RESEARCH PAPER

Effects of Cognitive Behavioral Therapy on Tension-Type Headache Secondary to Problematic Smartphone Use: A Randomized Controlled Trial

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Abstract

Background: Tension-type headache (TTH) is frequently exacerbated by prolonged smartphone use and associated postural deviations. While combining cognitive behavioral therapy (CBT) with conventional physical therapy (PT) can enhance treatment outcomes, its effects in patients with concurrent Problematic Smartphone Use (PSU) and tension-type headache have not yet been investigated.

Objectives/Aim: To compare the effects of a CBT-integrated PT program versus PT program alone on PSU, headache-related disability, forward head posture (FHP), and pain sensitivity in individuals with co-occurring PSU and TTH.

Methods: 64 participants meeting inclusion criteria were randomly assigned to 2 groups to either receive a CBT-integrated PT program or a PT program alone. Both groups received 12 treatment sessions over six weeks. Outcomes included the Smartphone Addiction Scale-Short Version (SAS-SV), Headache Impact Test-6 (HIT-6), craniovertebral angle (CVA), and pain pressure threshold (PPT).

Results: Significant treatment × time interactions were observed across all outcomes ($p < 0.001$), indicating greater improvements in the CBT-integrated PT program. Both groups showed statistically significant pre-post improvements ($p < 0.05$). Between-group comparison revealed that the CBT-integrated PT program group demonstrated significantly greater improvements in SAS-SV, HIT-6, and CVA, with mean differences that exceeded statistical significance thresholds ($p < 0.001$).

Conclusion: Incorporating CBT into a standard PT program yields superior short-term improvements in Pain severity, headache-related disability, and forward head posture compared to PT alone in patients with TTH associated with PSU.

Keywords: tension-type headache; Problematic Smartphone Use; cognitive-behavioral therapy; forward head posture; behavioral rehabilitation; pain sensitivity.

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Introduction

Smartphones have become indispensable tools in modern life, serving as multifunctional devices that support communication, internet connectivity, entertainment, navigation, education, and social interaction[1]. Over the past decade, their global usage has increased exponentially, particularly among young adults[2]. Despite their numerous advantages, smartphones have raised increasing concern, regarding excessive and uncontrolled use, as a behavioral problem. Such use, variously described as "mobile phone dependency," "mobile phone addiction," or "problematic mobile phone use," may result in psychological, physiological, and social impairments[3–6]. Although the term "smartphone addiction" is widely used, direct neurobiological evidence supporting the classification of excessive smartphone use as an addiction remains limited[7]. Consequently, many researchers have adopted the broader term Problematic Smartphone Use (PSU) to describe maladaptive patterns of smartphone use without assuming the presence of a true addictive behavior[7,8].

Nevertheless, PSU has been conceptualized as sharing several characteristics with behavioral addictions, including withdrawal, craving, impaired control, and disruption of psychosocial functioning, which may interfere with important daily activities and result in adverse consequences[8–10].

PSU has become increasingly prevalent among young adults, raising concerns about its potential physical and psychological consequences. Excessive smartphone use is characterized by uncontrolled or maladaptive patterns of use that may interfere with daily functioning and well-being [3,11]. According to a recent systematic review, Problematic Smartphone Use affects approximately 25.7% of adolescents worldwide, highlighting the substantial global burden of problematic smartphone use in this population[10]. University students appear particularly vulnerable, with a high prevalence of PSU reported among Egyptian students[12]. For instance, prevalence rates of 36% have been reported among university students in Saudi Arabia, 29.8% in China, and 39.8% in Turkey[13–15]. Prolonged smartphone use has been associated with several musculoskeletal complaints, including neck and upper body symptoms, as well as headache, fatigue, sleep disturbance, and impaired concentration[16–18].

The postural demands and abnormal musculoskeletal loading associated with PSU may represent an important mechanism linking PSU to musculoskeletal symptoms[19]. Smartphone use commonly involves sustained cervical flexion and forward head posture (FHP), which increases mechanical loading on the cervical spine and its related musculature[20] . Prolonged

adoption of such postures may contribute to muscle fatigue, altered muscle activation, reduced cervical mobility, and the development of myofascial trigger points (MTrPs)[21–23]. Active MTrPs within the cervical and craniofacial musculature, particularly the upper trapezius, sternocleidomastoid, suboccipital, and temporalis muscles, have been associated with tension-type headache (TTH)[24–26]. TTH is the most prevalent primary headache disorder and is characterized by bilateral, pressing or tightening pain that may be accompanied by pericranial tenderness[27,28]. Peripheral nociceptive input from myofascial tissues, together with central sensitization and psychosocial factors, may contribute to the persistence and progression of headache symptoms[28]. In line with this proposed mechanism, higher PSU severity has been associated with increased headache frequency and duration, while prolonged smartphone use accompanied by poor postural alignment has been linked to greater headache severity[2,29]. Thus, sustained smartphone-related postural loading may represent a modifiable contributor to cervical musculoskeletal dysfunction and TTH[30]. Conventional physical therapy is commonly used in the management of TTH and may include manual therapy, soft-tissue techniques, spinal mobilization, and corrective exercises[31]. These interventions have demonstrated beneficial effects on headache frequency and intensity, cervical mobility, and functional outcomes[32,33]. However, physical therapy primarily addresses the musculoskeletal manifestations of TTH, but it doesn't adequately target the behavioral patterns underlying excessive smartphone use. Continued maladaptive smartphone behavior may consequently contribute in maintaining repetitive cervical loading and potentially compromise the sustainability of treatment effects[2,34]. Cognitive Behavioral Therapy (CBT) may add marked benefits to conventional physical therapy by addressing maladaptive behaviors, cognitions, coping strategies, and self-management. CBT has demonstrated benefits in chronic musculoskeletal pain, headache management, and behavioral addiction-related problems[35–37]. Behavioral and physical interventions may therefore provide a more comprehensive approach by simultaneously addressing the behavioral drivers and musculoskeletal consequences associated with PSU[38].

Despite the potential rationale for such an integrated approach, evidence regarding the effectiveness of combining CBT with conventional physical therapy in young adults with coexisting PSU and TTH remains limited. Therefore, this randomized controlled trial aimed to investigate the effects of adding structured CBT to conventional physical therapy on PSU severity, headache-related disability, MTrP sensitivity, and FHP in young adults with coexisting PSU and TTH.

Materials and Methods

Study Design and Setting

This study is a single-blind RCT conducted at the outpatient clinics of the Faculty of Physical Therapy, British University in Egypt between December 2024 and September 2025. The trial followed the CONSORT 2025 guidelines for RCTs.

Ethical approval for the study was obtained from the Ethics Committee of the Faculty of Physical Therapy, Cairo University, Egypt, with the reference number (P.T.REC/012/005099). All participants provided written informed consent prior to enrollment. The study was registered at ClinicalTrials.gov on 26th of November 2025 with registration number: NCT06631222. The implemented trial protocol and the statistical analysis plan are publicly accessible through the ClinicalTrials.gov registry at NCT06631222.

Participants

Participants were eligible for inclusion if they were aged 19–34 years[39], had Problematic Smartphone Use indicated by Smartphone Addiction Scale–Short Version (SAS-SV) scores of ≥31 for males and ≥33 for females[40], and met the diagnostic criteria for tension-type headache (TTH) according to the International Headache Society (IHS) criteria [41]. In addition, participants were required to present with forward head posture (FHP), defined as a craniovertebral angle (CVA) between ≤ 44° to ≤ 54° [42], and to have at least one active myofascial trigger point (MTrP) in the upper trapezius, sternocleidomastoid (SCM), temporalis, or suboccipital muscles, identified according to the established criteria[43].

Participants were excluded if they had cervical spine pathology, secondary headache disorders, vestibular dysfunction, rheumatologic or neurological disorders, pregnancy, or had undergone recent manual therapy or PT interventions. Uncontrolled hypertension, atherosclerosis, joint instability, cervical radiographic abnormalities, generalized hyperlaxity, or were changing prophylactic headache medication.

Sample Size & Group allocation

An a priori sample size calculation was performed using G*Power software (version 3.1.9.7) to determine the required sample size for a MANOVA: Repeated measures, within-between interaction. The calculation assumed two intervention groups and two measurement occasions (pre- and post-intervention), with a significance level (α) of 0.05, statistical power (1−β) of 0.95, a correlation among repeated measures of 0.50, and a nonsphericity correction (ε) of 1.00 and A conservative medium effect size of f = 0.25 was adopted, following Cohen's (1988) conventional benchmarks for effect size. The analysis indicated that a minimum total sample size of 54 participants (27 per group) was required to achieve the specified statistical power. To account for an anticipated dropout rate of approximately 20%, the required sample size was increased to 66 participants (33 per group).

After baseline assessments were completed, participants were randomly assigned in a 1:1 ratio to either the CBT-integrated PT program group or the PT group using an independent, computer-generated simple randomisation sequence. Allocation concealment was maintained using opaque, sequentially numbered, sealed envelopes prepared by an independent research assistant who was not involved in participant assessment or treatment.The statistical analyst was blinded to treatment allocation during the primary analysis. The assessor remained unaware of group allocation throughout the entire study and did not have access to any treatment documentation or the randomization sequence. The treating therapist, although necessarily aware of treatment content, did not participate in any assessment procedures. At study completion, the assessor and analyst reported any suspected unblinding; no breaches were identified.

Procedure

All participants completed twelve supervised treatment sessions delivered over six consecutive weeks (two sessions per week),

with each session lasting 45-60 minutes. All interventions were administered by licensed physical therapists with five years of experience.

CBT-integrated PT program

Participants in the CBT-integrated PT program group received a structured, six-session CBT program integrated into their first six PT sessions. Each CBT module lasted approximately 20 minutes and followed a model incorporating cognitive, operant, and respondent principles [44]. The CBT program included**: Psychoeducation** explaining the behavioral mechanisms linking PSU, posture, and pain, using visual diagrams and structured explanation[45]. **Cognitive restructuring** during which participants identified maladaptive beliefs related to smartphone use and pain, and therapists used Socratic questioning, thought-record worksheets, and behavioral experiments to restructure these cognitions[46]. **Behavioral activation and goal setting**, where participants developed SMART goals to modify phone-use patterns, incorporate posture breaks, and reduce device exposure during high-risk periods; self-monitoring logs were used to record behavior, posture, mood, and pain[47].**Respondent strategies and relapse-prevention training**, including diaphragmatic breathing, progressive muscle relaxation[48], identification of personal triggers (e.g., stress, notifications), and development of coping strategies and graded-activity plans to build resilience[49].Complete specification and intervention details in Appendix A.

PT program

Participants in both groups received the same standardized PT program, which combined manual therapy targeting the suboccipital musculature, MTrPs, and upper cervical mobility; postural correction; and targeted therapeutic exercises. The program was designed to reduce myofascial hypertonicity, improve upper cervical and cervicothoracic mobility, correct FHP, and strengthen the deep cervical flexors and scapular stabilizers. A home exercise program (HEP) accompanied the supervised sessions. Participants were instructed to complete the HEP three times per week, using the same exercise sequence taught during supervised sessions. They were provided with written instructions and video demonstrations to ensure accuracy. Adherence was monitored through weekly logbooks and telephone follow-ups. Complete specification and intervention details in Appendix A.

Outcome measures

All outcomes were assessed at baseline and after 6 weeks of intervention by the same trained assessor. Assessments were conducted in a controlled environment following standardized procedures to ensure replicability.

Smartphone Addiction Scale-Short Version (SAS-SV): PSU severity was evaluated using the SAS-SV (Primary Outcome), a validated 10-item self-report measure scored on a six-point Likert scale (total score 10-60). Higher scores indicate greater addiction severity. Sex-specific cutoffs (≥31 for males; ≥33 for females) were applied [50,51]. Participants completed the scale independently in a quiet room under neutral supervision to minimize response bias.

Headache Impact Test (HIT-6): Headache-related disability was assessed using the HIT-6, which measures functional impact across six domains: pain, social and role functioning, cognitive functioning, vitality, and psychological distress. Scores range from 36 to 78, with higher values indicating greater disability[52].

Forward Head Posture (FHP) was quantified using the CVA measured through standardized digital photogrammetry.[53] Each participant stood barefoot in a relaxed posture with their eyes focused on a visual target at eye level. Reflective markers were affixed to the tragus of the ear and the C7 spinous process to enhance anatomical landmark visibility. Three lateral photographs were taken at each time point under identical lighting and background conditions. Images were analyzed using the ON Protractor™ application (Android v1.6)[54]. The software projected a horizontal reference line through C7 and a second line connecting C7 to the tragus; the angle formed by these lines represented the CVA. The mean of the three measurements was used for analysis.

Pain Pressure Threshold (PPT) was measured at 4 MTrP sites bilaterally (8 sites). Bilateral upper trapezius, SCM, temporalis, and suboccipital sites were measured in every participant regardless of trigger-point status using a digital algometer (Wagner FPX, Greenwich, CT, USA) [55]. The assessor applied pressure perpendicularly at an approximate rate of 1 kg/cm² per second, practiced in advance using a metronome to standardize speed. Participants verbally indicated the point at which pressure first became painful, and that value was recorded. Three measurements were taken at each site with rest intervals of 20-30 seconds. The site was standardized for every muscle in all participants. The same procedure was applied in reassessment using the same standardized site and by the same blinded assessor

Harms: Adverse events were defined as any undesirable sign, symptom, or clinical event occurring during the intervention period that was temporally associated with the study intervention. Participants were monitored for adverse events throughout the intervention period, and any events reported spontaneously by participants or identified by the treating therapist were recorded and assessed for their relationship to the intervention. Serious adverse events were defined as events resulting in death, life-threatening illness, hospitalization, significant disability, or other medically important consequences.

Statistical analysis

Statistical analyses were performed using IBM SPSS Statistics version 29.0. Data entry accuracy and outlier detection were completed before inferential analysis. Continuous variables were assessed for normality using the Shapiro-Wilk test, and homogeneity of variance was assessed using Levene's test. For the multivariate analysis, additional assumptions including multivariate normality, equality of covariance matrices, multicollinearity, and correlations among dependent variables were examined.

A 2 × 2 mixed-design MANOVA was conducted to evaluate the effects of treatment group (CBT-integrated PT program vs PT), time (pre-intervention vs post-intervention), and their interaction on the primary and secondary non-PPT outcomes (SAS-SV, HIT-6, and CVA). Pillai's trace was used as the multivariate test statistic. Where significant multivariate effects were identified, follow-up univariate analyses and pairwise

comparisons were performed with Bonferroni adjustment for multiple comparisons.

Pain pressure threshold (PPT) was assessed separately at eight prespecified bilateral anatomical sites: right and left upper trapezius, right and left sternocleidomastoid, right and left temporalis, and right and left suboccipital sites. Each PPT site was analyzed separately using a 2 × 2 mixed-design analysis to examine the effects of treatment group, time, and the treatment-by-time interaction. Bonferroni adjustment was applied across the eight site-specific PPT analyses to account for multiple testing. The site-specific results are presented separately in Table 4.

Statistical significance was set at $p < 0.05$ after adjustment for multiple comparisons, where applicable. Effect estimates were reported with 95% confidence intervals to support interpretation of the magnitude and precision of treatment effects.

The primary analysis followed the intention-to-treat (ITT) principle. All randomized participants were analyzed according to their originally assigned treatment group, regardless of adherence or withdrawal after randomization. Missing outcome data were addressed using multiple imputation. The imputation model included treatment allocation and the corresponding baseline outcome measure, with imputed values generated for missing post-intervention outcome measurements. Estimates from the imputed datasets were pooled using standard multiple-imputation procedures.

Data availability: De-identified study data may be made available from the corresponding author upon reasonable request, subject to applicable ethical and data-protection requirements.

Results

A total of 90 individuals were screened for eligibility, of whom 22 did not meet all the inclusion criteria. Four participants withdrew before randomization, resulting in 64 participants who were randomly allocated to either the CBT-integrated PT program group (n = 32) or the PT group (n = 32). During the follow-up period, 61 participants continued receiving their allocated care and treatment sessions, while 3 participants withdrew or were lost to follow-up. Adherence to the interventions and attendance were tracked using session logs, and all participants attended at least 85% of the supervised PT and CBT sessions, which was considered an acceptable level of adherence[56]. Adherence to the home exercise program (HEP) and CBT homework was monitored using participant logbooks documenting the date and duration of completion and was defined as completing ≥80% of the prescribed home sessions and CBT assignments. No major protocol deviations were reported during the study period, and no intervention-related adverse events occurred in either group. A CONSORT flow diagram depicting participant screening, allocation, follow-up, and analysis is presented in **Figure 1.**

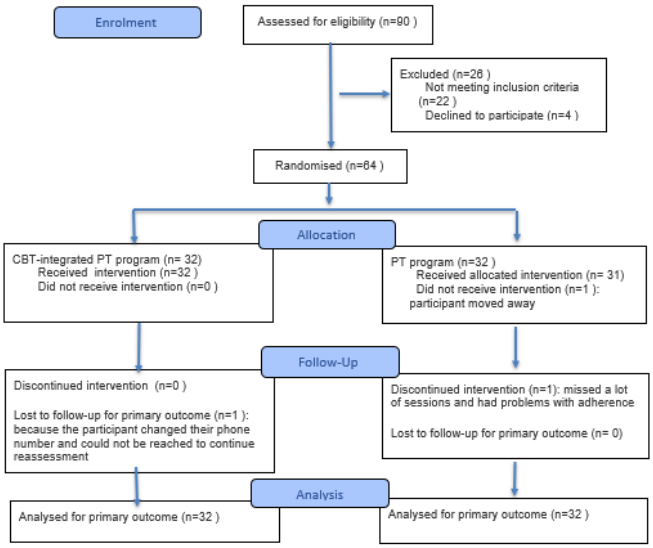


Figure 1. CONSORT Flow diagram

Table 1. Baseline Characteristics of Participants (n = 64)

Variable	CBT-integrated PT program (n = 32) Mean ± SD	PT program (n = 32) Mean ± SD	t / χ^2	p-value
Age (years)	25.9 ± 5.12	26.0 ± 4.88	-0.11	0.799
Weight (kg)	66.3 ± 7.2	67.1 ± 7.0	-0.59	0.146
Height (cm)	170.2 ± 8.5	171.4 ± 8.0	-0.84	0.322
BMI (kg/m²)	22.78 ± 1.44	22.86 ± 1.52	-0.29	0.309
Sex, *n* (%)				
Male	20 (62.5%)	18 (56%)	$\chi^2 = 0.09$	0.744
Female	12 (37.5%)	14 (44%)		

SD = Standard deviation; BMI = Body mass index; t = t-test; χ^2 = chi-square test

Overall Multivariate Effect

Repeated-measures 2 × 2 mixed-design MANOVA was conducted to evaluate the combined effects of treatment (CBT-integrated PT program vs PT) and time (pre vs post) on all outcome variables (SAS-SV, HIT-6, CVA, and PPT). The analysis showed a significant interaction effect between treatment and time, indicating that the two groups responded differently across the intervention period. Significant main effects of time and treatment were also observed, reflecting overall improvement in outcomes over time and superior results in the CBT-integrated PT program group regardless of baseline similarity.

Table 2. Multivariate MANOVA Results for Treatment, Time, and Interaction Effects

Effect	F-value	p-value
Treatment × Time Interaction	382.27	<0.001*
Main Effect of Time	1692.43	<0.001*
Main Effect of Treatment	1481.48	<0.001*

*Significant at $p \leq 0.05$; F-value = Multivariate MANOVA test statistic.

Primary Outcome

Both groups demonstrated significant reductions in SAS-SV scores following the intervention ($p < 0.001$). The CBT-integrated PT program group showed a larger improvement compared to the PT group ($p < 0.001$). This between-group difference exceeded the established MCID range of 7–10 points

for the SAS-SV, indicating meaningful improvement[57] (Table 3).

Table 3. SAS-SV, HIT-6, and CVA, Pre- and Post-Treatment

Outcome	Time	CBT-Integrated PT program (Mean ± SD)	PT (Mean ± SD)	MD (95% CI)	p-value
SAS-SV Score	Pre	44.80 ± 2.46	44.79 ± 2.43	0.01 (-1.56, 1.57)	0.990
	Post	30.80 ± 3.30	39.20 ± 1.85	-8.40 (-10.11,6.69)	<0.001*
HIT-6 score	Pre	67.35 ± 3.36	67.22 ± 3.44	0.13 (-2.04, 2.31)	0.901
	Post	50.00 ± 3.84	60.32 ± 3.07	-10.3 (-12.55,8.10)	<0.001*
CVA (degrees)	Pre	37.87 ± 2.56	37.78 ± 2.40	0.09 (-1.50, 1.68)	0.914
	Post	46.19 ± 4.75	41.14 ± 2.88	5.05 (2.53, 7.56)	<0.001*

SAS-SV = Smartphone Addiction Scale-Short Version; **HIT-6** = Headache Impact Test-6 items; **CVA** = Craniovertebral angle; **SD** = Standard deviation; **MD** = Mean difference; **CI** = 95% confidence interval; **Significant at $p \leq 0.05$.*

Secondary Outcomes

Headache's impact was assessed via HIT-6. Significant post-intervention reductions in HIT-6 scores ($p < 0.001$) were noted in both groups. The CBT-integrated PT program group demonstrated a larger decrease in headache-related disability, with post-treatment reductions exceeding 10 points. (Table 3).

Forward Head Posture was assessed via CVA. Significant improvement over time ($p = 0.001$) was noted in both groups. However, the CBT-integrated PT program group achieved a significantly larger post-treatment increase in CVA compared with the PT group ($p = 0.001$). The absolute changes exceeded the 10° threshold typically considered clinically relevant for CVA [58](Table 3).

Pain Sensitivity, assessed by PPT, improved substantially across all muscle sites in both groups, with improvements in the SCM and Temporalis muscles being particularly large in the PT group. CBT-integrated PT program group also showed improvements but did so inconsistently (Table 4).

Table 4. Pain Pressure Threshold (kg/cm²); Pre and Post Treatment

Muscle	Time	CBT-integrated PT program (Mean ± SD)	PT (Mean ± SD)	MD (95% CI)	p-value
Upper Trapezius - Right	Pre	2.44 ± 0.65	2.48 ± 0.66	-0.01 (-0.10, 0.08)	0.842
	Post	3.22 ± 0.46	1.98 ± 0.45	1.25 (1.09, 1.40)	<0.001*
Upper Trapezius - Left	Pre	2.12 ± 0.72	2.14 ± 0.78	0.07 (-0.68, 0.81)	0.859
	Post	3.19 ± 0.33	4.38 ± 0.47	-1.19 (-1.33, -1.05)	<0.001*
SCM - Right	Pre	1.30 ± 0.33	1.27 ± 0.36	-0.01 (-0.32, 0.21)	0.935
	Post	2.26 ± 0.25	4.07 ± 0.35	-1.80 (-1.91,-1.70)	<0.001*
SCM - Left	Pre	1.60 ± 0.40	1.60 ± 0.40	-0.01 (-0.24, 0.21)	0.891
	Post	1.90 ± 0.42	3.51 ± 0.60	-1.61 (-1.79, -1.43)	<0.001*
Suboccipital-Right	Pre	2.33 ± 0.50	2.27 ± 0.50	-0.02 (-0.34, 0.30)	0.895
	Post	4.28 ± 0.46	3.24 ± 0.52	1.04 (0.87, 1.21)	<0.001*
Suboccipital - Left	Pre	2.60 ± 0.23	2.56 ± 0.25	0.01 (-0.14, 0.17)	0.853
	Post	3.98 ± 0.39	3.78 ± 0.25	0.19 (0.08, 0.30)	0.001*
Temporalis - Right	Pre	1.19 ± 0.16	1.21 ± 0.19	-0.01 (-0.09, 0.08)	0.894
	Post	3.36 ± 0.64	4.60 ± 0.47	-1.25 (-1.44,1.05)	<0.001*
Temporalis - Left	Pre	1.95 ± 0.49	1.88 ± 0.45	-0.03 (-0.29, 0.23)	0.853
	Post	3.19 ± 0.54	4.74 ± 0.32	-3.56 (-3.72, -3.42)	<0.001*

SD = Standard deviation; **MD** = Mean difference; **CI** = 95% confidence interval; **SCM** = Sternocleidomastoid muscle; **Significant at $p \leq 0.05$*; MCID for PPT is 15% increase from baseline.

Discussion

This randomized controlled trial was conducted to evaluate whether the addition of structured CBT to conventional physical therapy would enhance outcomes related to PSU, headache-related disability, MTrP sensitivity, and FHP in young adults with coexisting PSU and TTH. The present randomized controlled trial demonstrated that adding structured CBT to conventional physical therapy produced greater improvements in PPT, FHP, headache-related disability, and Smartphone use severity than conventional physical therapy alone in young adults with coexisting PSU and TTH. The significant treatment-by-time interaction ($p<0.001$) indicates that the pattern of change differed substantially between the two interventions, supporting an additional benefit of the integrated approach, regardless of baseline similarity.

Effect on Problematic Smartphone Use

The most pronounced between-group behavioral effect was observed for smartphone use severity. SAS-SV scores decreased by approximately 31% in the CBT-Integrated PT Program compared with 12.5% in the PT group, with a significant post-treatment difference (mean difference −8.40, 95% CI −10.11 to −6.69, $p<0.001$). These results suggest that the reduction in PSU was not simply a consequence of improved physical symptoms but was directly influenced by the behavioral component of the intervention.

These results corroborate the existing body of literature supporting CBT-based interventions for Problematic Smartphone Use and behavioral dependence[59–61]. CBT may reduce PSU by identifying maladaptive beliefs and triggers, restructuring dysfunctional cognitions, strengthening self-regulation, and replacing compulsive smartphone-checking behaviors with alternative activities[59]. The inclusion of goal setting, self-monitoring, technology-free periods, behavioral substitution, and relapse-prevention strategies in the present intervention may therefore explain the substantially greater reduction in PSU.

Effect on forward head posture

Both groups demonstrated improvement in FHP; however, the increase in craniovertebral angle was substantially greater in the CBT-Integrated PT Program group (22% vs. 9%, $p<0.001$). This finding is consistent with previous evidence associating prolonged smartphone use with sustained cervical flexion and FHP[62–64].The improvement observed in both groups may be attributed to the corrective exercise component, which targeted deep cervical flexors, suboccipital muscles, and scapular stabilizers[65,66]. The additional postural improvement following CBT may be related to its behavioral component. The intervention incorporated psychoeducation, self-monitoring, goal setting, posture-correction breaks, and strategies to reduce prolonged smartphone exposure[67,68]. These strategies may have reduced the behaviors responsible for sustained smartphone-related postural loading, thereby complementing the direct physical effects of corrective exercise[67].

Effect on headache-related disability

A statistically significant reduction in headache-related disability was observed in both groups, with a substantially greater reduction in HIT-6 scores following the CBT-Integrated PT Program (26% vs. 10%, $p<0.001$). These findings agree with the existing evidence supporting CBT and behavioral interventions for reducing headache burden and improving daily functioning [36]. The greater improvement may be explained by CBT's ability to modify maladaptive pain-related cognitions, coping strategies, emotional responses, and physiological arousal[67,69]. The present findings also support a multimodal approach to TTH, in which physical therapy addresses cervical mobility, muscle dysfunction, and postural impairments, while CBT addresses cognitive and behavioral contributors to pain. Similar advantages of integrating psychological and physical interventions have been reported in chronic musculoskeletal pain populations[67,68]. Thus, the greater reduction in HIT-6 scores may reflect the broader therapeutic targets of the combined intervention[67].

Effect on pain pressure threshold

With respect to pressure pain threshold (PPT), no significant differences were observed at baseline for any of the examined muscles, indicating comparable pain sensitivity before treatment. Following the intervention, significant differences emerged across nearly all muscle sites. The CBT-integrated physical therapy group demonstrated higher PPT values in the right upper trapezius and right and left suboccipital muscles, whereas the physical therapy group demonstrated higher PPT values in the left upper trapezius, sternocleidomastoid muscle, and temporalis muscle. These findings suggest that both interventions were associated with improvements in mechanical pain sensitivity; however, the direction of the between-group differences varied according to the muscle examined. Therefore, the results do not indicate a consistent advantage of either intervention across all assessed muscle groups. The observed side-specific variations may reflect differences in muscle involvement, headache characteristics, habitual smartphone-use patterns, or individual variability in myofascial pain distribution. Consequently, while both interventions appear to influence pain sensitivity, the clinical significance of these heterogeneous muscle-specific responses warrants further investigation.

Nevertheless, the observed increases in PPT across multiple cervical and craniofacial muscles in both groups support the contribution of myofascial dysfunction to TTH and are consistent with evidence linking active MTrPs in the cervical and craniofacial musculature with headache symptoms. [24,70,71]. onventional physical therapy may reduce local muscle sensitivity and mechanical dysfunction through manual therapy and corrective exercise, whereas CBT may additionally target pain-related cognitions, attention to pain, coping strategies, and central pain modulation [69,72] .Previous studies have similarly reported beneficial effects of manual therapy, soft-tissue techniques, and multimodal physical therapy on pain sensitivity and clinical outcomes in TTH [73,74.]

Integrated effect of CBT and physical therapy

Overall, the present findings suggest that combining CBT with conventional physical therapy may provide broader benefits than physical therapy alone for individuals with coexisting PSU and TTH. While conventional physical therapy directly targets cervical musculoskeletal impairments, CBT addresses behavioral patterns and cognitive-emotional factors that may perpetuate excessive smartphone use and pain. This complementary approach is consistent with the biopsychosocial model of pain, whereby mechanical, psychological, and

behavioral factors interact to influence symptom persistence and disability[75]

The present findings are also consistent with previous research demonstrating greater benefits from integrating CBT with physiotherapy compared with physiotherapy alone in chronic pain populations[76–78] . However, the current study extends this concept to individuals with coexisting PSU and TTH, suggesting that targeting the behavior contributing to prolonged smartphone exposure may enhance the effects of physical rehabilitation. The concurrent improvements in myofascial sensitivity, FHP, headache-related disability, and PSU severity support the potential value of an integrated behavioral rehabilitation model for this population.

Limitations

The follow-up period was limited to immediate post-treatment outcomes, preventing assessment of the long-term durability of the observed improvements. Although randomization was adequately performed, assessor blinding may not have been fully maintained, potentially introducing measurement bias. The sample consisted solely of young adults, limiting generalizability to older adults or adolescents. Variability in adherence to CBT homework and the home exercise program may also have influenced treatment response. Finally, the study did not evaluate neurophysiological or behavioral mediators of improvement, which could have helped clarify the mechanisms underlying the treatment effects.

Future studies should therefore include longer follow-up periods, multicenter designs, broader age groups, and mediation analyses to explore the neurobehavioral pathways influenced by the CBT-Integrated PT Program group

Conflict of interest and Funding

Authors declare no conflict of interest of any type and have received no funding to complete the research.

Patient Anonymity and Consent

Since On-Line journals are largely available for public access, ethical and legal considerations mandate that patients' anonymity be preserved. Research papers must indicate informed consent for procedures and the involvement of an ethical committee, proof of which may be required in the review process of the paper.

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