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Effectiveness of "Aerobic Exercises" on Severity of Symptoms and Function in Participants with Mild Adult Attention Deficit Hyperactivity Disorder [ADHD] - Pre-Post Interventional Study

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Abstract: ***Background: Attention Deficit Hyperactivity Disorder is a neurodevelopmental disorder characterized by symptoms of inattention, hyperactivity, and impulsivity. It is usually first diagnosed in childhood and often lasts into adulthood. Aerobic exercises have been suggested as a potential intervention to alleviate symptoms and improve functioning in individuals with ADHD. However, the effectiveness of aerobic exercises in adult population remains understudied. Objective: This study aimed to determine the effectiveness of aerobic exercises in reducing symptom severity and improving overall functioning in adults with mild ADHD. Methodology: Sixty participants with mild adult ADHD were recruited and screened using the Adult ADHD Self-Report Scale (ASRS-v1.1) Symptom checklist and DSM5 Criteria. Participants underwent an 8-week aerobic exercise intervention. Outcome measures, including BAARS-iv and SDS scores, were assessed at baseline and post intervention. Results: Statistically and clinically significant improvement were observed in symptom severity and functions following the 8- week aerobic exercise intervention. Intra-group comparisons revealed significant reductions in BAARS-iv and SDS scores post- intervention, with p-values < 0.05. Conclusion: This study provides positive evidence supporting the effectiveness of aerobic exercises in reducing symptom severity and improving overall functioning in adults with mild ADHD. The findings suggest that aerobic exercises are valuable adjunctive intervention for individuals with ADHD.***

Keywords: Adult Attention Deficit Hyperactivity Disorder (ADHD), Aerobic exercises, Functional impairment, Symptom severity

1. Introduction

Attention deficit hyperactivity disorder (ADHD) is the most prevalent neuropsychiatric disorder, affecting 5- 10% of children in school age, and continuing through adolescence and adulthood in about 30-50% of them.[1] In India, the pooled prevalence of ADHD among children and adolescents is 7.1%.[2] Attention Deficit Hyperactivity Disorder is a psychiatric condition that has long been recognized as affecting ability to function. Individuals suffering from this disorder show patterns of developmentally inappropriate levels of inattentiveness, hyperactivity, or impulsivity.[3] ADHD is one of the most common neurodevelopmental disorders of childhood. It is usually first diagnosed in childhood and often lasts into adulthood.[4] Types of ADHD: 1) Predominantly inattentive 2) Predominantly impulsive or hyperactive 3) Combination of the above.[3]

Symptoms of Adult ADHD is difficulty getting started on tasks, variable attention to details, difficulties with self-organization and with prioritization, poor persistence in tasks that require sustained mental effort, impulsivity and tolerance, hyperactivity, chaotic life-styles, associated psychiatric comorbidities, disorganization, substance abuse. Symptoms are present consistently since childhood, and do not occur episodically. Impairments in function are global not selective. The impact of ADHD is generally noticeable in all spheres of life, to a greater or lesser degree.[5]

DSM-V (Diagnostic & Statistical Manual for Mental Disorders-V) is available as the diagnostic criteria for an adult ADHD. According to DSM-5, Mild ADHD represents with Few, if any, symptoms in excess of those required to make the diagnosis are present, and symptoms result in only minor functional impairments.[6-11] Empirically Informed Guidelines for Adult ADHD are available to finalizing the diagnosis.[12] The evaluation of the patient with ADHD is usually done with different rating scales and multiple informants who may include the teachers and parents.[3] Adult-specific rating scales are critically helpful in diagnosing adult symptoms and presentations, while also providing metrics for measuring patient response to treatment and changes in QoL.[13]

The pathophysiology of adult ADHD involves genetic, neurobiological, and environmental factors. Genetic influences include strong associations with dopamine receptor genes e.g., DRD4 and other ADHD- susceptibility genes.[5] Neurobiological factors involve dysfunction in dopamine and noradrenaline pathways affecting attention, executive function, and motivation, as well as reduced brain volume (e.g., frontal lobe, caudate nucleus, cerebellum) and delayed brain maturation. Functional changes include altered connectivity in front striatal and other networks, decreased activity in attention- related networks, and increased activity in the default mode network. Environmental risk factors, such as prenatal exposure to alcohol or tobacco, birth complications, and brain injuries, interact with genetic predispositions to influence the development of ADHD.[14]

Aerobic exercise, which involves rhythmic and repetitive movements of large muscle groups, has shown potential

benefits for managing ADHD by addressing neurophysiological dysfunctions. [15-16] It increases neurotransmitters like dopamine, norepinephrine, and serotonin, which are often dysregulated in ADHD, helping to improve executive and attentional functions similar to stimulant medications. Studies by Wigal et al. demonstrated increased epinephrine and norepinephrine levels after cycling in boys with ADHD, though dopamine levels increased only in healthy participants. Gapin et al. found that 40 minutes of moderate exercise improved response inhibition in ADHD patients, while healthy controls showed broader cognitive improvements. Fritz and O'Connor reported enhanced mood, motivation, and reduced fatigue and depression after 20 minutes of cycling, though vigilance and hyperactivity remained unchanged.[17-18]

The purpose of this study was to delve into the underexplored area of learning disabilities in adults, specifically focusing on its profound impact on daily routines and academic work. In many professions, individuals with learning disabilities often face challenges that may be misconstrued as behavioural issues, leading to stigmatization and misunderstanding. The overarching goal of this research is to challenge prevailing misconceptions by emphasizing that individuals with learning disabilities are fundamentally normal; their struggles stem from a genuine learning disability rather than personal shortcomings.

This study explores the intersection of learning disabilities and physiotherapy, focusing on how physical activities can benefit adults with ADHD. It examines the role of physiotherapists in providing non-pharmacological interventions to improve daily functioning, academic performance, and overall well-being. The findings aim to enhance understanding, empathy, and tailored interventions, promoting holistic management strategies for adults with learning disabilities.

Research on adult ADHD highlights its significant impact on personal, social, and occupational life, with Barkley (2000) emphasizing its seriousness.[19] While psychostimulants are the primary treatment (National Collaborating Centre for Mental Health, 2018), they have side effects. Josh Oliel (2018) found pharmacotherapy more effective than aerobic exercise, but Roberto Villa Gonzalez et al. (2019) proposed exercise as a potential complement to medication. [15-20] Studies on adults remain limited, with varied results. Silvan Kill Drori et al. (2020) called for further research on aerobic exercise's effectiveness, while Aylin Mehren et al. (2019) showed potential benefits for executive function. [21-22] However, another study by Mehren et al. (2019) found no significant impact on behavioral performance.[23] The need of this study to assess aerobic exercise's role in managing adult ADHD symptoms within the local population. Study hypothesized that aerobic exercise would have a statistically significant effect on reducing ADHD symptom severity and improving function in adults with ADHD.

2. Materials & Methodology

An experimental study pre-post design for 1 year was done with 60 adult participants with mild ADHD [mean age 20.60 ± 1.92 yrs.] based on sample size calculation with using formula, selected by simple random sampling from Institutional neuro physiotherapy OPD from Surendra Nagar city of Gujarat, state of India. The equipment used in this analysis were inch tape, weighing machine, stadiometer, scales, marking cones, stethoscope & stopwatch. Before the procedure, written consent was taken from the participants. Participants who fulfil the DSM-5 and confirmed by Neuro Physician/psychiatrist, ASRS V.1.1 score 21-38/72 (Mild Category), Age 18 – 25 years, complete 300m distance in 6 min walk test, and comply with study procedures were included in the study. Participants who were taking the treatment for ADHD at the time of study, involved in intensive aerobic exercise, had any Systemic Illness, ≥ 30 kg $\cdot$ m^{-2} BMI, had psychotic symptoms, and pregnant or breastfeeding women were excluded. The study was ethically approved by Institutional Ethical and Scientific Committee (224- E/23).

The study utilized two outcome measures: the Barkley Adult ADHD Rating Scale-IV (BAARS-IV) and the Sheehan Disability Scale (SDS). The BAARS-IV, a 30-items scale, assesses current ADHD symptoms and sluggish cognitive tempo in adults aged 18–89 based on DSM-5 criteria, using a 4-point Likert scale to evaluate symptom frequency and severity over the past six months.[24] The SDS is a 10-point visual analog scale that evaluates functional impairment in work/school, social, and family life, with scores ranging from 0 (unimpaired) to 30 (highly impaired) to indicate global functional impairment.[25] Sarah Gray et al., concluded that 18-item ASRS Symptom Checklist are feasible, reliable and cost- efficient approaches to use in the assessment and monitoring of ADHD symptoms.[26] Stacy J. Graves concluded that the BAARS-IV may provide information related to ADHD symptomatology. The BAARS-IV may be a more efficient measure, given that the items directly assess the symptoms related to the diagnostic criteria that is required for ADHD diagnosis, test-retest reliability (r = 0.85 to 0.90; Dupaul, Power, Anastopoulos, & Reid, 1998) and convergent validity (Rodriguez & Simon Dack, 2013; inattentive α = 0.71 and hyperactive/impulsive subscales α = 0.83; Knouse, et al., 2013).[27] Theresa Coles et, al., concluded that the SDS is a short, simple, and easy-to-score scale that has been successfully evaluated on reliability (r = 0.80), validity(α = 0.79-0.91), and responsiveness in adults with ADHD.[28]

3. Procedure

Initially, college students from the Medical, Paramedical, Engineering, and Commerce fields were contacted directly with the permission of their Head of the Institute. A basic screening questionnaire was provided to college students aged 18–25 years after obtaining permission. Adult volunteers were also screened using the ASRS and DSM-V criteria for Adult ADHD. Those who were unavailable on the day of screening were contacted through a Google Form. Individuals meeting the criteria were referred to a neurophysician/psychiatrist for a confirmatory diagnosis. Following referral, a detailed physiotherapy evaluation, including the 6-minute walk test and HR max determination, was conducted. Based on sample size calculations, 70 participants were initially considered, with

10 excluded for not meeting the inclusion criteria, leaving 60 participants. These participants underwent 8 weeks of aerobic exercise (2 sessions per week, 50–60 minutes each). Pre- and post-intervention scores of BAARS-IV and SDS were recorded at baseline and after 8 weeks and analyzed statistically.

Aerobic Exercises sessions were conducted twice a week for eight consecutive weeks. Sessions were comprised of ten minutes of warm-up, fifty to sixty minutes of aerobic exercise, and ten minutes of cooldown with stretches. Warm up period included jogging & cool down periods included whole body stretches. Stretch each muscle group for at least 60 seconds and sets of 30 seconds at a time. The fifty-minute of aerobic exercise component was subdivided into eight separate trials that each lasted five minutes. Within each trial, four minutes were dedicated to medium or high intensity aerobic exercise and one minute was dedicated to rest. Aerobic activities to perform during the trials; which included running, walk-lunges, high- knees, jumping-jacks, and walk-squats. Intensity of these trials was based on participant's maximum heart rate (HRmax; HRmax= 220 - age). Specifically, moderate exercise was defined as 50-60% of HRmax, whereas high intensity exercise was defined as 70-80% of HRmax. (American College of Sports Medicine, 2010). The initial session consists of six medium intensity trials and two high intensity trials. The intensity of the sessions was gradually increased, each week a medium intensity trial substituted with one of high intensity. By the final week the sessions were comprise exclusively of eight high intensity trials.[15,29,30]

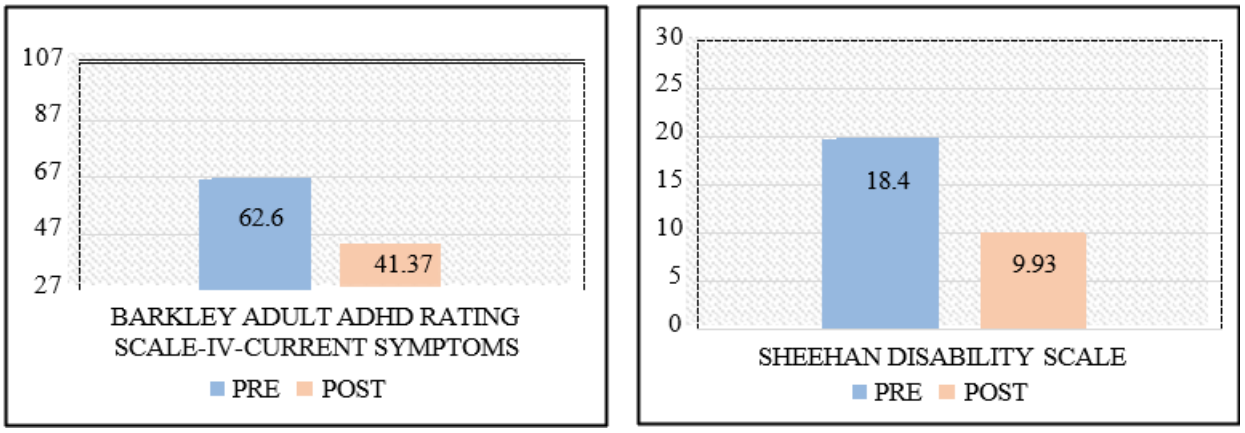
4. Result

All data were analyzed using SPSS version 26 for Windows (SPSS, Chicago, IL, USA). Descriptive statistics for the participants and assessed variables were calculated. The data were ordinal, so non-parametric tests were used for analysis. One criterion for choosing a non-parametric test is that the data are measured on a nominal or ordinal scale.[31] The experimental group's data were compared at baseline and after 8 weeks of intervention. Potential interactions between treatment and covariates, such as age, gender, and BMI, were also considered. As the variables were ordinal, the Wilcoxon Signed-Rank test was used to analyze pre- and post-intervention paired data. The results were presented as frequencies and percentages for categorical variables and as means, medians, standard deviations, and 95% confidence intervals for continuous variables. The frequency and percentage distribution of demographic variables in the experimental group showed that participants were aged 18 to 25 years, with 55% in the 18-20 age group and 45% in the 20-25 age group. The gender distribution in the study showed that 30% of participants were male and 70% were female in the experimental group. Table 1 shows the pre- and post- intervention mean ± SD, Z-values (BAARS-IV current symptoms: Z = -6.742; SDS: Z = -6.826), and a p-value of < 0.001.

Table 1: Shows pre and post treatment comparison of BAARS-iv and SDS

Experimental Group	Pre	Post	Z-value	*p*-value
Barkley Adult ADHD Rating Scale - iv (BAARS-iv) – current symptoms				
High INT.	62.60±15.53	41.37±13.85	-6.742	< 0.001
Sheehan Disability Scale (SDS)-functions				
High INT.	18.40±5.47	9.93±4.36	-6.826	< 0.001

In Graphs 1 and 2, BAARS-IV current symptoms and SDS mean scores at baseline and after 8 weeks of aerobic exercise are represented. There was a statistically significant difference in mean scores at each evaluation time point. Moreover, aerobic exercise showed a significant improvement in the severity of symptoms and functional outcomes among participants with mild adult ADHD.



Graph 1 and 2 shows Mean±SD of the Pre and Post values of Outcome Measures-BAARS-iv-current symptoms and SDS

5. Discussion

The present study aimed to evaluate the effectiveness of aerobic exercises in reducing the severity of symptoms and improving functional outcomes in adults with mild ADHD. A total of 60 participants were screened using the Adult ADHD Self-Report Scale (ASRS-v1.1) and DSM-5 criteria before undergoing an 8-week aerobic exercise intervention. Outcome measures, including the Barkley Adult ADHD Rating Scale-IV (BAARS-IV) and the Sheehan Disability Scale (SDS), were recorded at baseline and post-intervention. The results demonstrated a statistically

significant reduction in ADHD symptom severity and an improvement in functional outcomes, with a p-value of <0.001, indicating a strong effect of aerobic exercise. This improvement was evident in the mean pre- and post-intervention scores of BAARS-IV (Mean pre: 62.60, SD: 15.53; Mean post: 41.37, SD: 13.85) and SDS (Mean pre: 18.40, SD: 5.472; Mean post: 9.93, SD: 4.364), analysed using the Wilcoxon Sign Rank test. The intra- group comparison confirmed that aerobic exercise led to meaningful reductions in symptom severity and functional impairments.

These findings align with previous research, such as the study by Aylin Mehren et al. (2019), which reported improvements in executive function and attention following aerobic exercise in adults with ADHD. The potential mechanism through which aerobic exercises impact the severity of symptoms and functions in ADHD involves neurophysiological effects. These effects include increased central arousal, linked to elevated release of fronto-striatal neurotransmitters such as dopamine, epinephrine, norepinephrine, and serotonin. In individuals with ADHD, abnormalities in fronto-striatal functioning, particularly hypoactivity in the dopaminergic and noradrenergic systems, have been associated with attentional and executive impairments. Long-term exercise has been shown to result in significant increases in peripheral epinephrine and serotonin levels. Wigal et al. observed increases in both epinephrine and norepinephrine after exercise.[17]

The exercise-induced elevation of these neurotransmitters may potentially compensate for dysregulated catecholamine levels in ADHD, thereby contributing to improvements in cognitive and behavioural functioning. These beneficial changes encompass increases in gray matter in frontal and hippocampal areas, along with alterations in brain activation patterns and functional connectivity.[22]

The study observed an increase in participant confidence following the intervention, which may have contributed to improved daily functioning. This research had no attrition bias, as all participants completed the intervention, further strengthening the validity of the findings. Given the significant improvements observed, aerobic exercise can be considered a viable non- pharmacological strategy for ADHD management, particularly for individuals seeking alternatives to medication.

6. Conclusion

This pre-post interventional study provides compelling evidence that aerobic exercises have a significant positive impact on individuals with mild Adult Attention Deficit Hyperactivity Disorder (ADHD). These outcomes highlight the potential efficacy of incorporating aerobic exercises as a non-pharmacological approach in the comprehensive management of mild ADHD.

Overall, these findings contribute to the evolving understanding of lifestyle interventions for ADHD and underscore the potential of aerobic exercises in improving the lives of individuals with this condition.

7. Limitations

There was detection bias in double blinding of outcome measurement, as blinding of the therapist was not feasible in the study. No follow-up periods, to investigate the long-term effects of treatment. The study not included any quantitative measurement of symptoms measurement. The result came from a single-center study.

8. Future Recommendations

Future studies could be randomized controlled trail with large sample size**,** conducted with same protocol compared with another protocol of aerobic exercises, conducted with different FITT, conducted in different age groups and conducted in different centers.

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