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Effectiveness of sensory modulation intervention for adults with anxiety disorder

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ABSTRACT

Background: Anxiety disorders are characterized by excessive worry and apprehension that is often difficult to control, hence causing restlessness, palpitations, difficulty breathing, difficulty concentrating, and feeling sad or low mood, leading to occupational functioning impairment. Sensory Modulation is the central nervous system's neurological capacity to control environmental sensory stimuli and allow for a behavioral reaction to those stimuli. Research indicates that sensory modulation interventions have the potential to reduce distress levels and modulate arousal levels, thereby improving the occupational participation of adults with mental illnesses. As there are fewer studies conducted on adults with anxiety disorder for sensory modulation intervention, it is important to investigate this topic further.

Objectives: To determine the effectiveness of sensory modulation intervention on adults with anxiety disorder.

Materials and methods: The study used a non-equivalent control group pre-test-post-test design. Adults with anxiety disorder were selected using convenience sampling. The individuals who were chosen for inclusion and exclusion were screened using Beck's Anxiety Scale, with scores ranging from 20-69. The participants were grouped into experimental and control groups. The control group received conventional occupational therapy, while the experimental group received a sensory modulation intervention for 6 weeks. Before beginning the intervention, both groups completed the Canadian Occupational Performance Measure (COPM) and the WHO Disability Assessment Schedule 2.0 (WHODAS 2.0).

Results: Compared with the pre-test, post-test COPM scores in the experimental group improved significantly (p=0.017 for performance, p=0.003 for satisfaction), and WHODAS 2.0 disability scores decreased significantly (p=0.015) compared with the control group.

Conclusion: COPM and WHODAS 2.0 findings demonstrate that sensory modulation interventions produce meaningful functional gains in adults with anxiety disorders, along with occupational therapy-based rehabilitation to enhance independence, participation, and quality of life.

Introduction

Anxiety disorders are among the most prevalent mental health conditions worldwide, affecting approximately 4% of the population.[1] These disorders are characterized by excessive and persistent worry, heightened physiological arousal, and cognitive and emotional disturbances, which can significantly impair daily functioning, social participation, and overall quality of life.[2,3] Common symptoms include increased heart rate, agitation, hyperventilation, disturbed sleep, difficulty concentrating, overthinking, and, in severe cases, suicidal ideation.[4] According to the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), anxiety disorders encompass generalized anxiety disorder, panic disorder, social anxiety disorder, specific phobias, and agoraphobia.[5]

Conventional treatments, including pharmacotherapy and psychotherapy, have shown efficacy in reducing symptomatic distress. However, they often fail to address functional limitations or improve engagement in meaningful daily activities, highlighting a critical gap in existing interventions.[6,7] Occupational therapy emphasizes enhancing functional performance and participation in daily life, targeting the occupational deficits experienced by adults with anxiety disorders.[8] Emerging evidence suggests that sensory-based interventions may provide additional benefits by supporting emotional regulation, reducing distress, and facilitating engagement in daily occupations.[9]

Sensory modulation is both a neurological process and a therapeutic strategy. Neurologically, it refers to the central nervous system's ability to process, organize, and integrate sensory input from the environment, allowing adaptive responses to external and internal stimuli.[10] Therapeutically, sensory modulation interventions provide structured sensory experiences through tactile, auditory, visual, vestibular, and proprioceptive inputs to help individuals consciously regulate physiological and emotional arousal.[11,12] These interventions are non-invasive, self-directed, and empowering, aligning with trauma-informed and recovery-oriented practices.[13] Mental health settings increasingly employ strategies such as sensory rooms, sensory kits, and group-based sensory programs to promote emotional regulation, enhance self-awareness, and improve engagement in meaningful activities.[14]

Empirical studies indicate a link between sensory processing difficulties and anxiety.[11,15,16] Individuals with heightened sensory sensitivity often experience overstimulation, resulting in increased distress, avoidance behaviors, and reduced participation in daily activities.[17] By identifying personal sensory preferences and modulating sensory input appropriately, individuals can achieve optimal arousal levels, enhance self-regulation, and improve functional performance.[18] Occupational therapists utilize sensory modulation techniques to promote adaptive responses, reduce maladaptive behaviors, and facilitate engagement in meaningful

occupations.[19] Research has demonstrated that sensory modulation interventions can reduce distress, regulate arousal levels, and improve occupational performance in adults with various mental health conditions, including anxiety disorders.[20,21]

Despite these promising findings, limited research has specifically evaluated structured sensory modulation interventions in adults diagnosed with anxiety disorders, particularly regarding functional outcomes such as occupational performance and disability reduction.[21] Understanding the effectiveness of these interventions in improving daily functioning is critical for evidence-based occupational therapy practice and mental health rehabilitation. This specific age range (20-60 years) was chosen based on epidemiological data indicating that anxiety disorders peak in prevalence during working age, making functional and occupational rehabilitation particularly critical for this demographic.

Therefore, the present study aimed to evaluate the impact of a six-week sensory modulation intervention on anxiety reduction and occupational performance in adults with anxiety disorders. It was hypothesized that participants receiving the sensory modulation intervention would demonstrate greater improvements in functional performance and reduced disability compared with those receiving conventional occupational therapy alone.[20-22]

Materials and Methods

Study design

A non-equivalent control group pre-test-post-test design was employed to evaluate the effectiveness of sensory modulation intervention in adults diagnosed with anxiety disorders. This design allowed for the comparison of functional and clinical outcomes between an experimental group receiving sensory modulation intervention and a control group receiving conventional occupational therapy.[23,24]

Participants

A total of 80 participants, aged between 20 and 60 years, diagnosed with clinically significant anxiety by a psychiatrist and presenting with symptoms for a minimum of three months, were recruited. Only individuals with stable medication regimens for at least six weeks prior to study commencement were included. Both male and female participants were considered. Individuals were excluded if they were undergoing cognitive therapies, exhibited active psychotic symptoms, had significant cognitive impairments, or were under treatment with benzodiazepines. Sample size was determined a priori using G*Power software with an effect size of 0.5, an alpha level of 0.05, and statistical power of 0.80. Discontinuation criteria included failure to attend three consecutive therapy sessions or initiation of new psychotropic medications during the intervention period. Acknowledged as a methodological limitation, formal screening for baseline sensory processing impairments was not conducted prior to inclusion.

Recruitment and ethical considerations

Participants were recruited through convenience sampling from outpatient mental health services. The study team explained the study purpose in detail to all potential participants and obtained written informed consent before enrolment. The study adhered to ethical principles outlined in the Declaration of Helsinki and received approval from the institutional ethics committee.[25,26]

Procedure

Eighty participants were assigned to two groups of equal size (group A control and group B experimental, 40 participants each) using a computer-generated block randomization sequence to ensure allocation concealment. Pre-intervention assessments were conducted for both groups using the Beck Anxiety Inventory for screening, while the Canadian Occupational Performance Measure (COPM) and WHODAS 2.0 were used as outcome measures.

Intervention

The control group received conventional occupational therapy for anxiety management. Each session lasted 45 minutes and was delivered twice weekly over eight weeks. Interventions included diaphragmatic breathing training, restorative yoga, and mindfulness exercises, focusing on relaxation and anxiety reduction.[6,7]

The experimental group received a structured sensory modulation intervention delivered twice weekly over eight weeks, with each session lasting 45 minutes. The intervention began with education on the relationship between sensory input and autonomic nervous system responses, helping participants understand how sensory experiences influence arousal and emotional regulation. Individual sensory profiles, assessed through adolescent and adult sensory questionnaires, were reviewed to tailor intervention planning to each participant's unique sensory needs. Participants explored a variety of sensory tools-including weighted blankets, therapy balls, and sensory wraps-to identify strategies most suited to regulating their arousal levels. Subsequent sessions emphasized goal setting, practical application of selected sensory strategies in daily routines, and continued support to facilitate consistent use of these strategies. This structured approach aimed to enhance engagement in prioritized occupational activities and promote sustained self-regulation.[11,12,14,18,21]

Outcome measures

Functional performance and disability were assessed pre- and post-intervention using COPM and WHODAS 2.0 for both groups. The COPM is a standardized, client-centered outcome measure evaluating perceived performance

and satisfaction in daily activities (established test-retest reliability r>0.80). The WHODAS 2.0 is a 36-item validated tool measuring general health and disability across six domains (reliability alpha >0.85). The Beck Anxiety Inventory (BAI) is a 21-item self-report scale measuring clinical anxiety severity.[7,8]

Statistical analysis

Data analysis was performed using SPSS version 27.0. Descriptive statistics, including frequencies and measures of central tendency, summarized demographic characteristics. Prior to parametric analyses, the assumption of normality was formally verified using the Shapiro-Wilk test (p>0.05). Paired t-tests were used to evaluate within-group changes, while independent t-tests compared outcomes between groups. Two-tailed p≤0.05 was considered statistically significant.

Results

A total of 80 participants were enrolled in the study, with 40 assigned to the control group and 40 to the experimental group. The mean age of the study population was 37.27±10.56 years. Based on Beck Anxiety Inventory scores, 75% of participants were classified as having moderate anxiety, while 25% exhibited severe anxiety (Table 1).

Table 1. Demographic distribution of variables.

Demographic variables	Control (N=40)	Experimental (N=40)	Total (N=80)
Gender - Male	22 (55%)	22 (55%)	44 (55%)
Gender - Female	18 (45%)	18 (45%)	36 (45%)
Severity - Moderate	30 (75%)	30 (75%)	60 (75%)
Severity - Severe	10 (25%)	10 (25%)	20 (25%)

Pre-intervention comparisons between the control and experimental groups showed no statistically significant differences, indicating baseline equivalence. COPM performance scores were similar between the control and experimental groups (t=1.666, p=0.107), as were COPM satisfaction scores (t=0.054, p=0.957). Similarly, WHODAS 2.0 scores did not differ significantly between the two groups at baseline (t=-1.528, p=0.138) (Table 2 and Figure 1). These findings suggest that, before the intervention, both groups were comparable in occupational performance, satisfaction, and disability levels, providing an appropriate foundation for evaluating post-intervention effects.

Table 2. Comparison of pretest scores of COPM and WHODAS between the control group and the experimental group.

Outcome measures	Group	Mean	SD	t value	*p* value
COPM performance	Control	5.580	1.0884	1.666	0.107
	Experiment	4.847	1.3125		
COPM Satisfaction	Control	5.933	1.0933	0.054	0.957
	Experiment	5.907	1.5668		
WHO DAS 2.0	Control	102.67	9.641	-1.528	0.138
	Experiment	108.47	11.103		

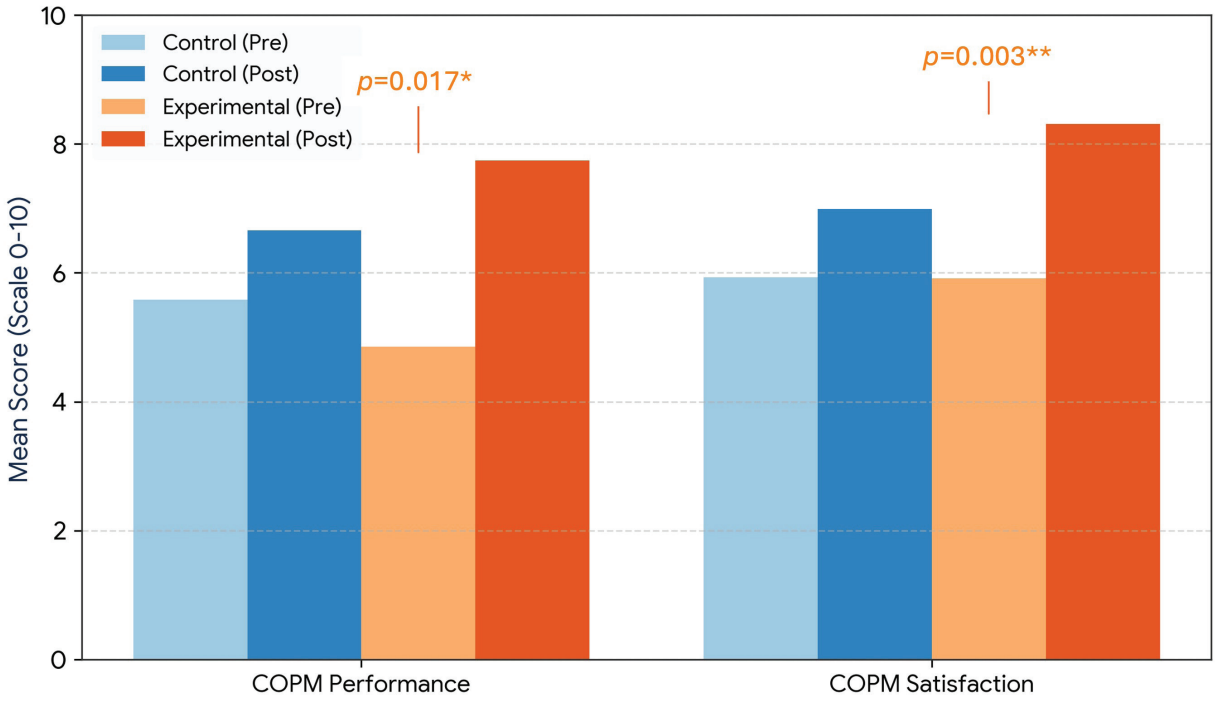


Figure 1. Pre-test and post-test COPM scores for the control and experimental groups.

Post-test comparisons revealed significant improvements in the experimental group relative to the control group. COPM performance scores were higher in the experimental group (t=-2.532, *p*=0.017), indicating improved perceived occupational performance following the sensory modulation intervention. Similarly, COPM satisfaction scores were significantly higher in the experimental group than in the control group (t=-3.262, *p*=0.003), reflecting improved satisfaction with occupational engagement. For disability, WHODAS 2.0 scores were lower in the experimental group than in the control group (t=2.600, *p*=0.015) (Table 3 and Figure 2), indicating reduced functional limitations following the intervention. These findings show that the sensory modulation intervention positively affected occupational performance, participant satisfaction, and overall disability levels. In contrast, the control group, which received conventional occupational therapy, showed comparatively smaller changes in these measures, suggesting that sensory modulation strategies contributed additional benefits beyond standard therapy alone.

Table 3. Comparison of post-test scores on the COPM and WHODAS 2.0 between the control and experimental groups.

Outcome measures	Group	Mean	SD	t value	*p* value
COPM Performance	Control	6.657	1.0302	-2.532	0.017
	Experiment	7.740	1.5066		
COPM Satisfaction	Control	6.993	0.9246	-3.262	0.003
	Experiment	8.307	1.2555		
WHO DAS 2.0	Control	95.53	9.826	2.600	0.015
	Experiment	85.53	11.192		

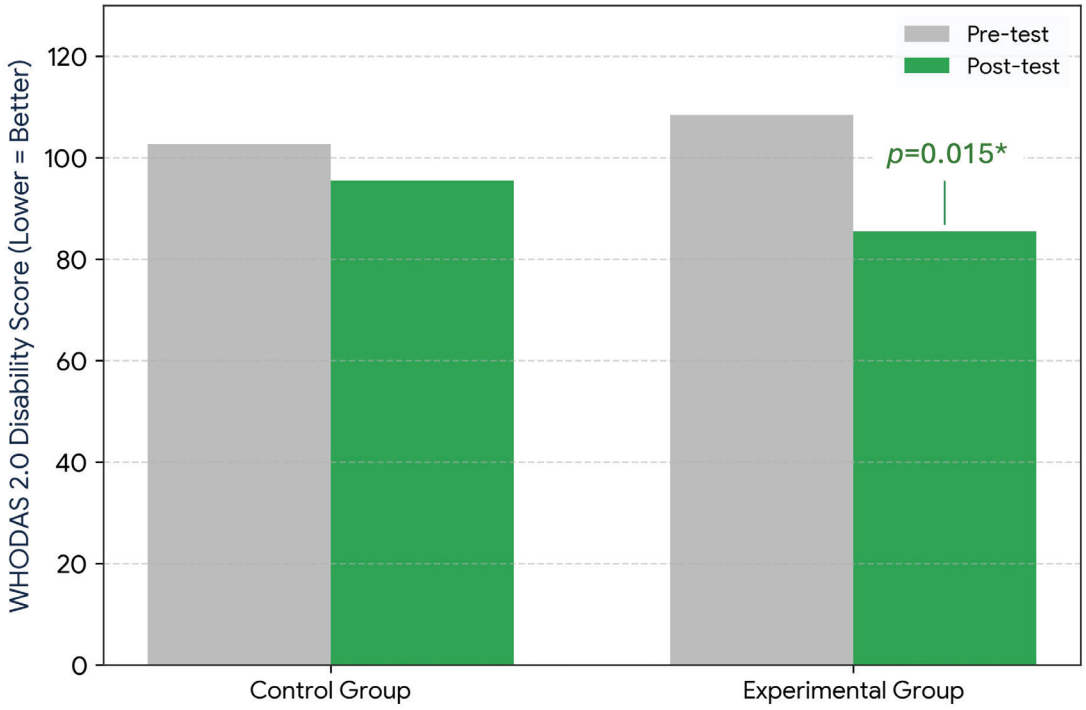


Figure 2. Pre-test and post-test WHODAS 2.0 scores between the control group and the experimental group.

Discussion

This study aimed to evaluate the effectiveness of sensory modulation intervention in adults with anxiety disorders by comparing occupational performance, satisfaction, and functional disability outcomes between an experimental group and a control group. Baseline comparisons revealed no statistically significant differences between groups in COPM performance, COPM satisfaction, or WHODAS 2.0 scores, confirming that post-intervention differences are attributable to the sensory modulation intervention rather than pre-existing disparities. This baseline equivalence strengthens the internal validity and supports the reliability of the findings.[7,8]

Post-intervention analyses showed that participants in the experimental group improved significantly in COPM performance and satisfaction scores compared with the control group. These findings suggest greater engagement in meaningful daily activities and increased satisfaction with occupational performance, highlighting COPM's responsiveness as a client-centered tool for detecting changes in occupational functioning.[7,27] Similarly, WHODAS 2.0 scores showed a notable reduction in disability in the experimental group, while the control group showed minimal change. This finding confirms the sensitivity of WHODAS 2.0 as a standardized measure for evaluating functional disability in adults with mental health conditions.[8,28]

Integrating COPM and WHODAS 2.0 outcomes provides both subjective and objective evidence of intervention effectiveness. Improvements in COPM scores reflect participants' perceived ability to perform daily tasks and satisfaction with their engagement, while reductions in WHODAS 2.0 scores indicate improved functional participation and reduced disability. Collectively, these results support the conclusion that sensory modulation interventions can produce meaningful functional gains for adults with anxiety disorders, aligning with rehabilitation frameworks that emphasize client-centered, occupation-based approaches to improve independence, participation, and quality of life.[18-20]

Structured sensory input tailored to individual preferences may optimize arousal levels, enabling better emotional regulation and increased readiness to engage in daily activities.[11,12,14,18] Educational and goal-setting components likely reinforced self-efficacy and awareness, promoting consistent use of sensory strategies in participants' routines.[21] Tailoring interventions based on individual sensory profiles enhances client-centered practice by addressing specific autonomic nervous system dysregulations. Compared to existing literature, this study extends current evidence by demonstrating targeted functional disability reduction within a non-equivalent control group design framework. These mechanisms underscore the potential of sensory modulation to complement conventional occupational therapy techniques by addressing both psychological and functional aspects of anxiety disorders.[20,21]

Limitations

The sample size was small, and a convenience sampling technique was used in the study. Additional methodological limitations include the lack of outcome assessor blinding (introducing potential measurement bias), the absence of formal baseline screening for sensory processing factors, and the lack of a long-term

follow-up assessment to evaluate the sustainability of intervention outcomes over time.

Future study

Future research should incorporate larger, more diverse multi-center samples and longitudinal follow-up assessments to evaluate the long-term sustainability of sensory modulation interventions.

Practical implication

Integrating structured sensory modulation programs into outpatient mental health settings provides occupational therapists with practical, non-invasive tools to enhance emotional regulation and functional participation in adults with anxiety.

Conclusion

The findings of this study demonstrate that a structured sensory modulation intervention can significantly enhance occupational performance, satisfaction, and functional participation in adults with anxiety disorders. Participants who received the eight-week sensory modulation program showed greater improvements in both subjective and objective outcomes compared with those who received conventional occupational therapy alone. These results highlight the value of incorporating sensory-based strategies to support emotional regulation, reduce disability, and improve engagement in meaningful daily activities. Future studies should include larger, more diverse samples and consider multi-site designs to enhance generalizability. Longitudinal investigations are recommended to assess the sustained impact of sensory modulation interventions. Furthermore, integrating physiological measurements such as heart rate variability or galvanic skin response may elucidate mechanisms of action. Additional research exploring combinations of sensory modulation with evidence-based interventions like cognitive-behavioral therapy or mindfulness could provide insights into synergistic effects on functional outcomes.

Ethical approval

The study received approval from the Institutional Ethics Committee of SRM Institute of Science and Technology (Approval No: SRMIEC- ST0424-1320) and adhered to the ethical principles of the Declaration of Helsinki.

Declaration of generative AI and AI-assisted technologies

AI tools (OpenAI ChatGPT) were used exclusively for English language proofreading and grammar correction during the preparation of this manuscript.

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Conflict of interest

The authors declare no conflict of interest.

CRediT authorship contribution statement

Ganapathy Sankar U: conceptualization, Supervision, writing-reviewing and editing; **Febin Maria Mathew:** methodology, data curation, formal analysis, writing-original draft; **Monisha Ravimumar:** data curation, writing-review and editing.

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