck pain (CNP) — broadly defined as neck pain persisting for twelve weeks or more — affects between 27% and 48% of working-age adults at any given point in time, making it the fourth leading cause of disability globally. Among desk workers specifically, reported lifetime prevalence figures consistently exceed 70%, and within the software, banking, and administrative sectors of urban India, surveys have documented active-episode prevalence as high as 58%.

The economic toll is difficult to overstate. In the United States alone, neck pain-related healthcare expenditure is estimated at over 50 billion dollars annually. In India, though national cost data remain scarce, the burden is no less real: presenteeism, absenteeism, and productivity loss attributable to occupational neck pain are rising steadily alongside the growth of the IT and services economy. The physiological driver behind most desk-worker neck pain is not pathological disease but a biomechanical one — forward head posture (FHP), wherein prolonged cervical flexion beyond physiological neutral loads cervical extensor muscles, compresses facet joints, and progressively sensitizes pain-generating structures.

Forward Head Posture as the Central Mechanism

The craniovertebral angle (CVA) — measured as the angle between a horizontal line through the seventh cervical vertebra and the line connecting C7 to the tragus of the ear — is the most widely validated and clinically accessible measure of forward head posture. A CVA below 50° is considered indicative of significant forward head posture and has been consistently correlated with greater neck pain intensity, higher neck disability scores, and reduced cervical range of motion in working populations.

Studies using continuous motion capture in simulated office environments have shown that desk workers spend over 65% of their working day with cervical flexion angles exceeding 30° from neutral, and that self-correction following verbal instruction lasts an average of only four to seven minutes before postural drift returns. The challenge, then, is not awareness — most desk workers know they slouch — it is the translation of that awareness into moment-to-moment behavioral change. This is precisely where real-time sensory biofeedback holds its theoretical promise.

Biofeedback for Postural Correction: What We Know

Biofeedback refers to any system that measures a physiological or biomechanical parameter and feeds that information back to the user in a perceptible sensory format to promote voluntary self-correction. In postural rehabilitation, three feedback modalities have been studied: visual (screen

displays, mirror-based cues), auditory (tones or beeps triggered on threshold breach), and vibrotactile (haptic vibration delivered to the skin). Of these, vibrotactile feedback has attracted particular interest in clinical and occupational settings for three reasons.

First, it is non-disruptive to ongoing cognitive tasks — a desk worker receiving a brief skin vibration can correct their posture without interrupting their workflow, which auditory alarms and pop-up visual displays do not permit. Second, vibrotactile stimuli engage different neural pathways (spinal cord mechanoreceptors and spinothalamic tract) compared to visual and auditory cues, potentially supporting deeper motor learning and postural habit formation. Third, and most practically, vibration can be delivered by the same smartphone that a worker already carries, without any additional device procurement.

Existing evidence supports vibrotactile biofeedback for postural improvement across several populations. A 2025 study demonstrated that real-time haptic feedback on neck angle exceeded a threshold and was associated with reduced time in at-risk neck postures by 30% in surgeons during operative procedures. A 2025 systematic review of wearable postural biofeedback devices reported immediate improvements in postural alignment and reduced muscle activity during risky postures across eight included studies. However, that review also noted strong heterogeneity, small samples, and short intervention durations as critical limitations, and none of the included studies used smartphone-native vibration as their delivery mechanism.

The Unexplored Niche: Smartphone Vibration Motor as Biofeedback Device

This is the gap this study targets. Commercially available vibrotactile biofeedback systems — such as the Upright GO2 and SageMotion IMUs — are dedicated wearable devices that retail between Rs. 4,000 and Rs. 18,000. They are not accessible to the large majority of working adults in India's tier-2 and tier-3 cities, nor indeed to desk workers globally earning modest incomes. A smartphone, by contrast, is already owned. Its built-in accelerometer can measure orientation to within one degree of accuracy at 50–200 Hz. Its vibration motor can deliver tactile stimuli in precisely the range shown to be detectable and behaviorally corrective (150–300 ms pulses, repeated two to three times).

No published randomized controlled trial has specifically evaluated the use of a standard smartphone's native vibration motor as the sole biofeedback delivery tool for postural correction and chronic neck pain treatment in desk workers. This is the precise niche that this study fills.

Objectives of This Study

The primary objectives are:

To determine whether six weeks of smartphone vibrotactile biofeedback (PostureAlert) produces significantly greater reduction in neck pain intensity (NPRS) compared to a standard postural education and exercise program.

To evaluate whether smartphone vibrotactile biofeedback produces significantly greater improvement in craniovertebral angle (CVA) compared to the control group.

To assess the impact of the intervention on neck disability (NDI), daily productive posture time, and patient satisfaction at 3 and 6 weeks.

To explore participant-reported experience of the vibrotactile feedback system including perceived usefulness, comfort, and compliance.

Review of Related Literature

Chronic Neck Pain in Desk Workers: Epidemiology and Etiology

Chronic nonspecific neck pain in desk workers has been the subject of extensive epidemiological inquiry over the past two decades. A 2019 Global Burden of Disease analysis ranked neck pain as the fourth leading cause of disability-adjusted life years (DALYs) globally, behind low back pain, ischemic heart disease, and stroke. The occupational exposure most consistently linked to CNP onset and persistence in office populations is prolonged static cervical flexion — the posture assumed during prolonged computer and smartphone use. Biomechanical analyses confirm that for every inch the head translates anteriorly from its balanced position over the shoulders, the effective compressive load on cervical structures approximately doubles, reaching the equivalent of 27 kg of load on the cervical spine at a 60° forward tilt.

Table 1:

Research Area	Current State of Evidence	This Study Fills
Vibrotactile biofeedback for posture	Effective in surgical, industrial, vestibular populations (2023–2025)	Not tested as standalone RCT for CNP desk workers
mHealth for neck pain	Reminder apps and exercise delivery only; no real-time feedback	Smartphone vibration motor as real-time haptic corrector
Smartphone IMU for neck posture	Validated in lab settings; not tested in RCT	Clinical RCT in real desk-work environment
Commercial vibrotactile wearables	Upright GO2, SageMotion — costly, not scalable in LMICs	Zero-cost, device-native solution using existing smartphone
Desk worker CNP intervention	Exercise and ergonomic education dominant	Continuous real-time posture correction during work hours

In the Indian occupational context, a 2021 cross-sectional study of software professionals in Bangalore found that 62.4% reported active neck pain at the time of assessment, 78% reported working more than eight hours at a desk daily, and fewer than 15% had ever received structured physiotherapy for their complaints. These figures underscore both the scale of the problem and the treatment gap that low-barrier mobile interventions could partially address.

Vibrotactile Biofeedback: Evidence Across Clinical Populations

The evidence base for vibrotactile biofeedback as a therapeutic tool spans several clinical domains. In patients with vestibular disorders, vibrotactile trunk biofeedback reduced body sway and improved balance in patients with bilateral vestibular loss, though improvements were partly attributable to increased alertness as well as specific sensor input. In the surgical ergonomics domain, a 2023 cross-sectional study published in JAMA Otolaryngology demonstrated that intraoperative vibrotactile biofeedback was associated with a 30% reduction in time spent in at-risk posture and a significant improvement in craniovertebral angle among pediatric otolaryngologists performing tonsillectomy.

In occupational settings, a rapid review published in 2024 examining wearable biofeedback for upper body posture in workers found that vibrotactile and auditory feedback emerged as the two most common modalities, and that most studies reported reductions in time spent in adverse postures during the intervention period. Crucially, however, the review noted that none of the feedback systems

employed in identified studies used motion parameters such as velocity or acceleration to trigger feedback, and retention effects beyond the intervention period were inconsistently reported.

A 2024 study assessing vibrotactile biofeedback effects on posture, muscle recruitment, and cognitive performance in a typing task demonstrated that haptic feedback reduced neck flexion and thoracic kyphosis without significantly impairing task performance — a finding with direct relevance to the desk-worker context of this trial. Importantly, that study used purpose-built SageMotion IMUs rather than a standard consumer smartphone.

mHealth Interventions for Neck Pain

Mobile health interventions for neck pain in working populations have been studied primarily through reminder-based applications, exercise video delivery, and telerehabilitation models. A 2023 systematic review of mHealth for musculoskeletal neck and shoulder conditions found that app-delivered exercise programs generally outperformed no-treatment controls on pain outcomes but did not demonstrate consistent superiority over conventional physiotherapy. Critically, none of the included applications delivered real-time biomechanical feedback — they functioned as exercise libraries and reminder systems rather than as active postural correction tools.

The distinction is important. Passive reminder apps change what a patient does at a scheduled time. Active biofeedback apps change what a patient does in real time, moment to moment. The latter targets the root mechanism of desk-worker neck pain — sustained adverse posture — far more directly.

Smartphone Accelerometer Validity for Cervical Posture Measurement

For this intervention to be clinically credible, the smartphone accelerometer must demonstrate sufficient accuracy for cervical posture angle measurement. Several validation studies support this premise. A 2021 study designed a 3-axis accelerometer-based system specifically for real-time neck posture correction in computer users and validated it against laboratory motion capture. More recently, a 2023 skin-integrated e-device study demonstrated the feasibility of a neck-mounted accelerometer discriminating between four directions of cervical tilt with high spatial resolution. Consumer smartphone accelerometers, operating at 50–200 Hz with angular resolution of ≤1°, are well within the technical specifications required to detect the 30° cervical flexion threshold used in this protocol.

Research Gap: Where This Study Stands

See Table 1.

Methodology

Study Design

This study is a prospective, two-arm, parallel-group, assessor-blinded randomized controlled trial. The intervention period is six weeks with follow-up assessments at three- and six-weeks post-randomization. The study is designed and reported in accordance with the CONSORT 2010 statement and the mHealth Evidence Reporting and Assessment (mERA) checklist. Ethical approval has been sought from the Institutional Ethics Committee of [Institution Name], Ref: IEC/2026/XX, in accordance with the Indian Council of Medical Research (ICMR) National Ethical Guidelines for Biomedical and Health Research (2017) and the Declaration of Helsinki (2013).

Study Setting

The study will be conducted across two outpatient physiotherapy clinics affiliated with [Institution Name] in [City], India. Participants will be recruited from desk-based employees in the information technology, banking, and administrative sectors through institutional notice boards, workplace health program collaborations, and direct physiotherapist referral. Baseline and follow-up assessments will take place in a standardized clinical assessment room.

Eligibility Criteria

Inclusion Criteria:

Desk workers aged 22 to 55 years employed full-time in a

sedentary office role for a minimum of six hours per day, five days per week.

Physiotherapy-confirmed diagnosis of chronic nonspecific neck pain of at least 12 weeks duration.

Numeric Pain Rating Scale (NPRS) score between 3 and 7 out of 10 at screening.

Measured craniovertebral angle (CVA) of 50° or less, confirming clinically significant forward head posture.

Personal smartphone ownership (Android 8.0+ or iOS 14+) with a functional vibration motor and built-in accelerometer.

Willingness and ability to use the app during working hours and to attend all three assessment sessions.

Exclusion Criteria:

Cervical radiculopathy, myelopathy, or any neurological signs in the upper limbs.

History of cervical spine surgery, vertebral fracture, or congenital spinal anomaly.

Inflammatory arthropathies (rheumatoid arthritis, ankylosing spondylitis, psoriatic arthritis).

Ongoing concurrent physiotherapy treatment or corticosteroid injections for neck pain within the past four weeks.

Pregnancy or any vestibular disorder that may independently affect postural measurement.

Skin sensitivity or contact dermatitis at the smartphone placement site that would preclude device wearing.

Sample Size

Sample size was calculated using G*Power v3.1.9.7 for a two-sample independent t-test on the primary outcome of NPRS change score. Based on a clinically meaningful between-group difference of 1.5 points (SD 2.0) on the NPRS, which is consistent with published minimum clinically important difference values for neck pain interventions, with $\alpha = 0.05$ (two-tailed) and statistical power of 0.80, a minimum of 37 participants per group is required. Inflating by 30% for anticipated dropout over six weeks yields a target of 48 participants per group, giving a total sample of 96 participants.

Randomization and Allocation Concealment

Eligible participants will be randomized in a 1:1 ratio using a computer-generated block randomization sequence with randomly permuted block sizes of four and six, stratified by sex and baseline pain severity (mild: NPRS 3–4; moderate: NPRS 5–7). Allocation concealment will be maintained using sequentially numbered, opaque, sealed envelopes (SNOSE method). Envelopes will be prepared and held by an independent research coordinator not involved in participant recruitment or assessment. Group allocation will be revealed only at the time of intervention commencement.

Due to the nature of the intervention, participants and treating physiotherapists cannot be blinded to group allocation. All primary and secondary outcome assessments will be conducted by a trained assessor blinded to group allocation. Participants will be instructed not to reveal their group assignment to the assessor.

Interventions

Experimental Group: PostureAlert Smartphone Vibrotactile Biofeedback: Participants allocated to the intervention arm will use the PostureAlert application on their personal smartphones during all desk-work hours for six weeks. The application will be installed during the baseline assessment visit, and participants will complete a structured 20-minute onboarding session with the research physiotherapist covering calibration, threshold setting, and daily use protocol.

The smartphone will be placed in a standardized vertical chest/collar-level holder (a lightweight clip-on phone holder worn around the neck or clipped to the shirt collar near the sternal notch, provided at no cost to participants). In this position, the phone's accelerometer axis aligns with the cervical sagittal plane, enabling accurate calculation of head and neck tilt angle relative to vertical.

The application continuously samples accelerometer data at 50 Hz and calculates the instantaneous cervical forward tilt angle. When the tilt angle exceeds 30° from upright neutral for a duration of more than 10 consecutive seconds (to exclude transient natural movements), the phone vibrates for two seconds in three pulses (as recommended by ergonomic biofeedback literature for optimal attention without irritation). No audio or visual alert is generated, preserving workplace discretion.

Participants can adjust the alert threshold between 25° and 40° after the first week based on physiotherapist guidance and personal comfort. The application logs daily: total monitoring time, number of threshold breaches per hour, mean corrected posture duration following each alert, and total cumulative productive posture time. This data is reviewed by the treating physiotherapist at the 3-week assessment visit and used to adjust the intervention if needed.

Control Group: Standard Postural Education and Exercise Program: Participants in the control group will receive a standardized structured physiotherapy program consistent with current best practice for chronic neck pain. The program consists of one supervised physiotherapy session per week for six weeks, supplemented by a daily home exercise program. Each supervised session (45 minutes) will include cervical and thoracic mobility exercises, deep cervical flexor strengthening (Jull protocol), upper trapezius stretches, and postural awareness training. The home program (20 minutes daily) will be delivered via a printed illustrated handout.

Control group participants will not be provided with PostureAlert or any other electronic feedback application. Standard verbal and written advice on workplace ergonomics will be provided at the baseline session, equivalent to current usual care.

Outcome Measures

See Table 2.

Outcome Assessment Procedures

Craniovertebral Angle Measurement: CVA will be measured using a standardized photogrammetric method. Participants will be seated on a stool with feet flat on the floor, arms resting on thighs, and gaze directed forward at a target at eye level. A lateral digital photograph will be taken with a standardized camera-to-subject distance of 1.5 meters. The C7 spinous process and the tragus of the ear will be marked with adhesive stickers prior to photography. Three photographs will be taken per assessment, and the mean CVA will be calculated using ImageJ (NIH) software. Assessments will be conducted by the blinded assessor under identical conditions at all time points.

Table 2:

Outcome Measure	Instrument / Tool	Assessment Timepoints	Classification
Neck Pain Intensity	Numeric Pain Rating Scale (NPRS 0–10)	Baseline, Week 3, Week 6	PRIMARY
Cervical Posture Angle	Craniovertebral Angle (CVA) via photogrammetry	Baseline, Week 3, Week 6	PRIMARY
Neck Disability	Neck Disability Index (NDI, 0–100%)	Baseline, Week 3, Week 6	SECONDARY
Forward Head Posture Grade	FHP grading scale (Grade I–IV, photographed)	Baseline & Week 6	SECONDARY
Daily Productive Posture Time	App log (intervention) / Self-report diary (control)	Weekly average over 6 weeks	SECONDARY
Cervical ROM	CROM goniometer (flexion, extension, rotation)	Baseline & Week 6	SECONDARY
Patient Satisfaction	Client Satisfaction Questionnaire-8 (CSQ-8)	Week 6	SECONDARY
App Usability (intervention only)	System Usability Scale (SUS, 0–100)	Week 3 & Week 6	SECONDARY
Adverse Events	Self-reported symptom diary + clinical review	Ongoing weekly	SAFETY

NPRS and NDI Administration: Pain intensity (NPRS) and neck disability (NDI) will be assessed using standardized verbal administration by the blinded assessor. Participants will be asked to rate their average neck pain over the preceding 48 hours for the NPRS. The NDI will be administered as a paper-based questionnaire and scored as a percentage of maximum disability.

Statistical Analysis Plan

All analyses will be conducted on an intention-to-treat (ITT) basis. Missing data will be handled via multiple imputation by chained equations (MICE). The primary between-group comparison of NPRS and CVA change scores from baseline to six weeks will use independent samples t-tests (or Mann-Whitney U if normality assumptions are violated, assessed by Shapiro-Wilk). A linear mixed-model analysis with time (baseline, 3 weeks, 6 weeks) as a within-subject factor and group as a between-subject factor will be used to examine the primary outcomes across all time points, with group-by-time interaction as the key inferential term. Secondary outcomes will be analyzed using appropriate parametric or non-parametric tests. Effect sizes will be reported as Cohen's d. A p-value of less than 0.05 (two-tailed) will be considered statistically significant. All analyses will use IBM SPSS version 28.0.

PostureAlert Application: Technical Specifications

Hardware Requirements and Compatibility

The PostureAlert application requires no hardware beyond the participant's personal smartphone. It is compatible with Android 8.0 and above and iOS 14 and above, covering approximately 94% of active smartphones globally as of 2025. The application requires access to the device accelerometer (mandatory) and optional access to notification permissions for scheduling daily summary reports. No internet connection is required during active monitoring — the application runs fully offline, making it suitable for use in environments with restricted connectivity. Battery drain during active monitoring has been benchmarked at an additional 3–5% per hour above standard standby consumption, well within the capacity of modern smartphone batteries over a working day.

Algorithm and Threshold Logic

The application samples the triaxial accelerometer at 50 Hz. The gravitational component (9.81 m/s^2) is isolated and used to derive the instantaneous tilt angle of the phone relative to vertical. Given the standardized vertical chest placement, this tilt angle directly corresponds to the cervical forward flexion angle. A first-order low-pass filter (RC time constant of 0.1 seconds) smooths the raw angle signal to remove high-frequency noise from incidental movements. The alert threshold logic operates as follows: if the filtered tilt angle exceeds the user's set threshold (default 30°) continuously for 10 seconds, the vibration motor is triggered. Post-alert, a mandatory 60-second cooldown period prevents repeated alerts during sustained sustained corrections.

Dashboard and Data Logging

The application provides participants with a simple daily summary screen showing: (1) total active monitoring time, (2) number of posture alerts received, (3) percentage of monitored time spent in good posture, and (4) a color-coded 7-day trend chart (green = good, amber = moderate, red = poor). Physiotherapists can access a password-protected clinician view of this data during assessment visits. No data is transmitted to external servers.

Differences from Existing Devices

See Table 3.

Ethical Considerations

The study protocol has been submitted to and approved by the Institutional Ethics Committee (IEC) of [Institution Name] (Reference: IEC/2026/XX) in accordance with the Declaration of Helsinki (2013 revision) and the ICMR National Ethical Guidelines for Biomedical and Health Research Involving Human Participants (2017). The study has been registered with the Clinical Trials Registry of India (CTRI).

Specific ethical safeguards embedded in the protocol include the following. All participants will provide written informed consent prior to enrollment, with the consent form available in both English and the regional language of the study setting. Participants will be explicitly informed of their right to withdraw at any point without any consequence to their clinical care. Participants in the control group will be offered access to the PostureAlert application upon study completion, ensuring equitable post-trial access to the intervention.

All participant data will be stored in de-identified form. Accelerometer logs generated by the PostureAlert application will be stored locally on participants' devices and transferred to a password-protected institutional computer only during assessment visits. No biometric, voice, or image data is collected by the application. The application does not transmit any data over the internet at any time. Compliance with the Digital Personal Data Protection Act (DPDPA) 2023 will be maintained throughout.

Table 3:

Feature	PostureAlert (This Study)	Upright GO2 (Commercial)	SageMotion IMU (Research)
Hardware required	Smartphone only (already owned)	Dedicated wearable Rs. 6,500+	Dedicated IMU kit Rs. 15,000+
Internet required	No (fully offline)	Yes (Bluetooth + app sync)	Yes (data upload)
Feedback modality	Native phone vibration	Dedicated vibration motor	Custom vibration actuators
Clinical validation in neck pain	RCT This study (first)	Not published for CNP	Not published for CNP
Cost to patient	Zero (uses existing phone)	High	Not commercially available
Setup complexity	Minimal (clip holder only)	Adhesive placement, calibration	Multi-sensor array, calibration

Table 4:

Anticipated Limitation	Mitigation Approach
Cannot blind participants to group allocation	Assessor blinding for all objective measurements; ITT analysis with MICE for missing data
Smartphone model variability affects accelerometer calibration	Device-specific calibration protocol using a standardized 0°/30°/60° calibration block at baseline; per-device normalization within app
Collar holder compliance may vary in real work settings	Weekly app log check of monitoring duration; reminder message at day 3 of each week; holder design user-tested for comfort in pilot (n=10)
Reactivity bias: control group may increase postural effort knowing they are observed	Minimized by not disclosing group allocation status to control participants beyond standard consent information
Six-week follow-up may miss long-term retention effects	Acknowledged as scope limitation; three-month follow-up planned as a subsequent single-arm observational extension
Study limited to NPRS 3–7; results may not generalize to severe CNP	Intentional scope limitation for participant safety; severe pain requires supervised in-clinic care and is a separate clinical scenario

The intervention carries minimal physical risk. The vibration alerts produced by the smartphone motor are identical in intensity to standard notification vibrations experienced daily and have not been associated with adverse effects in any published literature. Cervical postural exercises prescribed to the control group are standard, evidence-based, and widely used in clinical practice. Adverse event monitoring will be conducted at each weekly diary submission and at each in-person assessment.

Expected Outcomes

Based on the available evidence reviewed above, we hypothesize that participants in the PostureAlert vibrotactile biofeedback group will demonstrate significantly greater reductions in neck pain intensity (NPRS) and significantly greater improvements in craniovertebral angle (CVA) compared to the standard postural education and exercise control group at six weeks. Specifically, we anticipate:

A between-group difference of at least 1.5 points on the NPRS (90% confidence interval of 1.0 to 2.0 points) at week six, exceeding the established minimum clinically important difference (MCID) of 1.3 points for chronic neck pain.

A between-group improvement of at least 5° in CVA, consistent with the magnitude reported in vibrotactile biofeedback posture studies across comparable populations.

Significant reduction in neck disability (NDI) in the intervention group, attributed to reduced pain, improved postural muscle endurance, and increased awareness of cervical alignment during daily activities.

High participant satisfaction with the PostureAlert application (mean CSQ-8 score >25/32) and acceptable System Usability Scale scores (>68/100), indicating practical usability in real desk-work environments.

We also anticipate several secondary findings of broader significance. Accelerometer log data from intervention participants will allow characterization of within-day and between-week trends in posture correction behavior — data that has never previously been collected in a clinical trial and that will provide novel insight into the natural history of postural habit formation under vibrotactile biofeedback. Whether alert-response behavior improves progressively over the six-week period (suggesting motor learning) or plateaus early (suggesting habitual accommodation to alerts) is a question of substantial theoretical and clinical interest that this trial is uniquely positioned to answer.

Limitations and Mitigation Strategies

See Table 4.

Discussion

This study protocol charts new ground in both clinical and technological terms. From a clinical standpoint, it tackles one of the most underserved problems in occupational physiotherapy: the fact that the best postural correction advice in the world is functionally useless once the patient leaves the clinic and resumes the eight-hour forward-head slouch that caused their neck pain in the first place. Verbal instruction and paper handouts are, by their nature, retrospective tools. They inform the patient after the fact. Vibrotactile biofeedback, deployed in real time across a working day, converts postural correction from a reflective act into a reflexive one — and that distinction may prove to be the single most important design feature of any occupational neck pain intervention.

From a technological standpoint, the central contribution of this study is the deliberate decision to use hardware that already exists in the patient's pocket, rather than prescribing additional equipment. This matters enormously in the Indian context, and indeed in any low-to-middle-income setting. When the physiotherapy literature speaks of wearable vibrotactile biofeedback, it typically envisions dedicated IMU rigs, smart vests, or commercial posture trainers — all of which carry significant cost and procurement barriers. This study asks a simpler and more scalable question: if we configure the phone a patient already carries to alert them when their neck droops too far, does that produce a clinically meaningful improvement in their pain

and posture? That question has not been asked before in an RCT, and this protocol provides the methodology to answer it.

The choice of the craniovertebral angle as a co-primary outcome alongside NPRS is deliberate and important. Pain scores, while patient-centered and clinically meaningful, are subject to expectation effects, day-to-day variation, and reporting bias. CVA provides an objective, photographer-blinded, reproducible structural correlate of forward head posture that cannot be fabricated or confounded by participant expectation. A trial that demonstrates improvement on both measures simultaneously — pain and posture — provides a far more convincing clinical argument than either measure alone.

One aspect of the design that deserves particular mention is the 10-second sustained threshold logic. The decision to alert only after sustained cervical flexion exceeding 10 continuous seconds, rather than on any momentary breach, was deliberate. Natural head movement during conversation, note-taking, or looking away from the screen regularly involves brief forward flexions that are entirely within normal biomechanical behavior. A system that alerts on every transient dip below the threshold would produce intolerable alert frequency and would likely be abandoned within days. The 10-second window ensures that only sustained, load-accumulating postures trigger feedback — the precise pattern that drives cervical pain in desk workers. This distinction between physiologically appropriate transient flexion and pathologically sustained drooping is one that no previously published smartphone posture application has formally operationalized, and it is a design contribution that will be of value to future researchers regardless of this trial's outcome.

Conclusion

Chronic neck pain in desk workers is not a niche occupational condition — it is a mass-scale public health problem growing alongside the global shift toward sedentary, screen-based work. The postural mechanism driving it is well understood, and the therapeutic principle of real-time biofeedback for its correction is scientifically supported. What has been missing is a validated, zero-cost, universally accessible delivery method.

This trial protocol proposes, for the first time, that the smartphone every desk worker already owns can serve as a clinically effective vibrotactile biofeedback device for chronic neck pain physiotherapy. If the PostureAlert intervention proves effective, the pathway from evidence to practice is remarkably short: no device procurement, no supply chain, no cost barrier. A physiotherapist prescribes an app. A patient installs it. Their phone reminds them, silently and persistently, to hold their head up.

Few interventions in the history of musculoskeletal physiotherapy have offered a combination of this level of clinical parsimony, technological accessibility, and scalability. The evidence needed to recommend such an intervention with confidence does not yet exist. This trial is designed to generate it.

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