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Integrated Nutrition and Physical Activity Program Based on Social Cognitive Theory to Enhance Quality of Life, Nutritional Status, and Physical Activity in Older Adults

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ABSTRACT

Population aging in Indonesia demands scalable programs that elevate everyday functioning and well-being. This study evaluated an integrated nutrition and physical activity program grounded in Social Cognitive Theory for community-dwelling older adults. Using a quasi-experimental, community-based design, the intervention combined nutrition education with cooking practice, progressive exercise, self-efficacy-oriented counselling, and peer support, and was assessed with validated measures of quality of life, nutritional status, and physical activity. Participants receiving the program achieved marked improvements across all outcomes relative to comparison participants, and gains persisted beyond the intervention period. These benefits arose because the program simultaneously strengthened capability through skills and knowledge, opportunity through social support and access, and motivation through enhanced self-efficacy, goal setting, and self-monitoring. Hands-on practice and vicarious learning built mastery, while culturally adapted materials and peer leaders reduced barriers and reinforced adherence. Findings indicate that a theory-driven, multi-component approach is feasible within primary care and can advance healthy aging and equity in Indonesian communities.

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1. INTRODUCTION

The global population is experiencing a rapid demographic shift marked by an unprecedented increase in the proportion of older adults. According to the United Nations in 2015, the population aged sixty years and over is projected to more than double by the middle of the century, with the fastest growth occurring in developing countries. Indonesia, as the fourth most populous country in the world, is undergoing a similar demographic transition, with the proportion of older adults expected to surpass that of children under fifteen years by 2050 (based on Badan Pusat Statistik in 2020 and World Health Organization in 2017). This transformation brings new challenges for health systems, economies, and social structures, shifting public health priorities from mortality reduction toward the promotion of healthy and active aging. The World Health Organization defines healthy aging as the process of developing and maintaining functional ability that enables well-being in older age, emphasizing the interaction between intrinsic capacity, environmental conditions, and individual preferences, which was announced by the World Health Organization in 2015.

Quality of life in older adults is influenced by a complex interplay of biological, behavioral, environmental, and social factors. Blum's model estimates that behavioral factors, including diet, physical activity, smoking, and alcohol use, account for more than half of the determinants of health in later life (Blum, 1978). Evidence from multi-country longitudinal studies and systematic reviews shows that optimal nutrition and regular physical activity are critical for maintaining health, functional independence, and overall well-being in older adults (Amarantos *et al*., 2001; Moreno-Agostino *et al*., 2020; Marquez *et al*., 2020). However, age-related physiological changes, chronic conditions, and social barriers often limit healthy lifestyle adoption in this population (Brownie, 2006; Fávaro-Moreira *et al*., 2016). Nutrition risk, characterized by poor dietary intake and inadequate nutrient status, is highly prevalent among community-dwelling older adults and is associated with increased frailty, hospitalization, and reduced quality of life (Tucker *et al*., 2022; Molani-Gol *et al*., 2025). Similarly, physical inactivity remains common, with only a small proportion of older adults meeting public health recommendations for activity levels (see https://www.cdc.gov/physical-activity/php/reports/adults-50-and-older.html) (Troiano *et al*., 2008).

Integrating nutrition and physical activity within a single intervention may provide synergistic benefits, but such approaches are rarely implemented in Indonesia. Theory-driven frameworks, particularly Social Cognitive Theory (SCT), offer effective strategies for promoting sustainable behavior change by addressing self-efficacy, outcome expectations, self-regulation, and environmental supports (Bandura, 2001; White *et al*., 2012). SCT has been successfully applied in health promotion for older adults in various contexts, yet culturally adapted, multi-component programs grounded in this theory are limited in Southeast Asia. This study aims to evaluate the effectiveness of an integrated nutrition and physical activity intervention program based on SCT in improving quality of life, nutritional status, and physical activity among Indonesian older adults. The novelty lies in combining dietary counseling, structured exercise, behavioral counseling, and peer support within a culturally relevant, theory-based framework to address multiple determinants of healthy aging simultaneously.

2. THEORETICAL FRAMEWORK

2.1. Social Cognitive Theory (SCT)

SCT, developed by Albert Bandura, provides a robust theoretical foundation for understanding and promoting health behaviors in the elderly population (Bandura, 2001). SCT

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is particularly useful for understanding physical activity behavior in middle-aged and older adults and developing programs geared toward the initiation and maintenance of healthy behaviors (White *et al*., 2012). SCT specifies a core set of psychosocial determinants that include: self-efficacy (beliefs in capabilities to complete a course of action), outcome expectations (beliefs about probable outcomes of behaviors), goals (personal standards that guide behavior), impediments, and facilitators (barriers and enablers in the environment) (Bandura, 2004). Research shows that self-efficacy generally serves as an "active agent" in SCT models, with a significant influence on behavior adoption and maintenance (Anderson *et al*., 2010). Studies focusing on elderly populations have shown that self-efficacy and physical activity levels decline with age, while social support and the use of self-regulatory behaviors (such as goal setting, planning, and monitoring) tend to increase (Olson *et al*., 2017). Structural equation modeling analysis shows that self-efficacy influences physical activity both directly and indirectly via outcome expectations, suggesting that variables should be targeted in physical activity interventions (White *et al*., 2012). Research on diabetes patients using the SCT framework shows that social cognitive theory can accurately describe health behaviors, such as physical activity and nutritional behaviors concerning the interaction between the individual, environment, and behavior (Rad *et al*., 2024). SCT has helped researchers explore key factors of health behaviors and facilitates knowledge about these factors to develop health interventions that lead to behavior change (Plotnikoff *et al*., 2008). Application of SCT in primary health care settings shows that improving self-efficacy and motivation can lead to immediate improvements in various areas of behavior, including increased daily time spent in moderate to vigorous physical activity and frequency of raw vegetable intake (Islam *et al*., 2023). All included studies in systematic reviews viewed and adapted the construct of self-efficacy as an ideal framework for understanding how determinants of behavior operate together to explain actions and bring about specific behavior change among target populations (Islam *et al*., 2023).

Contemporary research increasingly recognizes that optimal health outcomes in elderly populations are achieved through integrated approaches that combine appropriate nutrition and physical activity interventions. The synergistic effects of these two factors have been demonstrated in multiple domains: enhanced muscle protein synthesis and maintenance of lean body mass, improved bone density and reduced fracture risk, better cardiovascular health and metabolic function, enhanced immune function, and reduced inflammation (Daly *et al*., 2020). A comprehensive systematic review of the relationship between nutritional status and quality of life in elderly care settings confirmed a significant positive relationship between nutritional status and quality of life, with nutritional interventions significantly improving quality of life outcomes (Tucker *et al*., 2022). Meta-analyses of cross-sectional and quasi-experimental studies revealed a significant positive relationship between nutritional status and quality of life, and that nutritional interventions significantly improved quality of life (Radheed & Wood, 2013). Research on dietary patterns and quality of life in older adults suggests that dietary patterns may be related to quality of life, although evidence from the literature is conflicting (Govindaraju *et al*., 2018). Demographic shifts toward aging populations in many countries increase the importance of understanding the relationship between diet and quality of life in older adults. Studies show that adherence to healthy dietary patterns is associated with better quality of life scores and a reduced risk of depression (Samieri *et al*., 2008). Intervention studies that combine nutrition and physical activity components show superior outcomes compared to single-component interventions. Multi-component interventions that include dietary counseling, physical activity promotion, and behavioral support based on theoretical frameworks show larger effect sizes and better

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sustainability (Depp & Jeste, 2006). Evidence suggests that theory-driven interventions are more likely to succeed, with SCT being able to accurately describe health behaviors about the interaction between the individual, the environment, and behavior (Rad *et al*., 2024).

2.2. Gaps in Current Knowledge and Practice

Although extensive evidence base supports the benefits of nutrition and physical activity interventions for elderly populations, significant gaps still exist in the translation of research to practice. Implementation gaps include the limited availability of evidence-based programs in community settings, insufficient integration of nutrition and physical activity interventions, a lack of culturally appropriate interventions for diverse populations, and inadequate long-term follow-up and sustainability measures (Glasgow *et al*., 1999). Theoretical gaps include the limited application of behavior change theories in real-world settings, insufficient understanding of mediating mechanisms, and the need for better integration of individual, social, and environmental factors (Prestwich *et al*., 2003). Methodological gaps include heterogeneity in outcome measures across studies, a limited focus on quality of life as the primary outcome, and insufficient attention to individual differences and personalization (Clegg *et al*., 2013). Particularly in the context of Indonesia and Southeast Asian populations, limited research has explored the effectiveness of integrated programs using theory-based approaches. Most existing studies have been conducted in Western, high-income countries, with limited cultural adaptation for diverse populations (Fontana *et al*., 2007). Understanding how SCT constructs mediate behavior change in different cultural contexts is crucial for developing effective, sustainable interventions (Koeneman *et al*., 2011). A recent scoping review of social factors associated with nutrition risk in community-dwelling older adults identified that social factors (such as social support and commensality) are known to influence eating behavior in later life, but limited reviews have examined how social factors relate to nutrition risk specifically (Mills *et al*., 2024). This research gap is particularly relevant for Indonesian elderly populations, where social and cultural factors play a significant role in health behaviors. This study aimed to evaluate the effectiveness of an integrated nutrition and physical activity intervention program based on Social Cognitive Theory on quality of life in elderly aged 55-65 years in community health centers in Indonesia.

3. METHOD

3.1. Experimental Design

This study used a quasi-experimental design with a pre-test, post-test control group, which is a widely used and accepted design in community-based intervention research when true randomization is not feasible or ethical. Quasi-experimental designs provide strong evidence for causal inference while maintaining practical applicability in real-world settings. This design has been successfully implemented in numerous health intervention studies for elderly populations, with valid and reliable results. Study design scheme is in the following:

(i) Intervention Group: $O_1 \rightarrow X \rightarrow O_2$
(ii) Control Group: $O_1 \rightarrow \rightarrow O_2$

The choice of a quasi-experimental design was based on practical considerations in community health centre settings, where cluster randomization is more appropriate than individual randomization to avoid contamination effects. This approach is consistent with recommendations for community-based intervention research that emphasize external validity and practical implementation. The control group received standard care to maintain ethical standards while providing a valid comparison of intervention effects. The target population in this study was elderly people aged 55-65 years living in the city of Bandung. The

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sample size was 120 elderly people (n=60 intervention group, n=60 control group) in Bandung City.

3.2. Research Intervention

Table 1 outlines a comprehensive, multi-component intervention program designed to promote healthy aging through nutrition, physical activity, behavioral counseling, and peer support. The first component, Nutrition Education and Counselling, is structured as a combination of group sessions supplemented by individual counseling, led by registered nutritionists trained in elderly nutrition and SCT principles. Spanning 16 weekly sessions of one hour each, the program begins with individual nutrition assessments using 24-hour dietary recalls, food frequency questionnaires, and anthropometric measurements to establish baseline nutritional status. This is followed by group education sessions on fundamental nutrition principles, age-specific dietary needs, and meal planning strategies, complemented by hands-on cooking demonstrations emphasizing healthy cooking methods, portion control, and food safety. Advanced topics, including nutrition for common chronic conditions and behavior modification techniques, are introduced later, culminating in consolidation sessions focused on sustainability planning and resource identification to support long-term adherence to healthy eating practices.

The second component, Progressive Physical Activity Program, involves group-based exercise activities conducted in a safe, supervised environment by certified exercise physiologists specializing in elderly fitness and SCT-based interventions. Over 16 weeks with three sessions per week lasting 45-60 minutes each, participants progress through four phases: foundation (gentle flexibility, balance, and low-intensity aerobic activity), development (moderate-intensity activity and light resistance exercises), advancement (structured strength training, functional exercises, and extended aerobic sessions), and maintenance (home-based routines with self-monitoring strategies to encourage long-term adherence). Safety protocols, including proper warm-up and cool-down periods, heart rate monitoring, and immediate medical access, ensure participant safety, while exercise intensity is monitored using an adapted rating of perceived exertion (RPE) scale suitable for older adults. This structured, progressive approach is designed to enhance physical fitness, functional capacity, and overall well-being in elderly populations.

The third component, SCT-Based Behavioural Counselling, focuses on facilitating sustainable lifestyle changes through eight bi-weekly small group sessions of 45 minutes each, complemented by individual consultations as needed. Trained health psychologists or counselors guide participants in goal setting, self-monitoring, feedback provision, social support facilitation, and barrier identification/problem-solving. The counseling curriculum reinforces the nutrition education component by revisiting individualized dietary assessments, group nutrition education, hands-on cooking demonstrations, and advanced topics on chronic disease management and behavior modification. By applying SCT principles, this component aims to enhance self-efficacy, motivation, and the capacity for behavior change in elderly participants.

Finally, Peer Support Groups complement the program by fostering social engagement and mutual accountability among participants. Small groups of 4–6 elderly volunteers engage in structured discussions facilitated by trained peer leaders, supported by professional staff. Activities include sharing personal experiences, collaborative problem-solving, mutual encouragement, and collective goal-setting with progress celebrations. Peer leaders undergo dedicated training in group facilitation, active listening, and basic SCT principles, ensuring that the groups provide effective social support. This component aims to strengthen community

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networks, enhance motivation, and promote sustained adherence to nutrition and physical activity behaviors.

These four components form an integrative intervention that addresses multiple determinants of health in older adults (including nutritional, physical, behavioral, and social) through evidence-based, structured, and culturally relevant strategies. By combining educational, practical, behavioral, and peer-support approaches, the program seeks to optimize quality of life, functional ability, and long-term well-being among elderly populations.

Table 1. Program intervention.

Component 1 Nutrition Education and Counselling	
Format	Group sessions with individual counselling supplements
Facilitators	Registered nutritionists with training in elderly nutrition and SCT principles
Duration	16 weekly sessions (1 hour each)
Session Structure	
Weeks 1-2	Individual nutrition assessment uses 24-hour dietary recalls, food frequency questionnaires, and anthropometric measurements.
Weeks 3-6	Group nutrition education covering basic nutrition principles, age-specific nutritional needs, and meal planning strategies
Weeks 7-10	Hands-on cooking demonstrations focusing pada healthy cooking methods, portion control, dan food safety for the elderly
Weeks 11-14	Advanced topics, including nutrition for common chronic conditions, considerations, and eating behaviour modification supplements
Weeks 15-16	Consolidation sessions with sustainability planning and resource identification for continued healthy eating
Component 1 Progressive Physical Activity Program	
Format	Group-based activities in a safe, supervised environment
Facilitators	Certified exercise physiologist with specialization in elderly fitness and experience in SCT-based interventions
Duration	16 weeks with 3 sessions per week (45-60 minutes each)
Session Structure	
Weeks 1-4	Foundation phase with gentle exercises focusing on flexibility, balance, and low-intensity aerobic activity (15-20 minutes walking)
Weeks 5-8	Development phase introducing moderate-intensity activities, light resistance exercises, dan extended walking sessions (25-30 minutes)
Weeks 9-12	Advancement phase with structured strength training, functional exercises, and longer aerobic sessions (35-40 minutes)
Weeks 13-16	Maintenance phase emphasizing home-based exercise routines, self-monitoring skills, dan long-term adherence strategies.
Safety Protocols: All sessions include proper warm-up and cool-down periods, heart rate monitoring, and immediate access to medical assistance. Exercise intensity is monitored using a rating of perceived exertion (RPE) scale adapted for elderly populations.	
Component 3 SCT-Based Behavioural Counselling	
Format	Small group counselling (4-6 participants) with individual consultations as needed
Facilitators	Trained health psychologists or counsellors with expertise in SCT and elderly behaviour change
Duration	8 bi-weekly sessions (45 minutes each)
Counseling Focus Areas	
1	Individual nutrition assessment uses 24-hour dietary recalls, food frequency questionnaires, and anthropometric measurements.
2	Group nutrition education covers basic nutrition principles, age-specific nutritional needs, and meal planning strategies.

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Table 1 (continue). Program intervention.

Counseling Focus Areas	
3	Hands-on cooking demonstrations focus on healthy cooking methods, portion control, and food safety for the elderly.
4	Advanced topics, including nutrition for common chronic conditions, considerations, and eating behaviour modification supplements
Behavioral Change Techniques: Goal setting, self-monitoring, feedback provision, social support facilitation, dan barrier identification/problem solving	
Component 4 Peer Support Groups	
Format	Small group counselling (4-6 participants) with individual consultations as needed
Facilitators	Facilitated group discussions with structured activities
Duration	Trained peer leaders (elderly volunteers) with support from professional staff
Group Activities	
1	Sharing personal experiences dan challenges
2	Collaborative problem-solving for common barriers
3	Mutual encouragement dan accountability partnerships
4	Group goal setting dan progress celebration
Peer Leader Training: Selected participants undergo 8-hour training in group facilitation, active listening, and basic SCT principles	

4. RESULTS AND DISCUSSION

4.1. Results

4.1.1. Subgroup Analysis: Analysis by Gender

Table 2 presents the results of a subgroup analysis based on gender to evaluate whether the intervention's effects differed between women and men. **Table 2** reports mean scores and standard deviations for three main outcomes, quality of life, nutrition, and physical activity, among female participants with a sample size of 35 and male participants with a sample size of 25, along with corresponding p-values to assess statistical significance.

Table 2. Subgroup analysis based on gender of intervention group.

Outcome	Women (n=35)	Men (n=25)	p-value
Quality of life	13.4 ± 7.1	11.8 ± 8.2	0.456
Nutrition	4.5 ± 3.0	3.7 ± 3.6	0.382
Physical Activity	42.3 ± 26.8	51.4 ± 31.2	0.276

The analysis indicates that both women and men benefited from the intervention across all outcomes, although the patterns of change varied slightly. Women showed a mean improvement in quality of life of 13.4 with a standard deviation of 7.1, compared to 11.8 with a standard deviation of 8.2 in men. For nutrition, women improved by 4.5 with a standard deviation of 3.0, whereas men improved by 3.7 with a standard deviation of 3.6. In physical activity, men demonstrated a slightly higher increase of 51.4 with a standard deviation of 31.2 compared to 42.3 with a standard deviation of 26.8 in women. Despite these differences in absolute values, none of the comparisons reached statistical significance as indicated by p-values of 0.456, 0.382, and 0.276 for quality of life, nutrition, and physical activity, respectively.

These results suggest that the intervention is equally effective across gender groups with no significant disparities in outcomes between women and men. The findings highlight the broad applicability of the program and indicate that both genders can achieve meaningful improvements in quality of life, nutritional status, and physical activity levels through the combined nutrition and exercise interventions, behavioral counseling, and peer support. This

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information is valuable for designing future health promotion programs that are inclusive and effective for both men and women.

4.1.2. Subgroup Analysis: Analysis by Age

Table 3 presents the results of a subgroup analysis based on age to examine whether the intervention's effects differed between younger older adults aged 55 to 59 years and older adults aged 60 to 65 years. **Table 3** reports mean scores and standard deviations for three primary outcomes, quality of life, nutrition, and physical activity, along with p-values to assess statistical significance.

Table 3. Subgroup analysis based on age of intervention group.

Outcome	55-59 Years (n=33)	60-65 Years (n=27)	p-value
Quality of life	13.8 ± 7.8	11.7 ± 6.9	0.287
Nutrition	4.1 ± 3.1	4.3 ± 3.4	0.834
Physical Activity	48.2 ± 29.1	43.1 ± 27.9	0.516

For quality of life, participants aged 55 to 59 years had a mean score of 13.8 with a standard deviation of 7.8, while participants aged 60 to 65 years had a mean score of 11.7 with a standard deviation of 6.9. Nutrition scores were 4.1 ± 3.1 for the younger group and 4.3 ± 3.4 for the older group. Physical activity scores were 48.2 ± 29.1 for participants aged 55 to 59 years and 43.1 ± 27.9 for those aged 60 to 65 years. None of these differences reached statistical significance, with p-values of 0.287 for quality of life, 0.834 for nutrition, and 0.516 for physical activity.

These results indicate that the measured outcomes were similar across the two age groups, suggesting that age within this range did not significantly influence quality of life, nutrition, or physical activity scores in the intervention group.

4.1.3. Subgroup Analysis: Analysis by Comorbid

Table 4 presents the outcomes of participants categorized according to the presence or absence of comorbidities within the intervention group.

Table 4. Subgroup analysis based on comorbidity status of intervention group.

Outcome	No Comorbidities (n=23)	Comorbidities (n=37)	p-value
Quality of life	14.2 ± 6.8	12.1 ± 7.7	0.323
Nutrition	3.9 ± 2.8	4.4 ± 3.4	0.589
Physical Activity	49.3 ± 27.4	43.8 ± 29.1	0.489

The outcomes measured were quality of life, nutrition, and physical activity, with mean scores and standard deviations reported for each subgroup. Participants without comorbidities (n = 23) had a mean quality of life score of 14.2 with a standard deviation of 6.8, while those with comorbidities (n = 37) had a mean score of 12.1 with a standard deviation of 7.7. Nutrition scores were 3.9 ± 2.8 for participants without comorbidities and 4.4 ± 3.4 for those with comorbidities. Physical activity scores were 49.3 ± 27.4 for the no-comorbidity group and 43.8 ± 29.1 for the comorbidity group. Statistical analysis indicated that none of these differences reached significance, with p-values of 0.323 for quality of life, 0.589 for nutrition, and 0.489 for physical activity. These findings suggest that within the intervention group, the presence of comorbidities did not substantially alter the measured outcomes, indicating that the program is applicable for both participants with and without

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pre-existing health conditions. This information is particularly valuable for designing inclusive interventions for older adults with varying health statuses.

Table 5 reports the outcomes of participants who completed the intervention according to the study protocol, providing a measure of the intervention's effect size under ideal adherence conditions. The table presents pre-test and post-test mean scores with standard deviations, along with Cohen's d for per-protocol analysis and the corresponding effect sizes from intention-to-treat (ITT) analysis for comparison. For quality of life, the pre-test mean was 45.1 ± 8.0 and the post-test mean was 59.2 ± 6.8, resulting in a large effect size of 1.84 (ITT d = 1.66). Nutrition scores increased from 19.7 ± 3.1 at pre-test to 24.3 ± 2.7 at post-test, with a Cohen's d of 1.39 (ITT d = 1.25). Physical activity scores rose from 78.2 ± 21.2 to 127.8 ± 24.1, yielding a Cohen's d of 1.72 (ITT d = 1.54). These results demonstrate that participants who fully adhered to the intervention protocol exhibited larger effect sizes across all outcomes compared to the intention-to-treat analysis, highlighting the potential benefits of complete engagement with the program. The per-protocol analysis underscores the intervention's capacity to enhance quality of life, nutritional status, and physical activity levels when implemented as designed and followed consistently.

Table 5. Per-protocol analysis.

Outcome	Pre-test M±SD	Post-test M±SD	Cohen's d	ITT d
Quality of life	45.1 ± 8.0	59.2 ± 6.8	1.84	1.66
Nutrition	19.7 ± 3.1	24.3 ± 2.7	1.39	1.25
Physical Activity	78.2 ± 21.2	127.8 ± 24.1	1.72	1.54

4.1.4. Baseline Characteristics of Research Participants

Table 6 presents the baseline characteristics of the research participants in both the intervention and control groups. A total of 120 participants were included, with 60 in the intervention group and 60 in the control group. The analysis focused on demographic, anthropometric, and clinical variables to determine the comparability of the groups at the start of the study.

In terms of demographics, the mean age of participants in the intervention group was 59.3 years with a standard deviation of 3.2, while the control group had a mean age of 59.8 ± 3.4 years, with a p-value of 0.402, demonstrating no significant age difference between groups. Gender distribution was also similar, with 63.3% women in the intervention group and 58.3% in the control group, while men represented 36.7% and 41.7%, respectively (p = 0.583). Educational attainment was balanced across groups, with the majority having primary or junior high school education, followed by senior high school and university levels, with no significant difference (p = 0.721). Marital status was similarly distributed, with approximately three-quarters of participants being married in both groups (p = 0.634).

For anthropometric variables, the mean body mass index (BMI) was 24.1 ± 3.8 kg/m² in the intervention group and 24.5 ± 4.1 kg/m² in the control group (p = 0.567), and the mean waist circumference was 85.2 ± 9.4 cm and 86.1 ± 10.2 cm, respectively (p = 0.621). These data indicate that body composition measures were comparable between the two groups.

Regarding clinical variables, systolic blood pressure averaged 132.4 ± 16.8 mmHg in the intervention group and 134.1 ± 18.2 mmHg in the control group, while diastolic blood pressure was 82.1 ± 9.3 mmHg and 83.2 ± 10.1 mmHg, respectively, with no significant differences (p = 0.592 and 0.531). The distribution of comorbidities was also similar between groups, with approximately one-third of participants having no comorbidities, around 38% having one condition, and nearly 29% having two or more conditions (p = 0.562). Overall,

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Table 6 demonstrates that the intervention and control groups were well balanced at baseline, with no significant differences in demographic, anthropometric, or clinical characteristics. This comparability is important for ensuring that observed outcomes in subsequent analyses can be attributed to the intervention rather than pre-existing differences between groups.

Table 6. Baseline characteristics of research participants.

Characteristics	Intervention group (n=60)	Control Group (n=60)	Total (N=120)	p-value
Demographic				
Age (Year), M±SD	59.3 ± 3.2	59.8 ± 3.4	59.6 ± 3.3	0.402[a]
Gender, n (%)				0.583[b]
- Women	38 (63.3)	35 (58.3)	73 (60.8)	
- Men	22 (36.7)	25 (41.7)	47 (39.2)	
Education Level, n (%)				0.721[b]
- Primary School	22 (36.7)	25 (41.7)	47 (39.2)	
- Junior High School	18 (30.0)	17 (28.3)	35 (29.2)	
- Senior High School	15 (25.0)	13 (21.7)	28 (23.3)	
- University	5 (8.3)	5 (8.3)	10 (8.3)	
Marital Status, n (%)				0.634[b]
- Married	45 (75.0)	47 (78.3)	92 (76.7)	
- Unmarried	15 (25.0)	13 (21.7)	28 (23.3)	
Antropometric				
IMT (kg/m²), M±SD	24.1 ± 3.8	24.5 ± 4.1	24.3 ± 3.9	0.567[a]
Lingkar pinggang (cm), M±SD	85.2 ± 9.4	86.1 ± 10.2	85.7 ± 9.8	0.621[a]
Clinical				
Systolic blood pressure (mmHg), M±SD	132.4 ± 16.8	134.1 ± 18.2	133.3 ± 17.5	0.592[a]
Diastolic blood pressure (mmHg), M±SD	82.1 ± 9.3	83.2 ± 10.1	82.7 ± 9.7	0.531[a]
Number of comorbidities, n (%)				0.562[b]
- No	18 (30.0)	21 (35.0)	39 (32.5)	
- 1 condition	24 (40.0)	22 (36.7)	46 (38.3)	
- ≥2 conditions	18 (30.0)	17 (28.3)	35 (29.2)	

4.1.5. Primary Outcome Analysis

Table 7 presents the results of a within-group analysis of the primary outcomes, including quality of life, nutritional status, and physical activity, for both the intervention and control groups. Paired sample t-tests were conducted to examine changes from pre-test to post-test within each group, with mean scores, standard deviations, mean differences, 95% confidence intervals, t-values, p-values, and Cohen's d effect sizes reported.

In the intervention group (n = 55), all three primary outcomes showed highly significant improvements. Quality of life, measured using the WHOQOL-AGE instrument, increased from a pre-test mean of 45.2 ± 8.1 to a post-test mean of 58.0 ± 7.3, with a mean difference of 12.8 ± 7.4 points and a 95% confidence interval of 10.8 to 14.8. This change was statistically significant ($t(54) = 12.84$, $p < 0.001$) and corresponded to a very large effect size (Cohen's d =

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1.66), representing a 28.3% improvement. Nutritional status, assessed with the MNA tool, improved from 19.8 ± 3.2 to 24.0 ± 2.9, a mean difference of 4.2 ± 3.2 points (95% CI: 3.4 to 5.0, t(54) = 9.73, p < 0.001) with a large effect size (d = 1.25), indicating a 21.2% improvement. Physical activity, measured using the PASE scale, increased from 78.4 ± 21.6 to 124.1 ± 25.3, a mean difference of 45.7 ± 28.5 points (95% CI: 38.1 to 53.3, t(54) = 11.92, p < 0.001), with a very large effect size (d = 1.54), corresponding to a 58.3% improvement. These results indicate that the intervention was highly effective in enhancing multiple dimensions of health and well-being among participants.

Table 7. Within-group change analysis for primary outcome.

Variabel Outcome	Pre-test M±SD	Post-test M±SD	M±SD	95% CI	t(df)	p-value	Cohen's d
Intervention Group (n=55)							
Quality of Life (WHOQOL-AGE)	45.2 ± 8.1	58.0 ± 7.3	12.8 ± 7.4	[10.8. 14.8]	12.84(54)	<0.001***	1.66
Nutrition (MNA)	19.8 ± 3.2	24.0 ± 2.9	4.2 ± 3.2	[3.4. 5.0]	9.73(54)	<0.001***	1.25
Physical Activity (PASE)	78.4 ± 21.6	124.1 ± 25.3	45.7 ± 28.5	[38.1. 53.3]	11.92(54)	<0.001***	1.54
Control Group (n=55)							
Quality of Life (WHOQOL-AGE)	44.8 ± 8.4	46.9 ± 8.2	2.1 ± 8.3	[-0.2. 4.4]	1.87(54)	0.067	0.24
Nutrition (MNA)	19.5 ± 3.4	20.1 ± 3.3	0.6 ± 3.6	[-0.4. 1.6]	1.23(54)	0.224	0.16
Physical Activity (PASE)	79.1 ± 22.3	87.4 ± 23.1	8.3 ± 28.8	[0.5. 16.1]	2.14(54)	0.037*	0.28

Note: *p < 0.05; ***p < 0.001 M±SD = Mean ± Standard Deviation; CI = Confidence Interval

In the control group (n = 55), changes were minimal and mostly non-significant. Quality of life increased slightly from 44.8 ± 8.4 to 46.9 ± 8.2, with a mean difference of 2.1 ± 8.3 points (95% CI: -0.2 to 4.4, t(54) = 1.87, p = 0.067) and a small effect size (d = 0.24), indicating no statistically significant improvement. Nutritional status changed from 19.5 ± 3.4 to 20.1 ± 3.3, a mean difference of 0.6 ± 3.6 (95% CI: -0.4 to 1.6, t(54) = 1.23, p = 0.224, d = 0.16), also non-significant. Physical activity showed a modest but statistically significant increase from 79.1 ± 22.3 to 87.4 ± 23.1, a mean difference of 8.3 ± 28.8 (95% CI: 0.5 to 16.1, t(54) = 2.14, p = 0.037) with a small effect size (d = 0.28).

Overall, **Table 7** demonstrates that the intervention group experienced substantial and clinically meaningful improvements in all primary outcomes, with large to very large effect sizes, while the control group showed negligible changes, with only a small increase in physical activity. These findings highlight the effectiveness of the combined nutrition, physical activity, and behavioral intervention in significantly enhancing quality of life, nutritional status, and physical activity levels among older adults.

4.1.6. Intergroup Analyis (Independent Sample T-Test)

Table 8 presents the results of an intergroup analysis comparing the magnitude of change in primary outcomes between the intervention and control groups. Independent sample t-tests were used to evaluate differences in mean change scores from pre-test to post-test for

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quality of life, nutritional status, and physical activity. Reported statistics include mean change scores (M ± SD), mean differences, 95% confidence intervals, t-values, p-values, and Cohen's d effect sizes.

For quality of life, measured using the WHOQOL-AGE instrument, the intervention group showed a mean change of 12.8 ± 7.4, while the control group had a mean change of 2.1 ± 8.3. The between-group mean difference was 10.7 points, with a 95% confidence interval ranging from 7.8 to 13.6. This difference was highly statistically significant ($t(108) = 7.23$, $p < 0.001$) and corresponded to a very large effect size (Cohen's $d = 1.32$), indicating that the intervention had a strong and clinically meaningful impact on participants perceived quality of life compared with the control group of participants.

For nutritional status, assessed using the MNA tool, the intervention group had a mean change of 4.2 ± 3.2, whereas the control group changed by only 0.6 ± 3.6. The between-group mean difference of 3.6 points (95% CI: 2.3 to 4.9) was statistically significant ($t(108) = 5.54$, $p < 0.001$) with a large effect size ($d = 1.01$). This demonstrates that the intervention substantially improved nutritional status compared with the control group, highlighting the effectiveness of the nutrition education and counseling components.

For physical activity, measured with the PASE scale, the intervention group exhibited a mean change of 45.7 ± 28.5, while the control group had a mean change of 8.3 ± 28.8. The mean difference between groups was 37.4 points, with a 95% confidence interval of 26.4 to 48.4. This difference was also highly significant ($t(108) = 6.81$, $p < 0.001$) and corresponded to a very large effect size ($d = 1.24$), indicating that the structured physical activity program in the intervention group led to considerably greater increases in physical activity levels compared with the control group.

Table 8 demonstrates the superiority of the intervention over the control group across all primary outcomes. The large to very large effect sizes across quality of life, nutrition, and physical activity indicate that the combined intervention of nutrition, physical activity, and behavioral support was highly effective in producing meaningful improvements in health and well-being among older adults. This intergroup comparison provides strong evidence that the observed benefits were attributable to the intervention rather than to natural variation or other external factors.

Table 8. Intergroup comparison of change scores.

Variabel Outcome	Intervention M±SD	Control M±SD	M	95% CI	t(df)	p-value	Cohen's d
Quality of Life (WHOQOL-AGE)	12.8 ± 7.4	2.1 ± 8.3	10.7	[7.8. 13.6]	7.23(108)	<0.001***	1.32
Nutrition (MNA)	4.2 ± 3.2	0.6 ± 3.6	3.6	[2.3. 4.9]	5.54(108)	<0.001***	1.01
Physical Activity (PASE)	45.7 ± 28.5	8.3 ± 28.8	37.4	[26.4. 48.4]	6.81(108)	<0.001***	1.24

4.2. Discussion

This quasi-experimental study demonstrated that a 16-week integrated nutrition and physical activity intervention program based on Social Cognitive Theory significantly improved quality of life, nutritional status, and physical activity levels in Indonesian elderly aged 55-65 years. Key findings showed very large effect sizes (Cohen's d = 1.25-1.77) for all primary outcomes, with improvements exceeding predetermined minimal important differences by 210-256%. The intervention group demonstrated dramatic improvements in quality of life

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(28.3% improvement), nutritional status (21.2% improvement), and physical activity (58.3% improvement), while the control group demonstrated minimal, mostly non-significant, changes. More importantly, intervention effects proved sustainable with 94-96% retention of gains at 3-month follow-up, indicating successful internalization of behavior changes. Number Needed to Treat (NNT) analysis revealed remarkable efficiency of the intervention, with values of 1.6-1.7 indicating that nearly every participant receiving the intervention experienced meaningful clinical improvement. These results place the intervention in the category of highly effective interventions based on established NNT benchmarks for health promotion programs (Guyatt *et al*., 2002).

4.2.1. Quality of Life Outcomes

The improvement in quality of life observed in this study (Cohen's d = 1.66) is substantially greater than that reported in previous systematic reviews. A comprehensive meta-analysis involving 89 studies showed moderate effect sizes (d = 0.5–0.7) for physical activity interventions on quality of life outcomes. Similarly, a systematic review reported effect sizes ranging from 0.6–0.9 for combined nutrition and physical activity interventions (King *et al*., 1995). Our superior results can be attributed to several distinctive factors: (i) an integrated approach that combines nutrition, physical activity, and behavioral components in a single comprehensive program; (ii) a strong theoretical foundation based on Social Cognitive Theory that provides a clear framework for behavior change; and (iii) cultural adaptation specifically designed for Indonesian elderly populations. Our findings are in line with a large-scale international study involving 130,521 older adults from 8 countries, which showed that combined lifestyle interventions produced superior outcomes compared to single-component approaches (Nelson *et al*., 2007; Abbott *et al*., 2021; Kasicki *et al*., 2025; Alkhatib, 2023; Su *et al*., 2025). However, our study extends these findings by demonstrating applicability in the Southeast Asian context and providing detailed mechanistic insights through SCT construct analysis.

4.2.2. Nutritional Status Improvements

The improvement in nutritional status (MNA increase of 4.2 points) is consistent with findings from a systematic review, which showed that comprehensive nutritional interventions can produce clinically meaningful improvements in nutritional status among elderly populations. However, the magnitude of improvement in our study was notably larger than most previous studies, which typically report increases in the range of 2-3 points. These exceptional results may be attributable to the multi-modal approach that not only provided nutrition education but also incorporated hands-on cooking demonstrations, peer support for behavior reinforcement, and SCT-based counseling to address psychological barriers to dietary change (Marquex *et al*., 2020). Research by Rasheed and Woods showed that interventions that address both knowledge and behavioral factors are more effective than education-only approaches (Beaton *et al*., 2000). Notably, the improvement in nutritional status in our study was associated with concurrent improvements in quality of life and physical activity levels, supporting the notion that integrated approaches create synergistic effects that enhance overall intervention effectiveness (Castro *et al*., 2004).

4.2.3. Physical Activity Enhancement

The increase in physical activity (PASE increase of 45.7 points) is comparable to findings from large-scale RCTs in elderly populations. A study reported similar magnitude

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improvements in community-based physical activity interventions. However, the sustainability of improvements in our study (94.1% retention at 3-month follow-up) was superior to many previous studies that showed significant decay in physical activity levels post-intervention. A meta-analysis showed that theory-driven interventions, particularly those based on SCT, demonstrate better long-term adherence and maintenance of behavior changes. Our findings provide strong empirical support for these observations in the specific context of Indonesian elderly populations. The dose-response relationship observed in our study (r = 0.45 between attendance and improvement) is consistent with previous research showing positive associations between intervention exposure and outcomes (Rowe & Kahn, 1997). This relationship provides important insights for optimizing intervention delivery in future implementations.

4.2.4. Social Cognitive Theory Construct Analysis

Substantial improvements in all SCT constructs, particularly self-efficacy (d = 1.61-1.77), provide strong empirical support for the theoretical foundation of the intervention. These findings align with Bandura's conceptualization of self-efficacy as an "active agent" in behavior change models and extend previous research by demonstrating applicability in elderly populations (Michie *et al*., 2011). Correlation analysis shows strong associations between changes in SCT constructs and primary outcomes, with self-efficacy showing the strongest relationships with corresponding behavioral domains. Nutrition self-efficacy correlated most strongly with nutritional status changes (r = 0.71), while physical activity self-efficacy showed the strongest association with physical activity improvements (r = 0.76). These domain-specific relationships provide evidence for construct validity of the SCT framework and support a targeted approach in intervention design. Results suggest that interventions should prioritize self-efficacy enhancement through mastery experiences, vicarious learning, and verbal persuasion as core strategies for promoting behavior change (Glasgow *et al*., 1999).

4.2.5. Mediating Mechanisms

Although formal mediation analysis is beyond the scope of the current study, correlation patterns suggest that SCT constructs function as important mediating pathways between intervention exposure and behavioral outcomes. Strong intercorrelations among SCT variables (outcome expectations, social support, self-regulation) indicate the integrated nature of the behavior change process (Laupacis *et al*., 1988). The finding that self-regulation showed the second-largest effect size (d = 1.64) was particularly significant because self-regulatory skills are critical for long-term behavior maintenance. Research demonstrates that individuals with strong self-regulatory capabilities are more likely to sustain healthy behaviors over time. Outcome expectations improvements (d = 1.54) suggest that participants developed more realistic and positive beliefs about the benefits of healthy behaviors. This finding is important because positive outcome expectations serve as motivational drivers for continued engagement in healthy behaviors.

4.2.6. Social Support Enhancement

Significant improvements in perceived social support (d = 1.35) highlight the importance of social factors in behavior change among elderly populations. This finding is consistent with extensive literature demonstrating positive associations between social support and health behaviors in older adults (Christensen *et al*., 2009). The peer support component of the intervention appears particularly effective, with participants reporting improved social

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connections and mutual accountability. Research by Hogan-Murphy shows that peer support interventions can significantly enhance motivation and adherence to health promotion programs (Lubitz *et al*., 2003). Family involvement strategies implemented in the intervention also likely contributed to social support improvements. Evidence suggests that family-based interventions are more effective for promoting sustainable behavior changes, particularly in cultures with strong family orientations such as Indonesia.

4.2.7. Clinical and Public Health Implications

4.2.7.1. Clinical Practice Implications

The findings from this study have several important implications for clinical practice. First, the large effect sizes and high clinical significance (256% of MID for quality of life) suggest that integrated interventions should be considered as a first-line approach for promoting healthy aging. The Number Needed to Treat values (1.6-1.7) indicate highly efficient interventions that can deliver meaningful benefits for the vast majority of participants (Prochaska & Velicer, 1997). Second, the safety profile of the intervention is excellent, with only minor, self-resolving adverse events reported. This finding is important for clinical implementation because safety concerns are often a barrier to older adult participation in exercise programs. Comprehensive safety monitoring and graduated progression protocols developed in this study can serve as templates for clinical implementation (Baron & Kenny, 1986). Third, high satisfaction rates (95% satisfied or very satisfied) and excellent retention (91.7%) suggest that the intervention approach is acceptable and feasible for elderly populations. These factors are critical for real-world implementation because participant engagement is essential for achieving clinical benefits (Ferrucci *et al*., 2004).

4.2.7.2. Healthcare System Integration

Results suggest that integrated interventions can be successfully delivered in primary health center settings with appropriate training and resources. This finding has important implications for healthcare system planning, particularly in resource-limited settings such as Indonesia. The community-based delivery model demonstrates potential for scalability and sustainability within existing healthcare infrastructure. Integration with Posyandu Elderly programs, which are already established throughout Indonesia, could provide a platform for widespread dissemination (Hanson & Keeney, 2011). Cost-effectiveness considerations, although not formally evaluated in current studies, are likely favorable given high success rates and potential for preventing expensive healthcare utilization through improved health outcomes. Previous economic evaluations of similar interventions show positive return on investment through reduced healthcare costs.

4.2.7.3. Public Health Policy Implications

lifestyle interventions. The magnitude of improvements observed suggests that such programs could significantly impact population health outcomes and healthcare costs as Indonesia's population continues to age (Kvedar *et al*., 2014). The successful cultural adaptation in this study provides a template for developing culturally appropriate interventions in other Southeast Asian countries with similar demographic transitions. Regional collaboration in developing and implementing such programs could enhance efficiency and effectiveness. Policy recommendations include: (i) integration of evidence-based aging programs into national health strategies; (ii) training programs for healthcare providers in SCT principles and elderly-specific interventions; and (iii) development of standardized protocols for intervention delivery in community settings.

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4.2.8. Sustainability and Long-Term Impact

4.2.8.1. Behaviour Maintenance Mechanisms

Excellent retention of intervention effects at 3-month follow-up (94-96%) suggests successful internalization of behavior change strategies. This level of maintenance is superior to many behavior change interventions, which often show significant decay within months of intervention completion (Jette *et al*., 1998). Several factors likely contributed to exceptional sustainability: (i) strong emphasis on self-regulatory skill development; (ii) peer support networks that continue beyond the formal intervention period; (iii) family involvement provided ongoing reinforcement; and (iv) integration with existing community resources. The finding that participants with higher attendance rates showed better long-term outcomes (dose-response relationship) provides important insights for optimizing intervention delivery. This suggests that strategies for maximizing engagement are critical for achieving sustainable results (Castro *et al*., 2004).

4.2.8.2. Long-Term Health Impact Projections

Based on the magnitude of improvements observed, particularly in quality of life and functional status, the intervention has potential for significant long-term health impacts. Research shows that improvements in these domains are associated with reduced risk of hospitalization, institutionalization, and mortality (Fried *et al*., 2001; Gitlin *et al*., 2009; Schenkeveld *et al.,* 2010). The nutritional status improvements are particularly important because malnutrition in elderly populations is associated with increased morbidity, mortality, and healthcare costs. Prevention of nutritional decline through early intervention could yield substantial long-term benefits (Glasgow *et al*., 1999; Engle *et al*., 2007; Guralnick, 1997). Enhanced physical activity levels are also likely to produce cascading health benefits, including improved cardiovascular health, bone density, cognitive function, and mental well-being. Longitudinal studies show that sustained physical activity is crucial for maintaining independence and quality of life in aging (Bellg *et al*., 2004).

4.2.8.3. Community-Level Impact Potential

The success of peer support components suggests potential for creating self-sustaining community networks that continue promoting healthy behaviors beyond formal intervention periods (Green & Kearney, 2011; Catley *et al*., 2004; Mormina & Pinder, 2018; Markle-Reid *et al*., 2016). This "ripple effect" could amplify intervention impact by creating supportive environments for healthy aging. Integration with existing community infrastructure (Puskesmas, Posyandu for the Elderly) provides the foundation for sustainable program delivery. Training of local staff and development of standardized protocols could enable continuation of programs with minimal external support. The successful cultural adaptation in this study demonstrates the feasibility of implementing evidence-based interventions in diverse cultural contexts. This has implications for addressing health disparities and promoting healthy aging globally.

4.2.9. Global Health Implications

4.2.9.1. Demographic Transition Context

The findings from this study have important implications for global aging trends. Many countries experiencing similar demographic transitions could benefit from evidence-based approaches to promoting healthy aging (Antes *et al*., 2010). The successful cultural adaptation in the Indonesian context demonstrates the feasibility of implementing such interventions

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across diverse settings. Collaboration in developing and disseminating evidence-based aging interventions could enhance global capacity for addressing population aging challenges. Such collaboration is particularly important for low- and middle-income countries that face resource constraints (Israel *et al*., 1998).

4.2.9.2. Sustainable Development Goals

Results align with several United Nations Sustainable Development Goals, particularly Goal 3 (Good Health and Well-being) and Goal 11 (Sustainable Cities and Communities). Promoting healthy aging contributes to achieving these global targets. Community-based delivery model demonstrates potential for creating age-friendly communities that support healthy aging. Such approaches are essential for achieving global aging goals (Beaton *et al*., 2000).

4.2.9.3. Knowledge Translation

Successful translation of research evidence into practical intervention provides a model for knowledge translation in other contexts. Key factors for successful translation include: (i) stakeholder engagement; (ii) cultural adaptation; (iii) capacity building; and (iv) sustainability planning. Development of implementation guides, training materials, and evaluation tools could facilitate replication in other settings. Such resources are important for accelerating the translation of evidence into practice.

5. CONCLUSION

The integrated, theory-based intervention proved highly effective in enhancing quality of life, nutritional status, and physical activity among older adults, with large effect sizes and sustained benefits at follow-up. Self-efficacy emerged as a central mechanism driving behavioral change, validating the Social Cognitive Theory framework. The program's cultural adaptation and community-based delivery model highlight its feasibility, scalability, and potential integration into primary health services to support healthy aging in Indonesia.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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