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EFFECTS OF A POSTURE CORRECTION PROGRAM ON COGNITIVE FATIGUE IN SCREEN EXPOSED ADULTS WITH ATTENTION DEFICIT HYPERACTIVITY DISORDER: A RANDOMIZED CONTROLLED TRIAL

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Abstract

For adults, having trouble reaching a level of mental effort may make screen viewing time more challenging due to these factors in adults: fatigue and forward head posture related to ADHD. This randomized controlled trial aimed to assess the effects of a structured posture correction program in addition to an educational physiotherapy program on cognitive fatigue in adults with ADHD who are exposed to screens. We used lotto system to randomize the 60 university students aged between 22 to 27 years (Mean = 23.35, SD = 1.22) into two groups, one experimental group to practice posture correction along with normal physiotherapy (n = 30) and one control group for normal physiotherapy (n = 30). These two groups underwent 16 weeks of training, 3 times per week. Cognitive fatigue measured by Mental Fatigue Scale (MFS), ADHD symptoms measured by Adult ADHD Self Report Scale (ASRS) and forward head posture by craniovertebral angle (CVA). Baseline means were 14.74 (SD = 2.62) for the MFS, 22.30 (SD = 2.68) for the ASRS, and 34.44° (SD = 5.21°) for the CVA. Since the Shapiro Wilk test showed that the distributions were not normal, the changes were compared using Mann Whitney tests. The experimental group improved more on the MFS (p = .029, r = .28), the ASRS (p = .043, r = .26), and the CVA (p = .009, r = .34). Holm adjustment was used; only the CVA difference was significant (adjusted statistic p = .027). The results indicate that posture correction may have a small benefit but the evidence for cognition fatigue reduction is preliminary, with potential to larger trials with objective measures.

INTRODUCTION

An attention deficit hyperactivity disorder (ADHD) is a condition that affects the brain, and it causes symptoms of inattention, hyperactivity and impulsivity that often last through childhood and into adulthood. In a recent meta-analysis of the prevalence of persistent and symptomatic adult ADHD, the prevalence of persistent adult ADHD was estimated to be 2.58% and symptomatic adult ADHD was estimated to be 6.76% (Song et al. 2021). In addition to the core symptoms, cognitive deficits on sustained tasks have been observed; there is some reason to believe that a component of the cognitive deficits is due to sleepiness and to low arousal level, as well as to symptom severity. Helfer et al., 2020 found that during an attention task, adults with ADHD were also sleepier its behavior was more prone to performance errors, with being sleepier during the task accounting for the performance errors.

Fatigue research distinguishes between the subjective feeling of fatigue from the objective mobilization of fatigue resources (what is called "fatigability"), which can be different (Kluger et al., 2013). The first route normally gives an indication of cognitive fatigue in ADHD, by means of a felt lack of mental endurance following extended effort. This group is often subjected to the propensity for screen-based studies and work, and the cumulative effects of extended screen time can put extra strain on their mind and body. There are associations between screen time and symptoms of ADHD, with the best evidence from children, long before facing the impact of the pandemic. There are associations with screening time and ADHD symptomology, and the best evidence is from children, well before the pandemic. Longer screen-time was associated with increased ADHD symptoms 2 years later in over 10,000 children aged 9–10, partly due to changes in cortical volume (Shou et al., 2025).

But screen use has an impact on the body as well. In a sample of 313 university students in Saudi Arabia, students who said that they got texts neck posture were more likely to have neck disorders than others, as were those in the "smartphone addicted" and "overused" groups (Sirajudeen et al., 2022). Functional consequences from forward head posture (FHP) are included in reduced respiratory function and altered cervical proprioception (Kang et al., 2021; Norasteh et al., 2025), and these indirectly can increase the cost of FHP maintenance during cognitive tasks. Studies in other populations gather additional support for a postural congruence with mental condition. People with lower mood and higher fears and self-focused self-referential thinking benefited from their sitting in an upright posture when participating in a stress task (Nair et al., 2015), and the higher self-reported fatigue in the stress task was reduced with upright sitting posture in people with mild to moderate depression symptoms (Wilkes et al., 2017).

Attention has also started to turn to physical activity as a remedy for adults who suffer from ADHD. In a randomized controlled trial, a 12-week program of physiotherapist-led exercises combined with usual care alleviated ADHD symptoms compared with usual care alone (Svedell et al., 2025). The program was, however, a general exercise program, and there do not seem to be any programs that have been tested with physical postural training specifically designed for adults with ADHD and cognitive fatigue when exposed to computers and other screens. This subjected trial set out to fill that gap. The aim was to identify posture correction program effect on cognitive fatigue in adults with the ADHD exposed to screens. The null hypothesis (H_0) stated that there was no significant effect of the program on the cognitive fatigue, while the alternative hypothesis (H_1) claimed there was a significant effect of the program on the cognitive fatigue.

Related Avoidance

There is good supporting evidence in the MSK literature for the exercise-based correction of FHP. So, based on a systematic review and meta-analysis, therapeutic exercise was found to be effective in improving forward head posture (Sheikhhoseini et al., 2018). After a randomized controlled trial of 32 office worker patients with FHP, scapular stabilization plus thoracic extension exercise showed an improvement in craniovertebral angle, breathing, pain and disability after six weeks of treatment. The benefits of this compared with a cervical stabilization and stretching position was only statistically significant on the outcomes of forced expiratory volume and pain (Kang et al., 2021). A later randomized motor learning-based training program that emphasized attention-demanding components resulted in a decrease in FHP, but "attention-demanding components" were maintained during a two-week detraining period (Argyrou

et al., 2025). Additionally, a systematic review of random temporal bone studies concluded cervical stabilization exercise may enhance cervical proprioception in asymptomatic FHP (Norasteh et al., 2025). These combined studies indicate that by engaging in exercise, one can change one's head posture. Inspection of the cognitive outcomes reported rarely focused on these outcomes and none of the trials was ADHD-centric. The remainder of the justification comes from the neurocognitive literature. Arousal regulation seems to be impaired among adults with ADHD, placing on-task sleepiness as a significant component of deficits in performance, and general exercise has led to symptom improvements in adults with ADHD (Helfer et al., 2020; Svedell et al., 2025). If posture affects both breathing and attentional cost of maintaining a posture, then correction of posture might alleviate some of the burden on such breathing and attention. This possibility seems reasonable, but has not yet been confirmed, and a controlled design was undertaken using both groups on the same standard of care, but varying only in the posture correction elements.

Method

Design and setting

The data was obtained from 240 students from the Department of Physiotherapy, Times University. All 240 students were screened and examined to diagnose and select 60 students with peripheral neuropathy who then became the samples in this research study and received the specified treatment in their groups. Hence, from the sample of 60 individuals for each group, aged 20-35, diagnosed with ADHD, after recruitment and fulfilling the inclusion criteria would be selected randomly for this study after approval from Times University, Multan. A two arm Parallel group randomized controlled trial was conducted in a department of Physical therapy at TIMES University Multan, Pakistan. Screening, intervention sessions and evaluations were all conducted on campus. The work was conducted under the institutional review board mechanism, informed consent was obtained prior to all procedures, and there were no required protocols for volunteer participation in the work or that participants were unable to withdraw. Written informed consent was obtained before all procedures were performed, all procedures were voluntarily performed and there was no barrier to the participant withdrawing from the work, and coded identifiers were used to ensure confidentiality.

Participants and allocation

This target population included university students with ADHD, who had been exposed to lengthy screen time. Adult males and females ages 20–35 who were on the list for the department, had cognitive fatigue, had moderate cognition inattention/impulsivity/hyperactivity were eligible for participation. The exclusion criteria included a lack of an ADHD diagnosis, the existence of cognitive fatigue, neurological disorders and/or the presence of other mental illness, conditions of the musculoskeletal or spine that would pose a potential safety risk with exercise and the use of an antipsychotic prescription for either neck or postural conditions.

Sample size was calculated using G*Power, with two tailed tests of the difference between two independent means, an effect size of d = 0.5, alpha = 0.10, and a power of 0.60, with an allocation ratio of one. Eligible students were identified using purposive sampling and each group (60) was matched using a sealed paper lottery and divided equally into Groups A and Group B (n = 30). The sample included 32 women (53.3%) and 28 men (46.7%), aged 22 to 27 years (M = 23.35, SD = 1.22), with identical gender distributions in both groups (16 women and 14 men each).

Interventions

Group A patients received a prescribed posture correction program as well as normal physio care. We used education programs for proper posture alignment and ergonomic computer uses with deep cervical flexor training with a chin tuck and cranio-cervical flexion exercise, scapular retraction, scapular dynamic stabilization, thoracic extension on foam roller, and suboccipital, levator scapulae, and pectoral muscle stretching.

Group B was given the conventional physiotherapy of the neck, shoulders and upper back, a hot pack or transcutaneous electrical nerve stimulation (TENS) to reduce pain, gentle range of motion exercises and

neck, shoulder and upper thoracic (back) mobilization, basic ergonomic coaching, and breathing and relaxation exercises if they chose. Both the intervention and control groups participated in the course for 16 weeks, 3 times/week.

Outcome measures

The main outcome was cognitive fatigue assessed by the Mental Fatigue Scale (MFS), a self-report scale designed for patients with neurological disorders and injuries (Johansson et al., 2010; Johansson & Rönnbäck, 2014). Fatigue scores of 0-10.4 were considered as no pathological fatigue, 10.5-14.9 as mild pathological fatigue, 15-20.4 status as moderate pathological fatigue, and 20.5 and above as severe pathological fatigue with a clinicopathological cut-off at 10.5. The Turkish version has acceptable internal consistency (Güven et al., 2023). Symptoms of ADHD were measured using the ASRS (Kessler et al.,] head posture was measured using craniovertebral angle (CVA), which was the angle formed between a horizontal line passing through the C7 spinous process and a line joining the C7 spinous process with the tragus on lateral photographs of sitting participants with reflective markers. Angles > 50° were considered normal, angles between 30° and 50°, mild FHP, and < 30° severe FHP. CVA values are slightly different when sitting vs. standing (Shaghayeghfard et al. 2016); it was imperative to have a consistent position at each assessment. Demographic data, as well as screen time dimensions (18 item Screen Time questionnaire; Vizcaino et al., 2019) were also collected, and all assessments were conducted again after the program under standardized circumstances.

Statistical analysis

IBM SPSS Statistics were used for data analysis. Normality was tested using Shapiro Wilk test (Shapiro, Wilk 1965). Being that the assumption did not hold true for any variable, nonparametric data analysis methods were chosen for baseline analyses (Spearman rank correlations, Schober et al., 2018) and for between group comparisons of change scores (Mann Whitney tests). Effect size $r = |Z| / \sqrt{N}$ were reported, and supplemented by rank biserial correlation and probability of superiority and read with benchmarks (Fritz et al., 2012). Holm adjusted error was used for three outcomes and a significance of $\alpha = .05$ was determined with a 2-tailed test. An extreme CVA value (20°, $z = 2.77$) was kept due to sensitivity checks which indicated that the interpretation did not change

Results

Baseline profile

The demographic characteristics and baseline profile of the participants are presented in Table 1. The mean (SD) ASRS score at baseline was 22.30 (2.68), considered as being in the mild to moderate range. The mean MFS was 14.74 (SD = 2.62) and fell in the upper half of the range for mild fatigue, while the mean CVA was 34.44° (SD = 5.21°) which fell within the mild FHP zone. Severity classifications are given in Table 2. There were no cases of normal CVA or the lowest or most severe fatigue categories among the participants.

Table 1. Demographic characteristics and baseline profile of the participants (N = 60

Characteristic	Group A (experimental)	Group B (control)	Total
Group allocation and gender			
Participants, n	30	30	60
Female, n (%)	16 (53.3)	16 (53.3)	32 (53.3)
Male, n (%)	14 (46.7)	14 (46.7)	28 (46.7)
Age (years)			
Mean (SD)	23.35 (1.22)		
Range	22 to 27		
Females, mean (SD)	22.94 (0.88)		

Characteristic	Group A (experimental)	Group B (control)	Total
Males, mean (SD)	23.82 (1.39)		
Baseline clinical profile, mean (SD)			
ASRS total score	22.30 (2.68)		
MFS total score	14.74 (2.62)		
CVA (degrees)	34.44 (5.21)		

Note. ASRS = Adult ADHD Self Report Scale; MFS = Mental Fatigue Scale; CVA = craniovertebral angle. Group allocation was by lottery with sealed papers. Age and baseline scores were summarized for the total sample only, and MFS and CVA values rest on 59 valid scores in the original data summaries. Percentages are column percentages within each group.

Table 2. Baseline severity classification (percent of sample)

Measure	Category (range)	%
ASRS	Mild to moderate (17 to 23)	71.7
	High (24 to 36)	28.3
MFS	Mild (10.5 to 14.9)	52.5
	Moderate (15 to 20.4)	47.5
CVA	Mild FHP (30° to 50°)	89.8
	Severe FHP (below 30°)	10.2

Note. ASRS = Adult ADHD Self Report Scale; MFS = Mental Fatigue Scale; CVA = craniovertebral angle; FHP = forward head posture. MFS and CVA percentages rest on 60 valid scores.
Shapiro Wilk results indicated departures from normality for the ASRS ($W = .957$, $p = .032$), MFS ($W = .898$, $p < .001$), CVA ($W = .925$, $p = .001$), and age ($W = .878$, $p < .001$), which supported the nonparametric strategy. The associations between the three outcomes were low and not significant (absolute rs ranged from .126 to .193, all $p > .14$), and there was no significant difference between men and women (ASRS $p = .501$; MFS $p = .281$; CVA $p = .083$).

Overall change from baseline

Across the sample, mean ASRS fell from 22.30 to 19.10 (3.20 points, 14.3%) and mean MFS fell from 14.74 to 11.80 (2.94 points, 19.9%), while mean CVA rose from 34.44° to 39.20° (4.76°, 13.8%). All results were positive (Table 3). The MFS mean, however, remained in the mild fatigue range whilst the CVA mean was maintained in the mild FHP range.

Table 3. Within group change from baseline to post intervention in ASRS, MFS, and CVA

Outcome	Sample	n	Baseline Mean (SD)	Post Mean (SD)	Mean change	SD of change	95% CI of change	dz
ASRS	All participants	60	22.30 (2.68)	19.10 (2.70)	3.20 lower	*Paired scores not available*		
	Group A	30	*Group means not reported*		2.10 lower	1.80	1.43 to 2.77	1.17
	Group B	30	*Group means not reported*		1.10 lower	1.60	0.50 to 1.70	0.69
MFS	All participants	60	14.74 (2.62)	11.80 (2.50)	2.94 lower	*Paired scores not available*		
	Group A	30	*Group means not reported*		2.00 lower	1.70	1.37 to 2.63	1.18
	Group B	30	*Group means not reported*		0.90 lower	1.50	0.34 to 1.46	0.60

Outcome	Sample	n	Baseline Mean (SD)	Post Mean (SD)	Mean change	SD of change	95% CI of change	dz
CVA (degrees)	All participants	60	34.44 (5.21)	39.20 (5.40)	4.76 higher	*Paired scores not available*		
	Group A	30	*Group means not reported*		5.20 higher	3.80	3.78 to 6.62	1.37
	Group B	30	*Group means not reported*		2.10 higher	3.40	0.83 to 3.37	0.62

Note. Mean change is the magnitude of change from baseline to post intervention, with its direction in words. A lower ASRS or MFS score and a higher CVA indicate improvement. The 95% CI of change = mean change ± 2.045 × SD / √30, and dz = mean change / SD of change, both derived from the reported group means and standard deviations of change (df = 29) as a parametric approximation. Because normality was not met, the Wilcoxon signed rank test is the planned within group test, and its p values require participant level paired scores that were not available. Pooled baseline and post intervention means are as reported for the full sample and do not reconcile with the group specific change scores.

Between group comparison

All three measures measured improvements in Group A compared to Group B (Table 4 and Figure 1). The MFS fell by 2.00 points (SD = 1.70) in Group A and 0.90 points (SD = 1.50) in Group B (Z = 2.18, p = .029, r = .28). The ASRS fell by 2.10 (SD = 1.80) versus 1.10 (SD = 1.60) points (Z = 2.02, p = .043, r = .26), and the CVA rose by 5.20° (SD = 3.80°) versus 2.10° (SD = 3.40°) (Z = 2.61, p = .009, r = .34)

Table 4. Between group comparison of change scores (Group A, n = 30; Group B, n = 30)

Outcome	Group A change, Mean (SD)	Group B change, Mean (SD)	Mean difference	Z	H(1)	p	Holm p	r	rrb	PS
ASRS	2.10 (1.80)	1.10 (1.60)	1.00	2.02	4.08	.043	.058	.26	.24	.62
MFS	2.00 (1.70)	0.90 (1.50)	1.10	2.18	4.75	.029	.058	.28	.27	.63
CVA (degrees)	5.20 (3.80)	2.10 (3.40)	3.10	2.61	6.81	.009	.027	.34	.33	.67

Note. Entries are magnitudes of change, with reductions for ASRS and MFS and an increase for CVA. Mean difference = Group A change minus Group B change, so positive values favor Group A. Group differences were tested with the Mann Whitney test, with the equivalent Kruskal Wallis H(1) = Z^2 shown. Z is reported in absolute value. r = |Z| / √N (N = 60); rrb = rank biserial correlation; PS = probability of superiority for Group A. Holm p = p value adjusted across the three outcomes; only the CVA difference remained below .05 after adjustment.

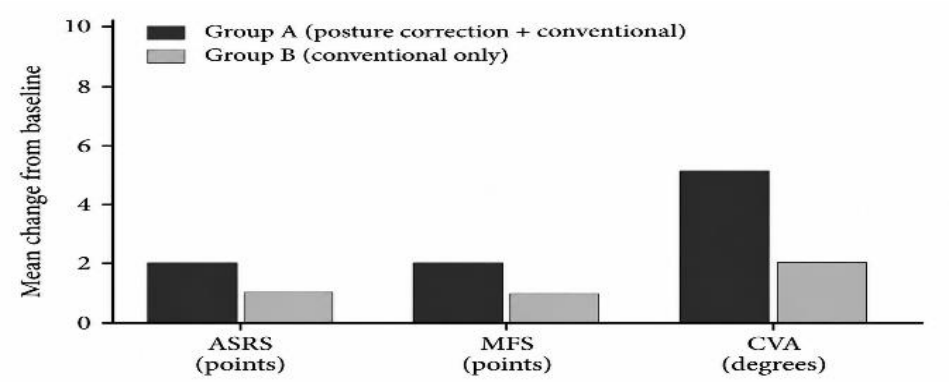


Figure 1. Mean change from baseline by group. Error bars show one standard deviation

The MFS correlation was ranked superior by Group A, as was the ASRS correlation with a rank of .24 and the CVA rank was .33. The probability of superiority = .63, .62, and .67 indicate that, randomly sampling a participant from Group A, a 62-67% chance was present that a improvement occurred more than a random sampling of a participant from Group B. Following Holm's adjustment the p values were: MFS: .058; ASRS: .058; and CVA: .027, which means that the postural difference was the only one that falls below .05

Discussion

In this trial, a posture correction program plus traditional physiotherapy was compared with traditional physiotherapy alone among screen exposed adults that had ADHD. The added postural components participants demonstrated greater improvements with regards to cognitive fatigue, ADHD symptom scores, and head posture. The posture outcome turned out to be strongest as it was the outcome remaining after correction to various outcomes. Fatigue and symptom advantages were small to moderate in size, and before adjustment reached conventional significance, suggesting that these results are somewhat encouraging.

The amount of gain in the posture finding indicates that exercise was moving the angle in the direction of forward head posture which is consistent with other evidence that exercise improves forward head posture (Sheikhhoseini et al., 2018) and with the gains of angle postures after scapular and thoracic exercise in office workers (Kang et al., 2021). Giving Group B stretching, mobilization and ergonomic recommendations, plus an additional improvement in Group A indicates that the additional value of specific strengthening of the deep cervical flexors and scapular deltoid girdle stabilizers is beneficial beyond general care. Despite this, the CVA mean was still in FHP mild zone following the program, correction was partial.

The result is more subtle for fatigue. The p value for the MFS difference was .029 for both pre-adjustment and .058 post-adjustment; and the effect size (r = .28) is in the small to moderate range. Multiple mechanisms are possible which might result in a true effect. Sitting upright has been correlated with better mood and reduced fatigue with difficult tasks (Nair et al., 2015; Wilkes et al., 2017), mechanized breathing and cervical proprioception may have a positive effect on alertness (Kang et al., 2021; Norasteh et al., 2025), and a more stable posture reduces the attentional cost of maintaining a posture (Nair et al., 2015; Wilkes et al., 2017; Kang et al., 2021; Norasteh et al., 2025). In these explanations the evidence five supporting is only of other populations and not in this population. The sides altering the account has to be interpreted on a par with the primary one. More deliberate attention and physical contact were provided to Group A, and by design, expectancy and familiarity with questionnaires self-reported scores were lower, as well as symptoms naturally fluctuating over a 16-week period.

The findings from the ASRS replicates those from an exercise program run by a physiotherapist in adults with ADHD (Svedell et al., 2025); the ASRS is a screening scale, which reflects the perceived severity of symptoms, not ADHD diagnosis (Kessler et al., 2005). Several baseline correlations between symptoms, between fatigue and between head posture were poor, indicating relatively independent variations in these

traits within this rather homogeneous sample. It does not exclude that there is a causal connection between posture and fatigue as the sample size is small and the scores are limited. Another is this: Measurement. The perception of fatigue is captured by the MFS and perceived fatigue and objective measure of fatigability don't necessarily agree (Kluger et al., 2013), leaving conclusions about cognitive fatigue open.

Regarding hypotheses, although the unadjusted MFS result favored H_1, there is scope for chance with the adjusted results and therefore the rejection of the null hypothesis for cognitive fatigue must be tentative. Practical implications are drawn should this be confirmed. This testing of posture correction is noninvasive, inexpensive and can be carried out by physiotherapists, and could be used to augment the pharmacological and behavioral treatment for adult study or work that uses long periods of screen time. Screening and defining the head's posture in these adults and adding ergonomic correction and posture breaks into educational institutions and workplace would be prudent until more evidence is created.

Limitation

There are a few limitations in this study: The sample was small and from just one institution and was fairly representative of 22 to 27 years of age (but not generalizable). Because of lenient parameters used in the sample size calculation (both alpha = 0.10 and power = 0.60), the trial was not powerful enough to establish relatively small parameters as significant. Those outcomes were self-reported, subject to a response bias, and photographic measurement, which can be subject to measurement variation, and neither filter nor cognitive endurance test scores were used. No information was provided about what occurs in relation to assessor blinding. No follow up collected formal within group scores for participants, screen time was collected but not analyzed as moderator and durability scores were not collected. Pooled baseline means and changes scores are descriptive only, since they are from separate summary data that will not exactly reconcile in cases where there are group specific means presented. Lastly, one participant did not have any MFS value or had their CVA not been verified, resulting in 60 valid MFS and CVA results.

Conclusion

Among screen exposed adults with ADHD, incorporation of a structured posture correction program into conventional physiotherapy regimens resulted in greater changes in head posture - and suggestively, greater changes in cognitive fatigue and ADHD symptom scores. The only difference on postures could not be reduced for several measures. Larger and multisite randomized trials including assessor blinding, objective cognitive endurance tasks and consistent use of CVA positioning orders, follow-up, and mediation analysis are needed to confirm if improvements in head positioning will result in reductions in fatigue.

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