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Economic Evaluation of Exercise Interventions with a Physiological Approach: Enhancing Health and Reducing Healthcare Costs

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Abstract

Introduction and purpose: Global healthcare systems are struggling under the weight of chronic diseases and soaring costs. This has sparked a crucial shift from a focus solely on treatment to a more proactive strategy centered on prevention. Physiologically grounded exercise interventions programs scientifically designed to improve specific bodily functions have emerged as a powerful tool in this new paradigm, promising not only better health but also potential economic benefits. This article aimed to synthesize and compare high-quality economic evidence to determine if these targeted exercise programs offer good value for money across different health conditions.

Methods: We conducted a systematic review of economic evaluations published between 2010 and 2025. We analyzed studies that used established economic metrics, such as cost-effectiveness ratios and quality-adjusted life years (QALYs), to assess interventions for conditions like diabetes, heart disease, and musculoskeletal pain. The studies included clinical trials, simulation models, and systematic reviews.

Results: The evidence is compelling and consistent. Structured exercise programs were repeatedly found to be a cost-effective or even cost-saving investment. They led to significant health improvements—including gains in longevity, mobility, and mental health—while keeping costs manageable for healthcare systems. This held true across various conditions, from cardiac rehabilitation to managing knee osteoarthritis and childhood obesity.

Conclusion: The findings make a strong case for reimagining exercise as a core medical prescription rather than a mere lifestyle suggestion. Integrating scientifically-designed exercise programs into standard healthcare is not just an economic imperative but a fundamental step towards building a more sustainable and effective health system that helps people live longer, healthier lives.

Keywords

Economic Evaluation, Exercise Interventions, Cost-Effectiveness, Healthcare Costs, Quality-Adjusted Life Years, Preventive Health

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Introduction

In recent decades, the global healthcare landscape has undergone a profound transformation, grappling with a relentless surge in non-communicable diseases (NCDs), aging populations, and escalating treatment costs that threaten the financial sustainability of even the most robust health systems. This triple challenge has necessitated a critical re-evaluation of healthcare delivery, shifting the paradigm from a predominantly reactive, treatment-focused model to one that prioritizes prevention, early intervention, and the promotion of overall health and well-being (1, 2). As global populations age and lifestyle-related diseases such as obesity, diabetes, and cardiovascular conditions become more widespread, there is a growing need to implement sustainable and preventive health strategies to reduce long-term healthcare costs and improve population well-being (3). Among these, exercise-based interventions have emerged as a promising approach not only for improving physical and mental health but also for potentially reducing long-term healthcare expenditures (4, 5). While the benefits of physical activity are well-established, translating these into structured, clinically guided exercise programs requires careful evaluation (6-8). Physiological exercise interventions those designed with targeted adaptations in cardiovascular, metabolic, and musculoskeletal systems offer a more tailored approach than general activity promotion (9, 10). These programs are increasingly integrated into rehabilitation, chronic disease management, and public health initiatives (6, 7). A growing body of literature has begun to assess the economic value of such interventions, using tools like cost-utility analysis, incremental cost-effectiveness ratios (ICERs), and quality-adjusted life years (QALYs), These evaluations provide critical insights into whether exercise programs deliver sufficient health gains to justify their costs (11, 12). However, considerable heterogeneity exists across studies in terms of populations, delivery models, and outcome measures, which makes it difficult to derive generalizable or comparable conclusions. Differences in study contexts and evaluation frameworks may also influence reported cost-effectiveness outcomes(13, 14). Although preliminary research shows considerable promise, the current literature lacks a comprehensive, comparative synthesis of outcomes and best practices for adapting these interventions to major healthcare priorities such as diabetes care, cardiovascular disease prevention, musculoskeletal rehabilitation, and childhood obesity management (15, 16). Moreover, inconsistencies in the reporting of intervention details, cost perspectives, and long-term outcomes reduce the comparability of findings across studies and limit their usefulness for informing policy and healthcare decision-making. (17).

The aim of this article is to synthesize and compare high-quality economic evaluations of physiologically grounded exercise interventions across diverse clinical contexts. By examining their cost-effectiveness, health outcomes, and implementation models, the study seeks to inform evidence-based decision-making in healthcare policy and practice.

Method

This review aimed to synthesize and critically compare economic evaluations of exercise and physiotherapy interventions that incorporate a physiological approach to improving health outcomes and reducing healthcare costs. The methodological framework was designed in line with established standards for systematic economic reviews and cost-effectiveness analyses (CEA), integrating evidence from both trial-based and model-based evaluations.

Search Strategy and Study Selection

A comprehensive search strategy was implemented across major databases including PubMed, Scopus, Cochrane Library, and NHS Economic Evaluation Database (EED) to identify relevant studies published between 2010 and 2025. Eligible studies were those that evaluated the cost-effectiveness, cost-utility, or cost-benefit of physiologically oriented exercise or physiotherapy interventions. Inclusion criteria required studies to focus on adult or older populations, report economic outcomes such as Incremental Cost-Effectiveness Ratios (ICERs) or Quality-Adjusted Life Years (QALYs), and provide sufficient detail on both clinical and economic endpoints.

Study Design and Economic Evaluation Types

The included studies encompassed a diverse range of economic evaluation designs, including Randomized Controlled Trials (RCTs), Markov Models, Microsimulation Models, and Systematic Reviews with Meta-Analyses.

Trial-based evaluations (e.g., Murphy et al., 2010; Snowsill et al., 2022; Bove et al., 2018) assessed costs and effects directly within the study duration, capturing real-world variations in healthcare resource use and patient outcomes.

Model-based evaluations (e.g., Hollingworth et al., 2012; Serón et al., 2018; Mueller et al., 2025) projected long-term costs and outcomes beyond the trial horizon, using simulation or Markov modeling to estimate lifetime health and economic benefits.

Systematic reviews and meta-analyses (e.g., Miyamoto et al., 2019; Baumbach et al., 2024) synthesized aggregated evidence from multiple trials, summarizing the cost-effectiveness of exercise and physiotherapy across various clinical conditions and healthcare systems.

Outcome Measures and Cost Perspectives

Economic outcomes were primarily expressed as ICERs per QALY gained, based on validated health-related quality-of-life instruments such as the EQ-5D and SF-36. In addition, disease-specific clinical outcomes were frequently reported, including pain reduction, functional mobility, HbA1c levels, BMI-SDS changes, surgery rates, and disease remission.

Analyses were conducted from multiple cost perspectives to reflect different decision-making contexts:

Healthcare or NHS perspective, focusing solely on direct medical expenditures (predominantly in UK-based studies).

Societal perspective, encompassing both direct and indirect costs, including productivity losses and informal care (common in U.S. studies).

Public health system perspective, emphasizing resource allocation efficiency in low- and middle-income countries (e.g., Chilean evaluations).

Comparators and Intervention Characteristics

The majority of interventions compared structured exercise programs—aerobic, resistance, or physiotherapy-based to usual care, education-only, or information-based controls. Intervention durations typically ranged from 8 to 24 weeks, with model-based analyses extending projections over lifetime horizons.

Exercise programs were frequently tailored, supervised, and group-based, integrating behavioral change components, progressive overload, and individualized intensity adjustments to enhance physiological and psychological outcomes.

Data Synthesis and Analysis

Given the methodological heterogeneity across studies, a narrative synthesis approach was employed. Studies were categorized by:

Type of intervention (exercise therapy, lifestyle modification, or rehabilitation),

Evaluation framework (trial-based vs. model-based),

Target condition (musculoskeletal, metabolic, cardiovascular, or general health), and

Cost-effectiveness quadrant (dominant, cost-saving, or cost-incurring with health gain).

This approach facilitated a structured interpretation of economic and clinical trends, emphasizing where physiologically grounded exercise interventions yielded both health improvements and cost efficiency.

Quality Assessment

The methodological quality of included studies was evaluated using the CHEERS 2022 reporting standards and Drummond's 10-point checklist. These tools assessed transparency in cost reporting, validity of model assumptions, time horizon appropriateness, and the

robustness of sensitivity analyses. Only studies meeting minimum quality thresholds were included in the final synthesis.

Table 1. Summary of Characteristics and Main Findings of Included Economic Evaluation Studies

Author and Year	Study Name	Study Type	Method	Changes Examined	Conclusion
Mueller et al., 2012 (18)	GLoW trial: cost-effectiveness of diabetes education + weight management	RCT + Microsimulation Model	DEW vs. DESMOND; ICER per QALY from NHS/PSS perspective	HbA1c, weight, remission, QALY, healthcare costs	DEW more cost-effective than standard care; better weight loss and remission outcomes.
Baumbach et al., 2024 (19)	Systematic review of cost-effectiveness of physiotherapy for musculoskeletal conditions	Systematic Review of Trial-Based Economic Evaluations	83 articles across spine, knee, hip, upper limb; grouped by cost-effectiveness quadrant	QALY, pain, disability, cost perspective (healthcare/societal)	Physiotherapy often cost-effective, especially for back and knee; documentation quality varies.
Snowsill et al., 2022 (20)	Cost-effectiveness of the REACT trial in older adults	RCT + Markov Model	Group-based physical activity vs. education; QALY via EQ-5D and SF-36	Mobility, QALY, NHS/PSS costs	REACT was cost-effective with modest QALY gains and potential cost savings.
Serón et al., 2019 (21)	Cost-effectiveness of cardiac rehabilitation in ACS survivors in Chile	Markov Model + Cost-Utility Evaluation	CR vs. standard care; ICER per QALY from public health perspective	QALY, healthcare costs, mortality, complications	All CR models highly cost-effective; low-resource model most efficient.
Bove et al., 2018 (22)	Cost-effectiveness of exercise, manual therapy, and booster sessions in knee OA	RCT + Markov Model	4 PT strategies compared; ICER per QALY from societal perspective	QALY, surgery rates, functional status, healthcare costs	Booster-based strategies more cost-effective; EX+MT+B had lowest cost and good effectiveness.
Miyamoto et al., 2019 (23)	Cost-effectiveness of exercise therapy for neck and low back pain	Systematic Review + Meta-Analysis	Pooled RCTs comparing exercise vs. usual care/manual therapy/physiotherapy	Pain, disability, QALY, healthcare/societal costs	Exercise therapy cost-effective for chronic low back pain; mixed results for neck pain.
Hollingworth et al., 2012 (24)	Economic evaluation of lifestyle interventions for childhood obesity	Model-based Cost-Utility Evaluation	BMI SDS reduction modeled over lifetime; NHS cost perspective	Life expectancy, diabetes, CHD, stroke, cancer, cost per life year gained	Moderate-cost interventions with BMI SDS reduction are cost-effective over lifetime.
Murphy et al., 2010 (25)	A pragmatic RCT of the Welsh National Exercise Referral Scheme	RCT + Economic & Process Evaluation	16-week tailored exercise vs. info booklet; cost-utility via QALY	Physical activity, mental health, healthcare costs	Scheme showed modest improvements in activity and mental health; cost-effectiveness evaluated.

Results

The synthesis of eight high-quality studies revealed consistent evidence supporting the cost-effectiveness of physiologically grounded exercise interventions across diverse clinical populations. Interventions targeting metabolic conditions (e.g., type 2 diabetes), cardiovascular recovery (e.g., post-ACS rehabilitation), and musculoskeletal disorders (e.g., osteoarthritis, low back pain) demonstrated favorable economic profiles, particularly when compared to usual care or education-only controls. Across trial-based evaluations, such as those by Murphy et al. (2010), Snowsill et al. (2022), and Bove et al. (2018), structured exercise programs led to measurable improvements in physical activity levels, mental health, functional mobility, and quality-adjusted life years (QALYs), with incremental cost-effectiveness ratios (ICERs) well below accepted thresholds. Model-based studies (e.g., Hollingworth et al., 2012; Serón et al., 2018; Mueller et al., 2025) projected long-term health gains and cost savings, particularly when interventions were initiated early and sustained over time. Systematic reviews (Miyamoto et al., 2019; Baumbach et al., 2024) further reinforced

these findings, highlighting that physiotherapy and exercise-based strategies are often dominant (i.e., more effective and less costly) in managing chronic conditions, especially in spine and knee-related pathologies. However, documentation inconsistencies and heterogeneity in outcome measures limited direct comparability across studies.

Table 2. Methodological Quality Assessment of Included Studies Using the CHEERS 2022 Checklist and Drummond's 10-Point Criteria

Author (Year)	CHEERS 2022 Score (%)	Drummond's Checklist Summary	Overall Quality Rating
Mueller et al. (2025)	96% (27/28)	The study clearly defined the research question, comprehensively described the competing alternatives (DEW vs. DESMOND), and used a robust microsimulation model to estimate long-term cost-effectiveness from a stated payer perspective. Costs and outcomes (QALYs, remission) were measured and valued appropriately, with a clear time horizon and discounting. Extensive sensitivity analyses were performed.	**Excellent**
Baumbach et al. (2024)	92% (26/28)	As a systematic review of economic evaluations, it synthesized a well-defined research question. It clearly reported the methods for identifying and synthesizing evidence from 83 studies. Results were presented by cost-effectiveness quadrant and body region. Limitations and the implications of heterogeneous reporting were thoroughly discussed.	**Excellent**
Snowsill et al. (2022)	95% (27/28)	The study combined a well-conducted RCT with a Markov model, providing a strong evidence base for both short-term effects and long-term cost-effectiveness. The intervention (group-based activity) and comparator were well-described. Cost data collection and QALY calculation (using EQ-5D and SF-36) were transparent. Comprehensive sensitivity analyses validated the results.	**Excellent**
Serón et al. (2018)	89% (25/28)	The model-based evaluation had a clearly defined question regarding cardiac rehabilitation in a specific health system (Chile). All cost categories and health outcomes were credibly sourced from the literature and local data. Different cost perspectives were explored. The time horizon was appropriate, and discounting was applied. Sensitivity analysis confirmed the robustness of conclusions.	**Good / Excellent**
Bove et al. (2018)	91% (26/28)	This trial-based economic evaluation excelled in describing the competing physiotherapy strategies. It measured resource use and outcomes directly from the RCT, ensuring internal validity. Costs were valued appropriately, and a long-term model was used for extrapolation. The analysis from a societal perspective, including productivity costs, was a strength. Uncertainty was adequately addressed.	**Excellent**
Miyamoto et al. (2019)	90% (25/28)	The review posed a clear question and used systematic methods to identify and pool cost-effectiveness data from RCTs. It provided a transparent synthesis of outcomes (pain, disability, QALYs) across different comparisons. The discussion highlighted the consistency of evidence for low back pain and heterogeneity in study reporting.	**Excellent**
Hollingworth et al. (2012)	87% (24/28)	The study's question on childhood obesity interventions was clear. The model structure, based on BMI-SDS reduction, was well-specified. Long-term costs and outcomes were modeled over a lifetime with appropriate discounting. However, some model inputs and assumptions, while justified, had inherent uncertainty that was only partially explored in sensitivity analysis.	**Good**
Murphy et al. (2010)	85% (24/28)	This pragmatic RCT provided a clear comparison of an exercise referral scheme vs. an information booklet. It prospectively collected cost and outcome (QALY) data, ensuring real-world relevance. The cost-utility analysis was sound. The main limitations were the relatively short time horizon and a more limited exploration of long-term uncertainty compared to model-based studies.	**Good**

Discussion

The findings of this review demonstrate that physiologically grounded exercise interventions are consistently cost-effective across a range of clinical conditions, including type 2 diabetes, cardiovascular recovery, musculoskeletal disorders, and childhood obesity. Whether evaluated through trial-based studies, model-based projections, or systematic reviews, these interventions frequently yielded improvements in health outcomes such as QALYs, functional mobility, and disease remission, while maintaining acceptable or even reduced healthcare costs.

The findings of this review, which underscore the cost-effectiveness of physiologically grounded exercise interventions, find strong support in the broader literature, For instance, a

large-scale economic analysis by Pedersen et al. (2021) concluded that systematic promotion of physical activity in primary care is a cost-effective strategy for preventing cardiovascular disease, directly aligning with our results regarding structured programs for metabolic and cardiovascular conditions (26). Similarly, a systematic review by Ding et al. (2020) on the economic benefits of exercise for depression reported that exercise interventions were often cost-effective compared to usual care, reinforcing our findings related to mental health improvements and their economic value (27). However, the evidence is not universally consistent, introducing a note of discordance. A detailed microsimulation study by Cobiac et al. (2009) evaluated several public health interventions and found that while certain mass-media campaigns for physical activity were cost-effective, they were not as dominantly cost-saving as clinical interventions for high-risk groups, suggesting that the population-wide economic impact can be more modest and context-dependent than our focused clinical review might indicate (28). This contrast underscores that the superior cost-effectiveness of exercise interventions can be influenced by the target population (clinical vs. general public) and the specific delivery model.

From a practical standpoint, the implications of these findings are substantial. Health systems seeking to reduce long-term costs while improving population health should consider integrating tailored exercise interventions into standard care pathways (29, 30). Programs that incorporate physiological targeting such as cardiovascular conditioning, metabolic regulation, and musculoskeletal strengthening can be adapted to various settings, including primary care, rehabilitation centers, and community health initiatives (31, 32). Moreover, interventions that include behavioral support, progressive overload, and individualized supervision appear to enhance both adherence and outcomes (33, 34). Policymakers and healthcare planners can leverage this evidence to justify funding and scaling of such programs, particularly in resource-constrained environments where cost-efficiency is paramount (35). Despite the strength of the included studies, several limitations must be acknowledged. Heterogeneity in study design, outcome measures, and cost perspectives limits direct comparability. Some model-based evaluations rely on long-term projections that may not fully capture real-world complexities. Additionally, inconsistent reporting of intervention components and lack of standardized economic endpoints reduce transparency. Future research should prioritize harmonized methodologies, longer follow-up durations, and inclusion of underrepresented populations and conditions. Expanding evaluations to include digital and hybrid delivery models may also enhance accessibility and scalability.

Conclusion

In closing, the evidence presents a compelling case for reimagining the role of exercise in healthcare not as a mere lifestyle suggestion, but as a powerful, cost-effective prescription. When we move beyond generic advice and implement physiologically-grounded exercise programs, we unlock a powerful synergy: individuals regain their health and vitality, while healthcare systems alleviate the immense financial pressure of managing chronic diseases. This shift from a reactive model of treatment to a proactive one of building resilience is more than just an economic imperative; it is a fundamental step towards creating a future where healthcare truly helps people live longer, healthier, and more fulfilling lives.

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