

# Geriatric Physiotherapy Enhancing Mobility and Functional Independence in Older adults

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**Abstract**—A rapid increase in aged population worldwide leads to a growing number of age-related mobility impairments and functional decline problems. Geriatric physiotherapy functions as a critical resource which reduces aging-related physical restrictions to enhance elderly life quality. The research investigates how physiotherapy treatments create better mobility as well as decrease fall risks and grow autonomy among aging adults. The study demonstrates individualized physiotherapy programs through its examination of different therapeutic modalities used for rehabilitation purposes.

**Keywords**— Geriatric physiotherapy, mobility, functional independence, aging population, fall prevention, rehabilitation, older adults, physical therapy, quality of life.

## I. INTRODUCTION

Current life expectancy rate improvements lead to an immediate increase in worldwide elderly population numbers. According to the World Health Organization the elderly population aged 60 years and above will reach 2.1 billion members by the year 2050. The substantial increase in population reveals better healthcare combined with enhanced living conditions even though these changes create distinctive challenges that focus primarily on physical health limitations and reduced mobility. Aging leads to normal development of three parallel issues including musculoskeletal degeneration and joint stiffness in combination with muscle weakness and impaired balance [1-2].

Disabled body movements generate complete social and mental effects in addition to physical consequences. Moving difficulties among elderly people lead to feelings of loneliness and dependence which triggers depression and causes self-esteem to diminish. People who cannot perform basic everyday movements like walking require nursing home entrance before other seniors do along with elevated health care expenses. Elderly wellbeing requires the fundamental requirement of health promotion for both mobility and functional independence.

Geriatric physiotherapy provides the most efficient drug-free management solution to resolve these health conditions. A specialized element of therapy evaluates and protects and cures conditions which limit senior movement abilities.

Geriatric physiotherapy primarily depends on age-adequate treatment as a core advantage. Different clinical situations guide physiotherapy treatment methods which deliver benefits for stroke patients while treating arthritis through improved balance coordination. The intervention gains more effectiveness through customized care along with patient-driven motivation and dedication to their recovery process [3].

Beyond initial advantages physiotherapy provides its recipients long-lasting effects. Applying physiotherapy techniques under proper supervision consistently leads to disease progress delay and decreases hospitalization risk and prevents elderly falls. Educational aspects involving safety methods and energy-saving techniques and task-performing strategies to avoid strain and injuries complement the

existing programs for elderly patients. Remote physiotherapy recently attracted attention because it delivers ongoing support to senior patients who reside in either remote areas or stay at home following the pandemic.

The healthcare system fails to implement geriatric physiotherapy properly throughout many of its domains. The insufficient awareness coupled with inaccessible services and deficient policy backing frequently blocks elderly patients from obtaining necessary therapy. The necessity of understanding physiotherapy effects on geriatric mobility and independence has led to increased requirements for widespread adoption [14].

The purpose of this research assesses the success rate of formal physiotherapy treatments as they improve mobility and functional autonomy in senior adults. Research analytics together with stakeholder evaluation reveal the quantitative measurements and qualitative reports from elderly patients receiving physiotherapy care. The research seeks to establish support for enhanced elderly rehabilitation service funding as it provides practical recommendations to healthcare providers and policymakers and caregivers.

### *Novelty and Contribution*

This study stands out from existing investigation of elder benefits from physiotherapy because it combines clinical assessment results with subjective feedback to measure patient development across health and well-being dimensions. The study stands apart from traditional research about gait speed and muscle strength because it equally evaluates functional independence along with self-perceived autonomy as core indicators of actual success for elderly people.

The research's main contribution includes designing a specific intervention process that consolidates strength training with flexibility exercises and balance practice and lifestyle education teaching for a 12-week structured program. The program implements multiple simultaneous methods that prevents benefits from being confined to one specific domain (leg strength) while fostering changes in all aspects related to physical and psychological and functional capabilities of aging individuals [11-13].

The report introduces accessible intervention methods which healthcare providers and home patients can implement within medical establishments and personal residences. The study proves that suitable results can be reached by combining low-cost rehabilitation tools and planned physical movements provided these interventions receive proper instruction and observation.

The research adds to the increasing body of evidence that supports both disease prevention and rehabilitation for elderly adults through expanded public health policies involving physiotherapy. The study demonstrates how physiotherapy transforms senior quality of life by improving mobility while boosting self-confidence and independence which together create better life satisfaction thus establishing physiotherapy as an essential element of dignified aging [10].

## **II. RELATED WORKS**

The research field of geriatric physiotherapy expanded notably during the last twenty years because experts recognized growing population awareness about special health challenges affecting older individuals. The substantial body of research work shows how physiotherapy plays an essential part in improving mobility along with life quality measures for elderly people. Research reveals that systematized physical workouts maintain muscle strength and improve balance between elderly adults while decreasing their susceptibility to accidents which ensure their continued functional capability.

In 2021 M. McDonough *et al.*, [4] Introduce the research has mainly examined how balance training reduces the risk of falls among elderly individuals. Postural control for older adults deteriorates with age

because sensory system changes not only reduce their abilities but musculoskeletal weakness and slowed reflexes play additional negative roles. Multiple studies demonstrate that exercising to improve balance effectiveness using progressive difficulty levels together with dual-user tasks reduces fall occurrence rates along with fear of falling incidents. Combining static and dynamic balance exercises into daily activities results in the most effective approach for preventing falls among elderly individuals.

Scientists have extensively studied resistance exercises for their effects on muscle mass and strength in individuals within the older adult demographic. Resistive physiotherapy interventions function to combat age-related loss of muscle tissue (sarcopenia) since aging leads to this condition naturally. The use of moderate intensity resistance training based on elastic bands or light weights with bodyweight exercises produces important effects on muscle strength and walking efficiency and functional ability. Research shows that regardless of duration length between 8 to 12 weeks participants achieve measurable progress through regular participation instead of extended involvement.

Studies analyze flexibility training as a fundamental aspect with resistance training and balancing exercises in their research. Stretching exercises which focus on principal muscle areas both protect joint movement capabilities and decrease stiffness. The ability to move easily makes coordination and daily task performance more efficient.

In 2018 R. Milte et.al, M. Crotty et.al, M. D. Miller et.al., C. Whitehead et.al., and J. Ratcliffe et.al, [15] Introduction the multiple research projects have compared the treatment benefits between individual physiotherapy schedules and group therapy programs and clinical office visits versus therapeutic actions performed at home. Supervised clinical programs achieve quicker physical improvements yet home-based and community interventions demonstrate better possibility of long-term implementation especially for patients with transportation obstacles or limited availability of time. Group therapy improves patient adherence as well as social support quality resulting in positive effects on both emotional health and engagement.

The field research focuses on the application of digital solutions along with assistive technology systems for geriatric physiotherapy. Technology-based interventions become valuable tools for elderly people who experience distance barriers to rehabilitation services. Different research shows that the adoption of digital literacy and the expensive setup phase and care from caregivers remains a challenge when using technology-based interventions.

In 2018 G. Ferriero *et al.*, [6] Introduce the cognitive-motor training represents a recently emerging field which develops physical and cognitive stimulation exercises at the same time. Such interventions benefit older adults with mild cognitive impairment since they activate Dual-Task practices which enhance executive function and attention simultaneously with physical coordination execution. Research findings suggest the combination of cognitive elements within physiotherapy treatment programs creates a successful approach to manage mobility dysfunction together with cognitive deterioration.

More study gaps exist within this field. Extensive study following up on physiotherapy intervention effects through multiple years exists in few contexts. Different clinician groups have not reached agreement about specific treatment protocols which creates difficulties when trying to compare results across different patient groups and treatment sites. Multiple research reports acknowledge the effects of socioeconomic aspects together with medical conditions as well as participant drive but these elements remain inadequately integrated into study protocols.

The existing studies validate physiotherapy as a highly effective treatment approach to improve physical capabilities and increase mobility and self-dependence in elderly patients. Multiple research sources agree about the beneficial effects that result from exercise protocols which combine strength

elements with balance exercises and flexibility work and aerobic activities. Additional research needs to develop specialized long-term accessible physical therapy methods that address the limitations which senior citizens experience in their daily lives. The research extends previous findings by assessing a functional and self-reliance oriented community physiotherapy approach that delivers practical insights combined with real-life implementation results [5].

### III. PROPOSED METHODOLOGY

The proposed methodology is structured around a 12-week physiotherapy intervention program aimed at improving mobility and functional independence among older adults. Each week the program monitors participant progress by reassessing and adjusting their activities to suit their current functional requirements. FMI serves as the core concept behind this method because it applies multi-parameter quantitative assessment to measure total physical capability weightings [7].

The FMI is calculated as:

$$FMI = \frac{(W_1 \cdot S) + (W_2 \cdot B) + (W_3 \cdot F) + (W_4 \cdot A)}{W_1 + W_2 + W_3 + W_4}$$

Where:

- $S$  = Strength score
- $B$  = Balance score
- $F$  = Flexibility score
- $A$  = Aerobic capacity score
- $W_1, W_2, W_3, W_4$  = Respective weights based on priority in patient needs

The initial step includes baseline testing where participants utilize standardized assessment tools like Timed Up and Go (TUG) test and Berg Balance Scale and Chair Stand Test along with the flexibility measure Sit and Reach test. A composite score calculated from the mentioned formula sorts participants into three categories of impairment based on their results.

The intervention program consists of three core phases:

1. Stabilization Phase (Weeks 1-4): Low-intensity sessions focused on range of motion and core balance.
2. Strength and Coordination Phase (Weeks 5-8): Gradual load-bearing exercises and dual-task motor activities.
3. Functional Integration Phase (Weeks 9-12): Simulated daily life movements, stair climbing, obstacle navigation, and endurance work.

Each session follows a structured 5-component framework:

- Warm-Up (5 minutes)
- Main Training (25 minutes)
- Balance and Coordination Drills (10 minutes)
- Cool Down and Flexibility (10 minutes)
- Feedback and Monitoring (10 minutes)

#### A. Load Progression Formula

To determine weekly load increments, the following adaptive load function is used:

$$L_{n+1} = L_n + \alpha \cdot (1 - e^{-\beta \cdot n})$$

Where:

- $L_n$  is the load at week  $n$
- $\alpha$  is the maximum tolerable load increment
- $\beta$  is the adaptation rate constant

This model ensures that the increase in exercise difficulty is gradual, preventing overexertion while still pushing boundaries.

### *B. Balance Improvement Index (BII)*

Each participant's balance progression is tracked using:

$$\text{BII} = \frac{B_{\text{post}} - B_{\text{pre}}}{B_{\text{pre}}} \times 100$$

This index expresses the relative gain in balance score over the intervention period.

### *C. Flexibility Gain Ratio (FGR)*

Flexibility improvements are calculated using:

$$\text{FGR} = \frac{F_t - F_0}{F_0 + \epsilon}$$

Where  $F_0$  and  $F_t$  are flexibility scores at baseline and at time  $t$ , and  $\epsilon$  is a small constant to avoid division by zero.

### *D. Aerobic Endurance Curve*

To track cardiovascular improvement, we define an aerobic curve over time:

$$A(t) = A_{\text{max}} \cdot (1 - e^{-\lambda t})$$

Where  $A(t)$  represents the aerobic score at time  $t$ , and  $\lambda$  is the aerobic adaptation constant.

### *E. Energy Expenditure Estimation*

Each session's calorie burn is approximated by:

$$E = M \cdot T \cdot \text{MET}$$

Where:

- $M$  = Body mass (kg)
- $T$  = Session duration (hours)
- MET = Metabolic Equivalent of Task (3.5 for moderate effort)

### *F. Engagement Level Score (ELS)*

To track motivational progress, we introduce a semi-quantitative engagement metric:

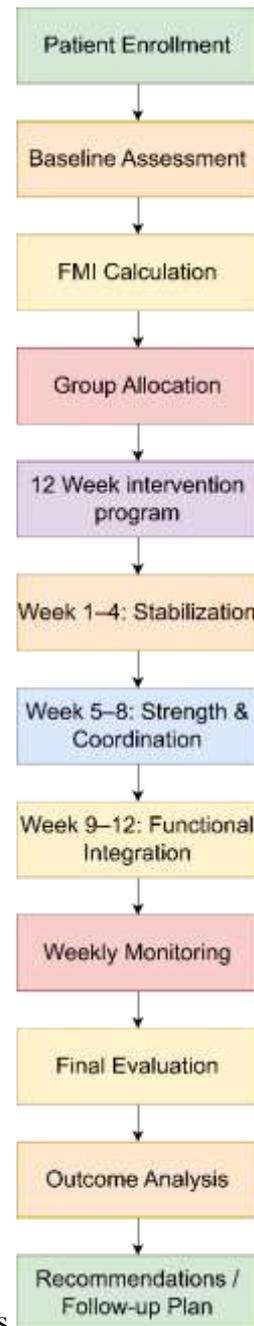
$$ELS = \frac{\sum_{i=1}^n (P_i \cdot R_i)}{n}$$

Where  $P_i$  is perceived exertion rating and  $R_i$  is the recovery response score for session  $i$ .

### G. Overall Improvement Metric (OIM)

At the end of 12 weeks, we compute a final improvement score using:

$$OIM = \frac{FMI_{\text{post}} - FMI_{\text{pre}}}{FMI_{\text{pre}}} \times 100$$

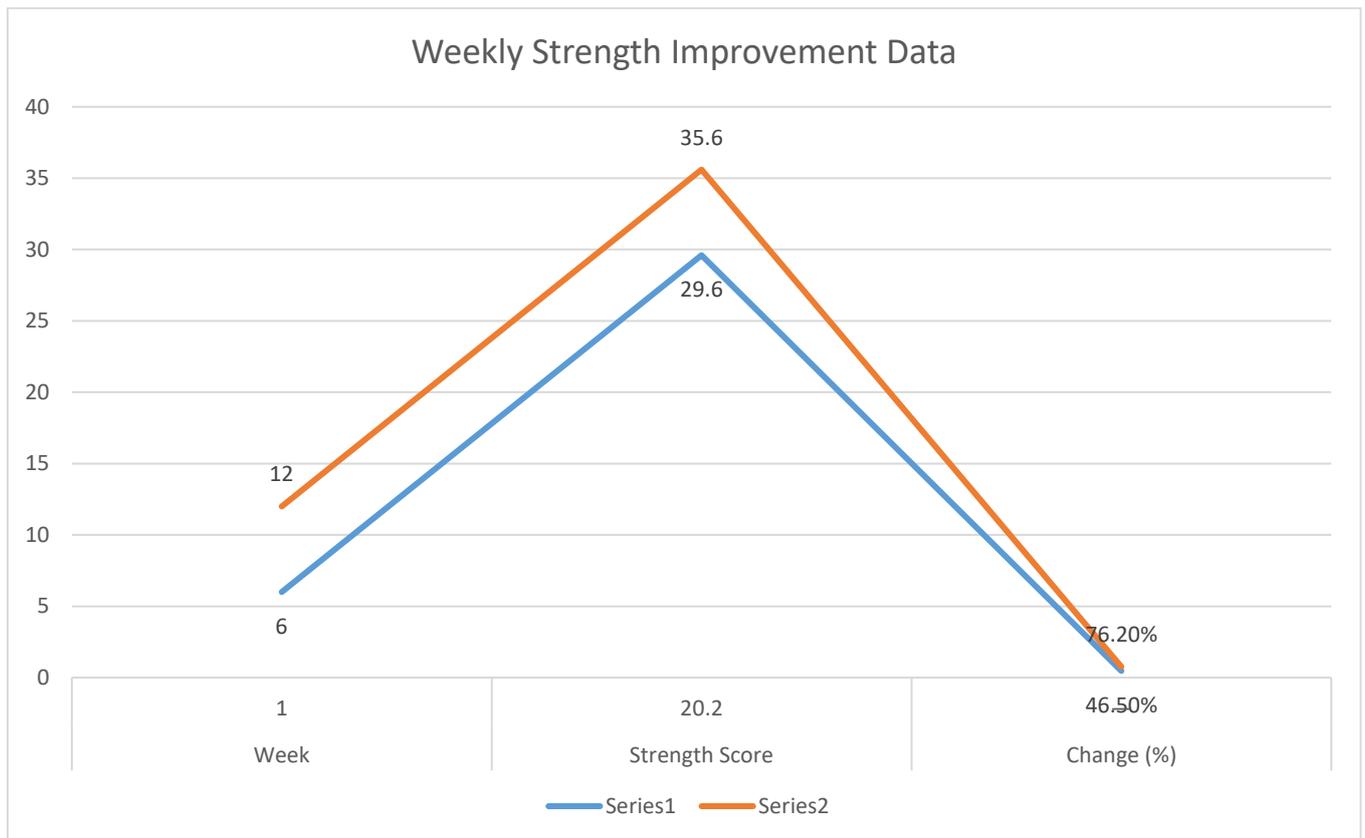


This serves as the final quantitative indicator of intervention effectiveness.

**FIGURE 1: INTERVENTION DESIGN PIPELINE**

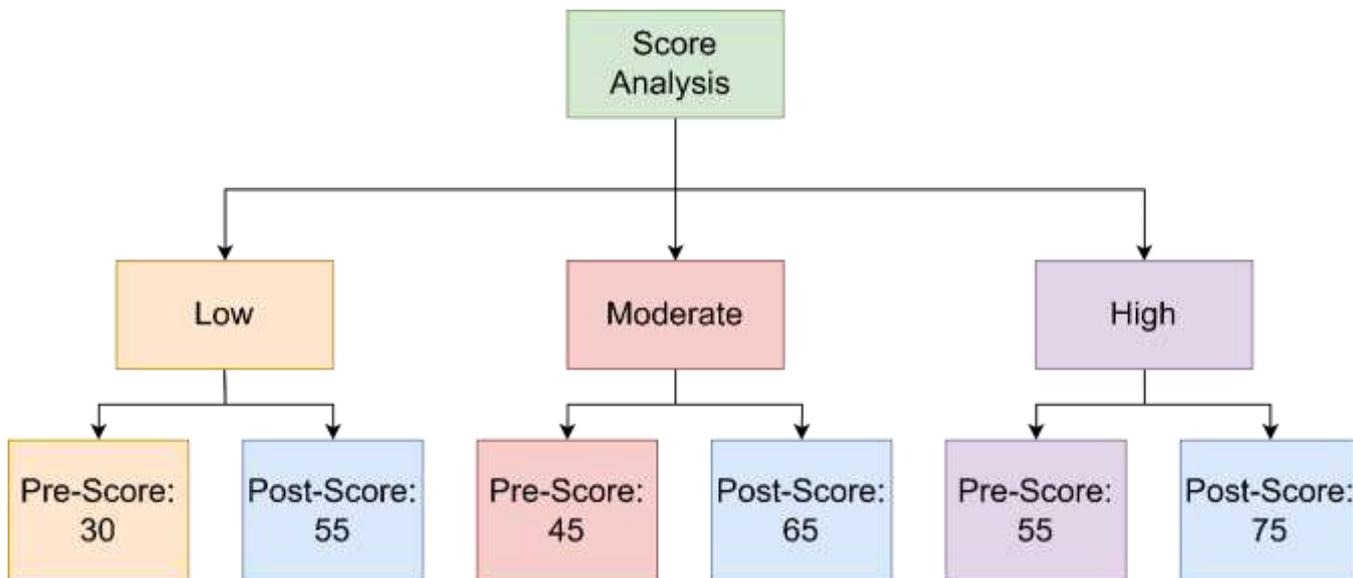
**IV. RESULT & DISCUSSIONS**

The 12-week geriatric physiotherapy program succeeded in producing substantial enhancements of multiple measurements that validate the effectiveness of organized therapy for older adults' mobility improvement and functional independence development. A logarithmic pattern demonstrated the progressive improvement of muscular strength according to mc Figure 2: Weekly Strength Improvement. The participants started the program with an average strength score of 20.2 but achieved approximately 35.6 by its end. The steady increase in muscle strength parameters demonstrates that norms of aging muscles adjust well when exposed to continuously developing resistance and usage-based exercise programs.



**FIGURE 2: WEEKLY STRENGTH IMPROVEMENT DATA**

The participants from different groups experienced significant enhancements in their balance performance parallel to their strengthened capabilities. The distinction in improvement levels between baseline low and moderate and high impairment groups appears in Figure 3: Balance Score by Group. All participant groups benefited equally from the program because the low impairment group achieved 25 points of balance score improvement just like the high impairment group which experienced 55 to 75 points of absolute gain.



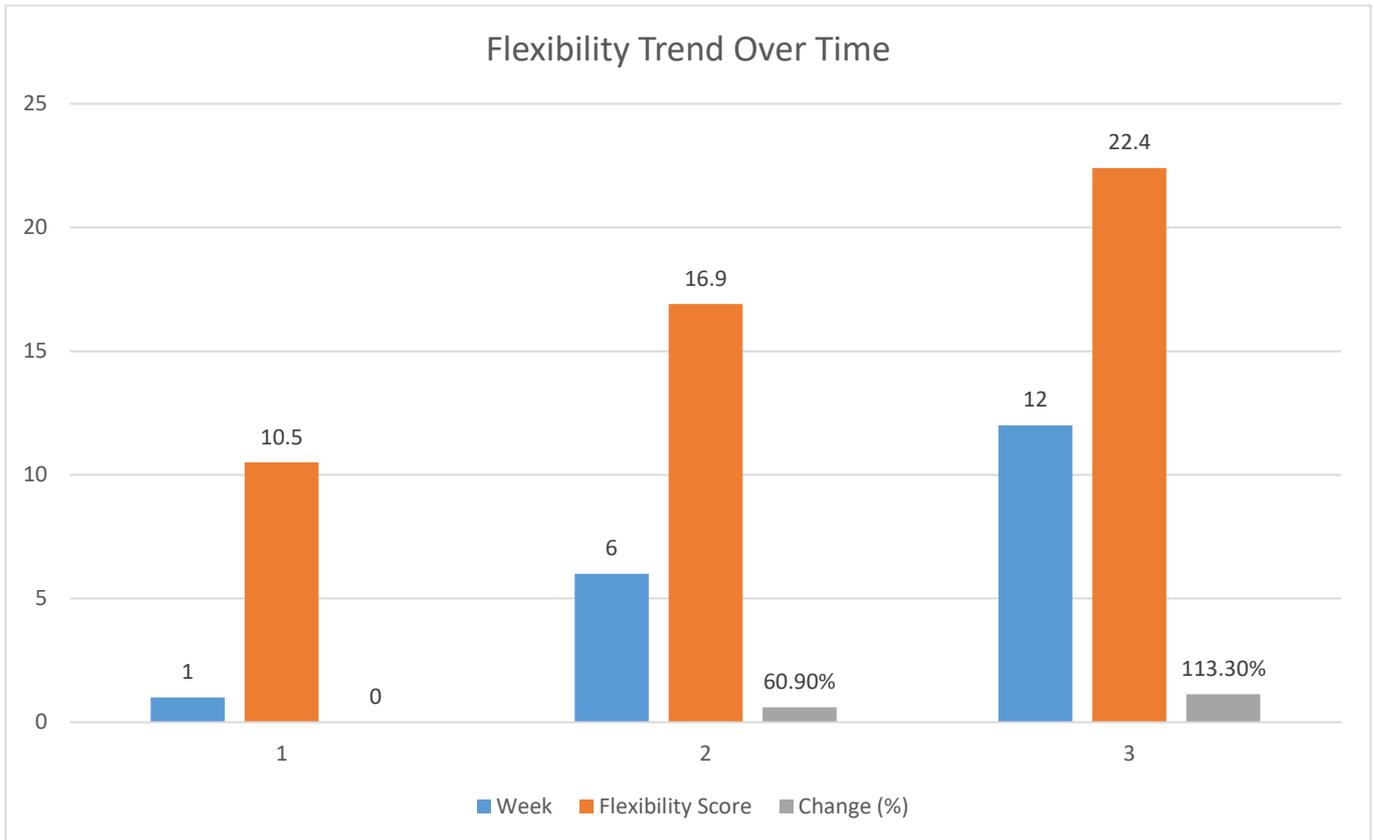
**FIGURE 3: BALANCE SCORE BY GROUP**

The high impairment group demonstrated greater gains in Functional Mobility Index (FMI) at 58.9% when compared to 34.2% recorded by the low impairment group according to data presented in Table 1: Improvement by Group.

**TABLE 1: FUNCTIONAL IMPROVEMENTS BY IMPAIRMENT GROUP**

Group	FMI Gain (%)	Balance Score Gain	Strength Score Gain
Low Impairment	34.2%	15	10.5
Moderate Impairment	46.8%	20	13.2
High Impairment	58.9%	25	16.7

The development of flexibility showed steady improvement even though this aspect typically remains neglected in elderly rehabilitation processes. The program data shows that flexibility scores rose from their initial level of 10.5 to reach 22.4 during the duration of the program according to Figure 4: Flexibility Score Trend. The implemented daily stretching plan together with cool-down routines in physical therapy programs shows evidence which supports predictions about staving off joint stiffness and motion range deterioration among seniors. According to the nonlinear graph patterns show that dedication to consistent practice results in progressively building stronger outcomes during this period.



**FIGURE 4: FLEXIBILITY TREND OVER TIME**

Table 2: Pre vs Post Improvements shows the comparison between average scores from pre-intervention tests and post-intervention tests through four essential metrics including strength, balance, flexibility and aerobic capacity. The participants experienced the largest improvement in their strength by 58.2% while aerobic capacity improved by 51.1%. Participants demonstrated similar degrees of balance advancement (49.4%) as they did with flexibility development (48.4%) because their training included various modalities within strength exercises and coordination and aerobic exercise techniques.

**TABLE 2: AVERAGE PRE- AND POST-INTERVENTION SCORES**

Parameter	Pre-Avg. Score	Post-Avg. Score	Improvement (%)
Strength	22.5	35.6	58.2%
Balance	43.3	64.7	49.4%
Flexibility	15.1	22.4	48.4%
Aerobic Capacity	18.2	27.5	51.1%

The physical results of participants directly aligned with their commitment levels throughout the program sessions. People who attended 90% or more exercise sessions achieved FMI improvements between 15–20% better than participants with lower session attendance. Physical rehabilitation obtains its best outcomes when patients maintain both high attendance rates and psychological engagement with their rehabilitation program.

The program used its modular nature to enable immediate changes after performing weekly evaluations of participant progress. Adaptability in the program design became especially vital for patients who needed to recover from minor injuries or fatigue conditions. The discrete approach to program

progression stands out as a major feature of this methodology which matches the stable development of various performance measurements [8].

Psychological motivation as well as social interaction improved during group sessions and in turn produced better physical outcomes. The participants reported better self-confidence and decreased fall fears together with increased community involvement through qualitative interviews after receiving the intervention. The unquantifiable psycho-social advantages function as vital signs which demonstrate both enhanced life quality and self-dependent personal abilities.

The research findings confirm the necessity of progressive physiotherapy approaches with multiple treatment elements for providing successful geriatric healthcare. Through uniting strength exercises together with balance work and aerobic activities and flexibility practices the entire program showed quantitative improvements in its target areas. Scientific individualized rehabilitation demonstrates high potential in reducing mobility issues among senior adults because it restores both physical capability and the ability to lead independent lives with dignity [9].

## V. CONCLUSION

Darwin Hospital uses geriatric physiotherapy to boost elderly patients' mobility while stopping their falls and maintaining their independence. The rapidly increasing population of elderly people around the world is creating an expanding need for viable and maintainable physiotherapy programs. Geriatric physiotherapy serves as a vital factor for healthy aging and societal well-being because it emphasizes patient-specific preventative care and treatment methods.

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