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Evidence-Based Perceptions of the 10,000-Step Target and Physical Activity Intentions: A Cross-Sectional Survey Using PLS-SEM

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ABSTRACT

Low levels of physical activity have encouraged the widespread use of numerical targets, such as 10,000 steps per day, as public health promotion tools. Despite their popularity, the effectiveness of step-based targets depends not only on campaign exposure but also on how individuals perceive the scientific evidence underlying these recommendations. This study examines the effect of evidence-based perception of the 10,000-step target on physical activity intention using a Structural Equation Modeling–Partial Least Squares (SEM–PLS) approach. A quantitative explanatory cross-sectional survey design was employed, with data collected at a single point in time through a questionnaire from 220 adults exposed to step-based physical activity programs or information. Evidence-based perception was modeled as a latent construct reflecting scientific understanding, perceived validity, and rationality of the step target, while physical activity intention was measured through indicators of readiness and behavioral commitment. The results indicate that evidence-based perception has a positive and significant effect on physical activity intention, with a strong path coefficient and a moderate R-square value. These findings suggest that evidence-based understanding plays a critical role in shaping physical activity intention, beyond the normative function of step targets. The study concludes that step-based physical activity promotion will be more effective when accompanied by evidence-based communication that fosters rational and informed acceptance of health recommendations.

Keywords: Evidence-Based Public Health; Physical Activity; Public Health Intervention; Step Count; Walking

INTRODUCTION

The target of walking 10,000 steps per day has become one of the most widely used physical activity recommendations in global health discourse. This figure is consistently adopted in public health campaigns, healthy lifestyle guidelines, and is integrated by default into various wearable devices and digital fitness applications. In practice, 10,000 steps are often positioned as an ideal standard of daily physical activity associated with improved

cardiovascular health, weight control, and reduced mortality risk. The popularity of this target reflects its success as a public health message that is simple, quantitative, and easily understood by the general population.

However, the scientific legitimacy of the 10,000 step target as an optimal threshold for physical activity remains subject to debate. Historically, this figure did not originate from clinical consensus or epidemiological trials, but rather from a pedometer marketing campaign in Japan during the 1960s. This origin raises epistemic concerns when the target is widely adopted in modern public health policies that demand an evidence-based foundation. As a result, tension emerges between the normative popularity of the step target and the requirements of public health practice grounded in the strength of scientific evidence.

From a practical perspective, the use of a single target such as 10,000 steps carries significant implications for the design and evaluation of public health interventions. Various population groups, particularly older adults, individuals with chronic diseases, and those with functional limitations, often demonstrate meaningful health benefits at lower levels of physical activity. When normative standards are set too high and lack contextual sensitivity, there is a risk of excluding vulnerable groups and reducing the attainability and sustainability of physical activity behaviors. Therefore, the effectiveness of 10,000 steps as a public health intervention cannot be separated from issues of health equity and population context.

The scientific literature indicates that the relationship between daily step counts and health outcomes is complex and non-uniform. Hall et al., in a study entitled Systematic review of the prospective association of daily step counts with risk of mortality, cardiovascular disease, and dysglycemia, demonstrated a dose response relationship between step counts and major health outcomes. However, the study did not identify 10,000 steps as a superior clinical threshold, instead emphasizing that gradual increases in step counts already provide significant health benefits. These findings are reinforced by Del Pozo Cruz et al. through the meta-analysis entitled How many steps a day to reduce the risk of all-cause mortality? A dose-response meta-analysis. The study showed that reductions in mortality risk became significant at approximately 6,000 to 8,000 steps per day, with diminishing additional benefits at higher step levels. Thus, 10,000 steps did not emerge as a consistently optimal epidemiological threshold.

Jayedi et al., in the study Daily Step Count and All-Cause Mortality: A Dose-Response Meta-analysis of Prospective Cohort Studies, also confirmed a non-linear relationship between step counts and mortality. Although this study provided high-level evidence, its primary focus remained on epidemiological associations and did not explicitly evaluate the implications of the 10,000 step target as a standard public health intervention. Conversely, several intervention studies have used the 10,000 step target as a reference for health programs. Fayehun et al., in Walking prescription of 10,000 steps per day in patients with type 2 diabetes mellitus, reported improvements in metabolic parameters

among patients with type 2 diabetes, while Pischke et al., in Impact of '10,000 Steps Duesseldorf' after one year, demonstrated increased physical activity and improved health indicators in a community population. However, these studies were population-specific and did not systematically compare the effectiveness of 10,000 steps with lower alternative step thresholds.

Criticism of the legitimacy of the 10,000 step figure has also been articulated by Ulmer et al. in The Myth of 10,000 Steps, which highlights the weak scientific basis of the target. Nevertheless, this review focused more on technological aspects and health application design rather than synthesizing clinical evidence across study designs. An earlier review by Choi et al. in Daily step goal of 10,000 steps: a literature review also failed to reflect recent epidemiological developments, as it was conducted prior to the availability of large-scale meta-analyses. Based on this mapping of the literature, it can be concluded that, to date, no systematic literature review grounded in an evidence hierarchy has explicitly evaluated the strength of scientific evidence supporting the 10,000 step per day target, compared it with alternative step thresholds based on health outcomes, and situated the findings within an evidence-based public health framework. This study aims to address this gap by systematically synthesizing scientific evidence on the effectiveness of walking 10,000 steps per day and identifying step thresholds that most consistently confer health benefits across populations.

METHOD

This study employed a systematic literature review approach grounded in evidence-based public health to assess the effectiveness of daily step counts, particularly the 10,000 step per day target, on various health outcomes. This approach was selected to ensure that evaluations of physical activity recommendations are based on the strength and quality of scientific evidence rather than normative popularity alone. The systematic review procedure followed PRISMA guidelines to ensure transparency and traceability of the literature selection process.

Article searches were conducted in the PubMed, Scopus, and Web of Science databases using keywords related to daily step counts and health outcomes, including daily steps, step count, walking, physical activity, mortality, cardiovascular disease, and metabolic health. Included articles were peer-reviewed publications up to 2025 with observational designs, prospective cohort studies, intervention trials, or meta-analyses, and reported step counts as a primary variable along with measurable health outcomes. Non-empirical articles, editorials, and studies with unclear methodologies were excluded from the analysis.

The literature selection process followed the PRISMA flow with the Identification stage yielding n = 462 records from all databases, followed by duplicate removal resulting in Screening of n = 389 articles based on titles and abstracts. After initial screening, Eligibility assessment involved n = 76 full-text articles, of which 52 were excluded for failing to meet inclusion criteria.

Consequently, Included n = 24 articles were analyzed in this systematic review. Data were extracted and synthesized narratively based on methodological quality and level of evidence, with explicit comparisons between the 10,000 step per day target and alternative step thresholds in the context of public health implications.

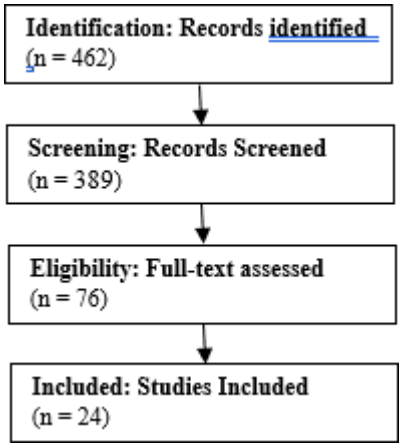

Figure 1. PRISMA Flowchart

RESULT AND DISCUSSION

Evaluation of the Strength of Scientific Evidence for the 10,000 Steps per Day Target on Health Outcomes

The synthesis of the literature analyzed in this systematic literature review indicates that the relationship between daily step counts and health outcomes is directionally consistent, yet not uniform in determining an optimal threshold. Prospective cohort studies and meta-analyses with high levels of evidence generally confirm a dose–response relationship between increasing step counts and reduced risks of all-cause mortality, cardiovascular disease, and metabolic disorders. Nevertheless, these findings do not consistently support the 10,000 steps per day target as the most effective evidence-based clinical threshold.

The meta-analysis conducted by Hall et al. demonstrates that increases in daily step counts are associated with gradual reductions in mortality and cardiovascular risk, without any specific surge in benefits occurring at the 10,000-step mark. This study emphasizes that health benefits emerge progressively as physical activity increases, suggesting that step counts function more as indicators of active behavior intensity rather than as discrete clinical thresholds. These findings imply that setting a single universal number as a health standard may oversimplify the complex relationship between physical activity and health outcomes.

More explicit evidence regarding health benefit thresholds is provided by the dose–response meta-analysis conducted by Del Pozo Cruz et al., which reports that reductions in mortality risk become significant at approximately 6,000 to 8,000 steps per day. At step levels beyond this range, additional health benefits persist but tend to diminish. This pattern indicates diminishing returns at higher step counts, suggesting that 10,000 steps should not be viewed as an

outcome-based optimal threshold, but rather as a target situated within a zone of additional benefit.

Similar results are reported by Jayedi et al. in a prospective cohort meta-analysis showing a non-linear relationship between step counts and mortality. This study highlights that the majority of health benefits are achieved when individuals transition from low to moderate levels of physical activity. Consequently, increases in step counts from a low baseline yield substantially greater health gains than increases from moderate to high levels. In this context, the 10,000-step target more accurately represents an upper bound of active behavior rather than a critical evidence-based threshold.

In contrast, intervention studies that explicitly adopt the 10,000-step target, such as the study by Fayehun et al. among patients with type 2 diabetes and the community-based program by Pischke et al., do report improvements in health parameters and increased physical activity. However, these studies were not designed to test 10,000 steps as an optimal threshold, but rather as a behavioral target that is easy to communicate and monitor. When positioned within the hierarchy of evidence, these findings reflect the effectiveness of the 10,000-step target as a physical activity promotion tool rather than as a clinically derived outcome-based standard. Overall, the synthesis of evidence indicates that the 10,000 steps per day target lacks strong support as an optimal threshold grounded in scientific evidence. Health benefits from walking increase with higher step counts, yet no consistent critical point is observed at the 10,000-step level. These findings position the 10,000-step target as a pragmatic guideline rather than a rigorously validated evidence-based boundary within the context of public health.

Variability in Health Responses to Step Counts Based on Population Characteristics

The analyzed literature demonstrates that health responses to daily step counts vary substantially across populations and are influenced by individual characteristics and social context. Age, baseline health status, fitness level, and socioeconomic environment are key factors moderating the relationship between step counts and health outcomes. This variability underscores that the effectiveness of step-based physical activity cannot be understood universally, but must instead be interpreted within specific population contexts. Among older adults, several cohort studies and meta-analyses indicate that significant health benefits are achieved at lower step counts compared to younger adult populations. Del Pozo Cruz et al. and Jayedi et al. report that in older age groups, reductions in mortality and cardiovascular events are already evident at approximately 6,000 to 7,000 steps per day. These findings suggest that the threshold for health benefits in older adults lies below the 10,000-step target, and that applying a universal standard may impose unrealistic expectations for this group.

Variability in response is also clearly observed among individuals with differing baseline health conditions. The intervention study by Fayehun et al. involving patients with type 2 diabetes shows that step-based increases in physical activity lead to improvements in metabolic parameters even when daily step counts do not approach 10,000. Similar findings are reported by Lefferts et al., who demonstrate that an increase of approximately 3,000 steps per day is sufficient to produce meaningful reductions in blood pressure among older adults with hypertension. These results reinforce the argument that health benefits are more strongly driven by relative increases from baseline activity levels rather than by achieving a specific absolute target.

Baseline fitness level further plays a crucial role in shaping responses to step counts. Individuals with low levels of physical activity experience greater health improvements when increasing their step counts compared to those who are already physically active. This pattern aligns with the concept of diminishing returns, whereby incremental health benefits decrease at higher step levels. As such, the 10,000-step target may be more relevant for individuals already at moderate to high activity levels, but is less appropriate as a primary reference for populations with low baseline activity.

Beyond biological factors, socioeconomic context also influences both the attainability and effectiveness of step-based activity. Access to safe walking environments, availability of leisure time, and social support significantly affect individuals' ability to meet daily step targets. In this context, the application of a single universal target risks introducing policy bias and excluding vulnerable groups facing structural constraints to physical activity. A synthesis of the variability in health responses to step counts is presented in Table 1.

Tabel 1. Variability of Health Responses to Daily Step Counts Across Population Characteristics

Population Group	Step Range Associated With Benefits	Main Health Outcomes	Key Evidence
Older adults	6000–8000 steps/day	Reduced all cause mortality and cardiovascular risk	Del Pozo Cruz et al. 2021; Jayedi et al. 2021
Adults with chronic conditions	3000–7000 steps/day	Improved metabolic control and blood pressure	Fayehun et al. 2018; Lefferts et al. 2023
Physically inactive adults	Relative increase from baseline	Significant health gains and functional improvement	Hall et al. 2020; Paluch et al. 2022
General adult population	7000–10000 steps/day	Gradual risk reduction with diminishing returns	Stens et al. 2023; Ding et al. 2025

The table confirms that there is no single optimal step count threshold applicable to all populations. The range of steps that provides health benefits varies systematically according to individual characteristics and social context. Therefore, step based physical activity recommendations should be contextual and population based rather than relying on a single numerical standard.

Implications of Evidence Based Findings for the Formulation of Physical Activity Based Public Health Interventions

The synthesis of evidence generated in this systematic literature review indicates that the effectiveness of physical activity based public health interventions cannot be reduced to the establishment of a single numerical target, including the 10,000 steps per day target. Scientific evidence across multiple study designs demonstrates that health benefits from walking are more strongly influenced by relative increases in activity from baseline, behavioral sustainability, and the alignment of interventions with the characteristics of target populations. Accordingly, an evidence based public health approach requires a paradigm shift from normative standardization toward adaptive and contextual policy formulation.

Within the context of public health policy, the 10,000 step target has strategic value as a physical activity promotion tool due to its simplicity, ease of communication, and feasibility of monitoring through digital technologies. Several community based and behavioral intervention studies indicate that this target is effective in increasing initial awareness and participation in physical activity. However, when the target is used as a health evaluation standard or as an indicator of intervention success, there is a risk of oversimplification that is not aligned with scientific evidence. Evidence shows that achieving significant health benefits does not require meeting the 10,000 step target, particularly among older adults and individuals with specific health conditions.

A key implication of these findings is the need to conceptually distinguish between behavioral targets and outcome based clinical thresholds. Behavioral targets are intended to encourage active lifestyle changes, whereas clinical thresholds should be established based on consistent causal evidence related to health risk reduction. Within the analyzed literature, the 10,000 step target primarily functions as a behavioral target that facilitates physical activity nudging rather than as a universally validated clinical threshold. The lack of clarity in this distinction within public policy may result in imprecise and non inclusive recommendations.

An evidence based approach also emphasizes the importance of accounting for population heterogeneity in the formulation of public health interventions. The variability in health responses to step counts identified across studies indicates that a one size fits all approach is inconsistent with the principles of health equity. Groups with physical limitations, chronic health conditions, or socioeconomic barriers are at risk of being positioned as failing to meet physical activity standards despite having achieved meaningful health

benefits from moderate increases in activity. Consequently, recommendations based on step ranges or relative increases from baseline are more consistent with scientific evidence and population realities.

In addition, behavioral sustainability is a key determinant of the long term impact of public health interventions. Evidence suggests that targets perceived as excessively high or unrealistic may reduce long term motivation and adherence. Interventions that emphasize gradual progression, flexibility, and adaptation to individual capacity are more likely to be sustainable and to achieve broader impact. In this context, 10,000 steps may serve as a long term aspiration, while lower intermediate targets can function as more realistic and evidence based indicators of progress. The findings of this systematic review also have implications for the design and evaluation of technology based public health programs, such as fitness applications and wearable devices. Reliance on a single numerical target risks neglecting the complexity of health responses and encouraging a purely quantitative orientation. An evidence based approach requires the integration of behavioral quality indicators, such as activity consistency, gradual improvement, and the integration of physical activity with other health strategies, including dietary control and risk factor management. Accordingly, health technologies should support personalized physical activity targets rather than reinforcing rigid numerical standards.

Overall, the evidence based implications of these findings underscore the need for physical activity based public health interventions to shift from a normative approach toward an adaptive approach grounded in scientific evidence. The 10,000 step per day target should be positioned as one flexible and contextual policy option rather than as a singular scientific reference. This approach enables public health policy to be more responsive to population diversity, to enhance behavioral sustainability, and to align with the principles of evidence based public health in advancing population health outcomes.

CONCLUSION

Based on the evidence based synthesis conducted through a systematic literature review, this study demonstrates that the 10,000 steps per day walking target is not fully supported as an optimal evidence based threshold within the context of public health interventions. The discussion indicates that the relationship between daily step counts and health outcomes follows a dose response pattern but is non linear and does not reveal a consistent clinical threshold at the 10,000 step level. Significant health benefits have been observed at lower step counts, particularly within moderate ranges, with a tendency toward diminishing returns at higher step levels. These findings indicate that 10,000 steps is more appropriately understood as a pragmatic target that promotes active behavior rather than as a rigid evidence based standard for public health evaluation.

This study also confirms the existence of variability in health responses to step counts based on population characteristics. Factors such as age, baseline health status, fitness level, and socioeconomic context significantly

influence the step thresholds at which health benefits occur. Older adults and groups with specific health conditions demonstrate meaningful benefits at lower step counts compared to healthy younger adult populations. Accordingly, a universal single target approach risks introducing policy bias and excluding vulnerable groups, even when these groups have achieved relevant health benefits from moderate increases in physical activity. These findings reinforce the urgency of contextual and population based physical activity recommendations.

Within the framework of evidence based public health, the primary implication of these findings is the need to shift from a normative approach toward an adaptive approach in the formulation of physical activity based public health interventions. From a theoretical perspective, there is a need to redefine physical activity thresholds based on health outcomes and population context rather than on popular normative figures. From a practical perspective, public health policy should adopt more flexible, realistic, and evidence based step recommendations that emphasize relative increases from baseline and behavioral sustainability. Future research is recommended to develop longitudinal studies and subgroup based meta analyses to strengthen the determination of optimal and relevant step thresholds for diverse population groups. Through this approach, physical activity based public health interventions are expected to become more inclusive, effective, and aligned with the principles of evidence based public health.

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