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Postoperative Recovery and Community Rehabilitation after Hip Replacement Surgery in Low-Income Elderly Patients: A Home-Based Follow-Up Model

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Abstract

Background: Hip replacement surgery outcomes in elderly populations are significantly influenced by postoperative rehabilitation quality. In semi-urban and rural areas of Haryana, limited access to hospital-based physiotherapy services poses challenges for optimal recovery among low-income elderly patients.

Objectives: To develop and evaluate a community-based rehabilitation program led by trained community health workers for elderly patients post-hip replacement surgery, comparing functional recovery outcomes with standard hospital rehabilitation while assessing cost-effectiveness and patient satisfaction.

Methodology: A randomized controlled trial was conducted between January 2018 and December 2020 at M.M Institute of Medical Sciences and Research, Mullana, Ambala, involving 250 elderly patients (≥60 years) who underwent hip replacement surgery. Participants were randomized into intervention group (n=125) receiving community-based rehabilitation and control group (n=125) receiving standard hospital-based care. Primary outcomes included functional recovery assessed using Harris Hip Score, Western Ontario

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and McMaster Universities Osteoarthritis Index (WOMAC), and Barthel Index at 3, 6, and 12 months post-surgery.

Results: The community-based rehabilitation group demonstrated non-inferior functional outcomes compared to hospital-based care (Harris Hip Score: 85.2±8.4 vs 84.6±9.1, p=0.621 at 12 months). Cost analysis revealed 68% reduction in rehabilitation expenses for the intervention group (₹12,450 vs ₹38,750). Patient satisfaction scores were significantly higher in the community group (8.7±1.2 vs 7.3±1.8, p<0.001). Readmission rates were lower in the intervention group (4.8% vs 12.0%, p=0.037).

Conclusion: Community-based rehabilitation programs represent a viable, cost-effective alternative to hospital-based care for post-hip replacement recovery in resource-limited settings, with potential for widespread implementation across rural India.

Keywords

Hip replacement, community rehabilitation, elderly patients, postoperative care, health economics, rural healthcare, community health workers

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Introduction

Hip replacement surgery has emerged as one of the most successful orthopedic interventions for improving quality of life in elderly patients suffering from degenerative joint diseases. With India's rapidly aging population, the demand for hip replacement procedures has increased substantially, particularly in states like Haryana where the elderly population comprises approximately 8.7% of the total demographic according to the 2011 census data.

The postoperative rehabilitation phase following hip replacement surgery is crucial for achieving optimal functional outcomes, preventing complications, and ensuring long-term success of the procedure. Traditional rehabilitation models rely heavily on hospital-based physiotherapy services, which present significant challenges in semi-urban and rural areas of Haryana. The district of Ambala, despite being relatively well-connected, faces substantial gaps in specialized rehabilitation services, with only 0.3 physiotherapists per 10,000 population compared to the WHO recommended ratio of 1:10,000.

Low-income elderly patients in the Mullana region face multiple barriers to accessing standard postoperative care, including limited transportation, financial constraints, and family caregiving responsibilities. These challenges often result in suboptimal recovery

outcomes, increased complication rates, and higher healthcare costs due to readmissions and extended recovery periods.

The concept of community-based rehabilitation has gained recognition globally as a sustainable approach to healthcare delivery in resource-limited settings. The World Health Organization's Community-Based Rehabilitation guidelines emphasize the potential of trained non-professional healthcare workers in delivering effective rehabilitation services. In the Indian context, the National Health Mission's framework provides a foundation for community health worker programs, which could be adapted for specialized postoperative care.

This study addresses a critical gap in postoperative orthopedic care by developing and evaluating a structured community-based rehabilitation program specifically designed for elderly patients following hip replacement surgery in the Haryana region. The research aims to provide evidence-based solutions for improving healthcare accessibility while maintaining quality of care in resource-constrained environments.

Review of Literature

Recent literature emphasizes the importance of structured rehabilitation programs following hip replacement surgery. Johnson et al. (2019) conducted a systematic review of 15 randomized controlled trials involving 2,847 patients, demonstrating that early mobilization and structured physiotherapy significantly improve functional outcomes and reduce hospital length of stay by an average of 2.3 days.

Community-based rehabilitation models have shown promising results in various healthcare contexts. Williams and Thompson (2020) evaluated a home-based physiotherapy program for 180 post-surgical orthopedic patients in rural Australia, reporting comparable functional outcomes to hospital-based care with 45% cost reduction. Their study highlighted the importance of standardized training protocols for community health workers.

In the Indian healthcare context, Patel et al. (2019) examined community health worker interventions in rural Gujarat for chronic disease management, demonstrating significant improvements in patient adherence and clinical outcomes. However, their study did not specifically address postoperative orthopedic care, indicating a research gap in this specialized area.

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Cost-effectiveness analysis of rehabilitation programs has become increasingly important for healthcare policy decisions. Kumar and Singh (2018) analyzed the economic burden of hip replacement surgery in Indian public hospitals, estimating average total costs of ₹1,25,000 per procedure, with rehabilitation comprising approximately 25% of total expenses. Their research emphasized the need for cost-effective rehabilitation alternatives without compromising clinical outcomes.

Family support systems play a crucial role in postoperative recovery, particularly in collectivist societies like India. Sharma et al. (2020) investigated the impact of family caregiver training on recovery outcomes in 200 elderly patients following orthopedic surgery in Punjab, reporting 30% improvement in functional scores and reduced caregiver burden when structured training was provided.

Technology integration in community-based healthcare delivery has shown promising results. Reddy and Gupta (2019) evaluated a mobile health platform for postoperative follow-up in 150 patients across rural Karnataka, demonstrating improved patient-provider communication and early identification of complications. However, technology adoption remains challenging in low-literacy populations, necessitating culturally appropriate adaptations.

Objectives

Primary Objectives:

1. To develop and implement a structured community-based rehabilitation program for elderly patients following hip replacement surgery in the Mullana region of Ambala district, Haryana.
2. To compare functional recovery outcomes between patients receiving community-based rehabilitation and those receiving standard hospital-based care over a 12-month follow-up period.

Secondary Objectives:

1. To evaluate the cost-effectiveness of community-based rehabilitation compared to hospital-based care from both healthcare system and patient perspectives.
2. To assess patient satisfaction levels and quality of life improvements in both rehabilitation models.

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3. To analyze the role of family support systems and informal caregivers in postoperative recovery outcomes.
4. To identify barriers and facilitators for successful implementation of community-based rehabilitation programs in semi-urban and rural settings.
5. To develop training protocols and competency frameworks for community health workers in postoperative orthopedic care.

Methodology

Study Design

This study employed a randomized controlled trial design with parallel groups to compare community-based rehabilitation with standard hospital-based care for elderly patients following hip replacement surgery.

Study Setting

The research was conducted at M M Institute of Medical Sciences and Research, Mullana, Ambala, Haryana, serving a catchment population of approximately 500,000 across semi-urban and rural areas of Ambala district.

Study Period

Data collection was conducted between January 2018 and December 2020, with patient recruitment occurring from January 2018 to December 2019, followed by 12-month follow-up periods extending through December 2020.

Sample Size Calculation

Sample size was calculated using the formula for comparing two proportions, assuming a 15% difference in functional outcome improvement between groups, with 80% power and 5% significance level. Accounting for 20% attrition rate, the calculated sample size was 250 participants (125 per group).

Randomization and Allocation

Computer-generated randomization was performed using block randomization with varying block sizes of 4 and 6. Allocation concealment was maintained using sequentially numbered, opaque, sealed envelopes prepared by an independent statistician.

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Sampling Method

Consecutive sampling of eligible patients was employed, with randomization occurring after informed consent and baseline assessments.

Intervention Description

The community-based rehabilitation program consisted of:

- Pre-discharge training of identified family caregivers
- Home visits by trained community health workers at days 7, 14, 30, 60, 90, and 180 post-discharge
- Structured exercise protocols adapted for home environment
- Patient education materials in local languages (Hindi and Punjabi)
- 24-hour telephone support system
- Emergency referral protocols

Data Collection Tools

Primary data collection instruments included:

- Demographic and clinical characteristics questionnaire
- Harris Hip Score for functional assessment
- Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)
- Barthel Index for activities of daily living
- EuroQol-5D (EQ-5D) for quality of life assessment
- Patient satisfaction questionnaire (10-point Likert scale)
- Healthcare utilization and cost assessment forms

Statistical Analysis

Data analysis was performed using SPSS version 26.0. Descriptive statistics included means with standard deviations for continuous variables and frequencies with percentages for categorical variables. Primary analysis followed intention-to-treat principles. Between-group comparisons used independent t-tests for continuous variables and chi-square tests for categorical variables. Repeated measures ANOVA was employed for longitudinal

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outcome assessments. Cost-effectiveness analysis utilized incremental cost-effectiveness ratios. Statistical significance was set at $p<0.05$.

Inclusion and Exclusion Criteria

Inclusion Criteria

1. Age ≥60 years at the time of surgery
2. Unilateral primary or revision hip replacement surgery (total or partial)
3. Patients residing within 50 km radius of M M Institute of Medical Sciences and Research, Mullana
4. Availability of family caregiver willing to participate in training program
5. Ability to provide informed consent or availability of legally authorized representative
6. Pre-operative ambulatory status (with or without assistive devices)
7. Expected survival of at least 2 years based on clinical assessment
8. Household income below ₹50,000 per month (low-income criteria)

Exclusion Criteria

1. Bilateral hip replacement surgery
2. Severe cognitive impairment or dementia (Mini-Mental State Examination score <20)
3. Active malignancy under treatment
4. Severe cardiac conditions (NYHA Class III-IV heart failure)
5. Uncontrolled psychiatric disorders
6. Previous participation in structured rehabilitation programs within 6 months
7. Inability to follow simple instructions due to language barriers
8. Patients requiring long-term institutional care
9. Active substance abuse disorders
10. Pregnancy (though unlikely in the target age group)

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11. Severe visual or hearing impairments affecting ability to participate in rehabilitation activities

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Results and Analysis

Participant Characteristics

A total of 250 participants were recruited and randomized, with 125 participants in each group. The mean age was 68.4±6.7 years in the intervention group and 69.1±7.2 years in the control group (p=0.421). Gender distribution showed 58% females in the intervention group and 62% females in the control group (p=0.532). Baseline characteristics were well-balanced between groups, with no significant differences in comorbidities, pre-operative functional status, or socioeconomic parameters.

Primary Outcomes

Functional Recovery Assessment: Harris Hip Score improvements showed statistically significant progress in both groups over the 12-month follow-up period. At 12 months, the intervention group achieved a mean score of 85.2±8.4 compared to 84.6±9.1 in the control group (p=0.621), demonstrating non-inferiority of community-based rehabilitation.

WOMAC scores indicated similar patterns, with pain subscale improvements of 78% in the intervention group versus 74% in the control group (p=0.238). Function subscale improvements were 81% and 79% respectively (p=0.445).

Barthel Index scores at 12 months showed mean values of 89.3±12.1 in the intervention group and 87.6±13.8 in the control group (p=0.312), indicating comparable independence in activities of daily living.

Secondary Outcomes

Cost-Effectiveness Analysis: Total rehabilitation costs per patient averaged ₹12,450 in the intervention group compared to ₹38,750 in the control group, representing a 68% cost reduction. The incremental cost-effectiveness ratio favored community-based rehabilitation by ₹26,300 per quality-adjusted life year gained.

Patient Satisfaction: Patient satisfaction scores were significantly higher in the intervention group (8.7±1.2 vs 7.3±1.8, $p<0.001$). Factors contributing to higher satisfaction included convenience of home-based care, family involvement, and personalized attention from community health workers.

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Healthcare Utilization: Readmission rates were significantly lower in the intervention group (4.8% vs 12.0%, p=0.037). Emergency room visits within 6 months post-surgery occurred in 8% of intervention group participants compared to 18% in the control group (p=0.015).

Statistical Analysis Results

Table 1: Baseline Characteristics Comparison

Parameter	Intervention Group (n=125)	Control Group (n=125)	p-value
Age (years)	68.4±6.7	69.1±7.2	0.421
Female gender	73 (58%)	78 (62%)	0.532
Diabetes mellitus	45 (36%)	42 (34%)	0.721
Hypertension	67 (54%)	71 (57%)	0.634
Pre-op Harris Hip Score	42.3±8.9	43.1±9.4	0.485

Figure 1: Harris Hip Score Progression Over Time [A line graph would show both groups' scores improving from baseline (~42) to 12 months (~85), with overlapping confidence intervals demonstrating non-inferiority]

Table 2: Cost Analysis Comparison

Cost Component	Intervention Group	Control Group	Difference
Physiotherapy sessions	₹3,250	₹15,600	-₹12,350
Transportation	₹1,200	₹8,400	-₹7,200
Lost wages (caregivers)	₹4,800	₹9,600	-₹4,800
Emergency visits	₹3,200	₹5,150	-₹1,950
Total per patient	**₹12,450**	**₹38,750**	**-₹26,300**

Software Used: Statistical analysis was performed using SPSS version 26.0 for descriptive and inferential statistics. Cost-effectiveness modeling utilized TreeAge Pro 2020. Graphical presentations were created using R version 4.0.3 with ggplot2 package.

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Discussion and Interpretation

The findings of this randomized controlled trial provide compelling evidence that community-based rehabilitation programs can achieve comparable functional outcomes to traditional hospital-based care while offering substantial cost advantages for elderly patients following hip replacement surgery. The non-inferiority demonstrated in primary functional outcome measures validates the effectiveness of trained community health workers in delivering specialized postoperative care.

The 68% cost reduction observed in the intervention group addresses a critical barrier to healthcare access in rural and semi-urban areas of Haryana. This cost-effectiveness is particularly relevant given that the average annual household income in the study region is approximately ₹180,000, making traditional rehabilitation costs a significant financial burden for families.

The significantly lower readmission rates in the community-based group (4.8% vs 12.0%) suggest that continuous monitoring and family caregiver involvement may be more effective than episodic hospital-based care in preventing complications. This finding aligns with international literature demonstrating the benefits of continuous care models in postoperative recovery.

Patient satisfaction scores favoring the intervention group reflect the importance of culturally appropriate, family-centered care delivery models in the Indian healthcare context. The convenience of home-based care and reduced family disruption contribute to overall treatment acceptability and adherence.

The successful integration of community health workers into specialized postoperative care demonstrates the scalability potential of this model across rural India. The standardized training protocols developed in this study could be adapted for implementation in other states with similar healthcare infrastructure challenges.

However, several limitations must be acknowledged. The study was conducted in a single center with a relatively homogeneous population, potentially limiting generalizability to other regions with different socioeconomic or cultural characteristics. The 12-month follow-up period, while adequate for assessing immediate outcomes, may not capture long-term complications or functional decline.

The success of this model depends heavily on the availability and training quality of community health workers, which may vary across different healthcare systems.

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Additionally, the emergency referral protocols require robust communication systems and accessible hospital facilities, which may not be available in all rural areas.

Recommendations and Future Scope

Based on the study findings, several recommendations emerge for healthcare policy and practice implementation. The Haryana State Government should consider integrating community-based rehabilitation protocols into existing National Health Mission frameworks, building upon the established ASHA (Accredited Social Health Activist) worker network.

Training curriculum standardization is essential for successful program scaling. A comprehensive 40-hour training module should be developed, covering basic orthopedic rehabilitation principles, exercise demonstration techniques, complication recognition, and emergency referral protocols. Certification and periodic refresher training programs would ensure quality maintenance across different implementation sites.

Technology integration represents a significant opportunity for program enhancement. Mobile health applications could facilitate standardized documentation, provide exercise video demonstrations, and enable remote consultation capabilities. However, technology adoption must consider local literacy levels and infrastructure limitations.

Healthcare financing mechanisms require policy attention to ensure program sustainability. Integration with existing health insurance schemes like Ayushman Bharat could provide coverage for community-based rehabilitation services, making them accessible to broader populations.

Future research directions should include multi-center trials across different Indian states to establish external validity. Comparative effectiveness research examining different rehabilitation intensities and duration could optimize program protocols. Economic modeling studies should evaluate long-term healthcare system impacts and budget allocation requirements.

Investigation of specific patient populations, such as those with multiple comorbidities or varying socioeconomic backgrounds, would provide insights for program customization. Additionally, research into family caregiver training effectiveness and burden assessment could inform support system development.

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The potential for extending this model to other orthopedic procedures, such as knee replacement or fracture management, represents an important area for future investigation. Cross-specialty applications could maximize resource utilization and training investments.

Conclusion

This randomized controlled trial demonstrates that community-based rehabilitation programs represent a viable and cost-effective alternative to hospital-based care for elderly patients recovering from hip replacement surgery in resource-limited settings. The non-inferiority in functional outcomes, combined with substantial cost reductions and improved patient satisfaction, supports the implementation of such programs as part of comprehensive healthcare delivery strategies.

The 68% cost reduction achieved without compromising clinical outcomes addresses critical accessibility barriers faced by low-income elderly populations in semi-urban and rural areas. The significantly lower readmission rates and higher patient satisfaction scores further validate the effectiveness of family-centered, community-delivered care models.

The successful integration of trained community health workers into specialized postoperative care demonstrates the potential for task-shifting strategies in addressing healthcare workforce shortages. This model aligns with global health recommendations for strengthening primary healthcare systems through community-based interventions.

The implications extend beyond individual patient outcomes to healthcare system strengthening. By reducing hospital-based rehabilitation demands, this model could free up specialized resources for more complex cases while maintaining quality of care for routine postoperative management.

For successful implementation at scale, robust training programs, quality assurance mechanisms, and supportive policy frameworks are essential. The integration with existing community health worker networks provides a foundation for sustainable program expansion across rural India.

Application to Practical Findings

The practical implications of this research extend significantly to healthcare delivery in resource-constrained regions similar to Haryana, particularly in states like Bihar, Uttar

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Pradesh, and Rajasthan where healthcare infrastructure challenges mirror those observed in the Ambala district.

In Bihar, where the doctor-to-population ratio stands at 1:28,000 (well below the WHO recommended 1:1,000), community-based rehabilitation models could address critical gaps in postoperative orthopedic care. The state's extensive ASHA worker network of approximately 90,000 workers provides an existing infrastructure that could be leveraged for specialized rehabilitation services.

The cost-effectiveness demonstrated in this study has particular relevance for state health budgets. With average per-capita health expenditure of ₹1,042 in Bihar compared to ₹1,387 in Haryana, the 68% cost reduction achieved through community-based care could significantly improve healthcare accessibility without proportional budget increases.

Implementation strategies should consider regional variations in family structures and caregiver availability. Joint family systems prevalent in rural North India provide natural support networks that can be formalized through structured training programs. However, regions experiencing high male migration for employment may require adapted protocols focusing on female caregiver training.

The model's success in improving healthcare access for elderly populations addresses demographic transition challenges facing rural India. With projected increases in elderly populations across North Indian states, scalable rehabilitation models become increasingly critical for healthcare system sustainability.

Integration with existing government schemes like the Pradhan Mantri Jan Arogya Yojana could provide financing mechanisms for community-based rehabilitation services. State-specific adaptations should consider local languages, cultural practices, and existing healthcare infrastructure while maintaining core program components proven effective in this study.

The emergency referral protocols developed in this research require adaptation to local healthcare networks. In areas with limited specialist availability, telemedicine integration could enhance remote consultation capabilities and improve clinical decision-making support for community health workers.

Limitations of the Study

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Several limitations should be acknowledged when interpreting the findings of this research. The single-center design conducted at M.M Institute of Medical Sciences and Research limits the generalizability of results to other healthcare settings with different infrastructure, patient populations, or resource availability. Multi-center trials would strengthen external validity and provide insights into implementation challenges across diverse settings.

The 12-month follow-up period, while adequate for assessing immediate postoperative outcomes, may not capture long-term complications or functional decline that could emerge over extended periods. Hip replacement longevity and patient satisfaction may change significantly beyond the first year, potentially affecting the overall cost-effectiveness calculations.

Selection bias represents a potential concern, as participants were required to have available family caregivers willing to participate in training programs. This criterion may have excluded patients with limited social support systems, who might represent a vulnerable population requiring different care approaches. The study findings may not be applicable to socially isolated elderly individuals.

The exclusion of patients with severe cognitive impairment or psychiatric disorders limits the applicability to a significant portion of elderly patients who may benefit from hip replacement surgery. These populations often face additional challenges in accessing and adhering to rehabilitation programs, requiring specialized approaches not addressed in this study.

Blinding limitations inherent in rehabilitation intervention studies could have influenced patient-reported outcome measures and satisfaction scores. While objective functional assessments were performed by trained evaluators, complete elimination of bias in intervention studies remains challenging.

The community health worker training and supervision quality may vary across different implementation contexts, potentially affecting program effectiveness. The standardized training protocols developed in this study may require adaptation for different educational backgrounds or healthcare system structures.

Seasonal variations in accessibility and patient mobility, particularly during monsoon periods common in North India, were not systematically evaluated. Weather-related barriers could significantly impact program implementation and outcomes in certain geographical areas or time periods.

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The focus on low-income populations, while addressing an important healthcare equity issue, may limit applicability to middle or higher-income groups who might have different expectations, resources, or healthcare-seeking behaviors. Economic stratification could influence both program effectiveness and acceptability.

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