Research Report

Economic Valuation of Physical Activity: A Multilayered Framework

Abstract: Physical activity is essential for public health, offering profound benefits in disease prevention and enhancing mental and physical health. This study quantifies the economic value of physical activity, focusing on the impact of walking 10,000 steps per day—a metric associated with significant health benefits. Our conceptual multi-layer framework evaluates economic value from individual, firm, and government perspectives, drawing on a systematic literature review. We estimate that an "active day" of walking 10,000 steps is valued at approximately $104.85 per day for individuals, translating into annualized benefits of $38,270. For firms, an active day equals $4.38 per employee plus a 2.7% productivity gain. In comparison, governments could see healthcare savings of 4.1%, a 2.2% productivity increase, and economic gains amounting to 1.56% relative to GDP. An exemplary illustration based on Western countries resulted in an annual economic value of $1,447 per citizen from a governmental point of view ($3.96 on a daily basis). These estimates underline the substantial economic benefits of physical activity across different societal levels. However, results are subject to limitations due to methodological choices and operationalizing model parameters. This study provides a robust framework for policymakers, healthcare providers, and corporate leaders to foster physical activity and enhance public health and economic outcomes.

Keywords: Physical Activity; Economic Value; Public Health; Systematic Literature Review; Healthcare Cost Savings

JEL Codes: I12, I18, J24, H51

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1 Introduction

Physical activity is widely recognized as a cornerstone of public health, significantly preventing chronic diseases, enhancing mental health, and improving quality of life (Lee et al., 2012; Warburton, 2006). For these reasons, the World Health Organization (WHO) recommends adults engage in at least 150 to 300 minutes of moderate-intensity or 75 to 150 minutes of vigorous-intensity aerobic physical activity per week and that children and adolescents get 60 minutes of physical activity every day. However, 27.5% of adults and 81% of adolescents do not meet these guidelines (WHO, 2022a).

Nearly 500 million new cases of preventable non-communicable diseases (NCDs) are expected to occur within this decade, with an estimated treatment cost of US$300 billion or around US$27 billion annually if current activity levels remain unchanged. Thus, physical inactivity significantly contributes to the increasing burden of morbidity and mortality, impacting both national health systems and the global economy. The highest economic cost is anticipated in high-income countries, where approximately 70% of healthcare expenditure will be devoted to treating NCDs caused by physical inactivity (WHO, 2022a). The prevalence of insufficient physical activity is 16% in low-income countries, 26% in middle-income countries, and 37% in high-income countries. Globally, 7.2% of all-cause mortality and 7.6% of cardiovascular disease deaths are attributable to physical inactivity. Notably, three-quarters of total deaths and cardiovascular disease deaths associated with physical inactivity will occur in middle-income countries. This indicates that while the relative burden is most significant in high-income countries, the largest number of people affected by physical inactivity live in middle-income countries due to their larger populations (Katzmarzyk et al., 2022).

Research has demonstrated that the value of physical activity can be manifold for all population groups (WHO, 2022a)[1]. It has been found that physical activity reduces the risk for and severity of numerous (chronic) diseases and comorbidities like type 2 diabetes, specific cancer types, cardiovascular diseases such as hypertension, or mental illness (Kyu et al., 2016; Santos et al., 2023; Whitfield et al., 2017; Woodcock et al., 2011). This translates into the prevention of premature deaths, a reduction in healthcare costs and utilization, and decreased productivity loss while increasing individual fitness and quality of life. Thus, physical activity can lead to substantial health gains and economic benefits across all population groups.

From the evidence and perspectives mentioned above, it is intuitive to deduce that economies, employers, and individuals should be incentivized to promote or initiate physical activity to improve and protect emotional, physical, and financial capital, among others (Bailey et al., 2013). Governments and corporations have already implemented various initiatives to promote physical activity. For example, Singapore‘s National Steps Challenge rewards citizens for meeting step goals (HealthHub, 2024). Finland's Fit for Life Program offers grants for community exercise projects (European Commission, 2022), and the UK's Cycle to Work

[1] To be noted, most academic studies in the field apply an epidemiological approach, examining specific population groups, such as, for example, men, women, elderly, adults, adolescents, children, employees in various domains, or individuals with morbidities and treatment adherence. However, also at the macro-level, i.e., within and between countries, differences are examined.

Scheme provides tax incentives for employees to purchase bicycles (GOV.UK, 2019). On an individual level, economic incentives for physical activity include health insurance programs that offer rewards for meeting fitness goals (Vitality, 2024), fitness apps such as Sweatcoin that provide digital currency or cash prizes (Sweatcoin, 2024), employer-sponsored programs (Virgin, 2024), and community challenges that promote exercise through community events and charitable donations (parkrun, 2024).

Phrases like “motion is lotion”, “the only bad workout is the one that didn’t happen”, or “sitting is the new smoking” all aim to emphasize the benefits of movement and exercise for joint health and overall well-being. While it is evident that physical activity is economically valuable, how can this value be quantified? We argue that this cannot be answered in a simple way but that a stakeholder-orientated approach must be taken. The value of physical activity varies depending on whether it is viewed from the perspective of an individual, an organization, or an economy. Furthermore, different stakeholders will use significantly different variables and evaluation criteria to assess the value of physical activity. Thus, we pose the following research question (RQ):

RQ: “What is the economic value of physical activity from individual, industry, and government-level perspectives?”

To answer the question, we develop a conceptual multi-layer framework for the economic value of physical activity relying on a systematic literature review (SLR) approach. Building on the identification and analysis of existing concepts and results on physical activity assessment and valuation, results are classified and synthesized utilizing a concept matrix. After synthesizing key concepts, theories, and findings from the literature, a conceptual framework is developed that accounts for the interrelation of different concepts and offers options for practical implementation. Further, we analyze the interrelationships between the three stakeholder categories.

To illustrate our conceptualization, we rely on empirical findings from the SLR process to operationalize the model and estimate the economic value of 10,000 steps (our proxy for an “active day”). An "active day" has an approximate economic value of $104.85 for individuals, translating to an annual benefit of $38,270. This estimation considers factors such as healthcare cost savings, reduced mortality risk, and increased productivity due to improved health. At the firm level, an active day provides a direct economic value of $4.38 per employee, plus a 2.7% increase in productivity. This reflects cost savings and productivity gains due to better employee health and reduced absenteeism. For governments, initiating widespread physical activity can lead to significant economic benefits, including an estimated 4.1% savings in healthcare costs, a 2.2% increase in productivity, and economic gains of 1.56% relative to GDP. These results are derived from the observed impacts on healthcare expenditure and national productivity metrics. It is important to acknowledge that these findings are subject to limitations influenced by the methodological choices made in this study. These choices include the selection of specific economic metrics, relying on average values, and making assumptions in operationalizing the model parameters. While these decisions were necessary to conduct the analysis, they introduce constraints on the generalizability and applicability of the results. The findings underscore the substantial economic benefits of regular physical activity, highlighting its potential to contribute significantly to individual well-being, corporate efficiency, and national economic health. However, it is important to note that the identified values are broad averages and will be subject to significant variations based on individual, firm-specific, and country-specific factors.

We contribute to understanding the economic value of physical activity by developing a comprehensive, multi-layer conceptual framework that integrates perspectives from individuals, industries, and governments. This framework synthesizes existing literature and variables that influence the economic impact of physical activity. The findings provide actionable insights for policymakers, healthcare providers, and other stakeholders to design and implement targeted initiatives that promote physical activity. By highlighting the economic benefits and offering an illustrative evaluation model, this study supports the development of more effective strategies to increase physical activity levels, ultimately contributing to improved public health outcomes and reduced healthcare costs.

2 Data and Methodology

2.1 Definitions

To tackle our research question, we needed to define the meaning of "physical activity", "economic value", and what aspects were covered for each perspective.

Physical activity. We relied on the WHO's definition of physical activity as "any bodily movement produced by skeletal muscles that require energy expenditure" (WHO, 2022b). Physical activity can be categorized by intensity (e.g., moderate vs. vigorous) and purpose (e.g., recreational, occupational, transportation). Our analysis included all domains, such as leisure-time activities (household chores or gardening), work-related activities, and sports. Additionally, physical activity contrasts sedentary behavior and physical inactivity, whereby the latter refers to not getting enough moderate-to-vigorous physical activity to meet WHO guidelines (e.g., Ortolan et al., 2022).

Economic value. We defined economic value as the financial benefit of physical activity for individuals, firms, and society. Direct and indirect financial benefits encompass, for example, healthcare savings, productivity gains, reduced illness absenteeism, and broader economic impact on economic growth. This value can be assessed from multiple perspectives, highlighting different facets of the economic impact. We only include the economic value of physical activity from the individual, industry, and government perspectives and exclude any additional costs arising from interventions. Thus, we neglect any return-on-investment estimations.

2.2 Systematic Literature Review

To develop a comprehensive concept matrix for our conceptualization approach, we employed a systematic literature review (SLR) to gather the most pertinent literature in the field. The primary goal of an SLR is to identify, evaluate, and synthesize studies that are relevant to the research questions, thereby summarizing existing evidence on the economic value of physical activity and highlighting any methodological challenges (Kitchenham, 2004). Our methodological framework follows the structured approach recommended by Webster and Watson (2002) and vom Brocke et al. (2015), ensuring rigor and depth in our research. The process began with a structured literature search to identify relevant studies. This was followed by a selection process involving defining specific inclusion and exclusion criteria to refine the final set of relevant papers (Webster and Watson, 2002). Next, we synthesized the existing literature at a conceptual level to form the basis for constructing a concept matrix. This matrix includes individual, industry, and governmental physical activity outcomes. Building on the SLR findings, we developed a conceptual multi-layer framework that delineates the economic value of physical activity from the perspectives of individuals, industries, and governments.

We utilized the scientific database Scopus in 2024 to capture the most relevant and recent literature. To produce ample results, we tried different search strategies and keyword combinations (vom Brocke et al., 2015), ultimately resulting in the following most suitable search string, detailed in Figure 1, that resulted in a sample of 202 studies. The search string consisted of a three-layered design, encompassing 1) physical activity and related concepts, 2) economic and financial aspects, and 3) currency indicators. The inclusion of currency indicators was decided after identifying an extremely high number of publications with activity- and finance-specific keywords in the abstract, title, and keywords, which resulted in noise. Thus, including the indicators helped ensure that studies in the sample had a suitable fit.

Layer	Search string
Physical activity and related concepts	"ABS (("physical activit*" OR "exercis*" OR "work* out" OR "fitness" OR "physical training" OR "sedentary behavior" OR "physical inactivity")
Economic and financial aspects	AND ("cost saving*" OR "cost-of-illness*" OR "economic benefit*" OR "economic value" OR "economic evaluation" OR "economic analysis" OR "health* cost*" OR "financial value" OR "financial benefit" OR "financial saving*" OR "societal cost*" OR "healthcare cost*" OR (("personal" OR "individual" OR "employee*" OR "workforce" OR "workplace" OR "corporate" OR "company") AND ("absenteeism" OR "presenteeism" OR "satisfaction" OR "quality of life" OR "direct medial cost*" OR "direct non-medical costs" OR "engagement" OR "health promotion" OR "insurance claim*" OR "wellness program" OR "productivity" OR "job performance" OR "work-life balance" OR "health")))
Currency indicators	AND ("US$" OR "USD" OR "dollar" OR "$" OR "EUR" OR "€" OR "Euro" OR "Pound" OR "GBP" OR "£" OR "JPY" OR "CAD" OR "C$" OR "CNY" OR "CN¥"))"

Figure 1. Scopus database query. This figure shows the three-dimensional search string used to identify relevant literature in the Scopus database. The asterisk (*) is used as a wildcard character to include all possible word endings, allowing for broader search results that capture variations of the root word (e.g., "physical activit" will include "physical activity" and "physical activities").

To analyze the identified papers in more detail and determine their suitability for further review, we screened them according to the keywords used in both the title and abstract. We set both inclusion (IC) and exclusion criteria (EC) to narrow down the number of identified articles and extract the most relevant literature (Webster & Watson, 2002).

Initially, we identified 202 records from Scopus. We applied two inclusion criteria: articles in English language (IC1) and peer-reviewed research articles or conference proceeding papers (IC2) for further analysis. After applying the inclusion criteria, 185 articles remained.

Next, we screened the title and abstract. During this process, 109 articles were excluded because they were irrelevant or out of scope[2] (exclusion criteria EC1) to our research focus. Then, we conducted a full-text screening to assess the direct relevance of these studies to our research question, excluding a further 41 articles. We included empirical studies that were purely observational and with primary, secondary, and tertiary preventative interventions to promote and maintain physical activity among all population groups, including comprehensive and selected population groups.

Based on forward, backward, and hand searches, we identified 12 additional relevant articles. Eventually, we obtained a final selection of 47 articles. This set of articles was used to develop a conceptual multi-layer framework for the economic valuation of physical activity. The entire SLR selection process is illustrated in Figure 2.

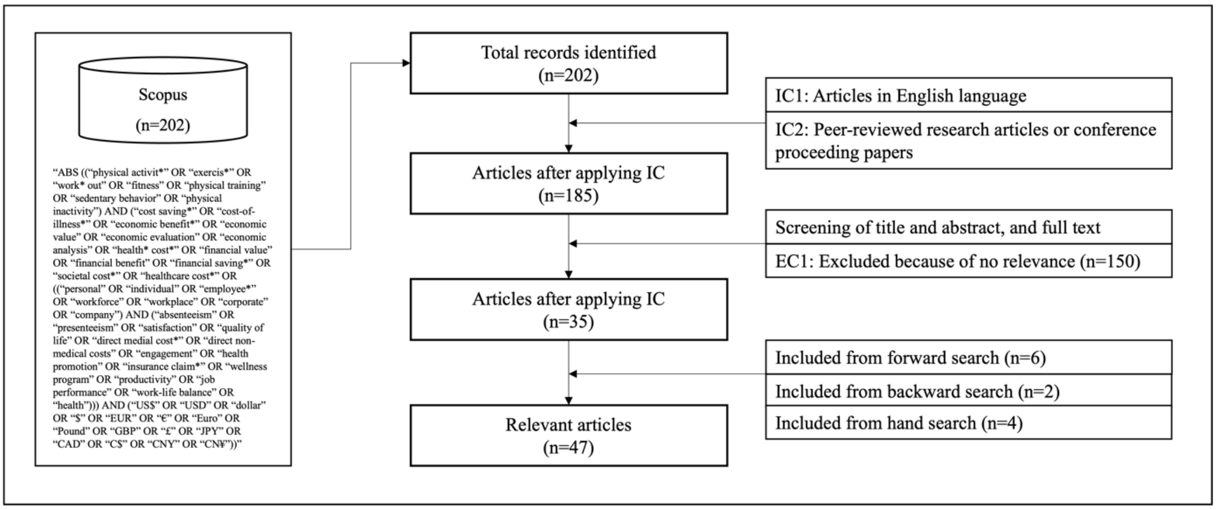


Figure 2. Flowchart of the literature identification and selection process.

[2] We excluded multicomponent interventions, i.e., holistic lifestyle interventions targeting behaviors such as diet, physical activity, smoking, or alcohol consumption of our sample, as we could not isolate the effect of each component (physical activity, among others) on the outcome (economic value). By focusing on single-component interventions or observational studies, we increased our analysis's precision and clarity. Since this study's objective was to estimate the economic value of physical activity, non-empirical studies and study protocols without results or concrete numbers were excluded. We excluded comparative studies on the cost-effectiveness of various interventions as it was not within the scope of this report to consider the costs of these different interventions in our calculation. We excluded studies that provided estimates of the value of physical activity in response to hypothetical urban and infrastructure changes as they added another layer of complexity to our analysis. The infrastructure changes relate to expenses connected to creating and maintaining facilities like parks, gyms, and recreational areas, intending to increase physical activity as a policy. Furthermore, we excluded studies focusing on the burden of physical inactivity as the results cannot be translated directly to the value of physical activity. The value of physical activity and the burden of physical inactivity are closely related as physical inactivity has health consequences such as the increased risk of chronic diseases or obesity that translate to economic costs like higher healthcare costs or loss of productivity.

3 Results

3.1 Conceptualizing the Economic Value of Physical Activity

Physical activity yields many benefits across individual, industry, and governmental levels, leading to improved health outcomes, economic gains, and societal well-being. Here, we consolidate the findings from various studies of our SLR to illustrate these interconnected benefits. Figure 3 displays how individual-level changes translate into various layering economic benefits for the individual, industry, and governmental levels. Additionally, it shows how interventions[3] from the industry and governmental levels can support individual-level changes, creating a reinforcing loop.

The simultaneity of Benefits from Physical Activity

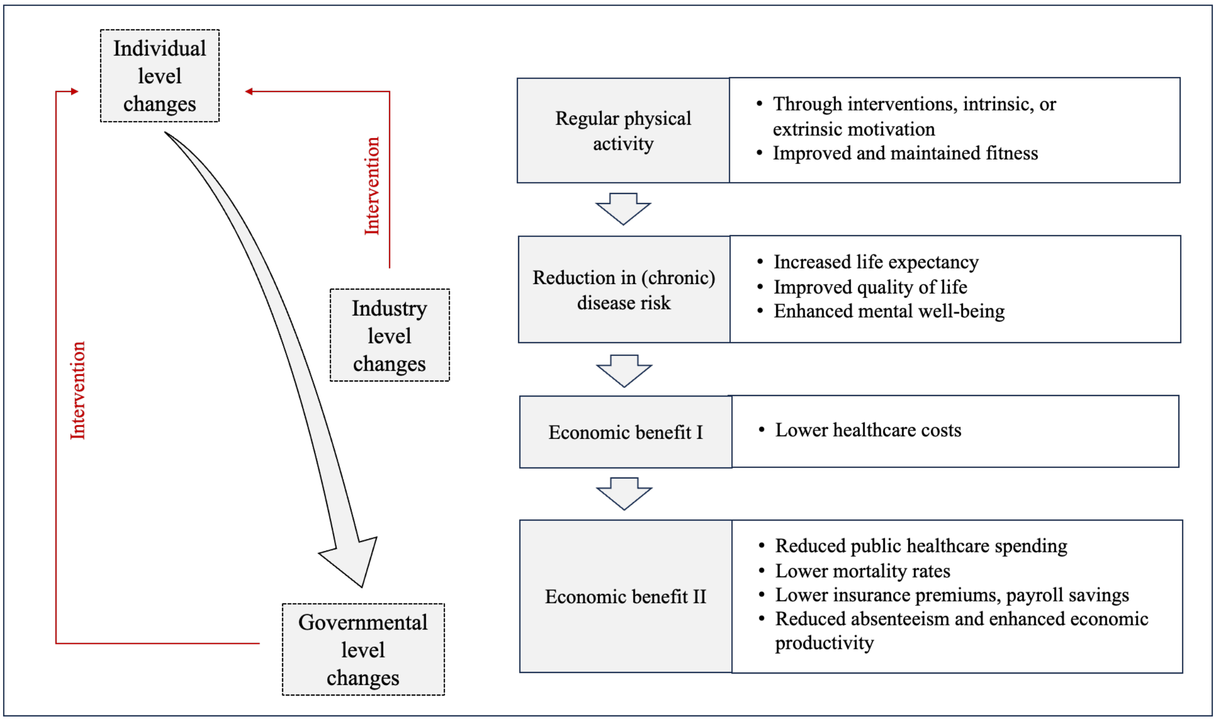


Figure 3. Effects of changes in physical activity.

At the individual level, regular exercise improves personal health and fitness (Towne et al., 2018), reducing medical expenses (Myers et al., 2019) and enhancing mental well-being (Wanjau et al., 2023), which in turn increases personal earnings and job stability (Lechner, 2009; Pfeifer & Cornelißen, 2010). Concurrently, the industry reaps the rewards from a

[3] State interventions promoting physical activity have shown significant health impacts, including reduced premature deaths and healthcare cost savings, alongside improvements in quality and quantity of life (Mizdrak et al., 2021; Ortolan et al., 2022; Rojas-Rueda, 2021; Velázquez-Cortés et al., 2023). Workplace fitness programs have been found to reduce medical costs related to type 2 diabetes and hypertension (Méndez-Hernández et al., 2012) and improve corporate productivity, leading to payroll savings (Shephard, 1992). Fitness interventions for firefighters have shown reduced injuries and economic benefits, resulting in a positive return on investment (Griffin et al., 2016).

healthier, more active workforce, leading to higher productivity (Hafner et al., 2020), lower insurance premiums (Park et al., 2023; Soliño-Fernandez et al., 2019), and reduced absenteeism and turnover rates (Shephard, 1992). These improvements contribute to significant payroll savings (Shephard, 1992), fewer insurance claims (Griffin et al., 2016), and stimulate economic productivity (Cadilhac et al., 2011). On a broader scale, government levels witness a healthier population (Kyu et al., 2016; Woodcock et al., 2011), which diminishes public healthcare spending (Baker et al., 2021; Grout et al., 2021; Katzmarzyk et al., 2022) and lowers national mortality rates (Hafner et al., 2020; Woodcock et al., 2011). These collective health gains also foster new markets for health-related products and services, generating tax revenues and bolstering economic growth (Hafner et al., 2020). Furthermore, widespread physical activity can lead to environmental benefits through reduced carbon footprints or increased air quality (Otero et al., 2018; Rojas-Rueda, 2021; Whitfield et al., 2017), as well as social benefits, such as enhanced community engagement and reduced social isolation (Bailey et al., 2013). Thus, the advantages of physical activity resonate simultaneously across multiple domains, creating a holistic improvement in societal well-being.

Disease Prevention and Reduction of Disease Burden

Physical activity is closely associated with preventing numerous diseases[4] (see Table 1 for a selection) and gains in life expectancy (Moore et al., 2012), translating into significant economic benefits. Observational, intervention and counterfactual studies consistently demonstrated that regular physical activity reduces healthcare costs by preventing and mitigating conditions like diabetes, dyslipidemia, arterial hypertension, and obesity (Araujo da Guarda, et al., 2023; Araujo, Kokubun, et al., 2023; Brown et al., 2024; Katzmarzyk & Janssen, 2004; Lima dos Santos et al., 2023; Myers et al., 2019; Peeters et al., 2018; Wang et al., 2021). These benefits are especially pronounced among individuals with existing morbidities and comorbidities like diabetes, hypertension, or obesity, thereby reducing the economic burden of these diseases through improvements in insulin sensitivity, blood pressure, and weight management.

Other benefits associated with regular physical activity included enhanced physical activity levels, reduced healthcare utilization, and improved quality and quantity of life (Philipsson et al., 2013; Pringle et al., 2010; Robinson et al., 2022; Towne et al., 2018; Wonders et al., 2022). Furthermore, reducing disease burden also reduces illness-related absenteeism and presenteeism (Hafner et al., 2020; Shephard, 1992). For instance, for individuals with cardiovascular disease, it was found that individuals engaging in higher levels of physical activity generally reported better health outcomes, which can be inferred to lead to less presenteeism and absenteeism (Araujo et al., 2022)

[4] For instance, meta-analyses have estimated the reduction in the risk of all-cause mortality, specific cancers, diabetes, cardiovascular diseases, neurodegenerative diseases, and type 2 diabetes. These studies assessed the potential health benefits and healthcare cost savings based on counterfactual scenarios of increased physical activity or decreased physical inactivity among various populations. The reduction in the burden of several chronic diseases could prevent deaths in different regions, ultimately leading to substantial amounts of direct and indirect cost savings per year (Aune et al., 2015; Baker et al., 2021; Cadilhac et al., 2011; Hamer & Chida, 2009; Kyu et al., 2016; Whitfield et al., 2017; Woodcock et al., 2011).

Table 1. Prevention of diseases associated with physical activity.

Disease or condition	References
Cardiovascular diseases such ischemic heart disease, ischemic stroke, coronary artery disease, and hypertension	Woodcock et al (2022), Whitfield et al (2018), Santos et al. (2022), Méndez-Hernández et al. (2012), Kyu et al. (2016), Cadilhac et al. (2011), LaMonte et al. (2018), Ortolan et al. (2022)
Cancers such as breast and colon cancer	Whitfield et al (2018), Santos et al. (2022), Kyu et al. (2016), Ortolan et al. (2022)
Osteoporosis-related fractures in the hip, clinical vertebral, or wrist	Nshimyumukiza et al. (2013), Silva et al. (2020), Ortolan et al. (2022)
Injuries like sprains and strains	Griffin et al. (2016)
Diabetes (Type 2)	Whitfield et al (2018), Kornas et al., (2021), Méndez-Hernández et al. (2012), Kyu et al. (2016), Aune et al. (2015), Cadilhac et al. (2011)
Neurodegenerative diseases such as dementia, Alzheimer's, and Parkinson's disease	Santos et al. (2022), Hamer & Chida (2009)
Respiratory diseases such as chronic obstructive pulmonary disease	Whitfield et al (2018), Robinson et al. (2022), Ortolan et al. (2022)
Mental disorders such as depression or anxiety	Whitfield et al (2018), Santos et al. (2022), Cadilhac et al. (2011), Philipsson et al. (2013), Wanjau et al. (2023)
Stroke	Santos et al. (2022), Kyu et al. (2016)
Obesity	Brown et al. (2014), Katzmarzyk & Janssen (2004)

Moreover, engaging in routine physical activity significantly reduces the economic burden on healthcare systems by decreasing the frequency and severity of secondary complications in specific populations, such as spinal cord injury patients. Reducing complications leads to fewer hospitalizations and lower long-term care costs (Miller & Herbert, 2016). Counterfactual studies suggested that programs promoting physical activity can be the most cost-effective and beneficial for disease burdens, such as osteoporosis, anxiety, or depression while leading to significant health benefits like increased life expectancy and improved overall quality of life[5] (Nshimyumukiza et al., 2013; Otero et al., 2018; Wanjau et al., 2023).

The reduced burden of these diseases results in lower healthcare costs, which benefits individuals, companies, and public health systems alike (Cadilhac et al., 2011; Ding et al., 2016). Lower healthcare costs translate into savings for personal and public healthcare expenditures and reduced employer insurance premiums (Griffin et al., 2016; Shephard, 1992).

[5] For context, the following three metrics are frequently used in research to assess quality of life or similar aspects: *QALYs (Quality-Adjusted Life Years)* comprise years of life adjusted for quality, using a utility factor to reflect the value of various health states, with each year in perfect health equivalent to one QALY. *DALYs (Disability-Adjusted Life Years)* represent the total years lost due to premature mortality combined with years lived with disability, each year weighted by the severity of disability to gauge the overall burden of disease. *HALYs (Health-Adjusted Life Years)* measure life expectancy free from disability, focusing on years lived in full health without adjusting for the quality of life.

Maintenance and Long-term Impacts of Physical Activity Levels

The long-term impacts of physical activity extend beyond immediate health benefits to include significant economic advantages. Sustained or increased physical activity over adulthood significantly reduced later-life healthcare costs (Coughlan et al., 2021). A 14-year study on older women found that even modest increases in physical activity significantly reduce healthcare costs and hospitalizations, with the most substantial benefits observed when moving from no or low activity to moderate activity (Peeters et al., 2018). Physical inactivity among seniors leads to higher healthcare utilization and costs, highlighting the importance of maintaining physical activity throughout life (Woolcott et al., 2010). These findings underscore the critical need for regular physical activity to achieve long-term health and economic benefits across all age groups.

Table 1. Benefits resulting from physical activity for the individual, industry, and governmental level[6]

	Individual level	Industry level	Governmental level
Physical fitness	Better personal health and fitness levels	Healthier and more active workforce	Healthier and more active population
Healthcare costs & utilization	Lower personal medical expenses	Lower insurance premiums for employees	Reduced public healthcare spending
Productivity	Increased personal earnings and job stability	Higher corporate productivity and reduced sickness absenteeism, presenteeism, and disability, payroll savings	Enhanced economic productivity and GDP
Mortality & quality of life	Increased life expectancy and quality of life due to improved physical and mental well-being, including psychological benefits	Reduced turnover and training costs	Lower national mortality rates, enhancing workforce and healthier population contributing to societal well-being
Morbidity & injury reduction	Fewer chronic illnesses, fractures, and improved long-term health	Lower health-related costs and improved workforce health	Reduced burden on public health systems
Economic gains	Virtual currency or other financial incentives	New markets for health-related products and services	Tax revenues from new economic activities

Benefits for the Industry and Overall Economy

Studies indicate reduced physical inactivity positively impacts the economy and society by enhancing productivity. Physical activity is associated with a reduction in illness-related

[6] Besides, there can be additional benefits such as the environmental impact (Otero et al., 2018; Rojas-Rueda, 2021; Whitfield et al., 2017) or social benefits (Bailey et al., 2013). For instance, changing transportation modes among large population groups from car to bike or train traveling can have a significant impact on the environment through lower pollution, increased air quality, and reduced traffic congestion.

absenteeism and presenteeism as well as reduced claims and claim costs, leading to modestly decreased employee turnover, increased overall productivity (corporate and private), and payroll savings for the company (Cadilhac et al., 2011; Griffin et al., 2016; Hafner et al., 2020; Shephard, 1992).

A macroeconomic simulation suggests that increasing physical activity to meet the WHO guidelines of at least 150 minutes of moderate-intensity physical activity across all groups could significantly boost global economic growth (Hafner et al., 2020). This growth is driven by enhanced productivity and extended workforce participation due to lower mortality rates. Indirectly, the health improvements associated with regular physical activity translate into economic gains by reducing healthcare costs and boosting overall economic productivity through a healthier, more active workforce.

Incentives

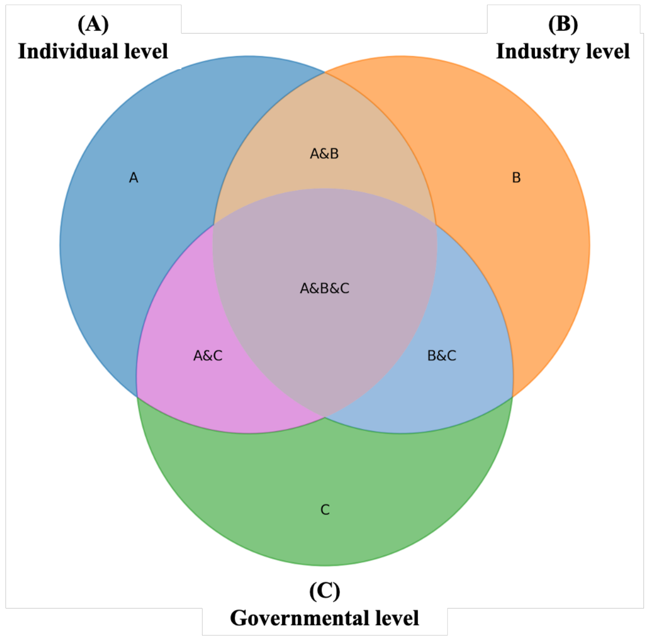
Notably, incentives can effectively motivate individuals to increase physical activity, offering rewards in return. For instance, the Sweatcoin app incentivizes users by converting steps into virtual currency, leading to significant and sustainable increases in physical activity for both general and sedentary populations (Derlyatka et al., 2019; Elliott et al., 2019). During a three-month trial, users reported higher levels of physical activity, life satisfaction, positive affect, and sleep quality. However, these changes were not maintained 12 months post-trial (Lemola et al., 2021).

Similarly, two studies offering financial incentives for engaging in health-related activities found short-term medical care cost savings to be a positive return on investment, particularly for women. Participants could earn vouchers, clothing, or points and exchange them for gift certificates, loyalty points for a specific private company, or donations to public projects (Kamimura et al., 2023; Maple et al., 2022).

Conclusion

The comprehensive analysis of physical activity highlights its extensive benefits across individual, industry, and governmental levels, demonstrating significant health improvements, economic advantages, and societal well-being. Regular exercise leads to better health, reduced healthcare costs, and enhanced mental well-being for individuals. Industries benefit from a healthier workforce, increasing productivity and reducing absenteeism and turnover rates. Governments experience reduced public healthcare expenditures, lower national mortality rates, and enhanced economic growth driven by a healthier, more active population. These interconnected benefits underscore the critical importance of promoting physical activity across all demographics to improve societal health and economic prosperity synergistically.

As described above, the Venn diagram in Figure 3 illustrates and describes the simultaneity of and overlapping benefits arising from physical activity.



A	• Reduced Mortality, morbidity, and injuries • Increased life expectancy • Lower healthcare costs
B	• Lower insurance premiums • Payroll savings • Lower training costs
C	• Lower public healthcare expenditure • Greater national productivity
A&B	• Reduced presenteeism • Absenteeism • Turnover
A&C	• Enhanced community well-being • Improved public health outcomes
B&C	• Workforce health • Economic stability
A&B&C	• Healthcare Costs and utilization • Productivity • Mortality • Quality of life • Morbidity and injury reduction • Economic gains

Figure 3. Intersectionality of benefits resulting from physical activity.

3.2 Formalizing the Economic Value of Physical Activity

To quantitatively assess the economic value of physical activity across (1) individual, (2) industry, and (3) governmental levels, this study proposes a novel, formula-based framework that draws directly from the systematic literature review. The core of this framework rests on constructing distinct mathematical models that operationalize the various benefits of physical activity as identified in our concept matrix. This approach provides a structured method to quantify the impacts and aligns theoretical and empirical findings with practical, actionable outcomes.

3.2.1 Individual Level Economic Value

Physical activity's individual-level economic value (IEV) is quantified by a formula integrating various health and economic variables reflecting personal outcomes. This subsection elaborates on the construction, parameterization, and potential applications of the IEV formula within our overarching conceptual framework. The IEV formula is designed to capture the comprehensive benefits of physical activity at an individual level, including enhancements in physical fitness, reductions in healthcare costs, productivity increases, improvements in quality of life, and reductions in morbidity and injury rates (see Table 2). The formula is expressed as follows:

$$IEV = \beta_1 \times \Delta PF_{ind} + \beta_2 \times \Delta HC_{ind} + \beta_3 \times \Delta Prod_{ind} + \beta_3 \times \Delta QoL_{ind} + \beta_4 \times \Delta MIR_{ind} + \beta_5 \times \Delta EG_{ind} + \sum_{j=1}^{n} \gamma_i \times CV_i + \epsilon$$

Where:

- ΔPF_{ind} represents the change in physical fitness due to physical activity.

- ΔHC_{ind} denotes the reduction in healthcare costs, including both direct medical costs and indirect costs such as medications and out-of-pocket expenses.
- $\Delta Prod_{ind}$ captures increased personal earnings and job stability due to improved health and reduced absenteeism.
- ΔQoL_{ind} reflects improvements in the quality of life.
- ΔMIR_{ind} involves decreasing morbidity and injury rates.
- ΔEG_{ind} reflects direct economic gains through incentives.
- CV_i represents control variables such as age, gender, comorbidities, socioeconomic status, etc.

The parameterization of the IEV formula involves the estimation of the coefficients (β_1 and γ_i) which are integral to understanding the magnitude of influence each variable has on the economic value of physical activity. The logical structure of the IEV model is constructed to provide a comprehensive view of how physical activity impacts individual economic outcomes. This structure not only helps in hypothesizing the direct impacts of physical activity—such as reduced healthcare costs and increased productivity—but also allows for exploring more nuanced effects, such as improved quality of life and reduced morbidity, which may indirectly influence economic value.

The inclusion of control variables (CV_i) enriches the model by accounting for additional variance that could distort the direct relationship between physical activity and its economic benefits. This is critical since, e.g., it likely makes a big difference if an individual already has a high level of fitness or not, or a comorbidity may be a decisive factor for the value of physical activity. This approach ensures that the estimated impacts of physical activity are more accurate and reflect real-world interactions between individual characteristics and health outcomes.

3.2.2 Firm-Level Economic Value

The economic value of physical activity at the firm level (FEV) extends the individual approach to a broader organizational context. This formula quantifies the aggregate benefits of physical activity among employees, encompassing reductions in healthcare costs, improvements in workforce productivity, decreases in morbidity and injury rates, and the development of new economic opportunities through enhanced employee wellness programs (see Table 2). The FEV formula is articulated as follows:

$$FEV = \theta_1 \times \Delta PF_{firm} + \theta_2 \times \Delta HC_{firm} + \theta_3 \times \Delta Prod_{firm} + \theta_3 \times \Delta QoL_{firm} \\ + \theta_4 \times \Delta MIR_{firm} + \theta_5 \times \Delta EG_{ind} + \sum_{j=1}^{n} \delta_i \times CV_i + \epsilon$$

Where:

- ΔPF_{firm} represents the firm's change in collective physical fitness levels due to endorsed physical activities.
- ΔHC_{firm} denotes the reduction in healthcare costs for the firm, capturing both direct costs (like medical claims) and indirect costs (such as reduced premium rates).
- $\Delta Prod_{firm}$ captures the increase in overall productivity attributed to better employee health, lower absenteeism, and enhanced job satisfaction.

- ΔQoL_{firm} reflects improvements in the quality of life for employees.
- ΔMIR_{firm} involves decreasing morbidity and injury rates.
- ΔEG_{firm} quantifies the economic gains from new markets for health-related products and services generated by a healthier workforce.
- CV_i includes control variables such as company size, industry type, geographical location, demographic makeup, and health policies.

3.2.3 Governmental-Level Economic Value

At the governmental or societal level, the economic value of physical activity (GEV) encapsulates the macroeconomic implications of improved public health standards. This model quantifies the broader benefits, such as reductions in public healthcare spending, enhancements in population-wide productivity, improvements in national quality of life, and reductions in morbidity and mortality rates. Additionally, it captures the economic gains from increased engagement in physical activities across the populace (see Table 2).

The GEV formula is designed to aggregate these broad effects into a coherent framework, illustrating the holistic benefits of physical activity from a governmental perspective:

$$GEV = \lambda_1 \times \Delta PF_{gov} + \lambda_2 \times \Delta HC_{gov} + \lambda_3 \times \Delta Prod_{gov} + \lambda_3 \times \Delta QoL_{gov} + \lambda_4 \times \Delta MIR_{gov} + \lambda_5 \times \Delta EG_{gov} + \sum_{j=1}^{n} \omega_i \times CV_i + \epsilon$$

Where:

- ΔPF_{gov} represents the change in physical fitness levels across the population.
- ΔHC_{gov} denotes reduced public healthcare expenditures due to improved health outcomes.
- $\Delta Prod_{gov}$ captures the increase in economic productivity attributable to healthier, more active citizens.
- ΔQoL_{gov} reflects improvements in the overall quality of life.
- ΔMIR_{gov} involves decreasing national morbidity and mortality rates, particularly from lifestyle-related diseases.
- ΔEG_{gov} quantifies the broader economic gains from increased physical activity, including reduced health insurance costs and consumer spending in health-related sectors.
- CV_i includes control variables such as demographic shifts, policy changes, and environmental factors.

3.3 Estimating the Economic Value of Physical Activity

To provide a concrete illustration of these formulas, we will apply them to the concept of an "active day", which we define as days where an individual, the workforce of firms, or the population of a country takes at least 10,000 steps. This specific, measurable criterion will allow us to effectively demonstrate how our formulas can be applied to real-world scenarios, offering a practical and relatable example of how the economic value of physical activity can be quantified. Further, walking up to 10,000 steps per day has been linked to health benefits by academic studies (Morgan et al., 2010; Paluch et al., 2022) and represents a reasonable target (Tudor-Locke et al., 2011).

As a basis, we rely on Althoff et al.'s (2017) large-scale study to assess the average number of individual steps, as shown in Table 3. It can be seen that the average step country varies drastically by country, thus making the country a major control variable. We rely on the mean of 5,075 for our initial estimation, resulting in an increase of 97% in the number of steps. To accurately assess the impact of increased physical activity on energy expenditure, we convert the step increments into Metabolic Equivalent of Task (METs). METs are a standard unit for estimating energy expenditure, where 1 MET represents the rate of energy expenditure at rest. Initially, the average daily steps were 5,075. Following an intervention, this number increases to 10,000 steps per day, resulting in an increment of 4,925 steps per day. To translate this into METs, we consider that moderate walking typically equates to approximately 3.3 METs. With an estimated walking pace of 100 steps per minute, 10,000 steps per day correspond to about 100 minutes, equivalent to 330 MET-minutes (3.3 METs multiplied by 100 minutes). For the initial 5,075 steps per day, the equivalent MET-minutes are calculated as follows: 5,075 steps correspond to approximately 50.74 minutes of walking, which, at 3.3 METs, equals 167.442 MET-minutes (3.3 METs multiplied by 50.74 minutes). The difference between the initial and post-intervention MET-minutes is thus 330 MET-minutes minus 167.442 MET-minutes, resulting in an increment of 162.558 MET-minutes per day. This increment reflects the additional energy expenditure due to the increased physical activity level from the intervention.

Table 3. Average steps per day per country. Based on Althoff et al. (2017).

Country	Average steps per day	Change compared to 10,000 steps	Increment of MET-minutes per day
Hong Kong	6,880	45%	102.96
China	6,189	62%	125.76
United Kingdom	5,444	84%	150.35
Germany	5,205	92%	158.24
France	5,141	95%	160.35
Australia	4,491	123%	181.80
Canada	4,819	108%	170.97
United States	4,774	109%	172.46
India	4,297	133%	188.20
Indonesia	3,513	185%	214.07
Mean	**5,075**	**97%**	**162.53**

Next, we utilize the findings from our literature review to operationalize model parameters annually. It must be noted that this operationalization builds on many assumptions and data input that cannot be standardized. Further, a unique systematic literature review and other data collection strategies would be required to obtain a more objective basis. However, our model input represents a suitable example and basis for future research. Table 4 shows the estimated annual value from walking 10,000 steps per model parameter.

Table 4. Summary model input based on the systematic literature review. Each cell presents the score and the sample of academic references representing the basis for the expert assessments. Metrics are expressed on a per-year basis.

Parameter	Individual-level	Firm-level (per employee)	Governmental-level
ΔPF_i	n/a	n/a	n/a
ΔHC_i	**$5,917 in healthcare cost savings** (Araujo, da Guarda, et al., 2023; Araujo, Kokubun, et al., 2023; Coughlan et al., 2021; de Souza de Silva et al., 2019; Myers et al., 2019; Robinson et al., 2022; Silva et al., 2020; Wang et al., 2021)	**$897 in healthcare cost savings** (Griffin et al., 2016; Mendez-Hernandez et al., 2012)	**4.1% savings in national healthcare expenditure** (Ding et al., 2016; Cadilhac et al., 2011)
$\Delta Prod_i$ (7)	**$3,950 in wage increases** (Kosteas, 2012)	**2.7% gain in productivity** (Shephard, 1992)	**2.2% cost savings in national production** (Cadilhac et al., 2011)
ΔQoL_i (8)	**$1,221 due to gain in QALYs and HALYs** (Grout et al., 2021; Mizdrak et al., 2021)	**$321 due to gain in QALYs and HALYs** (Grout et al., 2021; Mizdrak et al., 2021)	**1.36% value gain relative to GDP due to gain in QALYs and HALYs** (Brown et al., 2024; Grout et al., 2021; Mizdrak et al., 2021)
ΔMIR_i (9)	**$27,182 due to significant reduction in morbidity and mortality risk** (Hafner et al., 2020; Cadilhac et al., 2011; Baker et al., 2021)	**$482 due to significant reduction in morbidity and mortality risk** (Hafner et al., 2020; Cadilhac et al., 2011; (Baker et al., 2021; (Rojas-Rueda, 2021)	**0.5% increase in GDP based on reduced morbidity and mortality rates** (Hafner et al., 2020; Cadilhac et al., 2011; (Baker et al., 2021 (Rojas-Rueda, 2021; Ortolan et al., 2022)
ΔEG_i	n/a	n/a	n/a

Note: ΔPF_i and ΔEG_i are highly correlated with the other categories and are thus not operationalized.

We presented the data to three experts to determine an appropriate number or average value based on the underlying figures. We requested that they interpret the partially non-standardizable parameters and provide an estimation. An average value was calculated from these estimations, representing our model's final value. For illustration, the healthcare metric for individuals builds on the following data from the literature:

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[7] Valuing wage increases across different countries is challenging due to the dependency on national wage levels, making it difficult to use a standardized measure globally. The operationalization of wage increases as a raw number does not account for varying economic conditions, labor market dynamics, and living standards, which can significantly affect the interpretation and applicability of such data across diverse economic settings.

[8] The valuation of QALYs and HALYs can differ significantly due to the distinct methods used to adjust life years for quality and health. These differences often stem from how specific health states are weighted, reflecting varying perceptions and valuations of health outcomes across different healthcare studies and policies. Consequently, this variation can lead to substantial discrepancies in cost-effectiveness analyses and health policy decision-making.

[9] Valuing the reduction in morbidity and mortality risks presents a significant challenge due to the inherent complexity of quantifying the value of life. Although measures such as the Value of Statistical Life (VSL) attempt to operationalize this concept, the VSL varies widely across different countries and is influenced by a myriad of factors including economic conditions, cultural values, and societal priorities. This variability underscores the difficulty of applying a universal metric to the diverse contexts and perspectives that exist globally.

1. Annual healthcare savings of $1,389 per MET, which represents the mean across both individuals with hypertension ($1,752) and without hypertension ($1,027) in the United States (Wang et al., 2021).
2. Annual healthcare savings of $4,398 per MET, which represents the mean across both individuals with diabetes ($5,193) and without diabetes ($3,603) (Myers et al., 2019).
3. Annual healthcare savings of US$4,542.33 per MET based on the mean across individuals with normal weight, overweight, and obesity in the United States (de Souza de Silva et al., 2019)
4. Annual healthcare savings of $21.60 for habitual physical activity, which represents the mean across individuals with cardiovascular diseases with and without comorbidities for engaging in habitual physical activity compared to none in Brazil (Araujo et al., 2023a).
5. Annual healthcare savings of $41.995 per score increase in habitual physical activity. The mean across individuals with cardiovascular diseases with and without comorbidities for engaging in habitual physical activity compared to none in Brazil (Araujo et al., 2023b).
6. Annual healthcare savings of $3,677, representing the mean across participants with chronic obstructive pulmonary disease (COPD) engaging in a pedometer-based, web-mediated physical activity program compared to the control group. Increasing physical activity reduces healthcare costs by reducing the risk and severity of COPD-related acute exacerbations (Robinson et al., 2022).
7. Mean annual healthcare savings of $1,349 for individuals who increased their physical activity levels among both early adult (19-29) and middle-age (35-39) in the United States (corresponds to 15.85% of annual savings) (Coughlan et al., 2021).
8. Annual healthcare savings of $513.5. Mean across individuals with knee osteoarthritis who are insufficiently active (30-149 min/week) and active (150+ min/week) compared to their inactive counterparts due to a 3-year physical activity program designed to increase physical activity levels among inactive adults with knee osteoarthritis (Silva et al., 2020).

Based on this information, the two experts arrived at estimated annual savings of $3,500, $4250, and $10,000, resulting in a final score of $5,917 (SD=$2,904).

Table 5 shows the estimation results. An "active day" is valued at $104.85 for individuals, corresponding to $38,270 annually. The results are less easily interpreted for higher abstraction levels since firm and country-level control variables hinder direct utilization in raw currency terms. For firms, an active day is worth a fixed sum of $4.38 plus a 2.7% variable economic gain in productivity. Similarly, government-level value is expressed in relative terms. If the population of an "average steps" country, such as France, Germany, or Australia, starts to walk 10,000 steps daily, healthcare cost savings of 4.1%, productivity gains of 2.2%, and economic gains of 1.56% could be realistic.

Table 5. Estimation results. The table shows estimation results on a per-year and per-day basis for the value of an "active day".

	Annually	**Daily**
Individual-level	$38,270	$104.85
Firm-level (per employee)	$1,600 + 2.7% productivity gain	$4.38 + 2.7% productivity gain
Government-level	Cost savings in healthcare (4.1%) and production (2.2%) and economic gain of 1.56% relative to GDP	Cost savings in healthcare (4.1%) and production (2.2%) and economic gain of 1.56% relative to GDP

It is crucial to emphasize that the results presented are broad averages and will be highly influenced by various control variables such as individual characteristics, firm specifics, and country-level differences. Individual factors such as age, gender, health status, and baseline physical activity levels can significantly alter the economic benefits of increased physical activity (Myers et al., 2019, Lima dos Santos, 2023, Hafner et al., 2022, Grout et al., 2021). Similarly, firm-level outcomes may vary based on the industry, corporate culture, and existing health programs. Country-specific variables such as healthcare infrastructure, population density, and prevailing health policies also play a critical role in shaping the economic impact of physical activity. Thus, while the presented estimates provide a useful guideline, they should be interpreted cautiously, considering these variable factors that can substantially modify the outcomes.

To illustrate how the estimated economic value of physical activity may vary across different jurisdictions, we can examine the stark disparities in average daily steps per country (see Table 3). For instance, individuals in Hong Kong recorded an average of 6,880 steps per day, while those in Indonesia reported only 3,513 steps. These variations highlight the influence of geographical and cultural factors on physical activity levels, affecting the potential economic benefits of interventions aimed at increasing activity levels. Moreover, the differences become more pronounced when considering the healthcare savings associated with increased physical activity, particularly in individuals with comorbidities. For instance, individuals with comorbidities, as indicated by studies like Wang et al. (2021) and Myers et al. (2019), may experience healthcare savings that are approximately 70% higher for hypertension ($1,752 vs. $1,027) and around 42% higher for diabetes ($5,193 vs. $3,693) compared to those without comorbidities. These findings underscore the need for tailored interventions that account for individual health profiles and contextual factors, especially given the potentially amplified benefits for those with comorbidities and the higher prevalence of certain conditions among women.

Given that the UK, France, and Germany rank similarly to the global average in terms of steps taken (cf. Table 3), we can illustrate how exactly the government-level metrics would be expressed for the respective jurisdictions. However, this can only be interpreted as an illustration.

Table 6. Illustration of government-level economic gain.

	UK	**France**	**Germany**
Health expenditure	£182 bn (2022/23)	€308 bn (2021)	€474 bn (2021)
Cost saving (4.1%)	£7.46 bn	€12.63 bn	€19.43 bn
Production	£557 bn (2021)	€1,043 bn (2021)	€2,498 bn (2021)
Production increase (2.2%)	£12.25 bn	€22.95 bn	€54.96
GDP	£3,089 bn (2022)	€2,779 bn (2022)	€4.082 bn (2022)
GDP increase (1.56%)	£48.19 bn	€42.35 bn	€63.68 bn
Total economic gain	**£67.9 bn ($87.17 bn)**	**€78.93 bn ($85.37 bn)**	**€138.07 bn ($149.33 bn)**
Population size	66.97 m	67.97 m	83.80 m
Economic gain per person	**$1,302**	**$1,256**	**$1,782**

Quantifying a broader government-level economic value of an active day, we can determine an estimated value of $107.29 billion based on the mean value using the three illustrated values. On a per-person basis, this results in a mean economic value of $1,447 per citizen annually ($3.96 on a per-day basis). The above-mentioned limitations and the fact that three European countries form the basis must be taken into account. The illustration based on the total population is subject to the limitation that certain proportions of the population cannot walk as well so the actual economic value is not evenly distributed across all citizens. Accordingly, the figure is only an estimate for the Western world.

4 Discussion

The estimated economic values derived from our study provide insights into the scale and variability of the benefits of (increased) physical activity across different societal levels. Our findings reveal significant health benefits and cost savings for individuals, consistent with studies indicating reduced healthcare costs and enhanced well-being from regular physical activity (Kyu et al., 2016; Lee et al., 2012). For instance, the individual benefit of an "active day" translating to an annual (daily) gain of $38,270 ($104.85) showcases the profound impact of increased physical activity on reducing medical expenses, becoming more productive, and enhancing the quality of life.

At the firm level, the direct economic value of $4.38 per employee per active day, plus a 2.7% productivity gain, highlights the potential for businesses to achieve substantial economic returns through health promotion activities. These results align with research suggesting that healthier employees are more productive and less likely to incur high medical costs or absenteeism (Shephard, 1992).

The government-level implications of our findings—4.1% savings in healthcare costs, a 2.2% increase in productivity, and further economic gains of 1.56% of GDP—suggest that public health initiatives encouraging physical activity can be economically beneficial. This is particularly relevant given the rising healthcare expenditures associated with non-communicable diseases in high-income countries. The potential economic gains from increased physical activity could alleviate some financial burdens on national health systems, as corroborated by studies highlighting the cost-effectiveness of preventative health measures (WHO, 2022a). The estimated economic value of $107.29 billion as economic value for Western countries underscores the substantial financial benefits that could be achieved through increased physical activity at the population level. This figure highlights the potential for significant savings and productivity gains, reinforcing the importance of investing in public health initiatives that promote physical activity. It also suggests that even modest increases in activity levels could have a profound impact on national economies, particularly in high-income countries where healthcare costs are rising due to non-communicable diseases.

This study's findings are predicated on the assumption of an intervention—specifically, the adoption of a daily regimen of 10,000 steps. However, it is important to note that some of the economic and health benefits associated with this intervention, while significant initially, may level off over time. As individuals adapt to increased activity levels, the incremental gains in health and productivity might diminish (Kyu et al., 2016, Moore et al., 2012, Peeters et al., 2018). This plateau effect suggests that while initial interventions can result in substantial improvements, maintaining and enhancing these gains will likely require sustained efforts and possibly evolving strategies that continue to engage individuals and institutions long-term.

4.1 Implications for Policy and Practice

The findings of this study offer insights for governments seeking to enhance public health through physical activity. By integrating these results into public health initiatives, governments could substantially mitigate healthcare costs and improve the overall health of their populations. One effective strategy could involve significant infrastructure investments promoting active lifestyles, such as public parks, walking trails, and bike lanes (Rojas-Rueda, 2021; Velázquez-Cortés et al., 2023; Vert et al., 2019). These facilities encourage daily physical activity and enhance urban areas' aesthetic and environmental quality.

Additionally, governments might consider implementing incentive programs that reward physical activity achievements, similar to Singapore's National Steps Challenge. These programs can be particularly effective if they are tailored to diverse community needs and include components that engage various demographic groups. For instance, offering tax incentives for purchasing fitness equipment or discounts on health insurance premiums for individuals meeting specific activity milestones could further promote physical engagement across broader population segments.

The economic benefits of encouraging physical activity are clear for firms: lower healthcare costs and higher employee productivity. Businesses can leverage these benefits by establishing or enhancing corporate health programs. Initiatives could include subsidized gym memberships, installing onsite fitness facilities, or introducing structured wellness programs that encourage regular exercise. Moreover, integrating activity-friendly policies, such as flexible work hours for exercise or "walking meetings," can contribute to a healthier, more engaged workforce.

Employers could also explore partnerships with health technology companies to utilize wearables and health monitoring apps. These tools can help track physical activity levels and provide data-driven insights to personalize health programs further, thereby maximizing the potential health benefits for employees and, concurrently, productivity gains for the company.

Community-level interventions can be crucial in promoting physical activity and can significantly reduce healthcare expenditures when effectively implemented. Local governments and community organizations could develop programs encouraging communal exercise, such as group fitness classes in public spaces or community sports leagues. These activities promote health, strengthen community bonds, and improve social well-being. Further, community health initiatives could include educational campaigns highlighting the benefits of physical activity and providing practical guidance on incorporating more movement into daily routines. Collaborations with local businesses to sponsor community fitness events or challenges can also be a powerful way to engage larger audiences and create a culture of health. By emphasizing community engagement in promoting physical activity, these strategies collectively foster an environment where healthy lifestyle choices are accessible, encouraged, and sustained. Through comprehensive and inclusive approaches, the potential health benefits of physical activity can be realized on a larger scale, benefiting individuals, businesses, and the broader society.

4.2 Limitations and Future Research

Our study, while comprehensive, is subject to several methodological limitations that could affect the interpretation and generalizability of the findings. One significant limitation is the reliance on average values to estimate the economic impact of physical activity. This approach may oversimplify the complexities and variabilities inherent in individual and group behaviors, potentially leading to overgeneralized conclusions. For example, averaging masks important sub-group differences, such as those based on age, gender, or health status, which can significantly influence the outcomes of physical activity interventions.

An important direction for future research involves operationalizing detailed estimations of the economic model of physical activity for specific countries or major firms. This entails developing customized models that consider the unique economic, cultural, and infrastructural characteristics of different countries or the specific operational and strategic contexts of major firms. Such detailed models would allow for more accurate predictions and tailored recommendations, helping policymakers and business leaders make informed decisions about investing in health promotion initiatives. Researchers could rely on government data or partner with corporations to access relevant data, thus allowing them to objectively quantify the value of physical activity for a certain partner. For example, utilizing information on the preexisting fitness level and distributions of comorbidities, age, gender, and other variables could be a basis for a detailed and accurate assessment of the value of physical activity. While such information could be very valuable for firms to individually tailor incentive programs for their workforce, the ethical aspect of individual-level data needs to be considered when relying on variables such as gender or comorbidities.

This study incorporates expert estimations to quantify the economic benefits associated with physical activity. While expert input can provide valuable insights, it also introduces potential biases based on the experts' personal experiences, preferences, or the specificities of their professional backgrounds. These biases could skew the data, particularly if the expert sample lacks diversity or their views do not fully represent broader scientific consensus. By relying on three experts, we tried to reduce these biases by incorporating various perspectives that enhance our estimations' representativeness and improve our conclusions' robustness. However, it remains crucial to interpret these findings within the context of the known limitations of expert-based assessments.

Another key limitation of this study involves the data sources used. The data applied in our analysis is not universally applicable or reflective of all demographic groups. For instance, much of the data originates from studies conducted in high-income countries with specific health infrastructures and lifestyles that are not directly transferable to lower-income settings or diverse cultural contexts. This limitation is critical, as interventions effective in one regional or socio-economic context may not yield similar results in another. While this data was helpful in designing our conceptual model, an objective operationalization would necessitate an individual literature review and ideally incorporate other data inputs such as grey literature, surveys, and interviews to ensure a comprehensive and contextually relevant approach.

Future research should consider longitudinal studies that track individuals over extended periods to understand better the long-term impacts of physical activity on economic outcomes. Such studies could provide deeper insights into the causal relationships between physical activity and economic benefits, including long-term healthcare cost reductions and sustained improvements in productivity. Advancements in technology offer new opportunities for collecting more accurate and real-time data on physical activity levels. Future studies could utilize wearable technology and mobile health applications to gather detailed data on the patterns and intensities of physical activity. This approach would allow researchers to overcome some of the limitations associated with self-reported data and provide a better understanding of how physical activity varies by context and individual characteristics.

5 Conclusion

This study has analyzed the substantial economic and health benefits that can be derived from increased physical activity across various sectors of society. The findings underscore the potential for significant healthcare cost savings, enhanced productivity, and improved quality of life at individual, corporate, and governmental levels. Specifically, our estimates suggest that simple lifestyle changes, such as achieving 10,000 steps per day, can translate into considerable economic advantages—demonstrating a clear return on investment for promoting physical activity.

These benefits are not just limited to direct economic gains but also extend to broader societal advantages, including reduced healthcare burden, increased workplace efficiency, and enhanced public health. As such, physical activity should be viewed as a personal health strategy and a strategic economic policy lever that can contribute significantly to national and global prosperity.

Given the compelling evidence of the economic benefits of physical activity outlined in this study, a concerted effort from various stakeholders is essential. Policymakers are encouraged to integrate physical activity into public health agendas more robustly. This could involve creating and funding programs that make physical activity accessible to all parts of the population, improving infrastructure to support active lifestyles, and legislating for health-promoting environments in urban development.

Health professionals should consider prescribing physical activity as part of standard care for preventing and managing diseases, thereby incorporating it into the therapeutic arsenal that addresses both chronic and acute health conditions. Business leaders are also urged to recognize a physically active workforce's productivity and health benefits. Investing in employee wellness programs that promote physical activity can lead to a healthier, more motivated, and more productive workforce, reducing turnover and absenteeism while boosting corporate performance.

This study provides a foundation for understanding the multifaceted benefits of physical activity. It serves as a call to action for integrating these insights into policies and practices that enhance the well-being of individuals and communities alike. By adopting strategies that promote physical activity, stakeholders can improve health outcomes and drive significant economic growth, making a compelling case for why moving more should be a priority for everyone.

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