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EFFECT OF EXERGAMING EYE HAND COORIDNATION IN HEALTHY GERIATRICS – AN EXPIREMENTAL STUDY

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ABSTRACT

Background: Aging is associated with a decline in both physical and cognitive functions, including eye-hand coordination (EHC)—the ability to synchronize visual input with hand movements. EHC depends on the integration of sensory, motor, and cognitive processes such as attention and memory, and is essential for performing everyday tasks independently. Declines in EHC can increase dependency in daily life. Exergames, which combine physical and cognitive training, have shown potential in enhancing motor and cognitive abilities across all age groups, particularly in the elderly.

Methodology: 60 healthy Geriatric population participated in this study. Participants were selected on basis of the inclusion and exclusion criteria and divided into two equal groups using chit method. Group A participants underwent the Exergaming exercise protocol and Group B participants underwent Conventional exercise training for thrice a week for four weeks each. Mirror tracing test and Trail making test A and B were used to assess the pre and post intervention. Statistical analysis was done and conclusion was drawn accordingly.

Result: The performance of mirror tracing test compared between Group A and Group B, shows that In Group A errors and time taken for Mirror tracing test in reduced as compared to Group B with a mean difference of 12.5, with p value <0.0001.

Conclusion: The study Concludes that the effect of exergaming in improving eye hand coordination is effective after the 4 weeks of training in geriatrics population.

Keywords: Eye hand Co-ordination, Mirror tracing test, Exergaming, Trail making test A
Trail making test B

INTRODUCTION

The elderly population in India has experienced significant growth post-independence, as seen in the 2001 and 2011 censuses, with the number of elderly women surpassing elderly men over the past two decades(1,2). Globally, the population aged 60 and older is projected to rise from 12% to 22% by 2050. Ageing leads to various biological changes due to molecular and cellular damage(3,4,5). Notably, in 2017, India reported approximately 990,950 deaths, 59% of which were among the elderly, with cardiovascular diseases, chronic respiratory diseases, strokes, and cancers being the leading causes(6,7). The elderly also face various disabilities, with movement and visual impairments being the most prevalent, affecting 25% of individuals each. Additionally, 12% have hearing impairments, and some individuals have multiple

disabilities.(4,8,9,10) A major study highlighted visual impairment as the leading morbidity(11,12). Ageing impacts physical, psychological, and social functions, often resulting in cognitive decline that affects daily activities and overall quality of life, particularly in visuospatial processing and motor coordination(9,13). Visuospatial processing most significant cortical functions involved in Eye-Hand co-ordination (EHC) is re- mapping spatial information after eye movements, and transferring motor commands to primary motor areas for preparation. The cortex processes visuospatial information and controls the complex signal generation needed for multi-joint muscular contractions during accurate reaching and grasping (14,15)

Eye-hand coordination (EHC) is the capacity of the individual to execute purposeful hand movements based on visual input from the eyes. EHC depends critically on integrated control ocular and appendicular sensorimotor system to accomplish a single goal, such as touching a visual target. Effective coordination between the eyes and hands depends on intricate connections involving feedforward and feedback mechanisms among the visual, ocular, and limb motor systems. This coordination involves specific synchronizations in spatial and temporal aspects (16). Good coordination between the sensory visual system and the musculoskeletal system is required for efficient and effective human function during interaction with the nearby environment.(17) Eye-hand coordination requires the integrated functioning of multiple sensorimotor systems, including the visual system, vestibular system, proprioception, and the control systems for the eye, head, and arm, as well as cognitive elements such as attention and memory.(15)

Exergames are a form of interactive gaming that integrates physical activity with cognitive stimulation. These games necessitate physical movement in a digital, augmented, or virtual environment with interactive and mentally challenging elements (18,19). Technology and game-based rehabilitation systems can contribute to the development of both motor and cognitive functions with task-specific upper extremity exercises. (20) Despite being originally designed for children and youth entertainment, exergames have gained popularity among older adults for enhancing physical activity, health, and physical function. (21,22,23,24) Exergames are commonly used to offer moderate physical exercise for individuals with disabilities. It also enables individuals to participate in fun physical activities. (25,18) Exergaming was useful for safely improving the motor functions of the elderly, including lower-limb muscle strength, at an adequate intensity of exercise in a short period as well as prevention of falls. (26,27). Studies indicate that exergames are both secure and practical for the elderly population. (18)

METHODOLOGY

Study Design: Experimental study

Participants: 60 healthy Geriatric population participated in this study. Participants were selected on basis of the inclusion and exclusion criteria and randomly divided into two equal groups using the chit method.

Inclusion criteria:

- Healthy elderly 60- 70 years
- Both male and female
- Person capable of understanding tasks or giving commands and capable of executing them
- No cognitive deficit (MOCA test score 26 or above is to considered)
- Voluntarily participation and ability to sign the informed consent form

Exclusion criteria:

- Alzheimer's disease diagnosed or meeting the diagnostic criteria for dementia
- Non correctable visual impairments.
- Severe mental illness or behaviour problems and inability to cooperate with the trainer.
- Severe cardiovascular diseases resulting in an inability to walk independently.

Intervention:

Group A (Experimental) Played on Wii Fit device board three times per session thrice a week (approximately 30/ 45 mins.)

1. Tilt City
2. Juggling

Group B (Conventional) Played three times per session thrice a week (approximately 30/ 45 mins.)

1. Bounce the ball to the floor

2. Throwing the ball into the basket
3. Ruffle the ball use a racket.
4. Dribble the ball with hands
5. Throw and Catch the ball

Outcome Measure:

The study Adopted Mirror tracing test and Trail making test A and B to assess Eye hand coordination. Each Individual Took the test two times, Pre intervention and post intervention. Results were recorded.

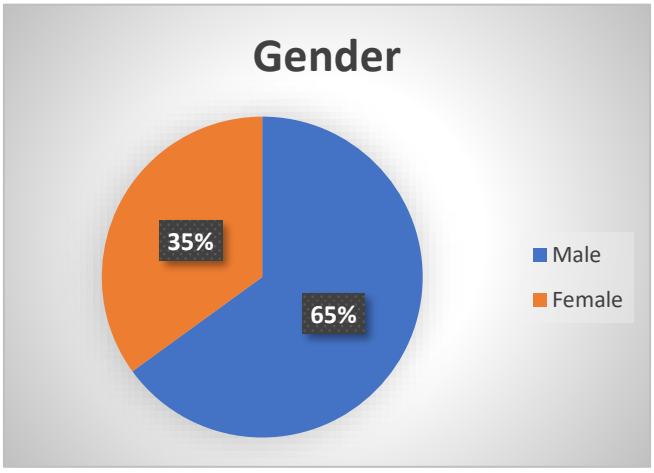
Statistical Analysis:

The data from the outcome measures: Mirror tracing test and Trail making test A and B was entered in MS Excel and Master Chart was created. The data was analyzed using Graph Pad Instat Software version Prism 9.5.1. Continuous variables were expressed as mean and SD. Data was initially explored to find out normal distribution. Shapiro Wilk test was used for analysis. Data was normally distributed. Therefore, paired t-test was used to analyse the data within the same group and unpaired t-test was used to analyse the data between groups. In all the tests performed, $p<0.05$ was considered to be statistically significant.

RESULT

	NO. OF INDIVIDUALS
Male	39
Female	21

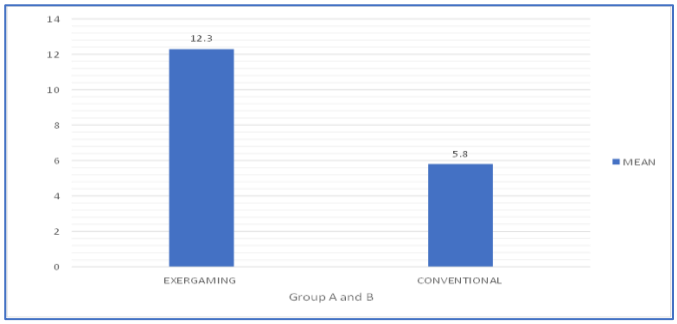
Table no.1 Gender distribution



Graph no.1 gender distribution

MMT	MEAN±SD	P VALUE
EXERGAMING	34.5±8.33	<0.0001
CONVENTIONAL	22.06±6.06	

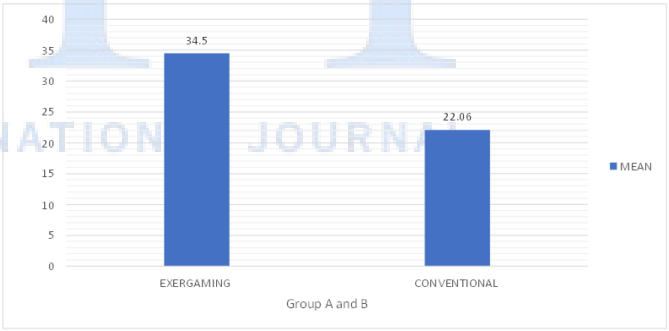
Table no:2 Comparison between Group A and Group B for time taken Mirror Tracing Test



Graph no:2 Comparison between Group A and Group B for time taken Mirror Tracing Test

ERRORS	MEAN±SD	P VALUE
EXERGAMING	12.3±2.7	<0.0001
CONVENTIONAL	5.8±2.5	

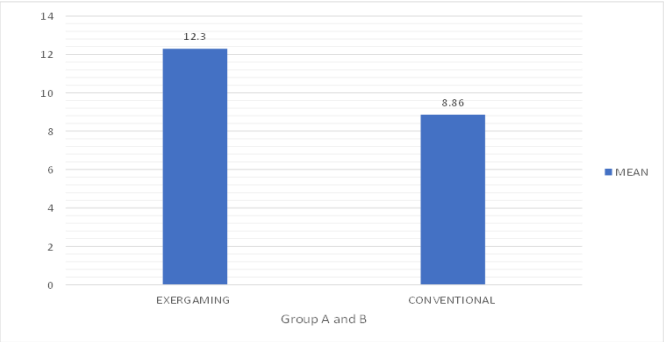
Table no:3 Comparison between Group A and Group B for No of Errors in Mirror Tracing Test



Graph no:3 Comparison between Group A and B for No of Errors in Mirror Tracing test.

TMT A	MEAN±SD	P VALUE
EXERGAMING	12.3±2.6	<0.0001
CONVENTIONAL	8.86±1.38	

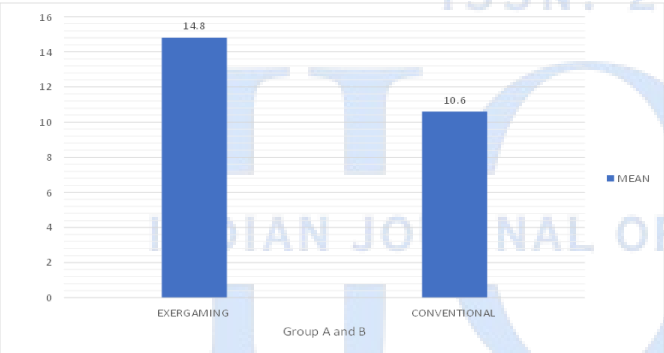
Table no:3 Comparison between Group A and Group B for Trail Making Test A



Graph no:4 Comparison between Group A and Group B for Trail Making Test A

TMT A	MEAN±SD	P VALUE
EXERGAMING	14.8±3.9	<0.0001
CONVENTIONAL	10.6±3.52	

Table no: 5 Comparison between Group A and Group B for Trail Making Test B



Graph no: 5 Comparison between Group A and Group B for Trail Making Test B

DISCUSSION

Beginning in 60's a slight overall accuracy decline is seen that progress slowly, linked to age-related biological changes in the nervous system. These include neuron loss, lipofuscin accumulation, neurofibrillary tangles, senile plaques, and reduced brain blood supply. The shrinkage of motor control areas, like the primary motor cortex, leads to decreased neurotransmitters such as dopamine and acetylcholine, resulting in delayed neural signal transmission. A study by Jihan et al. highlights that aging decreases perceptual-motor adaptability and spatial alignment, contributing to a decline in eye-hand coordination. (18)

Physical activity is vital for older adults to maintain physical and mental health while enhancing overall quality of life. Despite its importance, many seniors do not engage in physical activities due to a lack of enjoyment. Exergaming, which fuses technology, play, and exercise, has emerged as a rehabilitative tool for improving both physical and cognitive skills in older adults(28). Research indicates that exergaming boosts frontal theta activity, regardless of game complexity. Notably, Kalapna et al. demonstrated the effectiveness of the Wii Fit program in enhancing balance among older adults(24) Similarly, Donald et al. concluded that Wii Fit exergames represent a promising method for balance improvement. Performance improvements were noted in the mirror tracing test after four weeks of exergaming (29).

In this study we found out that performance for mirror tracing test in group A i.e. Exergaming Group was considerably improved with a mean difference between pre intervention and post intervention after 4 weeks of session is 34.5, with a p value <0.0001. The performance of Mirror tracing test in group B i.e. Conventional group time taken was improved with a mean difference between pre intervention and post intervention after 4 weeks of alternate session 22.1, with p value <0.0001. The performance of mirror tracing test compared between Group A and Group B, shows that In Group A time taken for Mirror tracing test in reduced as compared to Group B with a mean difference of 12.5, with p value <0.0001.

Furthermore, Ada Wai et al. found that exergames significantly advanced eye-hand coordination (EHC) in children, reducing time for task completion (30). Babadi et al. reported that virtual reality exercises resulted in better coordination among older individuals, decreasing task execution time (31). Alrubaye et al. noted significant performance gains in the mirror tracing test after EHC training for four weeks.

In this study we found out that performance of errors in mirror tracing test in group A i.e. Exergaming Group was considerably was decreased with a mean difference between pre intervention and post intervention after 4 weeks of sessions 12.4, with a p value <0.0001. The performance of errors in Mirror tracing test in group B i.e. Conventional group was decreased with a mean difference between pre intervention and post intervention after 4 weeks of session 5.8, with p value <0.0001. The performance of errors in mirror tracing test compared between Group A and Group B, shows that In Group A errors in Mirror tracing test were found reduced as

compared to Group B with a mean difference of 6.6, with p value <0.0001.

Finally, Middleton et al. highlighted substantial enhancements in hand coordination tasks in younger participants, suggesting that complex movements like those in surgery require more neural engagement (32).

New connections are generated in hippocampus and brain areas which gets strengthened and efficiency of connections are modified, allowing for fasters and more accurate transmission of signals. It also improves specific demand of the task, compensatory mechanism and learning consolidation these neural adaptation enables the brain to reorganize and improve EHC, reducing errors in the mirror tracing test and enhancing overall motor performance.

Also, this literature supports the current research accordance to the reduction of errors in mirror tracing test. (31,33)

The study focuses on the effects of visual search and motor speed on the performance of the TMT (Trail Making Test) in frail older adults. It reveals reduced reading ability, limited visual search skills, weak capability to hold two sequences concurrently, and declining attention and working memory functions(34). The performance of Trail making test A compared between Group A and Group B, shows that In Group A the time taken for Trail making test A were found reduced as compared to Group B with a mean difference of 3.4, with p value Exergaming, a method that involves dual-task activities, is considered the most effective method for improving cognitive functioning and preventing falls in older adults. These dual tasks require simultaneous coordination of movements and cognitive activities, including recall of movements and visual-spatial orientations. The performance of Trail making test A compared between Group A and Group B, shows that In Group A the time taken for Trail making test B were found significantly reduced as compared to Group B with a mean difference of 4.2, with p value <0.0001. It also found that the completion time for Trail Making Test B is longer than for Trail Making Test A, suggesting that the cognitive process taking place in conjunction with searching lasts longer, causing a delay in motor execution and a bigger lag between hand functions(35).

The study also found that trailing the executing hand after the eye movement and pausing the hand momentarily reduces the number of variables in the system, leading to the utilization of less motor-control associated cognitive assets and releasing additional attentional resources. The study also revealed that subjects need to allocate more attention to the task, which may be a result of the cognitive demands of the task(36).

Despite the strengths of this study, several limitations should be acknowledged. First, During the training the participants were involved cognitively although the cognition was not documented and analyzed. Also the level of individuals physical lifestyle of the subjects were not considered which might have influenced the performance. Future research should aim to conduct follow-up studies to determine the long-term effects on executive and accuracy-related functions, as well as to analyze and document aspects of cognitive functioning.

The findings of this study underscore the importance of incorporating eye-hand coordination (EHC) exercises into clinical practice for the elderly. Improvements in EHC have the potential to boost confidence and enhance the ability of older adults to perform activities of daily living (ADLs) independently. This highlights the value of integrating EHC-focused interventions into both preventive and rehabilitative programs for the geriatric population. By promoting motor control and functional independence, such exercises can contribute meaningfully to improving quality of life and reducing reliance on caregiver support. Clinicians and rehabilitation professionals should consider including EHC training as a routine part of elderly care protocols.

CONCLUSION

The present study Concludes that the effect of exergaming in improving eye hand coordination is effective after the 4 weeks of training in geriatrics population.

Conflicts Of Interest

There is no conflicts of interest.

Ethical Approval

The study was approved by the Institutional ethical committee of CMF's college of Physiotherapy MUHS, Pune, Maharashtra.

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