Oshada; Jurnal Kesehatan

https://nawalaeducation.com/index.php/O/index
Volume 2 Nomor 6, December 2025
e-ISSN : 3047-017X
DOI : https://doi.org/10.62872/sxxnth96

Modeling Evidence-Based Perceptions of the 10,000-Step Target and Its Impact on Physical Activity Intentions: A Structural Equation Modeling–PLS Approach

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Inputed : *November 10, 2025* *Revised* : *November 22, 2025*
Accepted : *December 13, 2025* *Published: December 29, 2025*

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 perception; physical activity intention; PLS-SEM; step target; walking behavior.*

INTRODUCTION

Low levels of physical activity in the population remain a persistent public health problem, despite the continued development of active lifestyle campaigns at both global and national levels. Insufficient physical activity contributes significantly to an increased risk of non-communicable diseases, such as cardiovascular disease, diabetes, and metabolic disorders, thereby reinforcing the urgency of effective and sustainable promotive and preventive interventions (Stamatakis et al., 2023). In response to this challenge, numeric target-based approaches to physical activity

promotion have increasingly been adopted because they are considered practical, easy to understand, and easy for individuals to monitor.

The 10,000 steps per day walking target represents the most popular example of this approach. This target has been widely adopted in public health programs, digital technology-based interventions, and fitness applications used in daily life. The history of step-based targets indicates that the 10,000-step figure functions as a simple and communicative symbol of active behavior, making it effective in increasing initial awareness of the importance of physical activity (Stamatakis et al., 2023; Vandelanotte et al., 2022). Several studies also show that step targets can encourage self-monitoring and increase individual engagement in walking activities, particularly in community-based and workplace-based programs (Safi et al., 2024; Hume et al., 2021).

However, the scientific legitimacy of the 10,000-step target as an evidence-based standard for physical activity remains debated in the health literature. Several studies emphasize that the health benefits of walking follow a dose-response pattern and do not depend on a single universal threshold value (Hamer & Blodgett, 2022; Washburn & Ihm, 2021). The discrepancy between the popularity of the 10,000-step target and the strength of the scientific evidence underpinning it raises conceptual concerns, particularly when the target is promoted without a rational explanation of its scientific basis. In this context, individuals may comply with the target normatively without truly understanding its relevance or flexibility in relation to personal conditions.

An evidence-based approach to physical activity promotion emphasizes the importance of individuals' rational understanding of health recommendations. Evidence-based practice not only requires the use of scientific evidence in policy formulation, but also demands attention to how such evidence is communicated and perceived by individuals as the targets of interventions (Hardcastle et al., 2021). Individuals' perceptions of the scientific validity of a health recommendation play a crucial role in shaping beliefs, attitudes, and readiness to engage consistently in the recommended behavior. In the context of physical activity, evidence-based perceptions of step targets may influence the extent to which individuals view the target as rational, credible, and worthy of internalization in daily routines.

Health behavior literature indicates that intention is a primary psychological determinant in the process of behavior change. Various behavioral models, including social-cognitive approaches, emphasize that intention is formed through cognitive evaluations of the benefits, rationality, and relevance of a behavior (Yu et al., 2025; Ahn et al., 2023). When individuals understand that a physical activity target is supported by reasonable scientific evidence, their intention to perform the behavior tends to be stronger and more stable. Conversely, when a target is perceived as arbitrary or not evidence-based, the resulting intention is likely to be fragile and prone to decline.

Nevertheless, physical activity research to date has largely focused on demographic, motivational, and environmental factors, while the cognitive dimension of evidence-based perceptions of physical activity targets has received relatively limited attention. Some studies have examined intention and physical activity behavior using psychosocial variables, but the focus has been more on motivation, social norms, or self-regulation rather than on evidence-based understanding of numeric targets used in physical activity promotion (Brown et al., 2024; Feil et al., 2023). In addition, many studies continue to rely on linear analytical approaches that

are insufficient for modeling latent relationships and psychological mechanisms simultaneously.

The research gap of this study lies in the absence of structural modeling that explicitly positions evidence-based perceptions of step targets as a primary latent construct in explaining physical activity intention. Research by Eric Stamatakis, Mahsa Ahmadi, Mark Murphy, Thomas Chico, Kathryn Milton, Borja Del Pozo Cruz, Peter Katzmarzyk, I-Min Lee, and Jason Gill entitled Journey of a Thousand Miles: From "Manpo-Kei" to the First Steps-Based Physical Activity Recommendations highlights the history and development of step-based recommendations, but does not examine individual psychological mechanisms related to these targets. The study by Mark Hamer and Jared Blodgett entitled The Step Count Conundrum critiques the scientific legitimacy of step targets, but does not model their impact on behavioral intention. Meanwhile, research by Chantal Vandelanotte, Christina Hooker, Annemarie Van Itallie, Ayesha Urooj, and Mitch Duncan entitled Understanding Super Engaged Users in the 10,000 Steps Online Physical Activity Program focuses on user engagement rather than evidence-based perceptions as a latent cognitive construct. Thus, an empirical gap remains in modeling how evidence-based perceptions of the 10,000-step target influence physical activity intention in a structural manner using the SEM–PLS approach.

Based on this gap, this study offers novelty in three aspects. Conceptually, this study positions evidence-based perceptions of the 10,000-step target as a key cognitive variable influencing physical activity intention. Methodologically, this study employs Structural Equation Modeling–Partial Least Squares to model latent relationships simultaneously and comprehensively. Analytically, this study shifts the focus from mere exposure to physical activity campaigns toward evidence-based understanding as a determinant of behavioral intention.

Accordingly, the objective of this study is to analyze the effect of evidence-based perceptions of the 10,000 steps per day target on individuals' intentions to engage in physical activity using the Structural Equation Modeling–Partial Least Squares approach. The findings of this study are expected to enrich the health behavior literature while providing an empirical foundation for the design of physical activity interventions that are more rational, flexible, and grounded in scientific evidence.

METHODOLOGY

Research Design

This study employs a quantitative approach with a cross-sectional explanatory design to examine the structural relationship between the latent construct of evidence-based perceptions of the 10,000-step target and physical activity intention. Data were collected at a single point in time and analyzed using Structural Equation Modeling with the Partial Least Squares approach. SEM–PLS was selected because it is appropriate for predictive-oriented research, the examination of latent variable relationships, and the development of behavior-based theoretical models, particularly when data distribution does not fully meet normality assumptions and the research model is relatively complex (Hair et al., 2021; Legate et al., 2023). The structural model was specified to evaluate the strength and direction of the statistical influence of evidence-based perceptions on physical activity intention simultaneously, without implying temporal or experimental causality.

Population and Sample

The research population comprises adult individuals who have been exposed to information, programs, or physical activity campaigns based on step targets through digital fitness applications, wearable devices, or community-based health promotion initiatives. The research sample was determined using a non-probability sampling technique with a purposive sampling approach. Inclusion criteria included individuals aged 18 years or older who reported prior experience using or being familiar with step-based physical activity targets. Sample size determination followed the sample adequacy principle in SEM–PLS, which recommends a minimum of ten times the number of indicators of the construct with the largest number of indicators. Based on this criterion, a total of 220 respondents were included in the analysis, which was considered sufficient to ensure the stability and robustness of both outer model and inner model estimations.

Research Instruments

The research instrument consisted of a structured questionnaire developed based on theoretical frameworks and prior empirical studies. The construct of evidence-based perception of the 10,000-step target was measured using six reflective indicators capturing scientific understanding of the step target, trust in its scientific validity, perceived rationality of the target, perceived flexibility relative to individual conditions, and belief that the target is supported by credible health evidence. Physical activity intention was measured using five reflective indicators representing individuals' readiness to engage in physical activity, personal commitment, short-term intention, medium-term intention, and willingness to maintain physical activity consistently.

All items were measured using a five-point Likert scale ranging from strongly disagree to strongly agree. The measurement model was evaluated through validity and reliability assessments within the SEM–PLS framework, including convergent validity assessed via outer loading values and Average Variance Extracted, construct reliability assessed using Cronbach's alpha and composite reliability, and discriminant validity evaluated using the Fornell–Larcker criterion and the heterotrait–monotrait ratio. Data analysis was conducted using the latest version of SmartPLS software.

RESULTS AND DISCUSSION

Sample Characteristics

A total of 220 respondents are analyzed in this study. The respondents consist of 57.3 percent females and 42.7 percent males. In terms of age, the majority of respondents fall within the age range of 21 to 35 years, reflecting a productive age group with high exposure to fitness applications and digital physical activity campaigns. Most respondents report having been familiar with or having used the 10,000 steps per day target through health applications or step-based physical activity programs. These characteristics indicate that the research sample is relevant for examining evidence-based perceptions of step targets and physical activity intention.

Table 1. Sample Characteristics

Characteristics	Category	Frequency	Percentage
Gender	Male	94	42.7
	Female	126	57.3
Age	18–25 years	78	35.5
	26–35 years	96	43.6
	>35 years	46	20.9
Exposure to step-based programs	Yes	182	82.7
	No	38	17.3

The interpretation of the table indicates that the majority of respondents possess characteristics consistent with the research context, namely adult individuals with exposure to step-based physical activity targets.

Evaluation of the Measurement Model

The evaluation of the outer model is conducted to assess convergent validity and construct reliability. All indicators in the evidence-based perception and physical activity intention constructs show outer loading values above the 0.70 threshold. The Average Variance Extracted values for each construct also exceed the minimum threshold of 0.50, while Cronbach's alpha and composite reliability values are above 0.70, indicating good internal reliability.

Table 2. Convergent Validity and Reliability

Construct	Indicator	Outer Loading	Cronbach's Alpha	Composite Reliability	AVE
Evidence-Based Perception	EB1	0.78	0.88	0.91	0.63
	EB2	0.81			
	EB3	0.83			
	EB4	0.76			
	EB5	0.80			
	EB6	0.79			
Physical Activity Intention	PA1	0.82	0.86	0.90	0.65
	PA2	0.79			
	PA3	0.84			
	PA4	0.78			
	PA5	0.80			

The interpretation of these results indicates that all indicators are convergently valid and that the constructs exhibit adequate levels of reliability for structural analysis.

Discriminant Validity

Discriminant validity is tested using the Fornell–Larcker criterion. The square root of the AVE for each construct is greater than the inter-construct correlations, indicating that each construct possesses sufficient conceptual uniqueness.

Table 3. Discriminant Validity (Fornell–Larcker Criterion)

Construct	Evidence-Based Perception	Physical Activity Intention
Evidence-Based Perception	0.79	
Physical Activity Intention	0.58	0.81

The interpretation of this table confirms that the constructs of evidence-based perception and physical activity intention are empirically distinct and do not exhibit issues of construct overlap.

Structural Model Evaluation

The evaluation of the inner model shows that evidence-based perceptions of the 10,000-step target have a moderate explanatory power for physical activity intention. The R-square value for the physical activity intention construct is 0.34, indicating that approximately 34 percent of the variation in physical activity intention can be explained by evidence-based perceptions.

Table 4. Coefficient of Determination (R-Square)

Endogenous Construct	R-Square
Physical Activity Intention	0.34

This interpretation indicates that evidence-based perception is a substantive predictor of physical activity intention, although other factors outside the model also play a role.

Hypothesis Testing

Hypothesis testing is conducted through path coefficient analysis and bootstrapping with 5,000 resamples. The results show that evidence-based perceptions of the 10,000-step target have a positive and significant effect on physical activity intention.

Table 5. Path Coefficients and Bootstrapping Results

Hypothesis	Path	Path Coefficient	t-value	p-value
H1	Evidence-Based Perception → Physical Activity Intention	0.58	9.41	<0.001

The interpretation of these results confirms that the stronger an individual's perception of the evidence-based validity of the 10,000-step target, the higher the individual's intention to engage in physical activity. This finding provides strong empirical support for the research hypothesis and underscores the important role of evidence-based cognitive factors in the formation of physical activity intention.

Discussion

The results of the Structural Equation Modeling–Partial Least Squares analysis show that evidence-based perceptions of the 10,000 steps per day target have a positive and significant effect on physical activity intention. These findings empirically support the main research hypothesis that individuals' understanding of and belief in the scientific basis of a physical activity target constitute an important cognitive determinant in the formation of behavioral intention. With a relatively strong path

coefficient and an R-square value in the moderate category, the results indicate that physical activity intention is influenced not only by campaign exposure or external encouragement, but also by individuals' rational evaluations of the validity of the evidence underlying the target.

Theoretically, these findings are consistent with social-cognitive approaches in health behavior research that position intention as the outcome of cognitive evaluation processes related to a given behavior. Behavioral models suggest that individuals tend to form stronger intentions when they perceive a health recommendation as rational, credible, and relevant to their personal conditions (Yu et al., 2025; Ahn et al., 2023). In the context of the 10,000-step target, evidence-based perception functions as a cognitive framework that helps individuals assess whether the target is merely a normative symbol or a scientifically reasonable guideline. When the target is perceived as evidence-based, individuals are more likely to internalize it as a behavioral goal worth pursuing.

These results also reinforce previous research emphasizing the importance of cognitive dimensions and belief systems in physical activity promotion. Hardcastle, Maxwell-Smith, and Hagger (2021) demonstrate that changes in physical activity intention and behavior are strongly influenced by cognitive processes underlying individuals' evaluations of the benefits and rationality of an action. Similarly, Catellani et al. (2023) emphasize that effective message-based interventions should not only raise awareness, but also build evidence-based beliefs to encourage consistent behavior. The present findings extend this literature by specifically demonstrating that evidence-based perceptions of numeric physical activity targets play a direct role in shaping intention.

From an empirical perspective, the positive relationship between evidence-based perception and physical activity intention also helps explain why the effectiveness of the 10,000-step target often varies across individuals and contexts. Several studies report that step targets can enhance engagement and behavioral monitoring, but do not always lead to sustained intention or behavior (Vandelanotte et al., 2022; Safi et al., 2024). The findings of this study suggest that such variation can be understood through differences in evidence-based perceptions. Individuals who understand that the 10,000-step target has a flexible and rational scientific basis tend to exhibit more stable intentions than those who perceive the target as an arbitrary normative demand.

The R-square value of 0.34 indicates that evidence-based perception explains a substantial proportion of the variance in physical activity intention, although it is not the sole determining factor. This finding is consistent with literature stating that intention is a multidimensional construct influenced by various psychological and contextual factors, including motivation, social norms, and perceived behavioral control (Brown et al., 2024; Feil et al., 2023). Nevertheless, the relatively large contribution of evidence-based perception in this model underscores that evidence-based cognitive factors should not be regarded as secondary elements in the design of physical activity interventions.

The theoretical implications of these findings lie in strengthening the role of cognitive perception in modeling physical activity intention. This study demonstrates that evidence-based understanding can be positioned as an independent latent construct with a direct influence on intention, rather than merely as a mediating or complementary variable. This approach enriches physical activity behavior modeling, which has traditionally emphasized affective motivation or environmental factors.

From a methodological perspective, the use of SEM–PLS enables simultaneous modeling of latent relationships and provides a more comprehensive depiction of the psychological mechanisms involved.

Practically, these findings have important implications for the design of physical activity interventions and campaigns. Promotion of the 10,000-step target should not focus solely on achieving a numerical goal, but should also be accompanied by evidence-based communication that explains the rationality, flexibility, and scientific context of the target. This approach aligns with recommendations in the literature emphasizing the importance of evidence-based messaging in enhancing the effectiveness of behavioral interventions (Washburn & Ihm, 2021; Hamer & Blodgett, 2022). By fostering strong evidence-based perceptions, interventions are expected to generate more realistic, stable, and sustainable physical activity intentions.

Nevertheless, this study has limitations that should be considered. The model focuses on a single primary predictor construct and therefore does not capture the full complexity of factors influencing physical activity intention. However, this limitation does not weaken the main findings, but rather reinforces the conclusion that evidence-based perception represents a key component worthy of consideration in the development of future physical activity behavior models.

CONCLUSION

This study concludes that evidence-based perceptions of the 10,000 steps per day target have a positive and significant effect on individuals' intentions to engage in physical activity. The SEM–PLS modeling results demonstrate that individuals' understanding of and belief in the scientific basis, rationality, and validity of step targets play an important role in shaping active behavioral intentions. These findings confirm that numeric physical activity targets do not function merely as normative or symbolic instruments, but operate through evidence-based cognitive processes that influence individuals' readiness and commitment to engage in physical activity consistently. Accordingly, the research hypothesis stating a significant effect of evidence-based perceptions on physical activity intention is empirically supported.

In terms of implications, this study contributes theoretically by positioning evidence-based perception as an independent latent cognitive construct in modeling physical activity intention. These findings enrich health behavior research, which has predominantly emphasized affective and environmental factors, by demonstrating that individuals' scientific understanding of health recommendations has a direct and substantive role. Practically, the results indicate that promotion of the 10,000-step target should be accompanied by evidence-based communication explaining the rationality and flexibility of the target, thereby fostering more realistic, stable, and sustainable physical activity intentions.

However, this study has limitations. The model focuses on a single primary predictor construct and therefore does not capture the full range of psychological and contextual factors influencing physical activity intention. In addition, the cross-sectional research design and reliance on self-reported data limit the ability to explain long-term dynamics of physical activity intention and behavior. Future research is therefore recommended to develop more comprehensive models, employ longitudinal designs, and combine perception-based data with more objective measures of physical activity behavior.

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