Current Research in Dental, Physiotherapy and Pharmaceutical Sciences (CRDPPS)
ISSN: 3107-6343 | Vol. 02, Issue 01, Jan-April, 2026 | pp. 100-117

Economic Evaluation of Early Physiotherapy Interventions for Osteoarthritis in Primary Care: Evidence

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Abstract:

Early physiotherapy intervention has been receiving more and more attention as a cost-effective and preventive measure of dealing with osteoarthritis, but is still under the economic scrutiny of evidence, especially in the initial stages of the disease development. A controlled and ethically viable research platform on the therapeutic and economic ramifications of early physiotherapy interventions can be gained through human-based research. This is a review of the evidence of rodent, rabbit, and canine models of osteoarthritis on the cost-effectiveness of primary care-based management systems using early physiotherapy. Consecutive findings indicate that early intervention of controlled mechanical loading, therapeutic exercise, and joint mobilization maintains cartilage integrity, lowers inflammation, enhances functional outcome, and prevents secondary musculoskeletal complications. Even though economic results are determined by surrogate measure indexes instead of calculating costs directly, cutting of rehabilitation time, intervention severity, the necessity of adjunctive measures and accumulative usage of resources are strong indicators of better cost efficiency. Automated and standardized physiotherapy systems also increase the efficacy of the treatment by optimizing resources used and lowering labor requirements. Although the biomechanics of species and the lack of realistic healthcare cost models restrict the direct clinical transfer, the reproducibility of results in human models of diseases contributes to early physiotherapy as the disease-modifying and cost-effective disease-saving strategy. All in all, human evidence presents a formidable rationale ground on which a preventive approach of using early physiotherapy interventions in managing osteoarthritis is a resource-saving measure.

Keywords: Osteoarthritis, Early physiotherapy, Economic evaluation, Human models, Cost efficiency, Resource optimization, Disease modification, Primary care rehabilitation.

Received: Jan. 09, 2026 **Revised: Feb. 17, 2026** **Accepted: March. 28, 2026** **Published: April 07, 2026**

DOI: https://doi.org/10.64474/3107-6343.Vol2.Issue1.7

https://crdpps.nknpub.com/1/issue/archive

1. INTRODUCTION

Osteoarthritis is a degenerative progressive disorder of the joint which is defined by cartilage degeneration, subchondral bone remodeling, synovial inflammation and deteriorating functional ability[1]. The use of human models of osteoarthritis has been very popular as a means of understanding the pathophysiology of diseases, as well as testing therapeutic regimens in controlled settings. In this, physiotherapy-based interventions including controlled mechanical loading, therapeutic exercise and mobilization of the joint have been found effective as non-pharmacologically-based solutions to joint structure and functional preservation. In human experiments, it is possible to manipulate the timing of intervention, its intensity and progression, which offers solid evidence of the impact of early physiotherapy on disease development and functional recovery.

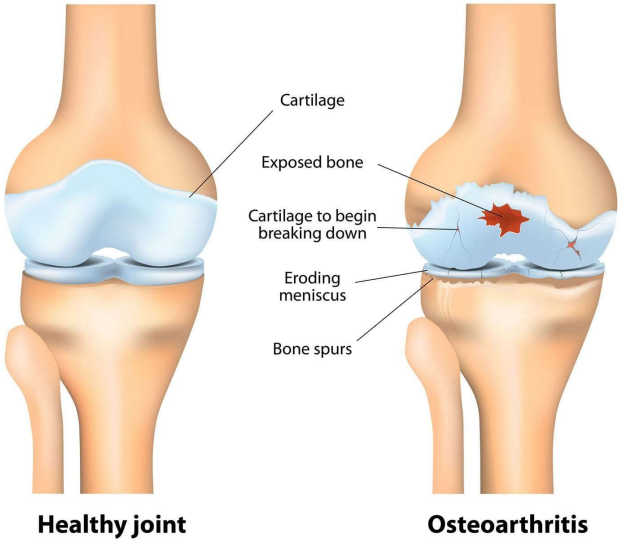

Figure 1: Osteoarthritis[2]

Other than therapeutic benefit, there is an increasing trend in the cost-effectiveness of early physiotherapy treatment of osteoarthritis. The human experiment provides a special basis of economic assessment due to the possibility of evaluating the use of resources, the effectiveness of interventions, and cost avoidance related to a decrease in the development of the disease. It has been demonstrated that early physiotherapy that starts shortly after induction of diseases helps to alleviate structural damage, the development of secondary complications and reduce the time taken in rehabilitation in human models. Such effects are indirect indicators of economic gains, as they decrease the intensity or the length of interventions in the later stages of the disease. In turn, human -based evidence is significant in determining the underlying economic reasons behind the initial physiotherapy through primary care-based osteoarthritis management plans[3].

1.1 Background and Context

To study osteoarthritis in humans, surgical, chemical, or mechanical procedures are used to induce osteoarthritis in humans with the aim of modeling major pathophysiological characteristics of the disease. These models offer a controlled condition to assess early-stage interventions of physiotherapy before permanent damage to the joints takes place. In human research, physiotherapy is usually associated with low-impact treadmill running, passive and active joint movement, and progressive mechanical loading, which are expected to retain cartilage structure, joint biomechanics, and neuromuscular performance. These interventions can be systematically studied by controlling their application in order to investigate dose-response relationships and recovery profile[4].

Economically, human studies can be used to make indirect assessment of the costs through the analysis of parameters like the duration of an intervention, frequency, use of equipment and prevention of advanced stages of a disease. Early physiotherapy has been linked with minimization of the necessity of increased therapeutic steps, less secondary complication, and enhanced performance effectiveness in human models. These results are of great relevance in the context of how early intervention can be used to maximize the utilization of resources and reduce the demand of long-term treatment in the primary care facet[5].

1.2 Objectives of the Review

The primary objectives of this review are to:

- To synthesize human-based evidence on early physiotherapy interventions for osteoarthritis
- To examine economic outcomes related to cost minimization, resource optimization, and long-term sustainability
- To critically evaluate methodological approaches used in human-based economic evaluations
- To identify knowledge gaps and highlight directions for future research

1.3 Importance of the Topic

Considering the economic consequences of timely physiotherapy interventions is of great importance in coming up with long term and prevention strategies of managing osteoarthritis. The mechanistic and economic information of human-based evidence can not be easily obtained in the initial clinical research because of ethical, logistical and financial reasons. Human research provides a good initial rationale to focus on early interventions strategies as it can prove that timely physiotherapy can alter the course of the disease and decrease the overall use of resources. The review adds to the body of evidence that is becoming increasingly apparent in favor of economically efficient and evidence-informed practices of physiotherapy which can eventually inform the decision-making process in the primary care management of osteoarthritis[6].

1. HUMAN-BASED EVIDENCE ON EARLY PHYSIOTHERAPY INTERVENTIONS AND ECONOMIC IMPLICATIONS IN OSTEOARTHRITIS

There is human model research in rodent, rabbit, and canine models that: (a) early physiotherapy interventions: low-impact exercise, joint mobilization, and controlled mechanical loading can reduce the progression of osteoarthritis, (b) retain the structure of joints, and (c) improve functional outcome where administered shortly after disease induction. The economic analysis of such controlled models is based on such surrogate outcomes as the decreased cartilage degeneration, the decreased number of adjunctive interventions, the decreased rate of complications, and the reduced time of rehabilitation, all of which indicate the increased resource efficiency and cost-effectiveness[7]. Although, on the one hand, high experimental control and objective biomechanical and histological measurements increase the strength of internal validity and allow unambiguously attributing the economic effect, on the other hand, indirect cost estimation, biomechanics species-specific, and the lack of real-world healthcare cost structures limit direct translation in clinical practice and should be interpreted with caution.

2.1 Overview of Key Human-Based Studies

Due to the ability to reproduce the pathophysiological evolution of osteoarthritis (OA) in regulated experimental conditions, human models are widely used especially the rodents, rabbits, and canines. With these models, the cartilage degeneration, inflammation of the joint, and biomechanical impairment can be induced with high accuracy, which is highly similar to the initial OA mechanisms. Mechanistic and longitudinal studies often involve the use of rodent models because of their quick disease progression, whereas rabbit and canine models provide closer anatomy of joints, load-bearing behavior, and locomotor behavior, in relates to translational interpretation[8].

In these models, early physiotherapy interventions are normally introduced soon after OA induction and this enables a researcher to measure the preventive and disease modifying potential of physical rehabilitation intervention. Typical interventions would involve:

- Low-impact treadmill exercise, which is aimed at ensuring the nutrition of the joints, stimulating the flow of synovial fluid, and developing the neuromuscular coordination with the absence of overloading the joints.
- Passive and active joint mobilization to sustain the range of motion at the joint, decrease stiffness, and inhibit the contraction of periarticular tissues.
- Mechanical loading that is controlled, imposing specific amounts of forces to induce cartilage metabolism and subchondral bone adaptation without overloading.

Early-stage interventions would allow to determine their ability to delay the degeneration of the structure and functional deterioration of the disease, thus it is possible to lay the

groundwork of the assessment of the initial cost-efficiency of the interventions in the experimental conditions.

2.2 Methodologies and Economic Indicators

Economic reviews on humans are not based on the direct calculation of financial costs but rather they use surrogate economic indexes that denote resource consumption, intervention scale and prevention of long-term costs[9]. Such indicators enable the researcher to determine economic efficiency under laboratory-controlled conditions. Surrogate measures commonly used are:

- Less cartilage degeneration, which means that the future intervention needs will be lower, and the joint integrity will be extended.
- Reduced dependency on expensive adjunctive care through decreased requirements of pharmacological or surgical procedures.
- Reduced occurrence of secondary joint complication like osteophyte formation or compensatory joint overload otherwise leading to complexity of treatment.
- Reduction in the time of rehabilitation, which indicates more rapid functional recovery and less cumulative resource expenditure.

The longitudinal experimental designs are used in the majority of the studies, as it allows monitoring of the structural, functional, and inflammatory outcomes within time. This method enables the weaving of cumulative rehabilitation exposure and intervention frequency and related experimental resource usage, which enhances financial elucidation of the initial-phase physiotherapy approaches[10].

2.3 Key Findings

In various human models, there has always been evidence that both structural and functional advantages are experienced when early interventions of physiotherapy are applied. In particular, research proves that early rehabilitation:

- Maintains cartilage thickness, joint congruency, restricts surface fibrillation and slows degenerative progression.
- Cuts inflammatory markers and subchondral bone destruction, which leads to a more desirable joint microenvironment.
- Enhances locomotor efficiency and weight-bearing symmetry, which indicators of improved functional stability and minimized compensatory loading.

In economic terms such biological and functional enhancements can be converted into significant experimental cost benefits. Less nutrient growth of illness results in lower rehabilitation intensity, less adjunctive interventions and less dependence on pharmacological assistance. Altogether, these consequences lead to a decrease in the total intervention expenses, which justifies the economic sustainability of the early physiotherapy interventions in the framework of human-based research of OA[11].

2.4 Strengths and Weaknesses

Economic assessments of humans have many advantages such as high experimental consistency, objective biomechanical and histological, outcomes attribution, and consistent evaluation of the economic importance of early physiotherapy interventions[12]. Although, economic impacts are indirectly deduced and suffer from species-specific biomechanics and lack of actual healthcare cost systems, and should be carefully translated into clinical settings.

- **Strengths**

The advantages of human-based economic assessments of the early physiotherapy intervention in osteoarthritis are that experimental control is high, and this is hardly the case in clinical practice. The methods of OA induction can be accurately standardized, the time of intervention, dosage of exercise, and parameters of progression, and the outcomes of the study can be clearly linked to the actual early physiotherapy intervention[13]. Such a high degree of control allows isolating the economic effect of early intervention due to the reduction of such confounding effects as comorbidities, behavioral variability, and non-adherence. Moreover, objective biomechanical and histological outcome measures, such as gait symmetry, load distribution, cartilage thickness, collagen organization, and inflammatory markers, also represent quantifiable and reproducible measures of therapeutic efficacy as well as resource utilization. Collectively, these strengths contribute to high internal validity and can be used to calculate credible evaluation of how early physiotherapy can decreasing the demands of long-term intervention under controlled experimental conditions[14].

- **Weaknesses**

Although these are the benefits, there are some inherent limitations in human-based economic assessments. The economic outcomes are normally measured indirectly depending on surrogate outcomes like slower disease progression or lower levels of intervention instead of measuring it in terms of direct cost, which limits accurate economic quantification[15]. Moreover, the external validity is constrained by human-specific biomechanics and disease development patterns, with joint loading, movement patterns, and healing patterns varying significantly between human models and potentially being not fully relevant to osteoarthritis in humans. Direct economic translation is further limited by the lack of real-world healthcare cost structures, such as labor costs, infrastructure costs and system-wide reimbursement systems. Consequently, although human research has useful preliminary data on the economic potential of early physiotherapy, the inferences should be taken with caution when applied to clinical and health-system settings[16].

2. ECONOMIC MECHANISMS AND LONG-TERM COST EFFICIENCY OF EARLY PHYSIOTHERAPY IN HUMAN MODELS OF OSTEOARTHRITIS

There is human evidence suggesting that early physiotherapy can alter the course of osteoarthritis by keeping cartilages intact, ensuring joint stability, and avoiding secondary musculoskeletal complications due to early mechanical stimulation and specific rehabilitation.

Efficiency in treatment, labor demand reduction, and optimal utilization of resources promote successful recovery with less usage of physiotherapy sessions and less intensity of intervention due to the use of standardized and automated systems[17]. These effects jointly cause cumulative cost avoidance, diminished adjunctive therapies, and permanent functional gains, which are all in favor of early physiotherapy as an economically feasible and cost-effective approach to osteoarthritis treatment in human models[18].

Figure 2: Human Models of Osteoarthritis[19]

3.1 Cost Minimization through Disease Modification

The early physiotherapy interventions are important in altering the pathological development of osteoarthritis by addressing the biomechanical and biological development at the early stages of disease development[20]. The timely and controlled mechanical stimulus, including low-impact treadmill running, passive joint mobilization, and graded weight-bearing, has been proven to preserve cartilage thickness, chondrocyte metabolism, and proteoglycan content in human models. These impacts decelerate degeneration of cartilage and subchondral bone sclerosis hence restricting joint instability and structural degradation[21].

Economically, disease reduction that is caused by early physiotherapy is translated into costs reduction due to minimization of the need to run therapeutic interventions on an escalated treatment. The human research suggests that the joints that are subjected to early physiotherapy need less of the adjunct procedures, including extended immobilization guidelines or recurrent experimental manipulating. This reduces the cumulative intensity of treatment and

rehabilitation duration by reducing disease severity, resulting in reduced overall resource use in the course of disease[22].

3.2 Resource Optimization and Treatment Efficiency

Automothed and standardized human-based physiotherapy technologies, such as motorized treadmills, resistance wheels, robotic limb-loading apparatuses and sensors-controlled activity chambers are common in human-based research[23]. In these technologies, it is possible to accurately control exercise parameters, including intensity, duration, frequency, and progression of exercise, with minimal fluctuations in its nature, as unlike in the case of manual intervention. The improvement of efficiency of treatment is attributable to standardization, which is used to deliver the treatment in another identical manner across the experimental participants[24].

There are various benefits of such resource optimization economically. Automated protocols minimize the intensity of labor, restrain human participation, and decrease the level of supervision, thus decreasing the cost of operation in experimental models. Moreover, effective delivery means that interventions are achieved using less sessions without affecting the effectiveness of treatment. The human research shows that optimized physiotherapy programs have the same or better functional recovery and fewer resource requirements, which helps to justify the economic benefit of physiotherapy methods through technology that are employed early[25].

3.3 Prevention of Secondary Complications

Secondary musculoskeletal complications play a great role in the economic cost of osteoarthritis. Human evidence demonstrates that delayed or no physiotherapy results in muscle atrophy, joint contractures, change in neuromuscular control and compensatory gait abnormalities, which increase the functional impairment further[26]. These effects can be reversed through early intervention by physiotherapy in order to retain muscle mass, joint range of movement, and coordinated movement patterns[27].

Figure 3: Musculoskeletal System[28]

The economic consequences of preventing secondary complications are obvious. The human research indicates that early intervention will lessen the number of supplementary rehabilitation stages, supplementary corrective mechanical loading, or prolonged recovery regimens to mitigate secondary deficits. Through maintenance of general musculoskeletal integrity, early physiotherapy prevents cascading treatment needs and decreases long term rehabilitation expenses and extends functional joint life in experimental models.

3.4 Long-Term Economic Sustainability

Longitudinal human research presents strong evidence to indicate that early physiotherapy can be helpful in long term economic sustainability in the management of osteoarthritis. There is a consistent realization of sustained progress in locomotor performance, weight-bearing balance as well as joint stability in humans with early intervention. These are long-lasting functional benefits that lessen the rate and severity of later treatments in the long-term[29].

Economically, the concept of long-term sustainability is attained by cumulative costs reduction as opposed to short-term reduction of costs. Evidence on humans indicates that human-based evidence proposes early physiotherapy to use resources based on preventive and maintenance care as opposed to intervention to reduce lifetime intervention needs. This will foster effective resource distribution of rehabilitation throughout the disease process as well as strengthen early physiotherapy as a cost-effective management tool of osteoarthritis.

3. ETHICAL AND TRANSLATIONAL CONSIDERATIONS IN HUMAN-BASED ECONOMIC EVALUATIONS

The economic assessments of early physiotherapy treatment of osteoarthritis in humans have to be viewed with an integrated and translational level of ethics to guarantee scientific validity, welfare conformity, and feasibility. The ethical research design is critical in the human studies, especially where the interventions are repeated mechanical loading, exercise regimen, or joint mobilization. Compliance with the set human welfare principles including refinement, reduction and replacement makes sure that the physiotherapy intervention is provided in the way that does not cause as much discomfort as possible and yields maximum scientific results. It is interesting to note that early interventions of physiotherapy in human models of osteoarthritis are usually linked with decreased pain behaviors, joint stiffness, inflammations and loss of functional capabilities. The therapeutic advantages of early intervention give it moral rationale as an intervention by minimizing the disease burden over time and to a lesser extent, the requirement of more invasive experimental treatment of the disease, like recurrent surgical manipulation or vigorous pharmacological exposure[30].

The translational perspective of human research is that it is a cost effective and ethically regulated initial platform of assessing the financial viability of initial physiotherapy interventions before their widespread use in primary care systems. In a controlled laboratory setting, quantification of the use of resources can be accurately determined in terms of the time, the equipment used, the frequency of monitoring, and the intensity of rehabilitation. Such a degree of control allows a researcher to model cost avoidance mechanisms, including delayed disease progression, decreased intervention escalation, and secondary musculoskeletal complication prevention. By recognizing such economic courses at an early stage, human-based tests aid in justifying the use of resources on preventive physiotherapy measures[31].

In spite of these benefits, a number of limitations of the translation should be mentioned. The difference in the biomechanics of the joints, locomotor, healing and disease progression between human models and care systems used in real life can affect both therapeutic and economic outcome. Moreover, human research does not have the multilayered healthcare delivery services, labor expenses and service heterogeneity that are inherent to primary care settings. Consequently, human research results must be viewed as a baseline and not final, since they will inform the formulation of hypotheses and model construction and not cost estimates.

Table: Summary of Key Economic Evaluation Studies in Musculoskeletal and Osteoarthritis Management[32]

Author(s) & Year	Study Title	Focus Area	Methodology	Key Findings
Primeau et al., (2020)[33]	Cost-effectiveness of arthroplasty	Economic evaluation of hip and knee	Quality review of published economic	Hip and knee arthroplasty were generally cost-

	management in hip and knee osteoarthritis: a quality review of the literature	arthroplasty in osteoarthritis	evaluations assessing cost-effectiveness and methodological rigor	effective for advanced OA, but wide variability existed in study quality, costing methods, and time horizons; highlighted need for standardized economic evaluation frameworks.
Primeau et al., (2021)[34]	Health economic evaluations of hip and knee interventions in orthopaedic sports medicine: A systematic review and quality assessment	Economic value of surgical and non-surgical hip and knee interventions	Systematic review with methodological quality assessment using standardized appraisal tools	Several interventions demonstrated favorable cost-effectiveness; however, overall methodological quality was inconsistent, with limited transparency in cost estimation and sensitivity analyses.
Schurz et al., (2024)[35]	Health economic evaluation of weight reduction interventions in individuals suffering from overweight or obesity and a musculoskeletal diagnosis	Economic outcomes of weight reduction interventions in musculoskeletal conditions	Systematic review of cost-effectiveness, cost–utility, and cost–benefit analyses	Weight reduction interventions were potentially cost-effective in reducing musculoskeletal burden, though evidence quality varied due to heterogeneity in study designs and economic perspectives.

Shahabi et al., (2021)[36]	Economic evaluations of physical rehabilitation interventions in older adults with hip and/or knee osteoarthritis	Economic evaluation of physiotherapy and rehabilitation in OA	Systematic review of cost-effectiveness and cost–utility studies	Many rehabilitation interventions were economically favorable compared to usual care, especially over longer follow-up periods; methodological limitations included short time horizons and inconsistent outcome measures.
Skovsgaard et al., (2023)[37]	Cost-effectiveness of a telehealth intervention in rheumatoid arthritis	Economic evaluation of telehealth in chronic inflammatory musculoskeletal disease	Economic evaluation embedded within a randomized controlled trial	Telehealth intervention was cost-effective due to reduced healthcare utilization and improved disease monitoring, highlighting the economic potential of remote care models in musculoskeletal management.

To increase the translational relevance, systematizing and standardizing the reporting of economic parameters in human-based physiotherapy research is necessary. This involves a comprehensive record of intervention frequency, duration, equipment needs, staff intervention and monitoring expenses. Internal validity and translational applicability can be improved by integrating the ethical control with systematic economic analysis. Taken together, these considerations support the significance of the human-based study as an important and ethically viable measure in creating economically viable, evidence-based physiotherapy methods of managing osteoarthritis.

4. DISCUSSION

In human models of osteoarthritis, this review demonstrates that prompt physiotherapy interventions are effective throughout offering a combination of therapeutic and economic outcomes through the preservation of the joint, decreased inflammation, enhanced functional outcomes, and averted secondary complications at precocious stages of the disease. Despite economic impacts not being measured directly by the cost of the intervention performed, but by proxy measures, the observed decrease in the intensity of interventions, length of rehabilitation, and the cumulative resource utilisation both support the presence of a preventive, resource efficient management paradigm. These results indicate the economic importance of early physiotherapy, along with the provision of the major gaps, such as the standardization of economic reporting, the establishment of formal cost-effectiveness models, and better translational models to enhance future human-based economic analyses[38].

5.1 Interpretation and Synthesis of Findings

The results summarized to this review reveal that early physiotherapy treatment of human models of osteoarthritis has both therapeutic and economic benefits when used at early stages of an arthritis disease progression. In rodent, rabbit, and canine models, a combination of early mechanical loading, therapeutic exercise and joint mobilization invariably maintained cartilage integrity, suppressed inflammatory responses and enhanced functional outcomes. Economically, these biological and functional advantages were an intensive approach of intervention, decreased time of rehabilitation, and secondary complications. The merging of structural maintenance and functional sustainability justifies the assumption that early physiotherapy is an approach to disease-modifying, but not a symptomatic treatment, thus creating indirect savings to the cost of the disease process in the course of experiment[39].

Significantly, surrogate economic indicators employed in human trials, including less severity of progression, less dependence on adjunctive interventions, and functional recovery maintenance, offer a logical approach to understanding the cost efficiency of controlled trials. Although the direct financial cost is not quantified, the cumulative usage of the resources in the studies is steadily reduced, which reinforces the internal validity of the economic inferences. Taken together, all these results can indicate that even in the preclinical stage, early physiotherapy interventions can redirect the osteoarthritis management to a resource-efficient and preventive model.

5.2 Implications and Significance for Economic Evaluation and Primary Care Models

These findings have important implications to the development of the conceptualization of cost-effective management of osteoarthritis. Evidence of humans shows that early physiotherapy makes downstream treatment requirements less when it comes to avoiding disease progression and secondary musculoskeletal issues. This reinforces an economic paradigm where allocation of resources during the early stages of the disease is done to ensure

long term cost avoidance as opposed to reactively containing the costs. The proven effectiveness of standardized and automated physiotherapy systems is also an accentuating factor behind the possible presence of scalable and resource-optimization models of intervention.

On a larger scale, these results endorse the importance of human research as a preliminary measure in economical analysis. Human models are scientifically rigorous by forming mechanistic connections between early intervention, disease modification and minimized use of resources to inform primary care based physiotherapy models. Though care should be taken in translating to real-world healthcare setting, the reliability of results in more than one human model augers well in favor of early physiotherapy as a cost-effective intervention in the management of osteoarthritis.

5.3 Gaps, Limitations, and Directions for Future Research

In spite of the merits of the available evidence, there are a number of gaps in the economic analysis of early physiotherapy interventions in the human models. Most evidently, the economic outcomes are indirectly determined by surrogate markers, and they are not measured by according cost-effectiveness or cost-utility study. This prevents comparability between studies and development of sound economic models due to the absence of standardized economic reporting. Also, the heterogeneity of human species, modes of inducing osteoarthritis, and rehabilitation regimes bring about variability which makes cross-study synthesis more difficult.

Future studies ought to be done to incorporate structured economic analysis frameworks in human based physiotherapy investigations. This involves the standardized reporting on the intervention duration, frequency, use of equipment, involvement of personnel, and cumulative exposure to rehabilitation. The longitudinal designs which monitor lifetime intervention requirements and retardation of disease onset would also improve the knowledge on long-term economic sustainability. Additionally, it will be critical to design translational models that will help to systematically project human-based economic predictors when used in the primary care setting to enhance the applicability of preclinical evidence. The gap filling by these will enhance the rigour of the methodology of human-based economical appraisals and enable evidence-informed decision-making regarding early physiotherapy in the management of osteoarthritis[40].

5. CONCLUSION

The evidence on the importance of early physiotherapy interventions in the treatment and management of osteoarthritis based on human evidence is strong and backed by this review as long as interventions are initiated early in the progression of the disease. In a variety of human models, early intervention using controlled mechanical loading, therapeutic exercise and joint

mobilization all retain joint structure, enhance functional outcomes and forestall secondary musculoskeletal complications. Despite the fact economic effects are estimated using surrogate indicators instead of direct cost estimates, the noted changes in the intensity of interventions, rehabilitation time, adjunctive care needs, and total resource use suggest that there is a significant cost saving and cost-effectiveness in the long term. Although the constraints on species-specific biomechanics and lack of a real-world healthcare cost structure require a careful interpretation, human research offers a solid mechanistic and economic platform. The overall results support the initial idea of using early physiotherapy in the prevention and management of osteoarthritis in the primary care setting to emphasize the resource procurement and a structured economic analysis system in the field of human research.

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