การพัฒนาและตรวจสอบคุณภาพของเครื่องมือประเมินพฤติกรรมตามหลักเวชศาสตร์วิถีชีวิตสำหรับผู้สูงอายุไทยในชุมชน : กรณีศึกษาเขตสุขภาพที่ 7

Development and Validation of the Lifestyle Medicine Assessment Tool for Community-Dwelling Thai Older Adults: A Case Study of Health Region 7

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บทคัดย่อ

การเข้าสู่สังคมผู้สูงอายุโดยสมบูรณ์ของประเทศไทยส่งผลให้ภาระโรคไม่ติดต่อเรื้อรัง (NCDs) เพิ่มสูงขึ้น การคัดกรองพฤติกรรมตามหลักเวชศาสตร์วิถีชีวิต (Lifestyle Medicine: LM) จึงเป็นกลยุทธ์สำคัญในการป้องกันและจัดการโรค งานวิจัยนี้มีวัตถุประสงค์เพื่อพัฒนาและตรวจสอบคุณภาพของเครื่องมือประเมินพฤติกรรมตามหลักเวชศาสตร์วิถีชีวิตสำหรับผู้สูงอายุไทย ตามแนวทางมาตรฐานสากล COSMIN ดำเนินการวิจัยแบบวิจัยและพัฒนา แบ่งเป็น 2 ระยะ คือการพัฒนาและตรวจสอบคุณภาพเครื่องมือ เก็บข้อมูลในกลุ่มตัวอย่างผู้สูงอายุในชมรม/โรงเรียนผู้สูงอายุ เขตสุขภาพที่ 7 จำนวน 273 คน (อายุเฉลี่ย 70.30 ± 6.60 ปี) ส่วนใหญ่เป็นเพศหญิง (ร้อยละ 71.8) และร้อยละ 62.6 มีโรคประจำตัว สถิติที่ใช้ครอบคลุมความตรงเชิงเนื้อหา ความเป็นไปได้ ความตรงเชิงโครงสร้างแบบก่อร่าง (Formative Validity) ความตรงตามเกณฑ์ และความเชื่อถือได้ (Test-Retest Reliability)

ผลการศึกษาพบว่าเครื่องมือ Thai LM-OA ประกอบด้วย 21 ข้อคำถาม ครอบคลุม 6 เสาหลักได้แก่ โภชนาการ 6 ข้อ และ การออกกำลังกาย, การนอนหลับ, พฤติกรรมเสี่ยง, การจัดการความเครียด และความสัมพันธ์ทางสังคม เสาละ 3 ข้อ เครื่องมือมีความตรงเชิงเนื้อหาระดับสูง (S-CVI = 0.97) และใช้เวลาตอบเฉลี่ย 5.40 นาที ผลการประเมินโมเดลเชิงก่อร่างไม่พบปัญหาความสัมพันธ์ทับซ้อน (VIF = 1.04 -1.55) โดยทุกองค์ประกอบมีค่า Outer Weights ที่มีนัยสำคัญทางสถิติ ($p < 0.001$) ในการอธิบายตัวแปรวิถีชีวิตพบว่าการนอนหลับ ($\lambda = 0.364$) และการออกกำลังกาย ($\lambda = 0.335$) มีน้ำหนักความสำคัญสูงสุด นอกจากนี้ พฤติกรรม LM มีความสัมพันธ์เชิงลบกับจำนวนโรคประจำตัวอย่างมีนัยสำคัญ ($\beta = -0.344$, $p < 0.001$) และมีความคงที่ในการวัดผลอยู่ในระดับดี (ICC = 0.71, 95% CI: 0.50-0.84)

โดยสรุป เครื่องมือ Thai LM-OA ได้รับการพัฒนาอย่างเป็นระบบ มีคุณภาพตามเกณฑ์มาตรฐานทางจิตมิติ มีความกระชับและแม่นยำ เหมาะสำหรับบุคลากรสาธารณสุขในการคัดกรอง วินิจฉัย และติดตามผลพฤติกรรมสุขภาพของผู้สูงอายุไทย เพื่อสนับสนุนการจัดบริการสุขภาพเชิงรุกตามแนวทางเวชศาสตร์วิถีชีวิตอย่างมีประสิทธิภาพ

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ABSTRACT

As Thailand transitions into a complete aged society, the burden of non-communicable diseases (NCDs) continues to increase. Effective assessment tools based on Lifestyle Medicine (LM) principles are essential for screening behavioral risks and monitoring health outcomes. This study aimed to develop and psychometrically validate the Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA), guided by selected COSMIN (Consensus-based Standards for the Selection of Health Measurement Instruments) recommendations. A Research and Development (R&D) design was employed. Data were collected from 273 community-dwelling older adults in Health Region 7 (mean age 70.30 ± 6.60 years), the majority of whom were female (71.8%), with 62.6% reporting underlying chronic conditions. Statistical analyses included content validity, feasibility, formative model evaluation, criterion-related validity, and test-retest reliability.

The resulting Thai LM-OA comprises 21 items across six core pillars: Nutrition, Physical Activity, Sleep, Risk Behavior Avoidance, Stress Management, and Social Connection. The instrument demonstrated high content validity (S-CVI = 0.97) and excellent feasibility, with an average completion time of 5.40 minutes. Formative model evaluation indicated no multicollinearity issues (VIF: 1.04–1.55). All sub-components showed significant outer weights ($p < 0.001$), with Sleep ($\lambda = 0.364$) and Physical Activity ($\lambda = 0.335$) being the most significant contributors to the lifestyle construct. Furthermore, criterion-related validity was supported by a significant negative association between overall LM behaviors and the number of chronic diseases ($\beta = -0.344$, $p < 0.001$). One-week test-retest reliability was good, with an ICC of 0.71 (95% CI: 0.50–0.84).

The Thai LM-OA is a systematically developed, concise, and psychometrically sound instrument. It provides healthcare professionals with an effective tool for screening and evaluating lifestyle behaviors among Thai older adults to support proactive health management.

Keywords: Lifestyle Medicine, Thai Older Adults, Instrument Development, Psychometric Properties, COSMIN

Introduction

Thailand, including Health Region 7, has officially transitioned into a complete aged society. As of 2025, the population of older adults (aged ≥60 years) has reached 12 million, comprising 20% of the total population. Projections indicate that by 2031, Thailand will advance to a super aged society, wherein older adults will constitute 28% of the population (United Nations, 2022). This rapid demographic transition poses substantial challenges to the nation's healthcare system, economy, and social structure, particularly due to the escalating burden of non-communicable diseases (NCDs).

NCDs including cardiovascular diseases, diabetes, cancer, and chronic respiratory diseases are the leading causes of mortality both in Thailand and globally (World Health Organization [WHO], 2025). Among Thai older adults, these issues are increasingly complex due to the prevalence of multimorbidity, or the co-occurrence of two or more chronic conditions. National-level studies have documented that nearly half of Thai older adults experience multimorbidity (Intarut et al., 2021; Thinuan et al., 2020), which is directly associated with polypharmacy, frailty, declines in physical and cognitive performance, and diminished quality of life (Intarut et al., 2021; Thinuan et al., 2020). These cascading effects not only impose substantial burdens on older individuals and their families but also challenge the capacity and sustainability of Thailand's national healthcare system.

Lifestyle behaviors are critical modifiable determinants of health (Ford et al., 2009). The WHO identifies major risk factors such as unhealthy diets, physical inactivity, tobacco use, and harmful alcohol consumption as primary drivers of NCDs (WHO, 2024). Importantly, adopting health-promoting lifestyle modifications can prevent up to 80% of NCD cases (Rippe, 2018). This evidence-based paradigm serves as the foundation of "Lifestyle Medicine (LM)," a medical specialty focused on using evidence-based lifestyle changes to prevent, treat, and even reverse various chronic diseases (Frates & Katz, 2022).

Lifestyle Medicine categorizes health behaviors into six essential pillars: (1) nutrition, (2) physical activity, (3) sleep, (4) stress management, (5) Risk Behavior Avoidance, and (6) positive social connections (American College of Lifestyle Medicine, n.d.). Integrating these six dimensions into daily life represents a proactive, cost-effective strategy for promoting healthy aging in older adults. However, the broad implementation of such a strategy requires high-quality "assessment tools" to enable healthcare professionals to systematically screen for behavioral risks, diagnose problems, plan personalized care, and monitor outcomes.

Although several health-promoting lifestyle instruments exist, such as the Health-Promoting Lifestyle Profile II (HPLP-II) (Walker et al., 1995), critical gaps persist when these tools are applied within the context of Thai older adults. First, existing tools often fail to cover all six pillars of Lifestyle Medicine, frequently overlooking sleep and social relationships. Second, most instruments were developed within Western cultural contexts, resulting in dietary and physical activity items that lack cultural relevance for Thai older adults, thereby undermining content validity (Pangalangan et al., 2024). Third, even when culturally adapted translations exist, these instruments often lack rigorous population-specific psychometric validation, potentially resulting in measurement error and suboptimal clinical decision-making. Given these substantial limitations, the development of a new assessment tool necessitates adherence to rigorous international standards.

The COSMIN (Consensus-based Standards for the Selection of Health Measurement Instruments) initiative provides internationally recognized guidance for developing and evaluating patient-reported outcome measures (PROMs) (Mokkink et al., 2010). The COSMIN taxonomy classifies measurement properties into three broad domains: reliability, validity, and responsiveness (Prinsen et al., 2018; Terwee et al., 2018). In the present study, selected COSMIN recommendations were used as a methodological guide for evaluating key psychometric properties of the Thai LM-OA, including content validity, construct validity, criterion-related validity, and test-retest reliability. This approach was intended to enhance methodological transparency, psychometric rigor, and the practical utility of the instrument for community-based health assessment and research among Thai older adults.

Consequently, this research was conducted with the objective of developing and validating the Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA). The tool is designed to encompass all six pillars of Lifestyle Medicine, ensure cultural and social appropriateness for the Thai context, and undergo psychometric evaluation guided by selected COSMIN recommendations. The anticipated outcome is a psychometrically sound, culturally appropriate instrument that enables systematic screening, tailored intervention planning, and longitudinal monitoring of lifestyle behaviors in Thai older adults. Such a tool will provide critical infrastructure to support evidence-based policies and programs aimed at promoting healthy aging and enhancing the sustainability of Thailand's healthcare system.

Research Objectives

1. To develop the Lifestyle Medicine Assessment Tool for Thai Older Adults (Thai LM-OA), focusing on a case study of the elderly population in Health Region 7.
2. To evaluate the psychometric properties of the Thai LM-OA in terms of content validity, construct validity, criterion-related validity, and test-retest reliability.

Methods

Study Design: This study employed a Research and Development (R&D) design, divided into two distinct phases:

Phase 1: Tool Development Phase

1. Literature Review: A comprehensive synthesis was conducted on existing health behavior assessment instruments, including the Health-Promoting Lifestyle Profile II (HPLP-II), the Lifestyle Medicine Health Behavior (LMHB) Scale, and the Lifestyle Medicine Assessment (LMA) Tool. Additionally, relevant Thai instruments were reviewed, such as the Lifestyle Medicine Assessment by the Thai Health Promotion Foundation (Thai-Health), the Department of Health's Elderly Health Behavior Assessment, and the Department of Health Service Support's Health Literacy and Behavior Scale (based on the "3E2S" principle) for individuals aged 15 and over.
2. Qualitative Study: A Single-Case Study and Narrative Inquiry were conducted to gain an in-depth understanding of the lifestyles and health behaviors of "Super-Agers" (individuals aged 90 and over).

This group was purposively selected for their outstanding physical health, functional performance, and ability to maintain an active lifestyle.

3. Item Generation: Based on the synthesized data from the literature review and qualitative findings, an initial item pool was generated. The items were designed to cover the six pillars of Lifestyle Medicine, utilizing a 5-point Likert-type Rating Scale.
4. Content Validity Assessment:
    - The draft instrument was submitted to a panel of 11 experts, including geriatricians, registered dietitians, and sports scientists, to evaluate the congruence between the items and their operational definitions.
    - The Content Validity Index (CVI) was calculated. The acceptance criteria were set at an Item-level CVI (I-CVI) = 0.80 and a Scale-level CVI (S-CVI) = 0.90.
    - The instrument was subsequently revised based on the experts' recommendations.
5. Pilot Testing: The content-validated instrument was pre-tested with 30 older adults who shared similar characteristics with the target population. Convenience sampling was used to recruit participants from those attending services or activities at Health Center 7, Khon Kaen. The pilot test aimed to assess linguistic clarity and the appropriateness of the administration time. Final adjustments were made to ensure the instrument was comprehensive and ready for field testing.

Phase 2: Psychometric Testing Phase

Main Data Collection: Data were collected from the primary sample of older adults (aged 60 and over) residing in Health Region 7. The study focused on the "Socially Active" group, defined as elderly individuals participating in senior citizens' clubs or "Elderly Schools" within the health region.

Sample Size Determination

The sample size for this study was determined primarily to examine the construct validity of the instrument using a formative composite model, following established guidelines for multivariate and psychometric research (Comrey & Lee, 1992; Tabachnick & Fidell, 2013). As there is no universal formula for fixed sample size in factor analysis or structural equation modeling, the determination was based on expert consensus and widely recognized heuristics. A key heuristic commonly employed in psychometric validation is the participant-to-item ratio, with recommendations typically ranging from 5:1 to 20:1 (Costello & Osborne, 2005). A ratio of 10 participants per item (10:1) is generally considered a robust and acceptable standard for ensuring stable analytical results and minimizing measurement error (Nunnally & Bernstein, 1994).

Given that the Thai LM-OA was anticipated to contain 21 items, the minimum required sample size was calculated at 210 participants (21 items × 10). To account for potential missing data or incomplete questionnaires during the data collection process, a 10% oversampling strategy was implemented (210 / 0.9 ≈ 233.3). Consequently, the final target sample size for this study was established at a minimum of 234 participants. During the actual data collection phase, a total of 273 fully completed and valid questionnaires were successfully

retrieved. All 273 responses were retained for the final analysis, yielding an actual participant-to-item ratio of approximately 13:1. This larger sample size further enhances statistical power, reduces standard errors, and ensures greater parameter stability for the formative construct model.

Data Analysis: Psychometric Testing Phase

1. Partial Least Squares Structural Equation Modeling (PLS-SEM)

The psychometric properties of the Thai LM-OA were evaluated using Partial Least Squares Structural Equation Modeling (PLS-SEM). The overall Lifestyle Medicine behavior construct was specified as a formative composite derived from six theoretically defined pillars. The analysis included item-level collinearity assessment and pillar-level outer weight estimation.

A. Measurement Model Assessment (Outer Model)

To validate the formative nature of the Lifestyle Medicine behavior construct, the following properties were assessed:

- Collinearity Assessment: The Variance Inflation Factor (VIF) was calculated at the item level for the 21 observed items. A VIF threshold of < 5.0 was applied to ensure that the formative dimensions were not redundant and did not suffer from multicollinearity issues.
- Significance and Relevance of Outer Weights: The statistical significance of the outer weights for each of the six pillars was determined. The T-statistics and p-values were estimated using the bootstrapping procedure with 5,000 subsamples. This process examined whether each pillar significantly contributed to the formation of the overall Thai LM-OA construct.

B. Structural Model Assessment (Inner Model)

The structural model was evaluated to provide evidence supporting criterion-related validity by examining the relationship between the Thai LM-OA and relevant health outcomes:

- Path Coefficients: The standardized path coefficients and their significance levels were examined to assess the predictive power of Lifestyle Medicine behaviors on underlying chronic diseases and Body Mass Index (BMI).
- Coefficient of Determination: The R^2 values were calculated to determine the amount of variance in health outcomes explained by the Thai LM-OA construct.

Software and Estimation:

All PLS-SEM analyses, including the estimation of weights, path coefficients, and bootstrapping, were performed using SmartPLS version 4.0 (SmartPLS GmbH, Oststeinbek, Germany).

Participant Selection Criteria

The selection of participants for the main data collection phase was based on the following criteria:

1. Inclusion Criteria

To be eligible for the study, participants had to meet the following requirements:

1) Older adults aged 60 years and older.

2) Being a member of the targeted senior clubs or senior schools and residing in the study area during the research period.

3) Ability to communicate effectively and understand the Thai language.

4) Voluntary participation with provided informed consent.

2. Exclusion Criteria

Participants were excluded from the study if they met any of the following conditions:

1) Death or relocation out of the study area during the research period.

2) Being categorized as "home-bound" or "bed-bound" individuals.

3) Having symptoms of confusion or dementia, as identified by the staff in charge of the respective senior clubs.

4) Experiencing acute medical conditions on the day of data collection (e.g., high fever, severe pain).

3. Discontinuation Criteria

Participants were withdrawn from the study under the following circumstances:

1) Encountering personal problems or health issues that prevented them from continuing with the research process.

2) Deciding to withdraw from the study or no longer being willing to participate at any stage.

Ethical Considerations

The study protocol was officially reviewed and approved by the Human Research Ethics Committee of Regional Health Promotion Centre 7 Khon Kaen, Thailand (Project Code: 143/2568) on October 9, 2025. All participants provided voluntary informed consent prior to their inclusion in the study.

Results

Phase 1: Tool Development Phase

1.1 Development of the Assessment Instrument

The development process resulted in the Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA), comprising 21 items. The instrument utilizes a 5-point Likert-type rating scale to measure health behaviors across the six pillars of Lifestyle Medicine.

1.2 Content Validity Assessment

The content validity of the draft instrument was evaluated by a panel of **11 experts** with diverse specializations, including:

- A Lifestyle Medicine physician
- A senior public health academic specialist
- Heads of various Health Promotion Development Groups (Older Adult, Working Age, and School Age populations)
- The Head of Health Promotion for the Elderly and Dependent Care
- The Head of Health Promotion for Monks and Religious Leaders

- The Head of the Lifestyle Medicine Clinic
- The Head of the Geriatric Clinic
- A registered dietitian
- A sports scientist

The Content Validity Index (CVI) was calculated based on the experts' ratings. The results indicated that the Item-level CVI (I-CVI) ranged from 0.80 to 1.00, while the Scale-level CVI (S-CVI) reached 0.97. These values significantly exceeded the established threshold of = 0.90, demonstrating that the instrument possesses high content validity and is comprehensively appropriate for the context of Thai aging and older adults.

Table 1: Content Validity Assessment of the Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA) by a Panel of 11 Experts

Pillars and Assessment Items	Agreed Experts (Score 3-4)	I-CVI
1. Nutrition		
1.1 Eating at least 4 servings of vegetables per day	11	1
1.2 Eating 1–3 servings of fruits per day	11	1
1.3 Consuming a total of 7–9 tablespoons of meat, eggs, or legumes	11	1
1.4 Consuming processed foods (e.g., sausages, meatballs, ham, bacon)	10	0.91
1.5 Consuming sugar-sweetened beverages (e.g., tea, coffee, sodas, energy drinks)	10	0.91
1.6 Drinking at least 8 glasses of clean water per day	11	1
2. Physical Activity		
2.1 Engaging in moderate-to-vigorous physical activity for at least 30 mins/day or 150 mins/week	11	1
2.2 Performing muscle-strengthening activities (e.g., push-ups, squats, wall presses)	10	0.91
2.3 Moving or changing posture every 2 hours during the day	9	0.82
3. Stress Management		
3.1 Maintaining a positive outlook or finding the good in various situations	10	0.91
3.2 Utilizing effective stress-reduction techniques (e.g., music, breathing exercises, meditation)	10	0.91
3.3 Frequency of mindfulness or spiritual practices (e.g., prayer, meditation) per week	10	0.91

4. Sleep Behavior		
4.1 Sleeping for 7–9 hours per day	11	1
4.2 Waking up feeling refreshed and energized	11	1
4.3 Quality of sleep (e.g., sleeping soundly without frequent midnight awakenings)	11	1
5. Risk Behavior Avoidance		
5.1 Tobacco smoking or use of shredded tobacco	11	1
5.2 Consumption of alcoholic beverages	11	1
5.3 Self-prescribing herbal medicines or unverified drug sets based on others' advice	11	1
6. Social Connections		
6.1 Communicating or meeting with family members, friends, or neighbors	11	1
6.2 Participating in community activities or social gatherings	11	1
6.3 Having a sense of reliable social support for counseling or assistance	11	1
Scale-level Content Validity Index (S-CVI)		0.97

1.3 Pilot Testing and Feasibility

The instrument, having been validated for content, was pre-tested with 30 participants who shared similar characteristics with the target population. Convenience sampling was employed to recruit participants from those attending health services or activities at Health Center 7, Khon Kaen.

The primary objectives of this pilot phase were to evaluate linguistic clarity and the appropriateness of the administration time. Following the pilot test, minor adjustments were made to refine the final version of the instrument.

Regarding feasibility, the time taken to complete the questionnaire was recorded (n=30). The results showed that the administration time ranged from 3 to 15 minutes, with an average of 5.40 minutes (minimum: 2.70, maximum: 15.20). This indicates that the Thai LM-OA is a concise tool, suitable for practical use in community settings.

Phase 2: Psychometric Testing Phase

Main Data Collection and Participant Characteristics

Data for the psychometric testing phase were collected from a primary sample of 273 participants residing in Health Region 7. The sample focused on "socially active" individuals (those participating in senior citizens' clubs or "Elderly Schools") who met the age criteria and were capable of communicating effectively in Thai. The demographic and baseline characteristics of the participants are summarized as follows:

2.1 Participant Characteristics

Table 2 Demographic data of the participants (n = 273)

Characteristics	Frequency (n)	Percentage (%)
Age (Year)		
60-69	128	46.9
70-79	125	45.8
80 and over	20	7.3
Mean ± SD	70.30 ± 6.60	
Min-Max	60-93	
Sex		
Male	77	28.2
Female	196	71.8

Table 2 Demographic data of the participants (n = 273) Cont.

	Frequency (n)	Percentage (%)
Marital Status		
Single	26	9.5
Married	161	59.0
Widowed	67	24.5
Divorced	16	5.9
Separated	3	1.1
Education		
No formal education	6	2.2
Primary school	57	20.9
Secondary school	29	10.6
Vocational certificate	13	4.8
Bachelor's degree	108	39.5
Postgraduate degree (Master's or higher)	60	22.0
Occupation		
Unemployed / Not working	39	14.3
Agriculture	56	20.5

Retired Government	141	51.7
Merchant / Private Business	14	5.1
General Laborer	8	2.9
Others	15	5.5
Underlying Diseases	171	62.6
Hypertension	83	30.4
Diabetes Mellitus	39	14.3
Cardiovascular Disease	12	4.4
Dyslipidemia	85	31.1
Body Mass Index (BMI)		
Normal (18.5-22.9 kg/m^2)	85	31.1
Underweight (<18.5 kg/m^2)	8	2.9
Overweight (23.0-24.9 kg/m^2)	81	29.7
Obesity Class 1 (25.0-29.9 kg/m^2)	88	32.2
Obesity Class 2 (30.0 kg/m^2+)	11	4.1

As shown in Table 2, the average age of the participants (n = 273) was 70.30 ± 6.60 years, ranging from 60 to 93 years. The majority were female (71.8%) and married (59.0%). Regarding educational and occupational background, 39.5% held a bachelor's degree, and 51.7% were retired government or state enterprise officers. In terms of health status, 62.6% had underlying chronic diseases. Regarding nutritional status, the most prevalent BMI category was Obesity Class 1 (25.0-29.9 kg/m^2), accounting for 32.2% of the sample.

2.2 Results of Structural Equation Modeling (PLS-SEM)

The psychometric properties of the instrument were evaluated using Partial Least Squares Structural Equation Modeling (PLS-SEM) via SmartPLS 4. The analysis treated Lifestyle Medicine behavior as a formative composite derived from six theoretically defined pillars. The results are as follows:

A. Measurement Model Assessment (Formative Construct)

The assessment focused on the quality of the Lifestyle Medicine behaviors as a formative construct. This involved evaluating the contribution of the six theoretically defined lifestyle medicine pillars to the overall Lifestyle Medicine behavior construct. The primary criteria for validation included:

1. Collinearity Assessment: To ensure that the pillars are distinct and do not exhibit multicollinearity issues.
2. Significance and Relevance of Outer Weights: To determine the relative contribution and importance of each pillar in forming the overall lifestyle variable.

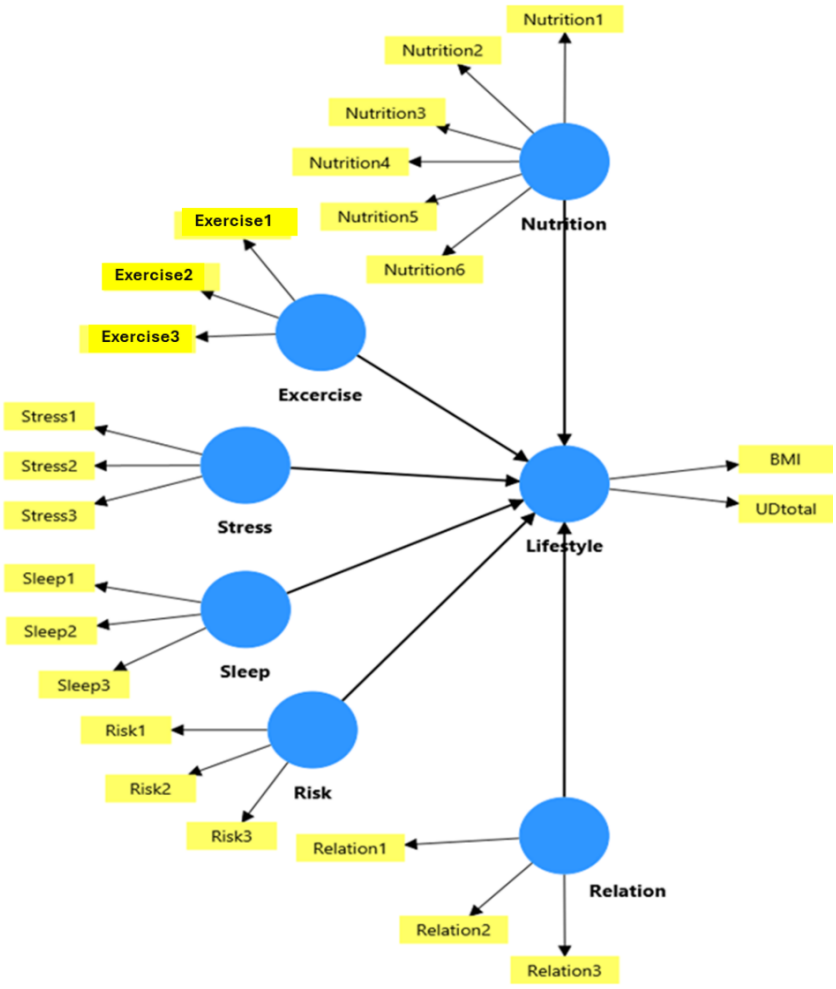

Figure 1: Relative Importance of the Six Pillars of Lifestyle Medicine in Forming the "Lifestyle" Construct

Note. Abbreviated labels in the figure represent the six lifestyle medicine pillars: Exercise = Physical Activity, Stress = Stress Management, Risk = Risk Behavior Avoidance, Relation = Social Connection, Nutrition = Nutrition, and Sleep = Restorative Sleep.

1. Collinearity Assessment

To examine potential redundancy among the observed indicators, the Variance Inflation Factor (VIF) was calculated at the item level for the 21 items of the Thai LM-OA.

Table 3 Item-Level Collinearity Statistics (VIF) of the 21 Observed Items of the Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA)

Item	VIF	Item	VIF
Physical Activity 1	1.113	Risk Behavior Avoidance 1	1.100
Physical Activity 2	1.076	Risk Behavior Avoidance 2	1.059
Physical Activity 3	1.098	Risk Behavior Avoidance 3	1.042
Nutrition1	1.313	Sleep1	1.552
Nutrition2	1.341	Sleep2	1.506
Nutrition3	1.242	Sleep3	1.402

Nutrition4	1.219	Stress Management 1	1.181
Nutrition5	1.138	Stress Management 2	1.162
Nutrition6	1.058	Stress Management 3	1.088
Social Connection 1	1.086		
Social Connection 2	1.163		
Social Connection 3	1.192		

- Criteria: According to Hair et al. (2022), a VIF value should be less than 5.0 (ideally < 3.0) to ensure that the indicators are distinct and do not exhibit excessive redundancy.
- Results: The analysis revealed that the item-level VIF values ranged from 1.042 to 1.552. Since all values were well below the threshold of 5.0, it can be concluded that there are no multicollinearity issues. This confirms the stability and appropriateness of each dimension in the model estimation.

2. Significance and Relevance of Outer Weights

The contribution of each dimension to the formation of the Thai LM-OA construct was evaluated through Outer Weights and T-statistics. This analysis determines the relative importance of the six pillars in defining the overall lifestyle medicine behavior.

Results of Formative Validity:

The analysis provided evidence supporting the formative validity of the instrument, as all six pillars demonstrated statistically significant outer weights ($p < 0.001$). These findings are theoretically consistent with the principles of Lifestyle Medicine.

The relative importance of each pillar is ranked as follows:

- Restorative Sleep exhibited the highest weight ($\lambda = 0.364$).
- Physical Activity followed with the second-highest weight ($\lambda = 0.335$).

In this study population, sleep and exercise were the most influential determinants in forming the overall lifestyle medicine behavior. This suggests that for Thai aging and older adults, interventions focusing on these two pillars may yield the most significant impact on their health-promoting lifestyles.

Table 4 Outer Weights of the Six Lifestyle Medicine Pillars Forming the Overall Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA) Construct

Pillars of Lifestyle Medicine	Original Sample (λ)	T-Statistics	P-Value	**Significance**
Sleep	**0.364**	**15.419**	**<0.001***	Significant (Highest Weight)
Physical Activity	0.335	13.987	<0.001*	Significant (High Weight)
Stress Management	0.261	10.970	<0.001*	Significant
Risk Behavior Avoidance	0.279	9.409	<0.001*	Significant
Social Connection	0.225	10.986	<0.001*	Significant

Nutrition	0.196	8.107	<0.001*	Significant

B. Structural Model Assessment and Criterion Validity

To provide evidence supporting criterion-related validity of the Thai LM-OA, the structural model was assessed by examining the predictive relationships between lifestyle medicine behaviors and health-related outcomes, specifically the number of underlying diseases (UD) and Body Mass Index (BMI).

Table 5 Structural Model Results for Criterion-Related Validity (Path Coefficients)

Path	Path Coefficient (β)	T-Statistics	P-Value	R^2	Conclusion
Lifestyle ⟶ UD	-0.344	13.041	<0.001*	0.119	Evidence Supported
Lifestyle ⟶ BMI	-0.031	0.697	0.551	0.002	Not Significant

Summary of Findings

The structural analysis demonstrated a significant and negative relationship between Lifestyle Medicine behaviors and the number of underlying diseases ($\beta = -0.344$, $p < 0.001$). This finding provides evidence supporting criterion-related validity of the tool, indicating that improved adherence to lifestyle medicine principles is effectively associated with a reduction in the number of chronic conditions.

The Lifestyle construct accounted for 11.9% of the variance ($R^2 = 0.119$) in underlying diseases, indicating modest but meaningful explanatory power within the context of behavioral health and geriatric research. In contrast, the relationship between lifestyle behaviors and BMI did not reach statistical significance ($\beta = -0.031$, $p = 0.551$).

2.3 Test-Retest Reliability

To evaluate the temporal stability of the Thai LM-OA, a 1-week test-retest was conducted with a sub-sample of 35 participants. The Intraclass Correlation Coefficient (ICC) for the total scale and its six pillars are as follows:

- Total Scale ICC: 0.71 (95% CI: 0.50–0.84)
- Nutrition: 0.77 (95% CI: 0.59–0.88)
- Physical Activity: 0.99 (95% CI: 0.98–0.99)
- Stress Management: 1.00
- Restorative Sleep: 0.76 (95% CI: 0.57–0.87)
- Risk Behavior Avoidance: 1.00
- Positive Social Connections: 0.67 (95% CI: 0.36–0.84)

Conclusion: The total ICC of 0.71 meets the acceptable threshold (≥ 0.70), demonstrating that the Thai LM-OA possesses good stability and reliability for consistent measurement over time.

2.4 Score Categorization and Interpretation (Traffic Light System)

The scoring criteria for the Thai LM-OA were established using a distribution-based approach (Mean± SD). To ensure practical utility for community health workers, the scores were categorized into a "Traffic Light" system:

1. Green (Appropriate Lifestyle): Scores higher than Mean + 1SD. This group demonstrates exemplary lifestyle medicine behaviors.
2. Yellow (Moderate Lifestyle): Scores within the Mean ± 1SD range. This group represents the average behavior and requires maintenance or slight improvement.
3. Red (Requires Improvement): Scores lower than Mean - 1SD. This group is at higher risk and requires urgent lifestyle intervention.

Scoring Interpretation of the Thai LM-OA

The assessment tool is divided into six pillars, with a total possible score of 105. The interpretation follows a "Traffic Light" logic to provide clear guidance for health practitioners and participants.

1. Pillar-Specific Scoring

The scoring for each dimension is categorized into three levels: Requires Improvement (Red), Moderate (Yellow), and Appropriate (Green).

A. Nutrition (6 items, Total 30 points)

	<20	Requires Improvement	An opportunity to receive clear lifestyle counselling for significant change
	20 – 24	Moderate	Some areas need adjustment or reinforcement for a better lifestyle
	25 – 30	Appropriate	Excellent lifestyle. Maintain these healthy habits and refine minor gaps

B. Other Five Pillars (3 items each, Total 15 points per pillar) (Includes: Physical Activity, Stress Management, Restorative Sleep, Risk Behavior Avoidance, and Social Connections)

	<10	Requires Improvement	An opportunity to receive clear lifestyle counselling for significant change
	10-12	Moderate	Some areas need adjustment or reinforcement for a better lifestyle
	13-15	Appropriate	Excellent lifestyle. Maintain these healthy habits and refine minor gaps

2. Total Lifestyle Score Interpretation (Total 105 points)

The overall score provides a holistic view of the participant's lifestyle medicine adherence.

	<80	Requires Improvement	An opportunity to receive clear lifestyle counselling for significant change
	80-89	Moderate	Some areas need adjustment or reinforcement for a better lifestyle
	90-105	Appropriate	Excellent lifestyle. Maintain these healthy habits and refine minor gaps

Summary of the Development and Psychometric Validation of the Thai LM-OA

The development and validation of the Thai Lifestyle Medicine Assessment for Aging and Older Adults (Thai LM-OA) yielded the following robust results:

1. Tool Composition and Feasibility

- Structure: The final instrument consists of 21 items covering the Six Pillars of Lifestyle Medicine: 1) Nutrition (6 items), 2) Physical Activity (3 items), 3) Restorative Sleep (3 items), 4) Risk Behavior Avoidance (3 items), 5) Stress Management (3 items), and 6) Social Connections (3 items).
- Measurement: Utilizes a Rating Scale (5 levels).
- Feasibility: The average administration time is 5.40 minutes (Range: 2.70–15.20 minutes), demonstrating its suitability for routine clinical and community use.

2. Validity Assessment

- Content Validity: The instrument achieved high content validity with an I-CVI of 0.80–1.00 and a Scale-level CVI (S-CVI) of 0.97, exceeding the standard threshold of 0.80.
- Formative Construct Validity (PLS-SEM):
  - Collinearity: All VIF values (1.04–1.55) were well below 5.0, confirming the absence of multicollinearity issues.
  - Relative Importance: All six pillars significantly contributed to the Lifestyle construct ($p < 0.001$). Restorative Sleep ($\lambda = 0.364$) and Physical Activity ($\lambda = 0.335$) emerged as the most influential determinants.
- Criterion-Related Validity: The tool provided evidence supporting criterion-related validity. Lifestyle medicine behaviors were negatively associated with the number of underlying diseases ($\beta = -0.344$, $p < 0.001$), explaining 11.9% of the variance, indicating modest but meaningful explanatory power.

3. Reliability

- Temporal Stability: The 1-week test-retest yielded an Intraclass Correlation Coefficient (ICC) of 0.71 (95% CI: 0.50–0.84), confirming that the Thai LM-OA provides consistent and stable measurements over time.

Discussion

The present study successfully validated the Thai Lifestyle Medicine Assessment Tool for Older Adults (Thai LM-OA) as a robust formative construct. The tool demonstrated significant predictive power regarding a key clinical outcome: the number of chronic conditions (underlying diseases) in Thai older adults. Given Thailand's rapid transition toward a super-aged society (United Nations, 2022), managing non-communicable diseases (NCDs) (World Health Organization [WHO], 2025) and multimorbidity (Intarut et al., 2021; Thinuan et al., 2020) has become a critical priority for the national healthcare system.

1. Structural Congruence and Practical Utility

Importantly, the conceptual strength and structural relevance of these items are firmly rooted in the empirical qualitative insights generated during Phase 1 (Super-Ager narratives). The narrative inquiry revealed that maintaining high health status and physical performance in advanced age is heavily driven by the lifelong accumulation of health capital, which manifests across six interconnected pillars.

Specifically, the qualitative findings demonstrated that: (1) Physical Activity and Exercise were sustained as core components of personal identity, objectively reflected by an optimal skeletal muscle mass index (SMI) of 7.1 kg/m² and a metabolic age of 69 years; (2) Nutritional Patterns were characterized by a strong preference for traditional local diets, focusing on natural whole foods and adequate protein intake while avoiding ultra-processed foods; (3) Sleep Hygiene involved a disciplined and consistent routine of approximately 8 hours per day; (4) Social Connection was deeply anchored in robust family and community support networks; (5) Stress Management was achieved through emotional resilience and maintaining a clear purpose in life; and (6) Risk Behavior Avoidance was highlighted by the complete cessation of smoking and alcohol consumption since midlife, heavily reinforced by family values.

By operationalizing these concrete, culturally specific qualitative themes into explicit, measurable items within the scale, the Thai LM-OA successfully bridges international lifestyle medicine standards with the authentic, lived experiences of healthy Thai older adults. Consequently, the resulting structure of the Thai LM-OA (comprising 6 pillars and 21 items) is highly consistent with the international framework of Lifestyle Medicine, ensuring strong face and construct validity.

Furthermore, the instrument demonstrates high clinical utility through its Feasibility: the average administration time of 5.40 minutes minimizes respondent fatigue—a crucial factor when assessing older populations. This efficiency is expected to enhance response rates and ensure high data quality in clinical practice. Additionally, in terms of Content Justification, the decision to allocate six items to the Nutrition pillar (compared to three items in other pillars) is justified by the inherent complexity of dietary behaviors. This allows for deeper insights into what is arguably a cornerstone pillar of health.

2. Robust Content Validity

The S-CVI of 0.97 significantly exceeds the standard thresholds of 0.80 and 0.90, reflecting a rigorous development process and strong expert consensus. Furthermore, the I-CVI values (0.80–1.00) confirm that each

item is clear, relevant, and accurately captures the essence of the six pillars, thereby minimizing measurement error at the conceptual level.

3. Formative Validity and Strategic Prioritization

Applying Partial Least Squares Structural Equation Modeling (PLS-SEM) (Hair et al., 2022), this study provided evidence supporting the Thai LM-OA as a formative composite, in which overall Lifestyle Medicine behavior is formed by six theoretically defined pillars.

Formative Validation: Significant Outer Weights ($p < .001$) for all pillars demonstrate that each dimension is an essential component of the construct. The absence of multicollinearity (VIF 1.042–1.552) ensures the stability and statistical integrity of the model (Comrey & Lee, 1992; Tabachnick & Fidell, 2013).

Prioritization for Intervention: Restorative Sleep ($w = 0.364$) and Physical Activity ($w = 0.335$) emerged as the strongest contributors to the lifestyle construct. This suggests that interventions focusing on sleep hygiene and physical movement may provide the most efficient pathway to improving overall health behaviors in this population.

4. Criterion-Related Validity: Predicting Clinical Outcomes

Chronic Disease Burden: The significant negative association between lifestyle scores and the number of underlying diseases ($\beta = -0.344$, $p < .001$) provides evidence supporting criterion-related validity of the tool. With an R^2 of 11.9%, lifestyle behaviors serve as a meaningful predictor of chronic disease burden in older adults (Hair et al., 2022).

The BMI Paradox: The lack of statistical significance regarding Body Mass Index (BMI) ($\beta = -0.031$, $p = 0.551$) likely reflects the physiological limitations of BMI in geriatric populations. Specifically, BMI often fails to distinguish between sarcopenia (age-related muscle loss) and adiposity, which may obscure its relationship with lifestyle behaviors.

5. Stability and Reliability

The one-week test-retest Intraclass Correlation Coefficient (ICC) of 0.71 meets the COSMIN guidelines for sufficient reliability (Mokkink et al., 2010). This level of stability indicates low measurement error, confirming that the tool reflects enduring lifestyle patterns rather than random fluctuations. Although the 95% Confidence Interval (0.50–0.84) was relatively broad due to the sub-sample size, the point estimate strongly supports the tool's utility for longitudinal studies and intervention monitoring.

6. Practical Implementation: The Traffic Light System

The distribution-based scoring (Mean ± SD) provides a practical "Traffic Light" clinical decision support system. Although developed among "socially active" and health-conscious older adults, these criteria aim to maximize health span and quality of life. For the general community, these thresholds may serve as preliminary reference criteria for health promotion and systematic risk screening.

Limitations and Future Directions

1. Cross-sectional Nature: This study identified predictive associations but not causality. Future longitudinal research is required to confirm if improving Thai LM-OA scores directly leads to a reduction in chronic diseases.
2. Generalizability: The sample was restricted to Health Region 7. Future studies should expand to include diverse urban and rural populations across Thailand.

Conclusion

The Thai LM-OA is a culturally tailored, validated, and efficient tool. It enables healthcare providers to screen, plan, and monitor lifestyle interventions effectively, ultimately fostering a data-driven approach to improving the health outcomes of the Thai elderly population.

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