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Effects Of Keyboard Training Program On Fine Motor Skills And Hand Function In Geriatric Population: An Interventional Study

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Abstract:
Objective: *To examine the effectiveness of a structured keyboard training program combined with conventional fine motor exercises in improving hand function and fine motor skills among young-old geriatric individuals.*
Background: *Fine motor decline with aging impairs the elderly's ability to perform daily tasks independently. Recent evidence suggests that therapeutic keyboard playing, which integrates auditory, cognitive, and motor components, may stimulate cortical plasticity and enhance motor control.*
Materials and Methods*: This interventional study involved 30 healthy elderly participants aged 65–74, randomly assigned to two groups. Group A (n=15) received conventional fine motor exercises, while Group B (n=15) received the same in addition to keyboard training. The intervention spanned 12 sessions across four weeks. Outcome measures included the Box and Blocks Test (BBT), Nine-Hole Peg Test (9HPT), and Time-Based ADL Boards I and II. Statistical analysis included paired and unpaired t-tests.*
Results*: Both groups demonstrated statistically significant improvement in all outcome measures post-intervention. However, Group B showed significantly greater gains in manual dexterity, hand-eye coordination, and task efficiency (p<0.05) compared to Group A.*
Conclusion: *Incorporating therapeutic keyboard training into geriatric rehabilitation programs may significantly enhance fine motor performance and support functional independence in elderly adults.*
Key Word: *fine motor skills, geriatric rehabilitation, keyboard training, hand function, occupational therapy, neuroplasticity*

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I. Introduction

Aging is a natural process that brings about gradual changes in the body's ability to adapt and regulate itself. While it is not a disease, it often goes hand in hand with conditions that reduce independence and quality of life. As people grow older, their strength and hand function gradually decline, making it harder to perform everyday tasks. Fine motor difficulties such as weaker pinch control, slower finger movements, and problems with grasping small objects often interfere with activities like writing, buttoning clothes, or using utensils.[1]

These changes are not caused by muscle weakness alone. Aging also affects the brain and nervous system. Structural changes such as thinning of the cortex and reduced connectivity, along with a drop in neuroplasticity, slow down motor processing and coordination. On top of this, muscle atrophy and poor sensory feedback further limit hand dexterity.[3,4] Together, these changes lead to greater dependency in daily life. Eye–hand coordination also worsens with age, leading to slower reaction times and reduced accuracy in movements needed for dressing, driving, or cooking.[5–7] People who remain physically active show fewer declines in coordination, while sedentary lifestyles make these problems worse.[8] Changes in eye movement control, such as slower and less accurate saccades, add further difficulty in tasks requiring precision.[9]

In recent years, music has been explored as a therapy to support both mind and body in older adults. Music therapy has been shown to reduce stress, improve memory, and encourage social engagement, while also stimulating motor function.[10,11] Therapeutic keyboard music playing (TKMP) is one such approach that combines hand and finger exercises with auditory feedback. It not only provides enjoyment but also encourages regular practice, helping improve coordination and dexterity. Although TKMP has been studied in conditions like stroke and neurological rehabilitation, there is still limited evidence for its use in healthy older adults.[12,13]

The present study therefore explores whether adding a structured keyboard training program to conventional exercises can improve fine motor skills and hand function in older adults. By engaging both the neural and muscular systems in an enjoyable way, this approach may help maintain independence and quality of life in the aging population.

II. Material And Methods

Study Design: An experimental study was conducted involving 30 healthy geriatric individuals aged 65–74. Participants were randomly assigned into two equal groups: Group A (control group) and Group B (experimental group). Inclusion criteria included individuals with population of healthy individuals of age 65 to 74, individuals with normal to corrected visual & hearing, MMSE score 25 to 30. Exclusion criteria included any recent injury to the upper extremity, physical impairment to hand & arm, neurological disorders.

Study Location: a) Physiotherapy OPD, Nanavati Max Hospital, Mumbai. b) Housing societies in Santacruz, Mumbai.

Study Duration: 1 year

Sample size: 30 patients.

Sample size calculation: The sample size was estimated on the basis of G power.

Subjects & selection method: The study population was drawn from 30 subjects who were healthy geriatric individuals segregated with the inclusion & exclusion criteria of the study, divided ramdomly by odd even method into two groups equally
Group A (N=15 patients) - Control group receiving Conventional exercises
Group B (N=15 patients) - Experimental group receiving Conventional exercises in adjunct with the Keyboard Training Program.

Inclusion criteria:
1. Population of healthy individuals of age 65 to 74.
2. Individuals with normal to corrected visual & hearing
3. MMSE score 25 to 30

Exclusion criteria:
1. Any recent injury to the upper extremity.
2. Physical impairment to hand & arm.
3. Neurological disorders.

Procedure methodology
- Ethical Committee Board of Nanavati Max Super Specialty Hospital approval was taken.
- Trial was registered with Clinical Trials Registry-India.
- Patients were assessed for Inclusion and Exclusion Criteria.
- Patients were randomly allocated in Group A and Group B.
- Both groups were assessed at baseline and post intervention using Box and Blocks Test, 9 Hole Peg Test, Time Based ADL Board I and Time-Based ADL Board II
- Both groups received therapy for 30 mins for a span of 12 sessions (4 weeks, 3 days per week for alternate days)
- The analysis of the results was done using Statistical analysis using Standard Package for Social Sciences - Version 30 (SPSS), with paired t-tests for intra-group comparisons and independent t-tests for inter-group comparisons.

a. Outcome Measures:
   i. Box and Block Test (BBT): Assesses gross manual dexterity.
   ii. Nine-Hole Peg Test (9HPT): Evaluates fine finger dexterity.
   iii. Time-Based ADL Board I: Assesses task efficiency in daily living simulations.
   iv. Time-Based ADL Board II: Assesses task efficiency in daily living simulations.

b. Interventional protocol:

Conventional Protocol (Group A): (Total 12 sessions- 3 sessions per week):

Conventional Group (Group A): Intervention Protocol Exercises	Session 1-4	Session 5-8	Session 9-12
• Thera-Putty: Flexion & extension of fingers.	Orange putty 10 times	Orange putty 15 times	Green putty 10 times

• Thera-Putty: Fingers impression.	Orange putty 10 times	Orange putty 15 times	Green putty 10 times
• Fingers flexing gripper with springs.	10 times	15 times	20 times
• Finger Springs	White 10 times	White 15 times	Black 10 times
• Thera-web exercises	Orange putty 10 times	Orange putty 15 times	Green putty 10 times
• Weighted Pegs	5 times	7 times	10 times
• Sponge & Pins	10 pins	15 pins	20 pins
• Turning coins	1 Big coin 10 times	1 Big & 1 small coin7 times each	1 Big & 1 small coin 10 times each
• Crossing circle	10 circles	15 circles	20 circles
• Finger Tapping	5 times	10 times	15 times
• Flexi-bar Exercises	Green 10 times	Blue 10 times	Black 10 times

Table 1: Group A Intervention protocol

Experimental Group B: TKPM + Conventional Exercises

Experimental Group B: TKPM + Conventional Exercises	**Description**
Exercise 1	Sa Re Ga Ma Pa Dha Ni Sa Sa Ni Dha Pa Ma Ga Re Sa
Exercise 2	Sa Re Ga, Re Ga Ma, Ga Ma Pa, Ma Pa Dha, Pa Dha Ni, Dha Ni Sa Sa Ni Dha, Ni Dha Pa, Dha Pa Ma, Pa Ma Ga, Ma Ga Re, Ga Re Sa
Exercise 3	Sa Ga, Re Ma, Ga Pa, Ma Dha, Pa Ni, Dha Sa Sa Dha, Ni Pa, Pa Ma, Pa Ga, Ma Re, Ga Sa

Table 2: Group B Intervention protocol

Statistical analysis

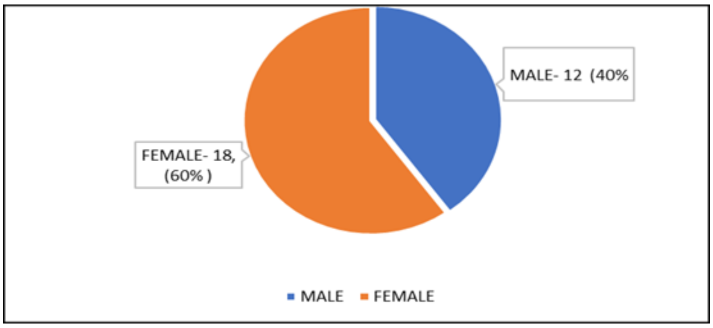
The present study evaluated the effectiveness of ADLs Boards and Keyboard Training Program in enhancing fine motor skills and hand function among the geriatric population. Statistical analysis using (SPSS) Standard Package for Social Sciences Version 30, with paired t-tests for intra-group comparisons and independent t-tests for inter-group comparisons.

III. Result

Table no 3 and Graph 1 show the gender distribution in the present study population where the male population is 40% whereas the female population is 60%.

Gender	N= 30
Male	12
Female	18

Table 3: Gender Distribution



Graph:1. Gender distribution graph.

Table no 4: Shows age range of population of the study

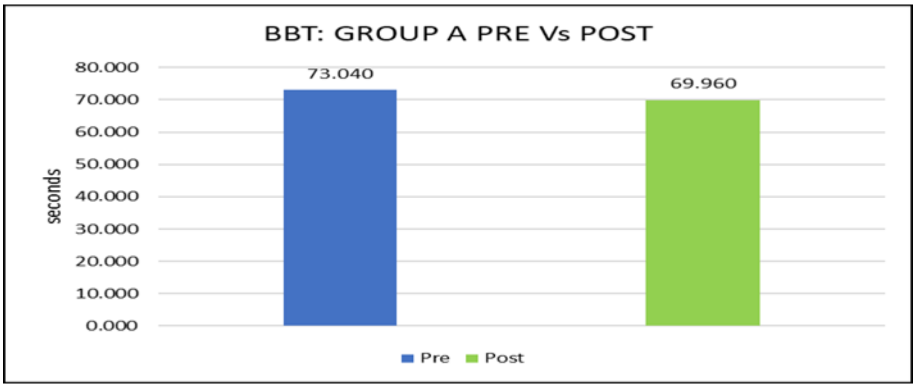
Age range	Mean age
65 – 74 years	69.3(± 3.3) years

Table 4: Age range of study

Table no 5 and Graph 2 represent the statistical analysis of fine motor skill assessment of BBT of dominant hand pre and post the intervention for Group A. The pre and post-intervention mean value for BBT dominant hand for group A is **73.04±3.76 and 69.96±3.09** respectively and **p=0.00**1, indicating a significant improvement.

Group A		
BBT Dominant Hand	**Mean±SD**	**P value**
Pre	73.04±3.76	0.001
Post	69.96±3.09	

Table 5: Group A BBT Pre and Post values of the Dominant hand.

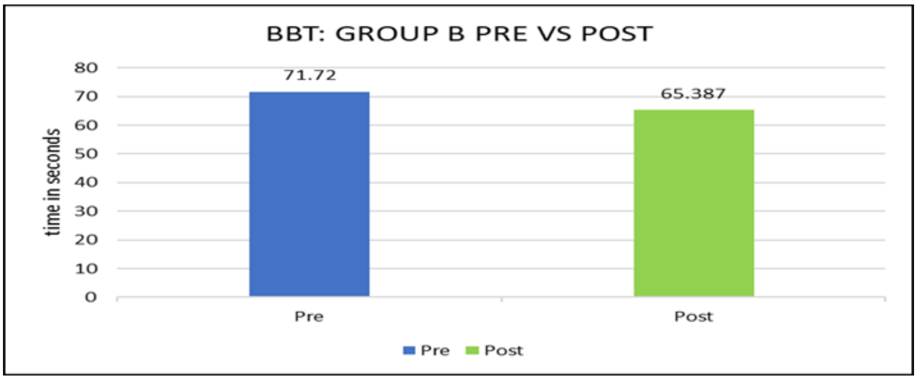


Graph 2: BBT Group A Dominant Hand

Table no 6 and Graph 3 represent the statistical analysis of fine motor skill assessment of BBT of dominant hand before and after the intervention for Group B. The pre and post-intervention mean value for BBT dominant hand for group B is **71.72±4.81** and **65.38±6.06** respectively and **p=0.001**, indicating a significant improvement.

Group B		
BBT Dominant Hand	**Mean±SD**	**P Value**
Pre	**71.72±4.81**	**0.001**
Post	**65.38±6.06**	

Table no 6: Group B BBT Pre and Post values of the Dominant hand.

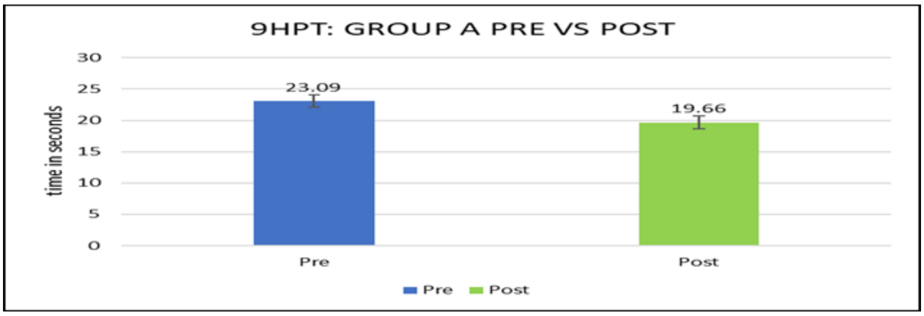


Graph 3: BBT Group B Dominant Hand.

Table no 7 and Graph 4 represent the statistical analysis of fine motor skill assessment of 9HPT of dominant hand pre and post the intervention for Group A. The pre and post-intervention mean value for 9HPT dominant hand for group A is **23.09±1.12 and 19.66±0.81** respectively with p-value **0.001,** indicating a significant improvement.

Group A		
9HPT Dominant Hand	**Mean±SD**	**P value**
Pre	**23.09±1.12**	**0.001**
Post	**19.66±0.81**	

Table no 7: Group A 9HPT Pre and Post values of the Dominant hand.

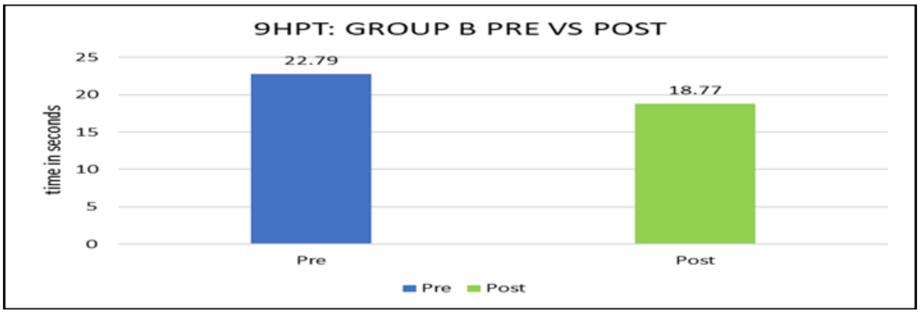


Graph 4: 9HPT Group A Dominant Hand

Table no 8 and Graph 5 represent the statistical analysis of fine motor skill assessment of 9HPT of dominant hand pre and post the intervention for Group B. The pre and post-intervention mean value for 9HPT dominant hand for group B is **22.79±1.26 and 18.77±1.21** respectively with p-value **0.001**, indicating a significant improvement.

Group B		
9HPT Dominant Hand	**Mean±SD**	**P Value**
Pre	**22.79±1.26**	**0.001**
Post	**18.77±1.21**	

Table no 8: Group B 9HPT Pre and Post values of the Dominant hand.

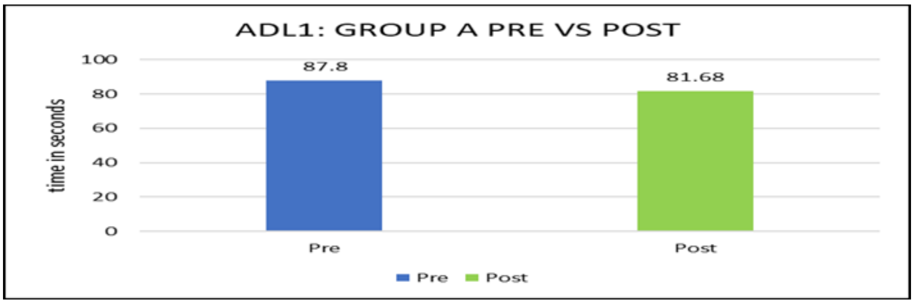


Graph 5: 9HPT Group B Dominant Hand

Table no 9 and Graph 6 represent the statistical analysis of fine motor skill assessment of ADL1 of dominant hand pre and post the intervention for Group A. The pre and post-intervention mean value for ADL1 for dominant hand for group A is **87.80±1.66 and 81.68±1.23** respectively with **p=0.001**, indicating a significant improvement.

Group A		
ADL1 Dominant Hand	**Mean±SD**	**P value**
Pre	**87.80±1.66**	**0.001**
Post	**81.68±1.23**	

Table no 9: Group A ADL1 Pre and Post values of the Dominant hand.

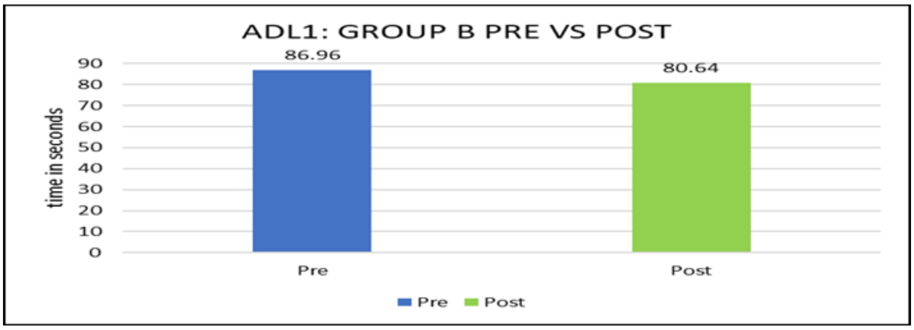


Graph 6: ADL1 Group A Dominant Hand

Table no 10 and Graph 7 represent the statistical analysis of fine motor skill assessment of ADL1 of dominant hand pre and post the intervention for Group B. The pre and post-intervention mean value for ADL1 for dominant hand for group B is **22.79±1.26 and 18.77±1.21** with **p=0.001,** indicating a significant improvement.

Group B		
ADL1 Dominant Hand	**Mean±SD**	**P value**
Pre	**22.79±1.26**	**0.001**
Post	**18.77±1.21**	

Table 11: Group B ADL1 Pre and Post values of the Dominant hand.

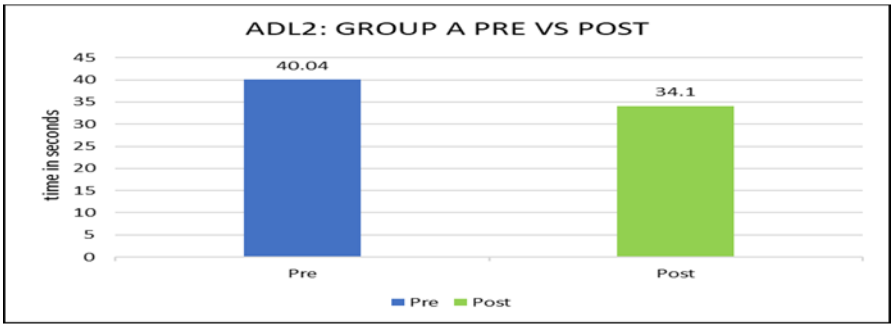


Graph 7: ADL1 Group B Dominant Hand

Table no 11 and Graph 8 represent the statistical analysis of fine motor skill assessment of ADL2 of dominant hand pre and post the intervention for Group A. The pre and post-intervention mean value for ADL1 for dominant hand for group A is **40.04±2.30 and 34.10±1.78** respectively with **p=0.001**, indicating a significant improvement

Group A		
ADL2 Dominant Hand	**Mean±SD**	**P value**
Pre	**40.04±2.30**	**0.001**
Post	**34.10±1.78**	

Table no 11: Group A ADL2 Pre and Post values of the Dominant hand.

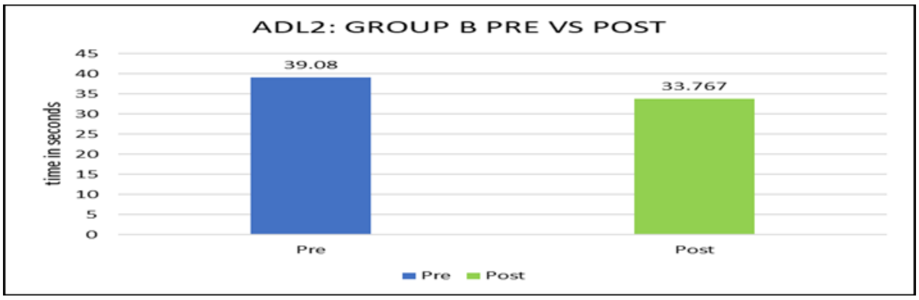


Graph 8: ADL2 Group A Dominant Hand

Table no 12 and Graph 9 represent the statistical analysis of fine motor skill assessment of ADL2 of dominant hand pre and post the intervention for Group B. The pre and post-intervention mean value for ADL2 for dominant hand for group B is **39.08±2.12 and 33.76±2.97** respectively with **p=0.001,** indicating a significant improvement.

Group A Vs Group B		
BBT Post Dominant Hand	**Mean±SD**	**P value**
Group A	**69.96±3.09**	**0.001**
Group B	**65.38±6.06**	

Table no 12: BBT Group A VS Group B Post Dominant hand

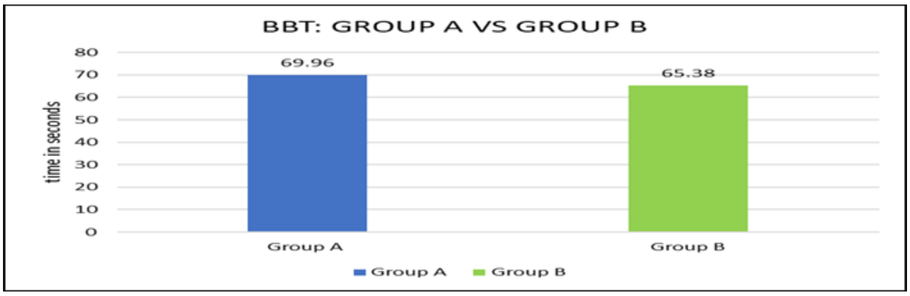


Graph 9: ADL2 Group B Dominant Hand

Table no 13 and Graph 10 represent the statistical analysis of fine motor skill assessment of BBT of dominant hand for Group A VS Group B. The mean value for BBT for dominant hand for Group A VS Group B is **69.96±3.09 and 65.38±6.06** respectively with **p=0.001**, indicating a significant improvement.

Group A Vs Group B		
BBT Post Dominant Hand	**Mean±SD**	**P value**
Group A	**69.96±3.09**	**0.001**
Group B	**65.38±6.06**	

Table no 13: BBT Group A VS Group B Post Dominant hand

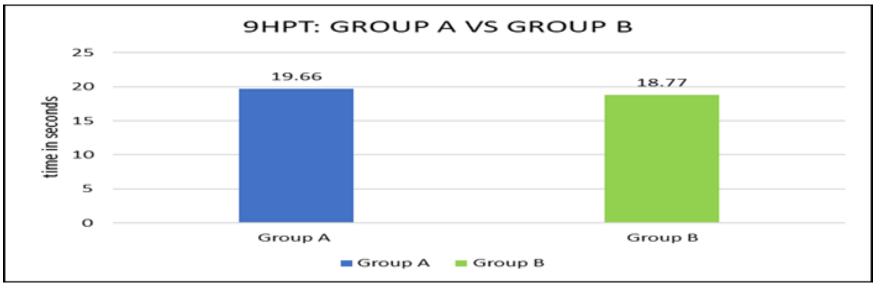


Graph 10: BBT Group A VS Group B Dominant Hand

Table no 14 and Graph 11 represents the statistical analysis of fine motor skill assessment of 9HPT of dominant hand for Group A VS Group B. The mean value for 9HPT for Group A VS Group B is **19.66±0.20 and 18.77±0.31** respectively with **p=0.02,** indicating a significant improvement.

Group A Vs Group B		
9HPT Post Dominant Hand	**Mean±SD**	**P value**
Group A	**19.66±0.20**	**0.02**
Group B	**18.77±0.31**	

Table no 14: 9HPT Group A VS Group B Dominant Hand

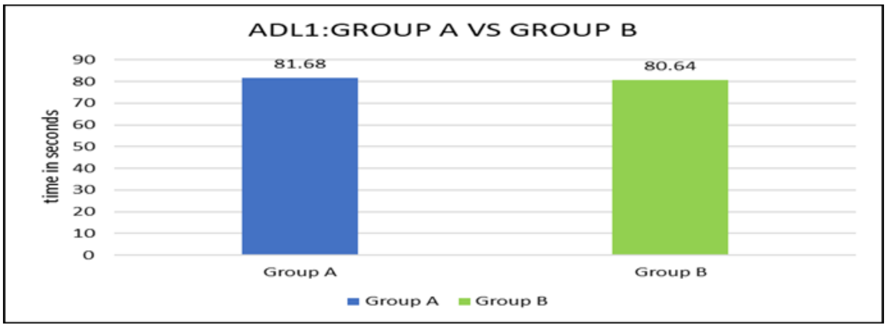


Graph 11: 9HPT Group A VS Group B Dominant Hand

Table no 15 and Graph 12 represents the statistical analysis of fine motor skill assessment of ADL1 of dominant hand for Group A VS Group B. The mean value for ADL1 for Group A VS Group B is **81.68±1.23 and 80.64±1.76** respectively with **p=0.007, not** indicating a significant improvement.

Group A Vs Group B		
ADL1 Post Dominant Hand	**Mean±SD**	**P value**
Group A	**81.68±1.23**	**0.007**
Group B	**80.64±1.76**	

Table no 15: ADL1 Group A VS Group B Dominant Hand

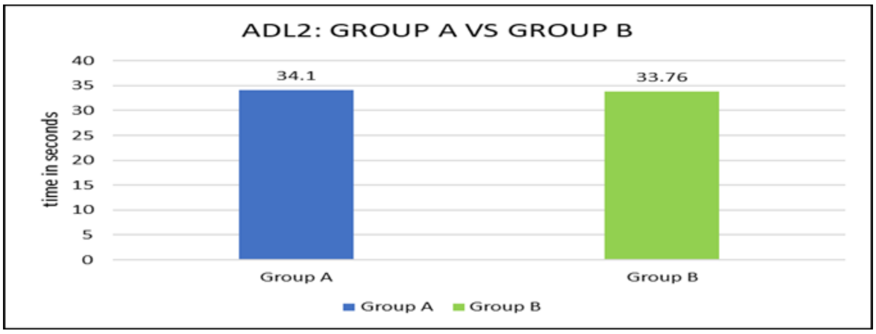


Graph 12: ADL1 Group A VS Group B Dominant Hand

Table no 16 and Graph 13 represents the statistical analysis of fine motor skill assessment of ADL2 of dominant hand for Group A VS Group B. The mean value for ADL2 for Group A VS Group B is **34.10±1.78 and 33.76±2.97** respectively with **p=0.001** each**,** indicating a significant improvement.

Group A Vs Group B		
ADL2 Post Dominant Hand	**Mean±SD**	**P Value**
Group A	**34.10±1.78**	**0.001**
Group B	**33.76±2.97**	

Table no16: ADL2 Group A VS Group B Dominant hand.



Graph 13: ADL2 Group A VS Group B Dominant Hand

IV. Discussion

The present study aimed to assess the effects of a Keyboard Training Program on fine motor skills and hand function in the geriatric population. Aging is associated with a decline in motor coordination, dexterity, and hand strength, which significantly affects daily functional activities and increases reliance on assistance. Structured interventions targeting fine motor skills can help mitigate these declines, promoting independence and enhancing quality of life. The integration of musical training into rehabilitation frameworks is gaining attention due to its ability to engage motor systems simultaneously.

Population Characteristics

A total of 30 participants (n=30) were enrolled in the study, comprising 12 males and 18 females, with an age range of 65-74 years and a mean age of 69.3 (± 3.3) years. Baseline characteristics were comparable across both groups, ensuring homogeneity and minimizing confounding factors, as confirmed by normality testing. Given that fine motor decline in aging is influenced by both intrinsic neural changes and extrinsic environmental factors.

Effect of ADL Board Activities on Hand Function

Hand function is essential for maintaining independence in performing daily activities, as it directly impacts an individual's ability to carry out self-care, household, and recreational tasks. The integration of keyboard training with conventional dexterity exercises provided a dynamic and engaging approach to hand rehabilitation. Significant improvements were observed in Time-Based ADL Board I and II assessments, highlighting enhanced functional capacity post-intervention. Group A showed improvements in ADL1 ($p=0.007$) and ADL2 ($p=0.001$), while Group B demonstrated significant gains in ADL1 ($p=0.001$) and ADL2 ($p=0.001$). These findings suggest that both conventional dexterity exercises and keyboard training positively impact hand function.

The combination of repetitive finger movements in keyboard training and structured hand exercises in conventional training likely contributed to these improvements. Fine motor rehabilitation, particularly for aging individuals, has been emphasized in previous literature as an essential aspect of maintaining autonomy. Studies by Hoogendam et al. (2014) and Shafizadeh et al. (2019) have demonstrated that targeted motor training enhances neuroplasticity, reinforcing the idea that structured training interventions can delay age-related motor decline. This study builds on these findings, highlighting the added benefits of musical interaction in keyboard training with conventional rehabilitation approaches.

Neurophysiological Mechanisms Underlying Motor Improvements

The improvements observed in both groups, particularly in Group B, suggest a strong neuroplastic response. Fine motor training is known to induce synaptic changes in the primary motor cortex (M1), cerebellum, and sensorimotor integration pathways. Playing a keyboard requires precise finger movements, which activate motor engrams and facilitate the formation of new neural connections. Studies have demonstrated that repetitive and structured fine motor training enhances corticospinal excitability and improves proprioceptive feedback, crucial for fine motor precision.

Furthermore, research suggests that the sensorimotor cortex undergoes functional reorganization when exposed to tasks requiring high levels of motor control and coordination. Keyboard training involves bilateral hand use, engaging both hemispheres of the brain and promoting interhemispheric communication via the corpus callosum. This is significant, as age-related declines in motor function have been linked to decreased interhemispheric connectivity and neural efficiency.[18]

Effect of Fine Motor Skills in Group A and Group B

Findings from the BBT and 9HPT assessments (Graph 3, 5, 7, 9, 10, 11, 12, and 13) confirm that fine motor skills are crucial for performing precise finger movements required for daily activities. Both Group A (conventional intervention) and Group B (keyboard training) showed statistically significant improvements in fine motor skills ($p<0.001$). However, Group B exhibited superior outcomes, as reflected in post-intervention values ($p<0.001$), suggesting that the repetitive and controlled finger movements involved in keyboard training contributed to improved dexterity and hand-eye coordination.

The engagement of both intrinsic and extrinsic hand muscles through structured practice facilitated better neuromuscular control. Neuromuscular control in the elderly is known to deteriorate due to reduced synaptic efficacy, muscle fiber loss, and diminished proprioceptive feedback.[19] By incorporating keyboard training, participants engaged in bilateral hand coordination, which further contributed to neuroplastic adaptations. The improvements observed in Group B suggest that the musical element of keyboard training provided additional motor benefits. Studies by Villeneuve et al. (2014) and Worschech et al. (2023) support this hypothesis, demonstrating that piano-based rehabilitation improves dexterity and motor function, particularly in post-stroke populations. This study extends these findings by demonstrating that keyboard training is effective not only for neurologically impaired individuals but also for healthy older adults seeking to enhance fine motor function.

Clinical Implications and Integration into Rehabilitation Protocols

By demonstrating that keyboard training serves as both a rehabilitation tool and a preventive intervention for fine motor deterioration, this study provides novel evidence supporting its integration into geriatric rehabilitation protocols. The findings emphasize its role in maintaining hand function, improving neuromuscular coordination, and promoting independence in daily activities.

Overall, the study establishes the Keyboard Training Program as an effective, engaging, and cost-efficient tool for improving hand function in older adults. Its structured engaging nature facilitates motor learning, making it a valuable addition to rehabilitation protocols tailored to specific training needs. The choice of intervention should be guided by the intended functional outcomes:

- Group A (conventional hand function exercises) was more effective in enhancing Activities of Daily Living (ADL) functions.

- Group B (keyboard-based training combined with conventional hand function exercises) was more beneficial for refining fine motor skills.

V. Conclusion

This study highlights the effectiveness of a structured Keyboard Training Program in improving fine motor skills and hand function in the geriatric population. While the primary focus was on the dominant hand, similar improvements were observed in the non-dominant hand across all measured parameters. Both intervention groups (Group A and Group B) demonstrated statistically significant progress following the intervention. The choice of intervention should be guided by the intended functional outcomes. Group A, conventional hand function exercises, proved to be more effective for enhancing Activities of Daily Living (ADL) functions. Conversely, Group B, which focused solely on keyboard-based training along with conventional hand function exercises, was more beneficial for refining fine motor skills.

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