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Factors Affecting Physical Activity Behavior Among the Elderly in Chiang Mai Province, Thailand

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Abstract

Background and Aim: Physical activity significantly impacts the elderly's quality of life. Despite its importance, insufficient activity levels among older adults remain a critical public health concern. This study aimed to examine physical activity behavior, explore the relationships between personal, predisposing, enabling, and reinforcing factors with physical activity behavior, and identify the factors affecting physical activity behavior among older adults in Chiang Mai Province.

Materials and Methods: A multi-stage sampling method was employed to select a sample of 400 elderly individuals in Chiang Mai Province. The research instrument was a questionnaire with an item-objective congruence index of 0.80, evaluated by three experts, and a Cronbach's alpha coefficient of 0.85. Data were analyzed using descriptive statistics, chi-square tests, and multiple regression analyses.

Results: The physical activity behavior of the elderly in Chiang Mai Province was low. Knowledge about the benefits of physical activity was the only factor that did not correlate with physical activity behavior. Attitude was found to have a low correlation with physical activity behavior ($r=0.120$, $p<.05$), while enabling factors and reinforcing factors showed moderate correlations ($r=0.390$, $p<.05$ and $r=0.359$, $p<.05$, respectively). The multiple regression analysis yielded the prediction equation: Physical activity behavior = 2.070 + (0.993 ENABLING FACTORS) + (0.485 EINFORCING FACTORS). This equation explained 16.4 percent of the variance in physical activity behavior among the elderly in the province ($R^2 = 0.164$, SEE = 1.023).

Conclusion: The study highlights the significance of enabling and reinforcing factors in shaping physical activity behavior among the elderly in this region. These findings can inform the development of targeted interventions and policies to promote active aging, while considering the specific cultural, social, and environmental contexts of the region.

Keywords: Physical Activity Behavior; Older Adults; Determinants; Chiang Mai Province; Northern Thailand

Introduction

Physical activity significantly influences the health and well-being of seniors worldwide. Research has demonstrated that consistent exercise effectively prevents chronic diseases and maintains functional independence among older adults (World Health Organization, 2020; Chodzko-Zajko et al., 2009; Taylor, 2014). Even small amounts of activity can make a significant difference. Structured programs help older adults stay independent and prevent functional decline (Bull et al., 2020).

Recent global evidence from *The Lancet Global Health* (Strain et al., 2024) emphasizes that insufficient physical activity significantly increases the risk of non-communicable diseases, poor physical and cognitive function, weight gain, and mental health issues among the elderly worldwide (Ramirez Varela et al., 2024). A comprehensive bibliometric analysis revealed that research on physical activity and cognitive function among older adults has rapidly evolved, with three distinct trajectory patterns emerging: rapid decline (10.35%), stable inactive (80.62%), and rapid growth (9.03%) groups, highlighting the heterogeneity in aging processes that requires targeted interventions (Chen et al., 2024).

The World Health Organization recommends that elderly individuals engage in 150-300 minutes of moderate exercise weekly. Muscle-strengthening and balance activities should be included (WHO, 2020). Research indicates a notable protective relationship between exercise participation and age-related conditions, particularly in the prevention of sarcopenia (OR = 0.45, 95% CI: 0.37-0.55) (Steffl et al., 2017).

Multiple studies show that regular exercise lowers mortality risk, improves muscle strength, and reduces the incidence of chronic diseases. Older adults who engage in physical activity demonstrate

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enhanced quality of life and reduced rates of cognitive decline relative to those who are sedentary (Taylor 2014). However, despite these established benefits, global participation remains concerning. Physical inactivity among older adults constitutes a major global public health issue, notwithstanding the recognized advantages of regular physical activity. Lee et al. (2021) report that only 45% of seniors globally adhere to the recommended exercise guidelines. Compliance rates in Southeast Asia are notably low, recorded at 40%.

Thailand's demographic transition presents unprecedented challenges that demand immediate attention. As of January 2024, 13.2 million Thai citizens (20% of the population) are aged over 60, making Thailand one of the fastest-aging countries globally (National Statistical Office, 2024). Demographic projections indicate this proportion will reach 31.37% by 2040, representing a demographic tsunami with profound implications for healthcare systems and social services (NESDC, 2024).

Thailand presents particularly concerning statistics, with just 33.7% of the elderly achieving adequate physical activity levels, revealing substantial urban-rural disparities (28.4% vs. 39.1%, respectively) (Department of Physical Activity, Ministry of Health, 2023). Current health surveillance data reveal alarming functional limitations: 24% of elderly males and 41% of elderly females experience physical difficulties in daily activities, including walking 300 meters and lifting objects over 5 kilograms (NESDC, 2024). National health data demonstrates that only 15.4% of adults aged 50+ engage in high levels of physical activity, while 30.7% are obese (Pengpid & Peltzer, 2023). Furthermore, the prevalence of activities of daily living (ADL) disabilities increased from 3.2% in 2007 to 4.1% in 2011, indicating deteriorating functional independence among Thai older adults (Knodel et al., 2015). These low activity levels among seniors represent a critical public health challenge that requires a comprehensive understanding and targeted interventions. Recent research from rural Thailand reveals even more concerning patterns, with 42% of the elderly performing no physical activity whatsoever, and vigorous and moderate-intensity activity participation rates of merely 43.7% and 48.7%, respectively (Somrongthong et al., 2017). A nationwide epidemiological study conducted between March 2021 and August 2022 found that 18.1% of Thai community-dwelling older adults suffer from sarcopenia, with nearly two-thirds (66.9%) classified as having severe sarcopenia (Vanitcharoenkul et al., 2024).

The study of factors affecting older adults' exercise participation requires strong theoretical frameworks capable of systematically evaluating a wide range of health-related determinants. The PRECEDE-PROCEED model (Green & Kreuter, 2005) offers a systematic framework for identifying and categorizing health behavior factors. Recent applications in health promotion have demonstrated significant effectiveness, with educational interventions based on this model achieving improvements of 32% in knowledge, 45% in self-efficacy, and nearly doubling enabling factors (Doshmangir et al., 2015). European research with adapted PRECEDE-PROCEED approaches successfully engaged community stakeholders but encountered challenges in involving inactive individuals and minority groups (Bammann et al., 2020). Furthermore, this approach is widely used in health promotion research to analyze complex factor interactions influencing exercise behavior in older adult populations.

The social ecological perspective highlights the significance of diverse environmental factors in influencing individual behavior change, acknowledging the interrelation of personal, interpersonal, organizational, community, and policy elements (McLeroy et al., 1988). In the Thai context, several specific factors have been identified.

Thai scholars have identified important factors influencing seniors' level of activity. Educational level (Peltzer & Pengpid, 2019), cultural impacts include family dynamics and community involvement (Thanakwang et al., 2022) and environmental impediments, including poor infrastructure in metropolitan settings, which affect 71.3% of older persons The integration of culturally-appropriate approaches as recommended by the World Health Organization (WHO, 2020), combined with Thailand's Third National Plan for older adults (2022–2037) ambitious target to achieve 50% participation of physical activity among the by 2030, creates an urgent need for evidence-based interventions. However, evidence-based interventions that are culturally adapted for rural Thai settings encounter significant implementation barriers.

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The successful deployment of these interventions requires a thorough understanding of local cultural, social, and environmental contexts.

Policy context demonstrates growing recognition of these challenges. WHO's Global Action Plan on Physical Activity (GAPPA) 2018-2030 calls for comprehensive national policies, yet the first Global Status Report on Physical Activity 2022 (World Health Organization, 2022). indicates insufficient progress globally, particularly in low- and middle-income countries (WHO, 2020). The establishment of the ASEAN Centre for Active Aging and Innovation (ACAI) under Thailand's leadership in 2018 reflects regional recognition of this challenge, yet the gap between policy aspirations and evidence-based implementation strategies remains substantial (ASEAN, 2018). The selection of municipal areas in Chiang Mai Province as the focus of this study reflects unique characteristics that differ from rural areas, including: higher population density, better access to healthcare facilities and public services, but limited green spaces, more severe air pollution (PM2.5), and higher living costs. These factors may influence older adult physical activity behavior differently compared to rural areas.

Chiang Mai Province serves as an important backdrop for investigating the factors affecting physical activity in older people. The province has 378,920, 21.14% of the total population. This is the second-largest senior population, behind Bangkok (Chiang Mai Provincial Statistical Office, 2021). The province has both quickly emerging metropolitan regions and traditional rural settlements, resulting in a variety of cultural and environmental factors that may influence physical activity patterns.

Unique social capital and traditional knowledge systems of Chiang Mai might support health promotion (Aung et al., 2022). Still, the primary challenges remain. These elements point to unequal use of recreational facilities and seasonal environmental dangers, including significant air pollution, which significantly limits chances for outdoor activities. Knowing the particular elements influencing physical activity behavior in this setting helps one to create suitable and successful treatments based on culture. Thus, further investigation is needed to close these knowledge gaps.

Despite extensive international research, critical knowledge gaps persist in the Thai context. Most studies examine urban or rural populations separately, missing opportunities to understand how personal, social, and environmental factors interact within comprehensive theoretical frameworks (Liangruenrom et al., 2018). The application of Western-derived models like PRECEDE-PROCEED in Southeast Asian cultural contexts remains largely untested, particularly regarding the role of cultural values such as "kreng jai" (considerate behavior) and collectivist orientations in shaping health behaviors (Brach et al., 2023).

Although several studies have investigated personal factors influencing physical activity among older adults, there are substantial gaps in the available literature. Previous studies have focused on urban or rural populations individually, ignoring the related nature of psychological, social, and environmental aspects within broad theoretical frameworks. Current research on the interactions of predisposing, enabling, and reinforcing variables impacting exercise habits among elders in Chiang Mai Province is minimal. A thorough examination of the province's unique population characteristics, cultural components, and environmental challenges is necessary, with a focus on their linkages. To understand these complex relationships and develop an appropriate theoretical framework, a comprehensive review of existing literature is essential.

Objectives

The objectives of this study were: (1) to assess the current levels of physical activity behavior amongolder adults people in Chiang Mai Province; (2) to investigate the relationships between personal characteristics, predisposing factors (knowledge and attitudes), enabling factors (skills, resources, and barriers), and reinforcing factors (social support and environmental influences) with physical activity behavior; and (3) to identify specific factors that significantly affect Our results will be essential in developing targeted, culturally relevant interventions and guiding policy decisions to promote active aging in northern Thailand, while accounting for the region's unique cultural, socioeconomic, and environmental features.

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Literature review

Physical activity among older adults has gathered considerable attention from scholars worldwide, although the knowledge of the complex contributing factors remains limited. This literature review synthesizes current information regarding the variables that affect exercise behavior I people, providing the theoretical framework for future studies in Chiang Mai Province, Thailand. Recent advances in physical activity research among older adults have revealed significant gaps in theoretical application and methodological rigor, particularly in non-Western contexts. While substantial evidence demonstrates the benefits of physical activity for healthy aging, understanding of the complex determinants influencing behavior change remains fragmented across different theoretical frameworks and cultural settings (Brach et al., 2023; European Review of Aging and Physical Activity).

Literature Search Methodology

A comprehensive literature search was conducted using multiple electronic databases, including PubMed, PsycINFO, Web of Science, and Google Scholar, for publications from 2000 to 2023. The search terms consisted of "physical activity," "elderly," "older adults," "determinants," "PRECEDE-PROCEED model," "social cognitive theory," and "intervention." Further studies focusing on specific theoretical frameworks, such as "self-efficacy," "enabling factors," and "reinforcing factors." The reference lists of obtained publications were systematically examined to discover more relevant studies. Research studies were included if they examined determinants, treatments, or conceptual applications of exercise in populations aged 60 and over, were published in peer-reviewed journals, and were available in English. The criteria for exclusion included studies that focus particularly on medical patients with particular disorders, therapies that only affected nutritional habits, and conference abstracts that did not provide full-text the opportunity. Priority was given to systematic reviews, meta-analyses, and longitudinal studies, with a specific focus on research performed in Asian contexts where necessary.

Theoretical Frameworks in Physical Activity Research

A comprehensive understanding of physical activity behavior among older adults requires integration of multiple theoretical perspectives that address both individual and environmental determinants. Three primary theoretical frameworks have dominated the literature: Social Cognitive Theory, Ecological Models, and the PRECEDE-PROCEED model, each offering distinct but complementary insights into behavior change mechanisms.

Social Cognitive Theory Applications

Social Cognitive Theory (SCT) has emerged as one of the most robust frameworks for understanding physical activity behavior in older populations. A recent systematic review and meta-analysis of SCT-based interventions found that self-efficacy consistently emerges as the strongest predictor of physical activity engagement, with effect sizes ranging from 0.26 to 0.45 across studies (Young et al., 2014). Longitudinal research involving 321 middle-aged and older adults (mean age 63.8 years) demonstrated that self-efficacy influences physical activity both directly and indirectly through outcome expectations and goal setting over 18 months (White et al., 2012). However, the application of SCT in diverse cultural contexts reveals important limitations. A cross-sectional study of 1,085 adults found that while individual psychological factors predicted 23.1% of variance in physical activity behavior, environmental and social factors showed stronger correlations in non-Western populations (Yen & Li, 2019). This finding suggests that Western-derived emphasis on individual cognitive factors may be less applicable in collectivist societies where social and environmental determinants predominate.

Ecological Model Applications

Ecological models have gained prominence for their multi-level approach to understanding physical activity determinants. Recent applications of the Ecological Model of Active Living demonstrated that intrapersonal factors ($\beta = 0.368$), perceived environment ($\beta = 0.074$), and behavior settings ($\beta = 0.238$) all contribute significantly to predicting active living, with the complete model explaining 23.1% of variance (Yen & Li, 2019). These findings support the theoretical premise that physical activity behavior results from complex interactions across multiple environmental levels. A 2021 study utilizing multilevel modeling with

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72,916 participants from South Korea revealed that social ecological factors affect physical activity differently across demographic groups, with social environment variables showing stronger effects among older adults compared to younger populations (Kim & Suh, 2021). This research highlighted the particular importance of neighborhood trust and social networks for older adults' physical activity participation, suggesting that ecological approaches may be especially relevant for aging populations.

PRECEDE-PROCEED Model Applications

The PRECEDE-PROCEED model offers a systematic framework particularly suited for intervention development and evaluation. Recent applications in health promotion have demonstrated significant effectiveness, with educational interventions based on this model achieving improvements of 32% in knowledge, 45% in self-efficacy, and nearly doubling enabling factors (Doshmangir et al., 2015). However, adaptations of the PRECEDE-PROCEED model for community-based physical activity interventions among older adults have shown mixed results. European research with adapted PRECEDE-PROCEED approaches successfully engaged community stakeholders but encountered challenges in involving inactive individuals and minority groups (Bammann et al., 2020). These findings highlight the need for cultural adaptation of Western-derived models when applied in different social contexts.

The global context of physical activity and aging.

While the health benefits of physical activity are well-established, understanding the factors that influence participation remains crucial for intervention development. The aging process leads to major changes in activity patterns, which strongly affect quality of life and create complex challenges for health promotion efforts (Chodzko-Zajko et al., 2009; Taylor, 2014). The aging process leads to major changes in activity patterns, which strongly affect the quality of life. Longitudinal study indicates sedentary behavior significantly increases the risk of long-term illness and mortality, whereas even moderate physical activity provides protective benefits against multiple medical problems, independent of changes in physical condition.

Global systematic reviews consistently demonstrate that physical activity reduces risks of cognitive decline by 35% (95% CI: 24-45%) and dementia by 20% (95% CI: 16-23%) among middle-aged and older adults (Blondell et al., 2014). However, recent meta-analyses reveal concerning limitations in research quality and geographical representation. Of 1,421 intervention studies identified across major systematic reviews, 87% were conducted in high-income countries, with significant underrepresentation of low- and middle-income nations where 69% of the world's older adults reside (Taylor et al., 2014).

Recent research efforts increasingly identify sedentary behavior as an individual risk factor, as opposed to physical inactivity. Older adults typically engage in sedentary activities for extended periods throughout the day, with this duration increasing with age. Continued periods of sitting are connected with metabolic dysfunction and further raise cardiovascular risk, even in people who conform to physical activity recommendations. Recognizing the negative effects of inadequate physical activity and extended sedentary behavior is necessary for formulating effective interventions meant for older adult populations.

Regional Research Patterns and Limitations

Analysis of physical activity research in South and Southeast Asia reveals critical gaps in both scope and methodological rigor. A systematic scoping review of nine studies from the region found that seven were conducted in Taiwan, with only one each from Pakistan and Thailand (Kadariya et al., 2019). This geographical concentration severely limits understanding of cultural and environmental factors affecting physical activity across diverse Southeast Asian populations.

Methodological limitations in regional research are equally concerning. All observational studies in the Asian systematic review relied on subjective measurement tools, with no use of objective physical activity monitoring (Kadariya et al., 2019). Sample sizes varied dramatically from 50 to 1,160 participants, with most studies employing cross-sectional designs that preclude causal inference about determinant-behavior relationships.

Understanding Physical Activity Determinants

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Researchers have identified numerous factors that influence physical activity participation among older adults across individual, social, and environmental domains. Age consistently emerges as a predictor, with relatively younger elderly individuals showing higher activity levels (Koeneman et al., 2011). Education also plays a crucial role, as those with higher educational attainment participate more frequently, possibly due to better health knowledge and greater resource access. Health status creates complex relationships with physical activity participation. Systematic reviews show that good health serves as both a prerequisite and outcome of regular activity, with healthier individuals more likely to start and maintain exercise routines (Koeneman et al., 2011).

However, assessment challenges complicate our understanding of these relationships. Measurement inconsistencies across studies, ranging from self-reported questionnaires to objective accelerometry, create difficulties in comparing findings and establishing standardized cutoff points for adequate activity levels. These methodological variations particularly affect cross-cultural comparisons and limit the generalizability of findings across different populations.

Critical Analysis of Research Limitations

Contemporary physical activity research faces several systematic limitations that compromise the generalizability and applicability of findings, particularly for non-Western older adult populations. A comprehensive analysis of 1,421 intervention studies revealed that 79% were randomized controlled trials, but 87% were conducted in high-income countries, creating significant geographical bias (Taylor et al., 2014). This overrepresentation of Western populations fundamentally limits the applicability of research findings to the majority of the world's aging population.

Measurement limitations represent another critical concern. The systematic scoping review of Thai physical activity research identified that most studies used "unspecified and non-validated measures of PA and SB," with limited longitudinal studies and insufficient coverage of environmental factors (Liangruenrom et al., 2018). These methodological weaknesses are particularly problematic given cultural differences in physical activity conceptualization and practice across different societies.

Psychological and Social-Cognitive Factors

Recent research has highlighted the central importance of psychological factors in determining activity participation. Self-efficacy emerges as particularly influential among older adults. White et al. (2012) tracked middle-aged and older individuals for 18 months, discovering that confidence in one's ability to be active serves as the strongest predictor of actual behavior. Their findings showed that self-efficacy works both directly and through expectations about activity benefits, supporting social cognitive theory applications in this population.

Interestingly, knowledge about activity benefits shows inconsistent relationships with actual behavior, suggesting that information alone fails to motivate participation among older adults. This observation underscores the need for comprehensive approaches that address multiple barriers simultaneously rather than relying solely on education.

Social and Environmental Influences

Social factors increasingly influence physical activity decisions among older adults. Healthcare providers, especially physicians, hold considerable sway over activity initiation, with research showing that medical advice is highly influential in older adults' decisions to become active. Family relationships and social connections also matter, as noted in studies examining social determinants of physical activity (Thanakwang et al., 2022). Recent research on social determinants reveals complex interactions between individual and environmental factors. A 2024 study examining social competence as a mediator between physical exercise and mental health among 3,240 older adults found that social factors explained 34% of the relationship between physical activity and psychological well-being (Hou et al., 2024). This finding suggests that the social benefits of physical activity may be as important as physical health outcomes for maintaining exercise behavior.

Economic factors create additional layers of influence. Research in Thailand shows that socioeconomic factors significantly affect daily life activities and quality of life among elderly populations

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(Somrongthong et al., 2017). Environmental conditions, including neighborhood safety and infrastructure quality, also shape activity patterns, particularly in urban-suburban contexts like those found in Chiang Mai Province.

Community-level factors deserve particular attention in intervention planning. Infrastructure availability, transportation accessibility, and social norms within communities significantly influence individual activity choices. Understanding these environmental determinants becomes especially important for developing population-level interventions that address structural barriers to active aging.

Effective Intervention Approaches

These findings support the rationale for comprehensive theoretical frameworks like the PRECEDE-PROCEED model, which addresses multiple determinants simultaneously. The model's systematic approach to predisposing, enabling, and reinforcing factors aligns with evidence showing that multi-component interventions outperform single-strategy approaches in promoting physical activity among older adults.

Applying Theoretical Frameworks

The PRECEDE-PROCEED model (Green & Kreuter, 2005) offers a systematic framework for identifying and categorizing health behavior factors. The model's components include predisposing factors (knowledge, attitudes, demographics), enabling factors (resources, access, barriers), and reinforcing factors (social support, family, healthcare providers). Recent applications demonstrate concrete evidence that systematic approaches achieve measurable outcomes: knowledge increased by 32%, self-efficacy improved by 45%, and enabling factors nearly doubled (Doshmangir et al., 2015). More recently, researchers have adapted this model for community settings. Bammann et al. (2020) successfully integrated PRECEDE-PROCEED principles with socio-ecological approaches, creating frameworks that community stakeholders validated for developing multi-level interventions. This adaptation recognizes that behavior change occurs within complex social and environmental contexts.

Cultural and Regional Considerations

While international research provides valuable insights into general patterns, cultural and contextual factors significantly influence how these patterns manifest in specific populations. Systematic reviews highlight varying determinant profiles across different geographic and cultural settings (Koeneman et al., 2011), while research in Thailand specifically shows unique patterns in physical activity behavior among older adults (Liangruenrom et al., 2018).

Southeast Asian contexts remain particularly understudied, despite evidence suggesting that cultural values, family structures, and traditional practices substantially influence how elderly individuals view and engage in physical activity. Thai cultural concepts such as "sanuk" (enjoyment) and respect for elder autonomy may significantly modify how Western-derived interventions function in practice. Family-centered decision-making processes and collective rather than individual health perspectives likely influence activity participation patterns differently than individualistic Western models suggest.

The adaptation of evidence-based interventions to Thai cultural contexts requires careful consideration of cultural values, social hierarchies, and traditional health beliefs. What works in Western individualistic societies may require substantial modification to align with Thai collective cultural orientations and respect for interpersonal harmony. Understanding these cultural nuances becomes essential for developing effective, culturally appropriate interventions rather than simply translating Western programs.

Quality Considerations and Study Limitations

The literature reviewed demonstrates varying methodological quality, with several important limitations that affect the interpretation and application of findings. Many studies employ cross-sectional designs that limit causal inference about determinant-behavior relationships. Sample sizes vary considerably, from small pilot studies to large population surveys, affecting statistical power and generalizability. Additionally, most research originates from Western, developed countries with predominantly Caucasian populations, limiting applicability to diverse ethnic and cultural groups.

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Measurement approaches show significant inconsistency across studies, with some relying on self-reported activity levels while others use objective monitoring devices. These methodological differences complicate cross-study comparisons and meta-analytic syntheses. Furthermore, many studies focus on specific age subgroups within the elderly population, making it difficult to generalize findings across the entire older adult spectrum.

Longitudinal studies, while providing stronger evidence for determinant-behavior relationships, often suffer from substantial attrition rates that may bias findings toward healthier, more motivated participants. These methodological considerations underscore the need for high-quality, culturally diverse research using standardized measurement approaches and appropriate theoretical frameworks.

Knowledge Gaps and Research Opportunities

Despite extensive research on elderly physical activity determinants, several important gaps persist. Most studies originate from Western, developed countries, leaving other cultural contexts underrepresented. Additionally, researchers have paid insufficient attention to how multiple determinants interact simultaneously across different influence levels.

Thailand-specific research has typically examined urban or rural populations separately, missing opportunities to understand how personal, social, and environmental factors work together within comprehensive theoretical frameworks. How predisposing, enabling, and reinforcing factors combine to influence physical activity behavior among elderly populations in Northern Thailand's distinctive cultural, social, and environmental setting remains largely unexplored.

This literature foundation supports our investigation of physical activity behavior determinants among elderly populations in Chiang Mai Province, Thailand. Our study addresses these identified gaps while building upon established knowledge in this important public health domain.

Conceptual Framework

The conceptual framework for this study is grounded in the PRECEDE-PROCEED model (PRECEDE-PROCEED model (Green & Kreuter, 2005), which provides a systematic approach for analyzing health behavior determinants across multiple levels. This model is particularly suitable for examining physical activity behavior among elderly populations as it comprehensively addresses the complex interplay of individual, social, and environmental factors that influence health-related behaviors.

PRECEDE-PROCEED Model Application

The PRECEDE component focuses on predisposing, reinforcing, and enabling factors that determine health behavior. Predisposing factors include knowledge about physical activity benefits, attitudes toward physical activity, and demographic characteristics (age, gender, education, income) that may influence an individual's likelihood to engage in physical activity. Enabling factors encompass resources and conditions that facilitate or hinder behavior, including access to exercise facilities, availability of safe walking areas, transportation, and financial resources. Reinforcing factors involve social support systems, family encouragement, healthcare provider recommendations, and community participation that sustain or discourage continued physical activity engagement.

Cultural Integration

The framework incorporates Thai cultural contexts, recognizing that traditional values such as "*kreng jai"* (considerate behavior), respect for elders, and collectivist orientations may influence how physical activity is perceived and practiced among older adults in Chiang Mai Province. These cultural dimensions interact with the PRECEDE factors to create unique behavioral patterns specific to northern Thai elderly populations.

Variable Relationships and Hypotheses

Based on the theoretical framework and previous research, the study hypothesizes that:

1. Predisposing factors (knowledge and attitudes) will show positive correlations with physical activity behavior, though knowledge may demonstrate weaker associations than attitudes.

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2. Enabling factors (access to facilities, resources, and supportive environments) will exhibit significant positive correlations with physical activity engagement.

3. Reinforcing factors (social support from family, peers, and healthcare providers) will demonstrate strong positive associations with sustained physical activity behavior.

4. The combination of enabling and reinforcing factors will emerge as stronger predictors of physical activity behavior than predisposing factors alone, reflecting the importance of environmental and social support systems in facilitating active aging.

Conceptual Framework

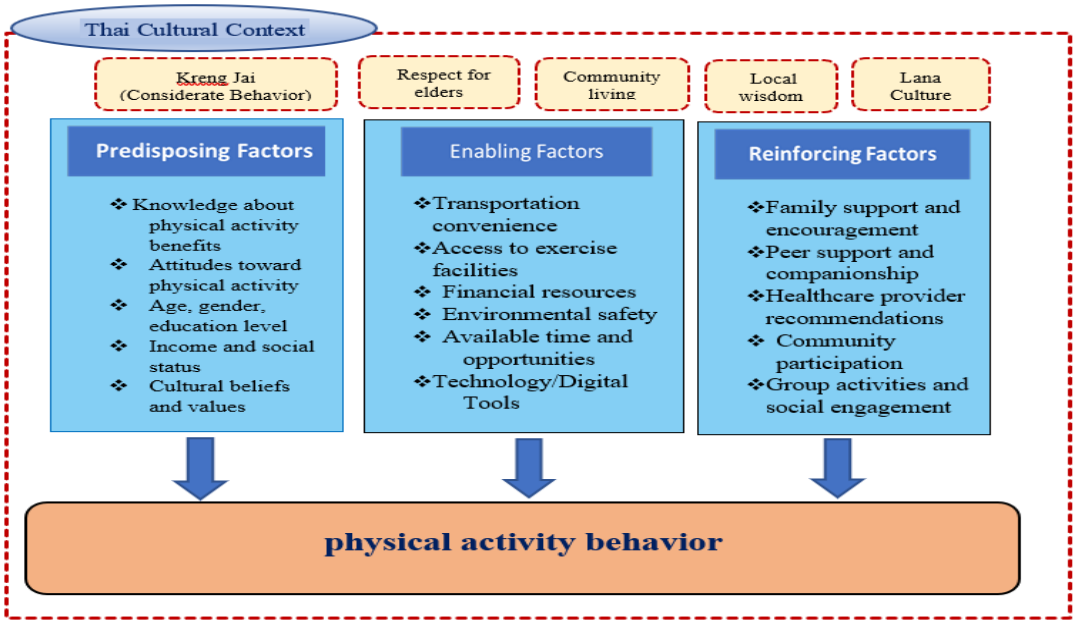


Figure 1 Conceptual Framework

Methodology

Participants

The target population consisted of older adults aged 60 years and over residing in five municipal areas of Chiang Mai Province (Mueang Chiang Mai, Mae Jo, Ton Pao, Kan Phatthana, and Mae Hia municipalities), with a total population of 44,944 older adults according to the 2021 municipal registration data (Chiang Mai Provincial Statistical Office, 2021). This municipal-specific sampling frame was chosen to focus on the unique challenges and opportunities facing older adults in urban-suburban environments, which differ significantly from rural settings in terms of infrastructure, services, and social support systems. Participants were excluded if they were unable or unwilling to participate in the study. Before commencing the research, ethical approval was obtained from the Ethical Committee for Human Research at Rajamangala University of Technology Lanna, Thailand (No.013/2564). All participants received a thorough explanation of the study protocol before participation. Written informed consent was then obtained from all participants before data collection.

Sample Size Determination

The sample size was calculated using Yamane's formula (Yamane, 1973) for the older adult population in municipal areas of Chiang Mai Province, totaling 44,944 individuals with a 95% confidence level and a margin of error of 0.05, resulting in a minimum sample size of 397, rounded up to 400 participants. This sample size provides an actual margin of error of 4.98%, which meets the required precision criteria for the study. A multi-stage sampling procedure was employed, starting with proportionate stratified sampling

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based on municipality population size to allocate samples for each municipality, followed by an accidental sampling method to select the participants. Data collection was conducted between January and March 2024. The response rate was 100%

Research Design.

This study employed a cross-sectional survey design using a structured questionnaire. The research instrument was developed through a systematic three-phase process:

Phase 1: Instrument Development

The questionnaire consisted of seven sections: (1) demographic characteristics, (2) physical activity knowledge using true-false format, (3) attitudes toward physical activity, (4) personal factors assessment using checklist format, (5) enabling factors, (6) reinforcing factors, and (7) physical activity behavior, with sections 5-7 utilizing 5-point Likert scales.

Predisposing factors were measured separately: knowledge (15 true-false items) and attitudes (12 Likert-scale items). Enabling factors combined facility access, financial resources, and environmental barriers into a composite score (12 items).

Reinforcing factors include integrated family, community, and healthcare provider support (11 items). The composite approach for enabling and reinforcing factors follows established PRECEDE-PROCEED applications (Green & Kreuter, 2005), treating these as synergistic influences while maintaining adequate statistical power.

Phase 2: Content Validation

Content validity was established through evaluation by three subject matter experts, yielding an item-objective congruence (IOC) index of 0.80.

Phase 3: Pilot Testing

Before data collection, the questionnaire was pilot tested with 30 elderly individuals from neighboring municipalities not included in the main study. Participants were selected using similar inclusion criteria to assess instrument reliability and clarity. Based on pilot test results, minor modifications were made to improve question clarity, and the overall instrument demonstrated high internal consistency (Cronbach's alpha = 0.85).

Scoring: Mean scores were grouped into five levels: very low (<1.50), low (1.51-2.50), moderate (2.51-3.50), high (3.51-4.50), and very high (4.51-5.00).

Statistical Analysis.

Statistical analyses were performed using both descriptive and inferential approaches. Descriptive statistics characterized the sample demographics and key study variables. Relationships between variables were examined using chi-square tests (χ^2) for categorical variables and Pearson correlations (r) for continuous variables. Multiple regression analysis (R^2) identified significant predictors of physical activity behavior, with variables selected based on significant bivariate associations. Standardized beta coefficients (β) were calculated to determine the relative contribution of each predictor. Enabling and reinforcing factors were analyzed as composite scores following established PRECEDE-PROCEED model applications (Green & Kreuter, 2005; Doshmangir et al., 2015). This approach was chosen to: (1) maintain theoretical consistency with the model's framework that views these factors as synergistic influences, (2) ensure adequate statistical power for the sample size of 400 participants, and (3) avoid multiple comparison issues when testing numerous sub-factors simultaneously. All analyses were conducted using SPSS version 28.0 with significance set at $p < .05$.

Results

This research examined physical activity behavior among elderly populations in Chiang Mai Province, exploring relationships between personal characteristics, predisposing factors (knowledge and attitudes), enabling factors (skills, resources, and barriers), and reinforcing factors (social support and environmental influences) with physical activity engagement. The study included 400 participants from five municipalities in Chiang Mai Province. The majority of participants were women (57.3%), aged between 60-69 years

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(52.2%), married (67%), and had completed primary education (55%). More than half of the participants (55%) reported a monthly income of 5,000-10,000 Thai Baht. The results are shown in Table 1.

Table 1 Demographic Characteristics of Participants (N=400)

Characteristic	Number (persons) N	Percentage (%)	Mean ± SD
Gender			
Female	229	57.3	-
Male	171	42.7	-
Age (years)			**67.3 ± 6.8**
60-69	209	52.2	-
70-79	156	39	-
≥80	35	8.8	-
Marital Status			
Married	268	67	-
Widowed	96	24	-
Single/Divorced	36	9	-
Education Level			
Primary education	220	55	-
Secondary education	120	30	-
Higher education	60	15	-
Monthly Income (Thai Baht)			
<5,000	100	25	-
5,000-10,000	220	55	-
>10,000	80	20	-
Municipality			
Mueang Chiang Mai	160	40	-
Mae Jo	80	20	-
Ton Pao	60	15	-
Kan Phatthana	60	15	-
Mae Hia	40	10	-

Note: *SD = Standard Deviation. Percentages may not sum to 100% due to rounding. Data collected from five municipal areas in Chiang Mai Province, Thailand (January-March 2024).*

Physical Activity Behavior Levels

The overall physical activity behavior of elderly participants in Chiang Mai Province was at a low level (Mean = 2.13, SD = 0.651). When examining individual activity components, most activities were at low levels, with the notable exception of 'Community walking for social interaction,' which demonstrated a moderate level (Mean = 2.88, SD = 1.112). The lowest participation was observed in community health activities such as yoga and traditional dance (Mean = 1.69, SD = 0.932), while activities to strengthen major muscle groups (Mean = 1.97, SD = 0.972). Balance and fall prevention exercises showed slightly higher engagement (Mean = 2.42, SD = 1.281), while brain, memory, and mood activities such as chess and singing had a mean score of 2.20 (SD = 1.132). The results are shown in Table 2.

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Table 2 Mean and standard deviation of physical activity behaviors (n=400)

Items of Engaging in Physical Activity	Mean	SD	Interpretation of PA Level
1. Community health activities (e.g., yoga, traditional dance)	1.69	0.932	Low
2. Physical/health activities (≥30 mins/day)	2.08	0.983	Low
3. Community walking for social interaction	2.88	1.112	Moderate
4. Community cycling for social interaction	1.79	1.023	Low
5. Engaging in moderate activities (300 mins/week) or vigorous activities (150 mins/week)	2.03	0.992	Low
6. Balance and fall prevention exercises (e.g., head exercises, hands-free chair rises)	2.42	1.281	Low
7. Engaging in activities to strengthen major muscle groups	1.97	0.972	Low
8. Brain, memory, and mood activities (e.g., chess, singing)	2.20	1.132	Low
Total	2.13	0.651	Low

PA Level= Physical Activity Level, SD=Standard Deviation

Correlation Analysis

The correlation analysis revealed distinctive patterns among the studied factors and physical activity behavior. Knowledge about the benefits of physical activity showed no significant relationship with physical activity behavior ($r = -.057$, $p > .05$). However, three factors demonstrated significant positive correlations with physical activity behavior: attitude showed a weak correlation ($r = 0.120$, $p < .05$), while both enabling factors ($r = 0.390$, $p < .01$) and reinforcing factors ($r = 0.359$, $p < .01$) exhibited moderate correlations. Among the predictor variables, enabling and reinforcing factors showed a strong intercorrelation ($r = .771$, $p < .01$), while knowledge showed a weak positive correlation with attitude ($r = .177$, $p < .05$). The pattern of relationships indicates that environmental and social factors substantially outweigh cognitive factors in predicting physical activity engagement among this elderly population. The results are shown in Table 3.

Table 3 Pearson Correlation Coefficients between Factors affecting Physical Activity Behavior (n=400)

Factors	1	2	3	4	Physical Activity Behaviors
1. Knowledge about the Benefits of Physical Activity	1	.177*	-0.011	0.023	-0.057
2. Attitude towards Physical Activity		1	.297*	.225**	.120*
3. Enabling Factors for Physical Activity			1	.771**	.390**
4. Reinforcing Factors for Physical Activity				1	.359**

*p < .05
**p < .01

Multiple Regression Analysis

The multiple regression analysis revealed that the predictors (enabling factors, knowledge, attitude, and reinforcing factors) collectively explained 16.4% of the variance in physical activity behavior among the elderly in Chiang Mai Province ($R = .405$, $R^2 = .164$, Adjusted $R^2 = .156$, SEE = 1.023). The Durbin-

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Watson value of 1.977 indicated no autocorrelation in the residuals, and the model demonstrated a medium effect size according to Cohen's (1988) guidelines. The results are shown in Table 4.

Table 4 Multiple Regression Analysis Results

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.405[a]	0. 164	0.156	1.023	1.977

Note: [a]Predictors: (Constant), Enabling Factors, Knowledge, Attitude, and Reinforcing Factors; Enter method; Dependent Variable: Physical Activity Behavior.
R^2 =.164 indicates a medium effect size according to Cohen's (1988) guidelines.

Analysis of individual predictors revealed two significant factors affecting physical activity behavior: enabling factors ($\beta = 0.270$, $p < .001$) and reinforcing factors ($\beta = 0.148$, $p < .05$). The overall model was statistically significant ($F(4,395) = 19.38$, $p < .001$). Knowledge ($\beta = -0.061$, $p = .196$) and attitude ($\beta = 0.017$, $p = .727$) were not significant predictors of physical activity behavior. The unstandardized coefficients provide practical insights: enabling factors showed a coefficient of 0.993, indicating that a one-unit increase in enabling factors corresponds to nearly a one-point increase in physical activity behavior. Reinforcing factors demonstrated a coefficient of 0.485, suggesting approximately half the impact per unit change compared to enabling factors. The results are shown in Table 5.

Table 5 Analysis of the Predictors' Influence on Physical Activity Behavior Among the Elderly in Chiang Mai Province (n = 400)

Predictors Affecting Physical Activity Behavior	B	S.E	b	t	p
(Constant)	2.07	0.447	-	4.635**	0
Knowledge	-0.045	0.035	-.061	-1.296	0.196
Attitude	0.035	0.101	0.017	0.349	0.727
Enabling Factors	0.993	0.273	0.270	3.645**	0
Reinforcing Factors	0.485	0.237	0.148	2.050*	0.041

Note: 1. $R^2 = .164$, Adjusted $R^2 = .156$, $F(4,395) = 19.38$, $p < .001$
2. *$p < .05$, **$p < .001$
3. Dependent Variable: Physical Activity Behavior
4. Method: Enter b=Beta

Prediction Equation and Practical Application

Based on the significant predictors identified in the multiple regression analysis, the prediction equation can be formulated as:

Physical Activity Behavior = 2.070 + (0.993 × Enabling Factors) + (0.485 × Reinforcing Factors)

This equation demonstrates practical utility for intervention planning. Given the observed physical activity mean of 2.13 on a five-point scale, the model suggests that improvements in enabling factors could realistically move participants from "low" (1.51-2.50) to "moderate" (2.51-3.50) activity levels. The standardized coefficients confirm the relative importance of environmental factors ($\beta = 0.270$) over social factors ($\beta = 0.148$) in this population.

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Discussion

The present study identified enabling and reinforcing factors as the primary determinants of physical activity behavior among older adult populations in Chiang Mai Province, Thailand. These environmental and social factors emerged as significant predictors, while cognitive factors showed no predictive power. These findings support the PRECEDE-PROCEED model framework (Green & Kreuter, 2005) while challenging the applicability of Western-derived cognitive theories in Thai cultural contexts.

Cultural Context and Low Physical Activity Behavior

The unexpectedly low levels of physical activity behavior among older adults in Chiang Mai Province (Mean = 2.13) reflect complex interactions between traditional Thai cultural values, environmental constraints, and socioeconomic factors specific to northern Thailand. This finding aligns with recent national data showing that only 15.4% of Thai adults aged 50+ engage in high levels of physical activity (Pengpid & Peltzer, 2023). The seasonal air pollution crisis in Chiang Mai, particularly PM2.5 levels reaching hazardous conditions during the dry season (March-May), significantly constrains outdoor physical activity opportunities for older adults. Furthermore, the urban municipal environment lacks age-friendly infrastructure specifically designed for older adults, unlike rural areas, where traditional occupational activities provide natural physical activity opportunities.

The Absence of Knowledge-Behavior Relationships

The absence of significant knowledge-behavior relationships (Table 3) represents a fundamental departure from Western health behavior models and reflects deeply embedded Thai cultural values that prioritize social harmony over individual health optimization. The concept of "kreng jai," considered behavior that avoids imposing on others, may explain why older Thai adults, despite possessing adequate health knowledge, choose not to act on this knowledge to avoid perceived social disruption.

The hierarchical nature of Thai society positions older adults as wisdom holders rather than knowledge recipients. Our findings suggest that external health education messages may inadvertently challenge this cultural role, creating psychological resistance that nullifies the knowledge-behavior relationship observed in individualistic societies.

Environmental and Social Determinants

The predominance of enabling factors ($\beta = 0.270$) and reinforcing factors ($\beta = 0.148$) over cognitive factors reflects the collectivist orientation of Thai society, where environmental accessibility and social approval carry greater behavioral influence than individual knowledge or attitudes. The strong intercorrelation between enabling and reinforcing factors ($r = .771$) suggests that environmental resources and social support systems are interconnected rather than independent influences in Thai contexts.

Integration with Thai Philosophical Frameworks

The findings align with the Sufficiency Economy Philosophy developed by His Majesty King Bhumibol Adulyadej, which emphasizes moderation, reasonableness, and self-immunity. This philosophy's focus on community-based solutions and environmental sustainability directly supports our finding that enabling and reinforcing factors predominate over individual cognitive factors.

Methodological Limitations

The use of composite scores for enabling and reinforcing factors provides insight into overall environmental and social influences, but limits specificity for intervention development. This approach was justified by strong intercorrelations between factors ($r = .771$) and adherence to established PRECEDE-PROCEED model applications (Green & Kreuter, 2005). However, future studies with larger sample sizes should consider sub-factor analysis using structural equation modeling.

The cross-sectional design precludes causal inference, and geographic specificity to Chiang Mai Province limits generalizability to other Thai regions. The substantial unexplained variance (83.6%) suggests that important cultural or contextual factors remain unidentified.

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Conclusion

This investigation provides evidence that environmental and social factors demonstrate greater predictive utility than cognitive determinants for physical activity behavior among Thai elderly populations. The absence of significant knowledge-behavior relationships challenges fundamental assumptions of Western health promotion theories and highlights the critical importance of cultural contextualization in health behavior research. The study's primary theoretical contribution lies in demonstrating that effective health promotion in Thai contexts requires integration of indigenous cultural frameworks rather than simple adaptation of Western cognitive-behavioral models. The predominance of enabling and reinforcing factors over predisposing factors supports socio-ecological intervention approaches that address structural barriers and community support systems rather than relying on individual knowledge transmission. Practical implications for Chiang Mai Province specifically include: (1) prioritizing air quality management during pollution seasons to remove environmental barriers to outdoor activity, (2) developing temple-based and community-centered exercise programs that align with traditional Thai values, (3) engaging families and community leaders as intervention agents rather than focusing solely on individual older adults, and (4) integrating traditional Thai activities (temple maintenance, gardening, grandchild care) into formal physical activity recommendations. Policy implications extend beyond local contexts to national and regional levels. Thailand's Third National Plan for the Elderly (2022-2037) should emphasize environmental infrastructure and community capacity building over individual health education to achieve its target of 50% physical activity participation by 2030. While these results provide valuable insights for intervention design, several limitations warrant consideration. The cross-sectional design limits causal inference, self-reported measures may introduce social desirability bias, and the geographic specificity to Chiang Mai Province may limit generalizability to rural Thailand. Additionally, the substantial unexplained variance suggests that important cultural factors remain unidentified. Despite these limitations, the present study makes important contributions to understanding physical activity determinants in Southeast Asian contexts. As demographic transitions accelerate across Southeast Asia, this research demonstrates that sustainable health promotion requires deep cultural integration rather than superficial adaptation of Western models. The success of healthy aging initiatives will depend on honoring traditional values while addressing contemporary health challenges through community-based, environmentally supported, and socially reinforced approaches to active aging.

Recommendation

Practice Implications

Healthcare administrators and policymakers should prioritize environmental interventions over traditional health education approaches. The study's findings demonstrate that enabling factors drive physical activity behavior more effectively than knowledge-based strategies, challenging conventional health promotion models in Thai older adult populations.

Priority Interventions

Environmental modifications should focus on three key areas: (1) developing age-friendly infrastructure, including safe walking paths and accessible exercise facilities, (2) implementing seasonal air quality management during pollution periods, and (3) establishing cross-sector collaboration between healthcare, urban planning, and transportation authorities. Social support interventions should engage family networks and community leaders as intervention agents while respecting cultural hierarchies and individual autonomy. Given the minimal impact of knowledge and attitudes on behavior in this population, traditional health promotion budgets could be more effectively invested in infrastructure development and community-based support systems.

Addressing the Chiang Mai Context

The low physical activity levels (Mean = 2.13) in Chiang Mai's municipal areas require targeted approaches addressing specific environmental constraints and social dynamics. The strong intercorrelation

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between enabling and reinforcing factors (r = .771) suggests that environmental resources and social support systems should be developed simultaneously rather than separately.

Policy Recommendations

Resource allocation decisions should shift from individual-focused health education toward environmental and social determinant modifications. The predominance of enabling factors (β = 0.270) over reinforcing factors (β = 0.148) indicates that environmental improvements should receive the highest priority, while social support enhancement remains important but secondary.

Research Priorities

Future investigations should establish causal relationships through longitudinal designs and extend findings to rural Thai populations. Studies with larger sample sizes (n > 800) should consider structural equation modeling to examine sub-components of enabling and reinforcing factors, providing more specific guidance for intervention development. Mixed-methods approaches incorporating cultural factors may explain the substantial unexplained variance in this model. Development of culturally-validated measurement instruments specific to Southeast Asian elderly populations represents a critical research need for advancing this field.

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