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Effects of a 4-week Dietary Behavior Modification Program on Disability, Pain, Weight, and Body Mass Index in Overweight Individuals with Knee Osteoarthritis

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Original Article

Effects of a 4-week Dietary Behavior Modification Program on Disability, Pain, Weight, and Body Mass Index in Overweight Individuals with Knee Osteoarthritis

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Keywords: Functional limitation, nutrition, obesity, degenerative joint, weight loss

Running Title: Thai Diet for OA Knee in the Overweight

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Abstract

Objective: This study evaluated the effects of a 4-week dietary behavior modification program on disability, pain, weight, and body mass index (BMI) in overweight adults with osteoarthritis knee (OA knee).

Material and Methods: An assessor-blinded study was conducted among adults aged 45–75 years with OA knee and BMI 25.0–29.9 kg/m². Participants who reported a pain score of 4 of 10 or greater on the numeric rating scale were enrolled. They (n= 18) were allocated to a 4-week dietary program emphasizing the Thai food-based dietary guidelines (50% vegetables and fruits, 25% whole-food carbohydrates, 25% lean protein), with 3 meals/day, no calorie counting, and food diaries. Outcomes were assessed at baseline and 4 weeks in random order, including Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) for disability, weight, BMI, and visual analog scale (VAS) for pain.

Results: After 4 weeks, there were significant improvements in weight and BMI, alongside WOMAC score, with clinically meaningful reductions in knee pain on the VAS. The dietary approach demonstrated good adherence via diaries and lacked adverse events related to dieting.

Conclusion: The 4-week dietary behavior modification program grounded in Thai food-based dietary guidelines can positively influence weight, pain, and disability outcomes in overweight individuals with OA knee, supporting weight management as a pivotal nonpharmacological strategy.

Keywords: Functional limitation, nutrition, obesity, degenerative joint, weight loss

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Introduction

Osteoarthritis knee (OA knee) remains a major global health burden with substantial international variation in prevalence, incidence, and years lived with the disability[1]. While the burden has risen in most countries, driven by populations with increasing life expectancies, these trends are projected to persist for individuals aged 45–75 years[1]. Prior evidence has emphasized the pivotal role of obesity as a modifiable risk factor that elevates knee-joint load and promotes adipose tissue-driven systemic inflammation, accelerating OA knee progression[2]. Consequently, public health messaging and policymaker awareness about OA knee risk factors, with nonpharmacological management and health-service capacity, have been identified as essential components for mitigating future OA knee burden[2–4]. Thus, weight management plays a critical role in both the prevention and management of osteoarthritis knee. According to the evidence, modest weight loss significantly reduces joint load, pain, and inflammation, while improving physical function and quality of life. Obesity not only accelerates the progression of OA knee through mechanical stress but also contributes to systemic inflammation, exacerbating joint degeneration[5,6]. Consequently, a comprehensive weight management strategy that includes dietary modification, exercise, and behavioral support is strongly recommended as the first step in nonpharmacological interventions for individuals with OA knee.

Despite these broad insights, a critical gap remains. Much of the evidence guiding dietary and weight management approaches comes from supervised, clinical-based programs conducted in diverse, often Western, settings, with reporting that varies (4-52 weeks) timeframes[7,8]. There is limited understanding of how standard dietary patterns, specifically for the Thai public health diet, culturally tailored to short-term dietary behavior modification interventions, affect disability, pain, weight, and BMI among adults with overweight status and OA knee within the Thai context. This gap restricts the ability to transform general weight management recommendations into effective, culturally appropriate public health strategies in Thailand, where dietary habits, food availability, and the social determinants of health may influence both adherence and outcomes.

Thus, the study was conducted within Thai cultural and dietary contexts in order to assess the effect of a 4-week dietary behavior modification program on disability, pain, weight, and body mass index in overweight individuals with osteoarthritis knee.

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Material and Methods

Participants

A quasi-experimental study design was conducted in Thailand, with blinded assessors who were unaware whether the test results corresponded to the pre- or post-intervention data. Inclusion criteria were based on the National Institute for Health and Care Excellence (UK) 2014 clinical criteria for osteoarthritis and required, (1) activity-related knee joint pain with a score of at least 4 on an 11-point Numeric Rating Scale (NRS; 0 = no pain, 10 = worst possible pain) during the past week, (2) morning stiffness < 30 minutes (or no morning stiffness), and (3) age 45–75 years. They also needed a history of knee pain on most days in the previous month or knee pain lasting for at least 3 days. Additionally, body mass index (BMI) had to be 25.0–29.9 kg/m^2 [9]. Participants with weight fluctuations greater than 5 kg in the past 3 months, confirmed by self-reported and medical records (rapid weight change may reflect underlying medical conditions, which could influence participant eligibility and ability to participate in the program), a non-communicable disease, recent knee injection, injury, or surgery within the past 3 months, a diagnosed psychiatric disorder (other than anxiety or depression), a history of eating disorders or bariatric surgery, or prior arthroplasty of all the eligible knee joints were excluded[9].

The sample size, using weight for the primary outcome, was calculated with 80% power, an effect size from the pilot study (standardized mean difference) of 1.0, and a significance level of 0.05. In order to adequately represent the variables of interest, at least 18 participants were required. All participants signed an informed consent form, approved by the Human Research Ethics Committee of Mae Fah Luang University (EC 25153-25), before participating in the study.

Research protocols

On the first day, participants were interviewed and evaluated, including baseline assessments for demographic information. Then, they were allocated to the intervention group. Outcomes were measured at baseline, with reassessment at 4 weeks (Figure 1).

The next day, all eligible participants received a dietary program based on the standard nutritional recommendations of the Ministry of Public Health of Thailand[10]. Each participant received individualized counseling from the investigator and a dietary guideline booklet outlining the principles and recommended proportions of food intake[10,11]. If participants encountered difficulties adhering to the program, they could contact the investigator for additional guidance

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and individualized adjustments. Moreover, they were contacted by phone every two days and were required to record their three meals in a booklet. Although the program did not involve calorie counting, participants were encouraged to limit their intake to no more than three meals per day to support weight loss efforts. They could adjust their medications or supplements as recommended by their healthcare providers without altering their primary pain management regimen. Each participant also received a food diary to record every meal consumed throughout the 4-week intervention period.

The dietary guideline booklet was designed in accordance with the Thai food-based dietary guidelines and the balanced plate model. The meal comprised 50% vegetables and fruits, 25% carbohydrates, and 25% lean protein[10,11]. The guideline: (1) Advised consuming a variety of foods across all 5 food groups to maintain a healthy body weight, with the balanced plate inherently supporting dietary variety and caloric balance[10,11]. (2) Emphasized daily intake of vegetables and fruits at 50% of the plate to enhance fiber intake, satiety, and the reduction of non-communicable disease risk, aligning with the global recommendations of at least 400 grams per day [10,11]. (3) Recommended regular consumption of fish, lean meats, eggs, legumes, and pulses, highlighting plant and animal-based protein sources to support muscle maintenance, metabolic function, and cardiometabolic health while reducing reliance on red and processed meats [10,11]. (4) Advised daily consumption of milk or fortified plant-based alternatives to provide calcium, vitamin D, and high-quality protein. (5) Advocated choosing foods moderate in total fat and selecting lean proteins and carbohydrates to limit saturated fat intake [10,11]. (6) Urged limiting added sugars and salt, with the balanced plate encouraging whole foods and preparation methods that minimize sugar and sodium loads[10,11]. (7) Recommended avoiding alcohol due to any associated health risks, while promoting nutrient-dense alternatives[10,11]. (8) Stressed consuming clean and safe foods through proper cleaning, storage, and cooking practices to prevent foodborne illness[10,11].

Moreover, they were advised to limit meals to no more than three per day to aid weight management without calorie counting, thereby reducing participant burden and enhancing feasibility[10,11].

Outcome assessments

Participants were assessed for their weight, body mass index (BMI), visual analog scale (VAS), and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) in a

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random sequence with a single blinded assessor who was unaware whether the test results corresponded to the pre- or post-intervention data. The rater had excellent intra-rater reliability with intraclass correlation coefficients (ICCs) = 0.90 - 0.99. The details of each assessment are as follows.

Weight and body mass index (BMI): Weight outcomes were measured using a digital weighing scale with two decimal places (kg), a precision balance that demonstrated high reliability, with an intraclass correlation coefficient (ICC) ranging from 0.97 to 0.99 [12]. Then, BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2).

Visual analog scale (VAS): Pain was assessed using VAS. Participants were positioned in a tranquil space and provided with a 10-centimeter scale labeled "no pain" at the left end and "worst imaginable pain" at the right end. They were instructed to indicate the point that most accurately reflected their current knee pain associated with osteoarthritis. The assessor then measured the distance from the "no pain" end to the participant's mark in centimeters, recording the value to the nearest millimeter [13].

Disability: The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a rigorously validated instrument for assessing pain, stiffness, and functional limitations in individuals with osteoarthritis knee (OA knee). The modified 22-item Thai WOMAC index, assessed content validity (index of content validity, floor and ceiling effects, skewness), convergent validity (Spearman correlations with the Lequesne algofunctional index 0.66 for pain, 0.69 for function), test and retest reliability (Spearman correlations and ICC = 0.65–0.71), and internal consistency (Cronbach's alpha = 0.85–0.97), finding face validity and concluding that the modified instrument possesses acceptable psychometric properties[14,15].

Statistical analysis

The data were analyzed using SPSS version 31.0. Descriptive statistics described the demographic data of the participants and the study findings. This study had normal distributions that were observed for baseline demographic and all variables. Therefore, this study used parametric statistical analysis for the outcomes. The dependent t-tests analyzed the differences

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between the baseline and the 4-week measurements for each outcome (within-group comparisons). The significance level was set at p-value less than 0.05.

Results

Participant characteristics

All participants achieved 97% of the dietary plan. A total of 18 participants (age 64 years, BMI 27.91 ± 1.62 kg/m²) with overweight status were enrolled in the study. Approximately 83% of participants were female, and all participants had at least one underlying health condition that was not a non-communicable disease. Normal distributions were observed for baseline demographic and all variables (Table 1).

Comparison of outcomes between baseline and the 4-week assessments.

Effect of the 4-week intervention: results demonstrated significant reductions in weight and BMI ($p<0.05$) (Table 2). The most notable outcome was the substantial improvement in the total WOMAC score, reflecting a comprehensive assessment of knee osteoarthritis symptomatology across pain, stiffness, and physical function domains. After the 4-week period, participants showed a statistically significant reduction in total WOMAC score from 29.61 ± 7.69 at baseline to 28.72 ± 7.61, with a mean difference in decrease of 0.88 (Table 2). This improvement represented a large effect (0.99) and indicates substantial clinical significance (Table 2). Moreover, the most distinguishing finding was not merely the statistical significance (p-value < 0.001) in the VAS scale for pain reduction (effect size −0.96, p-value < 0.001), but the improvements in WOMAC physical function (effect size −0.79, p-value = 0.004) (Table 2).

Discussion

This study demonstrated that the 4-week dietary behavior modification program anchored in the Thai food-based dietary guidelines yielded statistically significant and clinically meaningful improvements in disability, pain, and body composition among overweight adults with osteoarthritis knee. All participants achieved 97% of the dietary plan. The most prominent finding was a substantial reduction in the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) total scores, indicating comprehensive improvements in the pain, stiffness, and physical function domains. Additional gains included significant reductions in

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visual analog scale (VAS) pain scores, WOMAC physical function, and pain subscale, as well as modest weight loss and body mass index (BMI) reductions.

The decrease in weight and BMI (Table 2) may have been caused by the biomechanical alterations, as weight reduction likely diminishes knee-joint loading during ambulation, thereby reducing nociceptive input and improving function, even with relatively small weight changes[16,17]. In parallel, the anti-inflammatory effects of dietary modification and modest weight loss plausibly lowered circulating pro-inflammatory adipokines and cytokines, attenuating pain sensitization, cartilage degradation, and synovial inflammation[18]. The Thai food-based dietary guidelines emphasize whole foods, vegetables, fruits, lean proteins, and reduced processed items, aligning with anti-inflammatory principles, and may have contributed to the rapid improvements independent of substantial fat loss [10,11,19].

Additional dietary modifications have been shown to improve lipid profiles and insulin sensitivity, thereby modulating systemic inflammation and pain perception. Previous evidence suggests that anti-inflammatory diets alter circulating metabolites, which may have influenced pain perception in this study. These mechanisms could underline the observed changes in pain scores, supporting both immediate symptom relief and potential longer-term structural benefits[20,21].

Moreover, the results of the effect sizes observed in this study (Table 2) compared favorably with those reported in systematic reviews and meta-analyses of dietary interventions for osteoarthritis knee [22]. A comprehensive meta-analysis of randomized trials found pooled moderate standardized effects for pain (approximately −0.67) and function (approximately −0.62), with mean weight reductions of about 3.2 kg, while the present study yielded WOMAC total score effects of about −0.99 and VAS pain effects of about −0.96, exceeding these pooled estimates despite achieving smaller absolute weight loss, thus placing the intervention toward the upper end of reported efficacy [22]. Subgroup analyses within systematic reviews indicated that energy restricted dietary interventions produced larger pooled effects (pain scale = − 0.85, function = −0.95) compared with other dietary approaches, aligning closely with the magnitude of improvements observed in this trial and suggesting that the energy-restriction component, implemented by confining meals to no more than three per day and emphasizing nutrient-dense, whole foods may have been a critical driver of clinical benefit. Nevertheless, some meta-analyses reported dose-response relationships whereby substantial weight loss was associated with larger

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WOMAC improvements: roughly 2% reduction in WOMAC scores per 1% body weight loss. The current findings appear divergent by demonstrating substantial symptom gains with weight loss [23]. Although conducted on a small sample size, the study demonstrated clinically meaningful changes in WOMAC scores. Previous reports indicate that a clinical change of at least 0.84 points on the overall score reflects a significant clinical change; in this study, the observed change was 0.99 points.

Therefore, this study demonstrates that the Thai food-based dietary guidelines behavior modification program produced substantial, clinically meaningful improvements in disability and pain within 4 weeks, supporting dietary intervention as a potential first step, non-pharmacological treatment for overweight individuals with osteoarthritis knee. Its feasibility, requiring no calorie counting, aligns with national dietary guidelines and rapid benefits, suggesting broad applicability across diverse clinical settings, including primary care and community health programs. Moreover, culturally appropriate dietary recommendations can effectively inform osteoarthritis management without intensive professional supervision.

Limitation and future study

This study provides preliminary, exploratory evidence on the effects of a dietary intervention in adults with overweight status (BMI 25.0–29.9 kg/m²) over a 4-week period. However, there were several limitations, including: (1) the absence of a control group precludes inference about causality and raises the possibility that the observed changes reflect non-specific factors (e.g., increased attention, expectancy effects, or natural symptom fluctuation) rather than the intervention itself, (2) the small sample size (n = 18) limits generalizability and precludes any subgroup analyses that might identify differential responders, (3) the short duration restricts any assessment of the long-term sustainability or potential additive benefits of ongoing intervention, (4) the reliance on self-reported food diaries to gauge adherence without objective corroboration introduces reporting bias, (5) no inflammatory biomarkers, adipokines, or metabolic parameters were assessed to illuminate any potential mechanistic pathways, and (6) restricting inclusion to overweight rather than obese individuals narrows applicability to the higher BMI categories where effects may differ. Collectively, these findings should be considered preliminary and exploratory, warranting confirmation in adequately powered, controlled, and longer-term studies.

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Conclusion

This study demonstrated that the 4-week dietary behavior modification program in the Thai food-based dietary guidelines produced substantial and clinically meaningful improvements in disability, pain, and body composition among overweight adults with osteoarthritis knee.

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Conflict of interest

The authors declare no conflict of interest.

Ethical approval and informed consent statements

Human Research Ethics Committees of Mae Fah Luang University (EC 25153 - 25)

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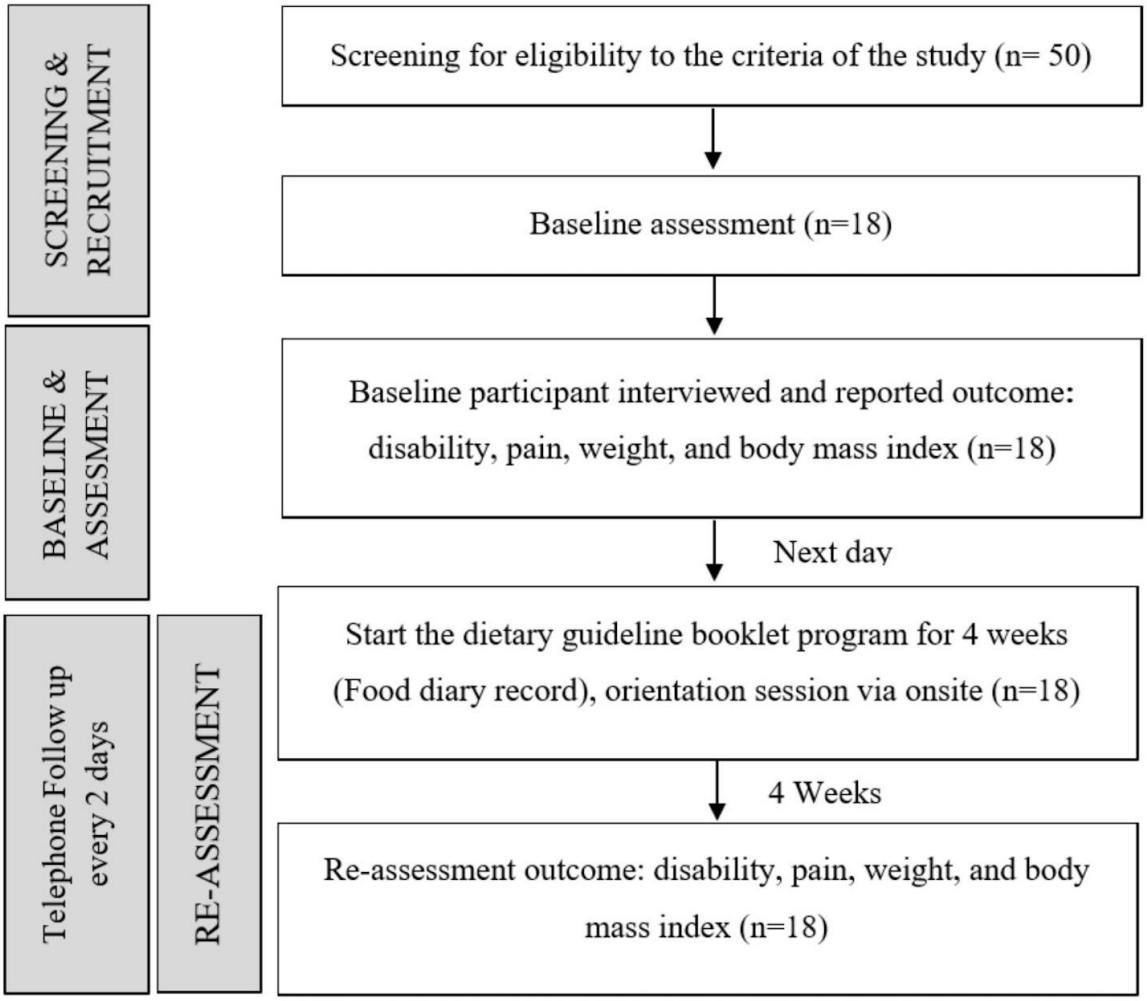


Figure 1 Participant flow chart

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Table 1 Baseline demographics of the participants (n = 18)

Variables	Baseline data	Skewness test
Age: year [a]	64.50 ± 4.51	- 0.57
Gender: Female, n (%)	15 (83.30)	- 1.59
BMI: kg/m²	27.91 ± 1.62	0.21
Knee pain score [a]	6.17 ± 1.23	0.42
Underlying diseases: yes, n (%)	13 (72.20)	1.00

Note: [a] The data are presented using mean ± standard deviation. The normal distribution is presented using the Skewness test from -3 to +3. Abbreviations: *n* number, *BMI* Body mass index, *kg/m²* kilogram per square meter.

Table 2 Comparison of outcomes between baseline and 4-week assessments (n= 18).

Variables	Baseline assessment [a]	4-week assessments [a]	Mean difference [a]	p-value [b]	Standardizer	Point Estimate
Weight [a]: kg	65.07±7.30 (61.44 – 68.70)	63.91±6.27 (60.79 – 67.02)	1.16 ± 2.15 (-2.24, - 0.09)	0.035*	2.15	-0.54
BMI [a]: kg/m²	27.91±1.62 (27.10- 28.72)	27.42±1.21 (26.82- 28.02)	-0.48 ± 0.87 (-0.92, - 0.05)	0.030*	0.87	-0.56
Visual analog scale [a]	6.44 ± 1.21 (5.84 – 7.04)	6.17 ± 1.23 (5.56 – 6.79)	-0.27 ± 0.28 (-0.41, - 0.13)	< 0.001*	0.28	-0.96

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Variables	Baseline assessment [a]	4-week assessments [a]	Mean difference [a]	p-value [b]	Standardizer	Point Estimate
Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC)						
Pain score [a]	4.94 ± 1.89 (4.00 – 5.89)	4.55 ± 1.65 (3.73 – 5.38)	-0.39 ± 0.50 (-0.64, -0.14)	0.004*	0.50	-0.78
Stiffness score [a]	3.06 ± 0.64 (2.74 – 3.37)	3.11 ± 0.58 (2.82 – 3.40)	0.06 ± 0.24 (-0.17, 0.06)	0.331	0.24	0.24
Physical function [a]	21.61 ± 5.75 (21.61 – 18.75)	21.06 ± 5.87 (18.14 – 23.97)	-0.55 ± 0.70 (-0.91, -0.21)	0.004*	0.70	-0.79
Total score [a]	29.61 ± 7.69 (25.79 – 33.43)	28.72 ± 7.61 (24.94 – 32.51)	-0.88 ± 0.90 (-0.92, -0.05)	< 0.001*	0.90	-0.99

Note: [a] The data are presented using mean ± SD (95% confidence intervals); [b] Baseline and 4-week outcomes were compared using a dependent samples t-test. Abbreviation: The data are presented using *n:* number, *BMI:* Body mass index, *kg/m²* kilogram per square meter, *kg:* kilogram.

Statistical significance set at * p-value=<0.05.

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