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How to Improve Dietary Intake of Undernourished Northern Thai Older Adults

タイ北部高齢者の栄養改善方法に関する研究

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ABBREVIATION

BMI	Body Mass Index
cm	Centimeter
g	Gram
IQR	Interqualtile Range
kg	Kilogram
MAC	Mid Arm Circumference
mcg	Microgram
mg	Milligram
mm	Millimeter
MNA-SF	Mini Nutrition Assessment - Short Form
PFC	Percentage of protein, lipids and carbohydrate to total calorie
RDAs	Recommended Dietary Allowances
SD	Standard Diviation
SPSS	Statistical Package for the Social Sciences
TSF	Tricep Skinfold

SUMMARY IN ENGLISH

Background: In Thailand, more than 20% of the elderly are over 60 years old, and the number is increasing rapidly. Undernutrition is highly prevalent in older adults. However, there is limited data on dietary patterns and effective strategies to promote adequate intake and improve nutritional status in community-dwelling older adults. Therefore, I conducted four studies. Study 1 and 2 were nutrition surveys, Study 3 was a pilot study to find an effective method for increasing energy and nutrient intakes, and in Study 4 I tried to confirm this.

Study 1. Nutrition Survey of Early-Stage Elderly in a Village in Phayao Province

The study included 43 early-stage elderly (55-70 years old) participants (15 males and 28 females). The average age was 59±10 years. The nutrition survey was conducted by 24-hour recall method. Results showed that participants had lower daily lipid intake (males 24±16 and females 25±15 g) than the Thai recommended dietary allowances (RDAs: male 40-70 and female 35-60 g), resulting in energy deficiency. The estimated daily energy intake was lower than the RDAs of 150 kcal in males and females. Carbohydrate and protein intakes met the RDAs. The food components largely consisted of rice and vegetables. The most common main course was curry. In males and females, underweight (BMI<18.5 kg/m^2) was 20% and 7%.

Study 2. Nutrition Survey of Late-Stage Elderly in a Village in Chiang Mai Province

One hundred twelve late-stage elderly (65-79 years old) women participated in the study. The average age was 70.4±2.8 years, which was 10 years older than in Study 1. The nutrition survey was conducted by 24-hour recall method for 3 days. Nutritional status was measured by body mass index (BMI), mid-arm circumference (MAC), triceps skinfold (TSF), and grip strength. Daily energy intake was about 100 kcal lower than the Thai RDAs. The main reason was a relatively low lipid intake. Forty-seven of the participants (42%) were underweight (BMI<18.5 kg/m^2). The average grip strength was 16.4±3.4 kg, indicating a low level of muscle strength.

In Study 1 and 2, we found that the older people had inadequate energy intake, mainly due to low lipid intake. A higher prevalence of underweight was observed in late-state elderly people (Study 2) than in early-stage elderly people (Study 1).

Study 3. Acceptability Study of a Higher Energy Meal and Snack (Pilot study of Study 4)

From Study 1 and 2, we found the older adults had inadequate intakes of energy and lipid.

We tried to find an effective method for increasing energy and nutrient intakes and Study 3 was conducted. The participants were eight adults (70.8±4.1 years) with risk of malnutrition (BMI 17.8±2.0 kg/m^2). A cross-over design was used to compare dietary intakes under two diets: control (regular meal and snack) and intervention (energy enhanced in meal and snack) on three days, and wash-out two days. Energy for the intervention meal was increased to about 700 kcal from about 600 kcal, and for the snack to about 380 kcal from about 140 kcal. A 24-hour dietary recall method was conducted for 3 days before, and during the intervention periods. With the meal, energy was not increased, perhaps because the meal was already substantial. The snack with slightly higher energy was a success, maybe because it was given between meals when people were hungry, resulting in about a 200 kcal gain.

Study 4. A Trial to Increase Energy and Nutrient Intakes, and Improve Anthropometric Indices with Snacks

Based on the pilot study (Study 3), we found that increasing energy from snack is more acceptable than increasing energy from meal. To confirm this finding, Study 4 was conducted. The participants were selected from community-dwelling older adults (65-79 years old) who were at risk of malnutrition (BMI ≤20 kg/m^2), and were assigned to either an intervention group (n=17) or a control group (n=17) (average age 71.5±4.7 and 72.1±5.3 years, respectively and BMI 19.4±2.4 and 18.7±1.9 kg/m^2, respectively). A randomized control study of 7 weeks was conducted. A nutrition survey by 24-hour recall method for 3 days, and measurements of body weight, mid-arm circumference (MAC), triceps skinfold (TSF), and grip strength were conducted at baseline, 3rd week and 7th week. An intervention snack consisted of two desserts and a 200 mL box of soymilk (total energy 548 kcal protein: fat: carbohydrate ratio of energy was 7%:33%:60 %). For the first 3 weeks, an intervention snack was provided every day, but there was a relatively large amount of leftovers, therefore, after the 4th week, the snack was provided every other day. A total of 29 participants (intervention 13 and control 16) completed the study. With the intervention snack, there were increased daily intakes of energy by 280±118 kcal (P=0.001); of lipid by 16±6 g (P=0.001); of protein by 7±7 g (P=0.033); and of carbohydrate by 29±17 g (P=0.001). Such increases were not observed in the control group. At 7 weeks, the intervention group increased body weight 0.8 kg (P=0.005), BMI 2 % (P=0.001), and MAC 4% (P=0.039) compared with baseline, while TSF and grip strength did not change. In conclusion, providing snacks was an effective way to increase energy and nutrient intakes, and to improve nutritional status in community-dwelling older adults at risk of malnutrition.

SUMMARY IN JAPANESE

背景: タイでは現在 20%以上の国民が 60 歳以上の高齢者で、その割合は急速に増加している。　一般的に、タイの高齢者では低栄養者の割合が高い。しかし、その原因と対策についてはほとんどわかっていない。そこで、博士課程では 4 つの研究を行った。研究 1 と 2 は高齢者の栄養調査、研究 3 はエネルギー・栄養素摂取量を増やすためのパイロット研究、研究 4 では研究 3 の確認試験を実施した。

研究 1. パヤオ県の村落における前期高齢者の栄養調査

本栄養調査は、前期高齢者（55-74 歳）43 人(男性 15 人、女性 28 人)を被験者とした。平均年齢 59±10 歳、栄養調査は 24 時間リコール法で行った。その結果、1 日の脂質摂取量(男性 24±16 g 、女性 25±15 g)　は、タイの推奨量(男性 40~70g、女性 35~60g)よりも低く、このことがエネルギー欠乏の主原因であった。エネルギー摂取量は、RDA よりも約 150 kcal 低かった。炭水化物摂取量は推奨量を満たしていた。利用した主食品は米と野菜で、最も一般的な主菜はカレーであった。低体重(BMI<18.5 kg/m^2)者は、男性で 20%で、女性では 7%であった。

研究 2. チェンマイ県の村落における後期高齢者の栄養調査

被験者は、後期高齢女性(65-79 歳)112 名（平均年齢 70.4±2.8 歳で、 研究 1 の被験者よりも約 10 歳年上であった。栄養調査は、24 時間リコール法により 3 日間行った。栄養状態は、body mass index (BMI)、中腕周(MAC)、三頭筋皮下脂肪厚 (TSF)、および握力によって判定した。その結果、タイの推奨量に比べて、エネルギー摂取量は約 100 kcal 低かった。主原因は、低い脂質摂取量であった。参加者の 47 人(42%)は低体重 (BMI<18.5 kg/m^2)であった。平均握力は 16.4±3.4 kg で低かった。

研究 1 と 2 の結果から、高齢者では、主に脂質摂取量が少ないため、エネルギー摂取量が不十分であった。低体重の割合は、早期高齢者(研究 1)よりも後期高齢者(研究 2)で多かった。

研究 3. エネルギー・栄養素摂取量増加のための効果的な方法（研究 4 のパイロット研究）

研究 1 と 2 から、高齢者はエネルギーと脂質の摂取量が不十分であることがわかったので、その改善法を見出すために研究 3 を実施した。参加者は、栄養失調のリスクを有する(BMI 17.8±2.0 kg/m^2)　8 人の高齢者(70.8±4.1 歳)であった。　クロスオーバーデザインを使用して、コントロール(通常の食事とスナック)と介入(食事とスナックでエネルギー増強)の 2 つの食事(3 日間、ウォッシュアウト 2 日間)の食事摂取量を比較した。　食事エネルギーは約 600 kcal から約 700 kcal に、スナックエネルギーは約 140 kcal から約 380 kcal に増やした。　3 日間の食事調査（24 時間リコール法）を、介入前および介入中に実施した。食事では、エネルギー摂取量の増加は見られなかった。その理由は、食事エネルギーがすでに多かったためと考えられる。スナックで約 200 kcal のエネルギー摂取量増加があったのは、与えた時間が食事の中間で、空腹なときであったためと考えらる。

研究 4. スナックによるエネルギー・栄養素の摂取量の増加および体位向上に関する研究

パイロット研究(研究 3)の結果、エネルギー摂取量の増加は、食事からは困難であるがスナックでは可能であることが分かった。この知見を確認するために、研究 4 を実施した。被験者は、栄養失調のリスクがある (BMI≤20 kg/m^2) 高齢者(65～79 歳)で、介入群(n = 17)または対照群(n = 17)のどちらかにランダムに割り当てた（平均年齢それぞれ 71.5±4.7 歳 および 72.1±5.3 歳、BMI それぞれ 19.4±2.4 および 18.7±1.9 kg/m^2）。研究期間は 7 週間とした。研究の開始時、3 週目および 7 週目に、3 日間の 24 時間リコール法による栄養調査および体重、中腕周(MAC)、三頭筋皮脂厚(TSF)、握力の測定を行った。スナックは、2 つデザートと豆乳（200 mL）とした(総エネルギー548kcal、エネルギーの PFC 比　7%:33%:60%)。スナックは、最初の 3 週間は毎日提供したが、比較的大量の食べ残しがあったため、4 週目以降は 1 日おきにした。合計 29 人の参加者(介入群 13 人および対照群 16 人)が研究を完了した。介入群では、1 日当たりのエネルギー摂取量が 280±118 kcal 増加した(P=0.001)（内訳：脂質 16±6 g (P=0.001)、タンパク質 7 ± 7g (P=0.033)、炭水化物 29±17 g (P=0.001)）。このような増加は対照群では観察されなかった。第 7 週目には、開始時点と比較して、介入群では体重 0.8 kg (P=0.005)、BMI 2% (P=0.001)、MAC 4% (P=0.039)

増加したが、対照群では変化しなかった。TSF および握力は腸群で変化なかった。結論:7週間のスナック提供により、栄養失調のリスクのある高齢者の、エネルギーと栄養素の摂取量が増加し、栄養状態が改善した。

STUDY 1

NUTRITION SURVEY OF EARLY ELDERLY IN A VILLAGE, PHAYAO PROVINCE

INTRODUCTION

The aging population is increasing rapidly worldwide. In Thailand, there were approximately 11 million older adults (16.7%) aged 60 years and older in 2019, and this number is expected to increase 5 percent every year (1).

Malnutrition referred to as undernutrition is common in older people. The estimated proportion of older adults who are at risk of malnutrition is about 27% in community/outpatients and 50% in other healthcare settings (2). Causes of malnutrition in the elderly are related to several factors, including inadequate intake, due to deterioration of the senses of smell and taste, and decline in gastric emptying associated with satiation (3). Malnutrition is associated with frailty, sarcopenia, and decreased immunocompetence and leads to an increased rate of mobility and mortality (4).

In Phayao Province in the northern part of Thailand, the older adult proportion has increased from 15.3 percent in 2012 to 20 percent in 2017 (5). Most older adults in Phayao work in the agricultural field. Currently, there are limited data on nutrition intake in this population in northern Thailand. Understanding the nutritional intake and dietary pattern of older people may help to design strategies to prevent or improve dietary intake and nutrition status.

The purpose of present study was to determine the nutritional intake and dietary pattern of early-stage elderly people in a village, Phayao Province.

METHODS

This study was conducted with a cross-sectional study from May to July 2019. The early-elderly (55-70 years) people who live in a village, Phayao Province, Thailand and having no dementia were enrolled in the study. The participants were interviewed using 24-hour dietary recall and assessed anthropometrically. Trained interviewers determined participants' dietary intake; they were requested to describe precisely the foods and beverages consumed during the 24 hours prior to the interview. All data were calculated for energy and nutrient intake (carbohydrate, protein, lipids, dietary fibre and sodium) by the INMUCAL-N software version 3, Institute of Nutrition, Mahidol University, Thailand.

Height was measured using a portable, free-standing stadiometer, body weight and percent body fat were measured about 2 hours or more after breakfast, using Omron Karada scan (model HBF-375, Japan). The body mass index (BMI) calculation is the weight in kilograms, divided by the height in meters squared (kg/m^2) and categorized into 4 groups according WHO cut off points: underweight: BMI <18.5 kg/m^2, normal: BMI 18.5-24.9 kg/m^2, overweight:

BMI 25.0-29.5 kg/m^2 and obesity: BMI > 30 kg/m^2.

This study was reviewed and approved by the Committee on Human Rights Related to Human Experimentation, University of Phayao, Phayao, Thailand. Project number 2/039/59.

All procedures of data analysis were performed using Microsoft Excel Software 2013. Descriptive statistics such as mean, standard deviation and percentage was used to quantify the characteristics of the participants, dietary intakes and compared with the Thai Recommended Dietary Allowances (RDAs).

RESULTS

The characteristics of the participants (n=43, average aged 59±10 years) are shown in Table 1. Prevalence of underweight, normal, overweight and obesity of the males and females in this study are shown in Figure 1. Data on dietary intake could be obtained from 43 participants who were fully interviewed for dietary recall. Energy and nutrient intake of the participants and Thai RDA are shown in Table 2. Comparison of energy and nutrient intakes with Thai RDA is shown in Figure 2.

The food components largely consisted of rice and vegetables. Common animal protein sources included chicken, fish such as Nile Tilapia (*Oreochromis niloticus*), snakehead fish (*Channa striatus*) and salt mackerel, pork belly, pork ribs, eggs and frog. Cooking oils included palm oil, soy bean oil, and lard. General seasonings used included salt, shrimp paste (Kapi), monosodium glutamate (MSG), fish sauce (Nampla), pickled fish (Plara), crab paste (Nampu) and soy sauce. The most common main course was soup. A sample of daily foods (1 day) is shown in Figure 3.

Table 1. Characteristics of the participants (n=43)

Characteristics	Male	Female
Number (%)	15 (35)	28 (65)
Height (cm)	162.7 ± 6.9	152.4 ± 8.8
Weight (kg)	60.3 ±13.4	53.2 ± 8.1
Body Mass Index (kg/m^2)	21.9 ± 2.6	23.2 ± 3.1
% Body fat	23.6 ± 4.2	32.1 ± 6.1

Note Data are mean ± SD

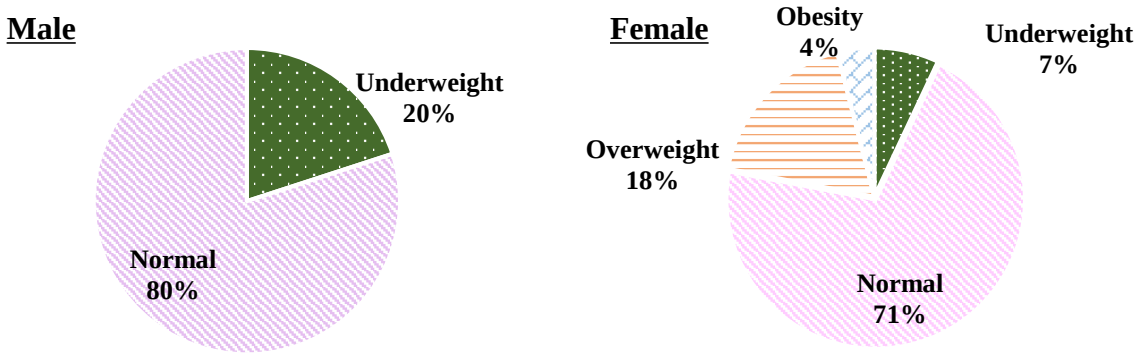

Figure 1. Prevalence of underweight, normal, and overweight in the males **(**n=15**)** and females **(**n=28**)**

Table 2. Energy and nutrient intake of the participants and Thai RDAs (6) (n=43)

	Daily intake		**RDA** [a]	
	Male (n=15)	**Female (n=28)**	**Male**	**Female**
Dietary energy (kcal)	1643 ± 387	1437± 440	1790	1560
Protein (g)	53 ± 18	54 ± 27	45-67	39-59
Fat (g)	24 ± 16	25 ± 15	40-70	35-60
Carbohydrate (g)	304 ± 98	246 ± 86	201-291	176-254
Dietary fibre (g)	6 ± 2	7 ± 4	25	
Sodium (mg)	3020 ± 1,481	3035 ± 1,503	2,000	
%Distribution of P:F:C[b]	13:13:74	15:16:69	10-15:20-35:45-65	

Note Data are mean ± SD; the number in blanket is %RDA; [a] Thai RDAs: Thai recommended dietary allowances, estimated energy requirement for Thai adult age 61 – 70 years (light activity). Distribution of energy: carbohydrate 45 – 65%, lipids 20-35% and protein is 1 kg/day (or 10-15%); [b] P: F: C is protein, fat and carbohydrates.

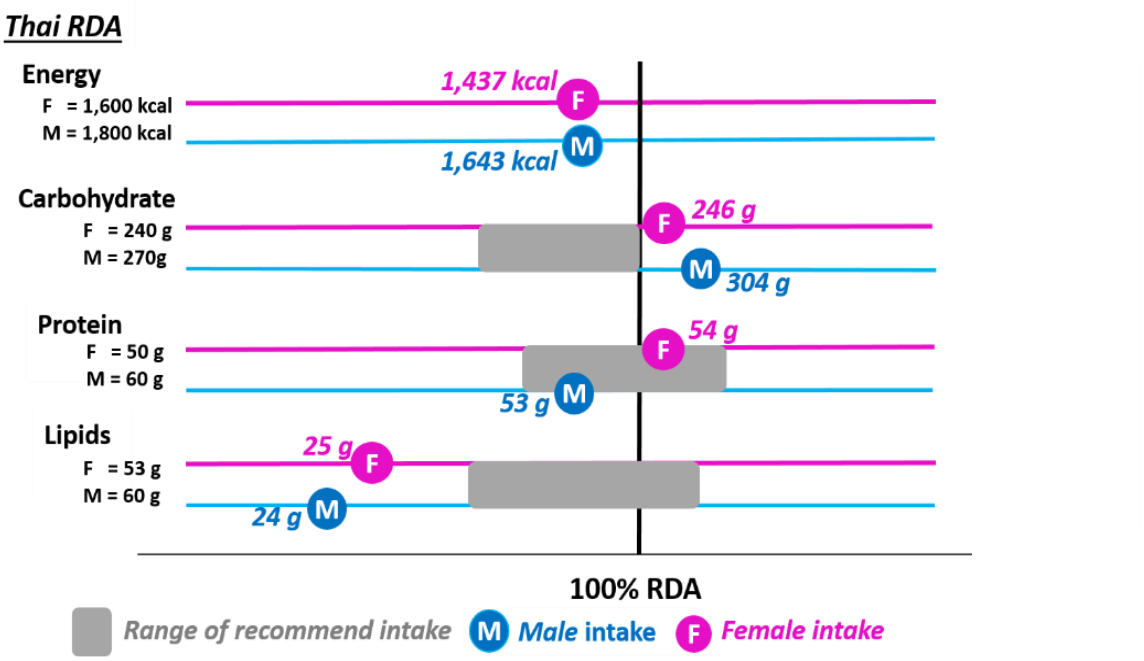

Figure 2. Comparison of energy and nutrient intakes with Thai RDAs

Figure 3. Examples of daily foods (1day)

DISCUSSION

This study showed that older adults had lower energy and lipid intake than the Thai RDA. The percentage of protein, fat, and carbohydrate to total calorie intake per day was 13:13:74 in males and 15:16:69 in females, respectively. This pattern seems to be similar to a previous study that determined dietary intake by 3-day dietary records in for Thai elderly in Bangkok (n=32) (7).

There are many studies demonstrating a decline in food intake with aging (8). A poor appetite is shown to be an important determinant of poor dietary intake in older adults and of incidence of undernutrition. Older persons often have a poor appetite due to various reasons including chewing problems, olfactory losses and poorer health. About one-fifth of the males and one-tenth of the females were found to be underweight, as determined by BMI less than 18.5 kg/m^2. This was two times as high as underweight in the survey of the Thai National Health Examination, NHES V 2014 that is shown in Figure 4. Undernutrition may start in the young old (60 – 69 years) and increase at advanced ages. However, the dietary patterns of older people may not change much compared to those of adulthood. Therefore, in order to have appropriate nutritional status in the later stages of life, healthy eating behaviors should be promoted at a young age.

The northern indigenous foods generally used little oil in cooking. Cooking with less oil may be appropriate for individuals who are overweight/ obese, but some older people take in too few calories and are also underweight; low fat/oil choices may make it difficult for them to consume enough food to maintain a positive energy balance (9). Adequate energy intake is necessary for optimizing protein utilization and allows the body to utilize protein for non – energy yielding functions such as the maintenance of lean body mass (10). In addition, we found carbohydrates were the main energy source (72% of total calories). Related to the data of the Thai National Health Examination Survey IV, of adults aged 30 - 59, reported that a carbohydrate-rich dietary pattern was popular in northern region of Thailand and rural areas (11).

BMI (kg/m^2)	60 - 69 years		70 - 79 years		80+ years	
	Male n=1,894	Female n=2,447	Male n=985	Female n=1,250	Male n=337	Female n=370
< 18.5	9.4	4.3	14.0	10.0	23.9	23.6
18.5 - 24.9	59.7	45.1	61.9	51.6	64.8	54.8
25 - 29.9	25.7	38.9	21.2	31.2	10.1	17.7
≥ 30	8.0	11.8	2.9	7.2	1.2	3.9

Adapted data from Thai National Health Examination Survey, NHES V

Figure 4. Percentage of Thai older adults according to BMI in 2014

In conclusion, the northern Thai older adults had inadequate energy and oils consumption. Although the amount of protein intake was sufficient, it may be necessary to consider whether the quality of the protein is good enough. Further studies may be suggested to promote the consumption of lipid by using vegetable oils for cooking dishes such as stir fried vegetables or rice and coconut milk in curry dishes, if the older people do not have dyslipidemia. In addition, to increase high biological value proteins, soybean milk may be recommended.

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STUDY 2
NUTRITION SURVEY OF LATE-STAGE ELDERLY IN A VILLAGE, CHIANG MAI PROVINCE

INTRODUCTION

The aging population is increasing rapidly worldwide. In Thailand, the number of older adults aged 60 years and older is expected to increase to 20% of the population by 2021 (1). Chiang Mai province is located in the northern part of Thailand in which there were more than 300,000 older adults (20%) in 2021, the third-highest population in the country. The increasing older adult population promotes a public health concern in society because a larger number of people require medical health care.

Malnutrition referred to as undernutrition is common among older adults over 60 years old. In 2015, the age standardized global prevalence of undernutrition was estimated to be 8.8% in men and 9.7% in women as determined by body mass index (BMI) less than 18.5 kg/m^2 (2). The Thai National Health Examination Survey 2019-2020 reported that the prevalence of underweight was 8.1% in men and 4.8% in women aged 60-69 years, and this trend increased at older ages (3). Similar to some studies conducted in 2020 among suburban community, Chiang Mai estimated that 10.6% of older adults aged 60 or above were underweight, and 54.8% were at risk of malnutrition based on the Mini Nutritional Assessment Tool (4). According to the above information, it can be seen that malnutrition in older adults is an important problem both globally and nationally, accelerating the need to implement strategies to prevent and handle malnutrition.

The purposes of Study 2 were to investigate their nutritional intake, anthropometry, and muscle strength among late-state elderly (65-79 years) women, which was 10 years older than the Study 1. This study conducted in a village, Chiang Mai Province, where the prevalence of underweight was about 16.6% or 1.5 times of the previous report (4).

METHODS

A cross-sectional study design was used from January to March 2022. Two hundred and ninety-eight older women were screened. The inclusion criterias were older people aged 65-79 years old who having no dementia or depression recorded in the medical history, capable of communication in Thai, and willing to provide written informed consent.

The sample size was calculated following Wayme's formula (5). Based on Tran et al study, the standard diviation of energy intake in older adults has been reported 229 kcal (6). A margin of error of 45 kcal and a confidence coefficient of 0.95 was used. The number of participants was at least 100, and the sapmple size required 112 considering a dropout of 12%.

The MNA-SF is a screening tool to help identify nutritional status among older people. It

comprises six questions including decline in food intake, weight loss, mobility, stress or acute illness, neuro- psychological problems and body mass index (BMI). It ranges from zero to 14, with a score 12 or greater indicating "well-nourished", a score of 8 to 11 standing for "at risk of malnourished" and a score less than seven representing malnourished. The MNA-SF has been validated to identify nutritional status for older adults in hospitals or long-term care setting, and community setting with sensitivity of 0.98, specificity of 1.00, and predictive value of 0.99 (7).

A 24-hour recall by interview method was conducted in three inconsecutive days. Trained interviewers determined participants' dietary intake; they were requested to describe precisely the foods and beverages consumed during the 24 hours prior to the interview. All data were entered and calculated for energy and macronutrient intakes (protein, lipids and carbohydrate) by the INMUCAL-N software version 4.0 (Institute of Nutrition, Mahidol University, Thailand).

Body weight was evaluated using a calibrated electronic scale (Omron model HBF214, Japan). The participants were asked to wear light clothes without socks. Height was measured using a portable free-standing stadiometer and recorded to the nearest 0.1 cm. BMI was calculated using body weight (kg) divided by the square of height (m).

Triceps skinfold (TSF) was measured using a FatO-caliper (Takei Kikai Kogyo Co., Ltd.), and mid-arm circumference (MAC) was measured by a tape. The participants were in a standing position with their arm hanging relaxed during the measurements. TSF and MAC were performed at the midpoint between the tip of the acromion and olecranon process of the arm, measured three times for each participant, and the mean value was recorded. A TSF of 12.0 mm reflects undernourished (8) and was used as anthropometric indicatos of adiposy (9). A MAC of 24.3 cm is the suggested cut-off to identify underweight in both men and women (10) and was seleted as indicators of muscle mass (9).

Grip strength was measured by a digital handgrip dynamometer (Camry, South El Monte, CA, USA) in a standing position and with the elbow in 90° flexion close to the body. Participants were allowed three maximal efforts, and the mean value was used. Low muscle strength is defined as handgrip strength <28 kg for men and <18 kg for women (11). Figure 1 showed nutrition survey method.

The study protocol and procedures were approved by the Ethical Committee of the Faculty of Public Health, Chiang Mai University, Thailand. Protocol number ET019/2020 was conducted in accordance with the Helsinki Declaration of 1975.

Statistical analyses were performed using SPSS Version 22 (IBM SPSS Statistics, Chicago, IL, USA). The Kolmogorov–Smirnov test of normality was run to determine whether data variables met parametric assumptions. Data were presented as mean ± SD for normal distribution. When distributions were not normal, the data were described by median and interquartile range (IQR) . Categorical variables were showed as percentages. The characteristics of the participants, and dietary intakes, were quantified and compared with the Thai Recommended Dietary Allowances (RDAs).

Body weight measurement

Mid arm circumference measurement

Triceps skinfold measurement

Grip strength test

Dietary interview by 24-hour recall method

Figure 1. Nutrition survey method

RESULTS

One hundred twelve late-stage elderly women participanted in the study. The average age was 70.4±2.8 years. Table 1 indicates daily energy and major macronutrient intakes of the participants. Mean intake of energy was 1438±134 kcal, about 100 kcal lower than the RDAs; lipid was 35±9 g, almost lower borderline of the RDAs; protein was 46±6 g and carbohydrate was 235±31 g, within the the RDAs. The percentage of protein, fat and carbohydrate to total calorie intake was 13:22:65.

Figure 2 presents examples of daily foods (1 day). The median **(**IQR**)** number of meals consumed per day was 5 **(**2**)** meals including 3 main meals and 2 snacks between meal. Sticky rice was a stable food. The most common main course was soup (or curry) with various local vegetables. Common animal protein sources included pork, chicken, fish such as Nile Tilapia *(Oreochromis niloticus),* and dried snakehead fish *(Channa striatus)*, eggs, and beef**.** Cooking oils included palm oil, lard, and soy bean oil**.** The general snacks were sesonal fruits such as oranges, cultivated banana **(**Namwa**)** and soy milk**.**

Table 1. Daily energy and major macronutrient intakes

Variable	All (n=112)	RDAs
Energy (kcal)	1438 ± 134	1540
Protein (g)	46 ± 6	39-58
Lipid/Fat (g)	35 ± 9	34-60
Carbohydrate (g)	235 ± 31	173-250
% distribution of P:F:C	13:22:65	10-15:20-35:45-65

Note Data are expressed in mean±SD. P:F:C: The percentage of protein, fat and carbohydrate to total calorie intake; RDAs: Thai recommended dietary allowances, estimated energy requirement for Thai woman adult age 70-79 years (light activity).

Table 2 shows anthropometric parameters of the participants. Mean height was 157.5±10.0 cm, mean body weight was 54.8±58.1 kg and mean BMI was 20.2±3.8 kg/m^2. Forty-seven of the participants (42%) were underweight (BMI<18.5 kg/m^2). The average grip strength and MNA-SF was 16.4±3.4 kg and 10±3 score, indicating a low level of muscle strength and at risk of malnutrition.

Figure 2. Examples of daily foods **(**1 day**)**

Table 2. Anthropometric parameters

Variable	**All (n=112)**	**Cut-off/ Interpretation**
Height (cm)	157.5 ± 10.0	
Body weight (kg)	54.8 ± 58.1	
BMI (kg/m^2)	20.2 ± 3.8	
<18.5 kg/m^2, n (%)	47 (42)	underweight
18.5-24.9 kg/m^2, n (%)	52 (46)	normal
25.0-29.5 kg/m^2, n (%)	13 (12)	overweight
MAC (cm)	26.5±4.0	≤24.3 cm undernutrition
TSF (mm)	18.0±5.9	≤12.0 mm undernutrition
Grip strength (kg)	16.4±3.4	<18 kg low muscle strength
MNA-SF (score)	10±3	At risk of malnutrition

Note BMI: body mass index; MAC :mid-arm circumference; TSF :triceps skinfold; MNA-SF :mini nutrition assessment-short form.

Table 3 presents demographic of the participants. Most of the participants had education in primary school (98.2%), lived with family (92.9%), were labor workers (64.3%), had income between 2000 and 8000 baht/month (53.6%), no smoking (88.4%), and no drinking alcohol (98.2%).

Table 3. Demographics of the participants

Variable	All (n=112)
Levels of education, n (%)	
Primary school	110 (98.2)
High school	2 (1.8)
Living arrangement, n (%)	
Living with family	104 (92.9)
Living alone	8 (7.1)
Occupation, n (%)	
Labor worker	72 (64.3)
Farmer	40 (35.7)
Income (Baht/month), n (%)	
2000-8000	60 (53.6)
< 2000	52 (46.4)
Smoking, n (%)	
No	99 (88.4)
Yes	13 (11.6)
Drinking alcohol, n (%)	
No	110 (98.2)
Yes	2 (1.8)

Note Data are expressed in number (percentage).

DISCUSSION

This cross-sectional study was conducted to investigate nutritional intake, anthropometry, and muscle strength among late-state elderly (65-79 years) women in a village, Chiang Mai Province. In our study, we found that older people had inadequate energy intake, primarily due to a relatively low lipid intake. Moreover, the participants had low muscle strength, and nearly half were underweight.

The current study showed that daily energy intake was about 100 kcal lower than the Thai RDAs.The percentage distruibution of protein, fat, and carbohydrate to total calorie intake (PFC) was 13:22:65. The results are consistent with intake data of early-stage elderly (55-70 years old) from previous studies (12) that showed daily energy intake was about 150 kcal lower than the RDAs, and a percentage distribution of PFC was 15:16:69. Comparing our findings to those of Phodhichai et al., who investigated dietary intake in 249 older adults (77±8 years old) living in public residential homes. The percentage distribution of PFC was a similar found to be 13:26:61, using 24-hour recall method (13).

Several studies suggest that old people had insufficient energy and nutrient intake (14-16). A poor appetite is shown to be an important determinant of inadequate dietary intake in older people. Older people often have less appetite with early satiety and consume smaller meals than young adults due to physiological changes, including gastrointestinal dysfunction such as maldigestion and malabsorption, dental problems such as loss of teeth that affect oral function, and dry mouth syndrome that affects the perception of taste and smell (17, 18)

In this study, the most common main dish was soup or curry, which was cooked with heat and water without oils, as is traditional northern Thai cooking style. Moreover, we observed that most older adults were more likely to eat the same food repetitively. Long-term intake with these dietary patterns in may lead to energy, and nutrient deficiencies and a risk of undernourished. Related to a study in Japanese older home-care recipients (n=317, age 84 years) reported lower dietary variety (assessed through food frequency score) was significantly associated with malnutrition (19).

In our study, the participants' grip strength was below the cut-off values (<18 kg in women), indicating low muscle strength. Similar results are also shown in some studies, for example, Hayfron et al. who assessed dietary intake, and measured antrhopemetric parameters in 150 older people (60-87 years) (20). The grip strength of elderly people declines with age and low grip strength is associated with a variety of poor health outcomes, including chronic morbidity, functional disability, and mortality (21, 22). In the conclusion, older people had

inadequate energy intake, mainly due to low lipid intake. A higher prevalence of underweight was observed in late-state elderly people (Study 2) than in early-stage elderly people (Study 1).

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STUDY 3
ACCEPTABILITY STUDY OF A HIGHER ENERGY MEAL AND SNACK

INTRODUCTION

Our previous study (Study 1 and 2) showed the older people had inadequate energy intake, mainly due to low lipid intake (1). We tried to find an effective method for increasing energy and nutrient intakes.

The effective strategies to promote adequate intake in undernourished community-dwelling older adults were still limited, while it is recognized and treated in hospitals. Oral nutrition supplement is a simple strategy used to improve intake in adults; however, some studies reported low compliance and satisfaction with oral nutrition supplement that may be related to unfamiliarity with and a lack of variety of foods (2). Some systematic reviews reported that food fortification by basic cooking ingredients such as oil, mayonnaise, honey, egg, and powdered milk may improve energy and protein intake in older adults.

This study (Study 3) was conducted before the main study. The reason was that we did not know whether our undernourished participants could consume higher energy than their current intake, perhaps we could suggest two methods, one was increasing energy from meal and the other was snack. According to the previous study, we observed that snacks had a small amount of energy.

It is important to explore the effective strategies to promote adequate dietary intake in community-dwelling older adults. This will be helpful in preventing or slowing progression of chronic diseases and diminish hospitalization. The objective of this study was to investigate effects of energy enhance meal and snack on energy intakes in older adults at risk of malnutrition.

METHODS

This study was a randomized, controlled, cross-over design from November to December 2020. We evaluated dietary intakes under two diets: control (regular diet); intervention (energy enhanced) at meal and snack for three days. Washout period was two days. The potential participants were screened from medical records of a Health Promotion Hospital. Those willing to participate were informed about the study and screened for inclusion criteria were aged 65-79 years old, BMI than 20 kg/m^2 and/or recent unintentional weight loss, able to eat by mouth, not having any illness that may affect taste or appetite such as cancer, chronic kidney disease and having no dementia or depression.

After screening, eight participants (6 females and 2 males) were included in the study and they provided informed consent.

Daily meal and snack were delivered to the participants' homes. Meal consisted of glutinous rice, a main dish (meat/fish), boiled vegetable and soup with meat/fish and vegetable.

In the intervention meal, rice bran oil was used, and soy bean oil was used in the control diet, general ingredients and seasoning were kept the same in both diets. The composition, energy and macronutrient content of the meal and snack in the control and intervention diets are shown in appendixes: Table 1. Energy, protein, lipid and carbohydrate in the intervention and control meales were 660 - 699 and 580 - 598 kcal, 29 - 43 and 28 - 43 g, 24 - 34 and 10 - 19 g, 69 - 76 and 68 - 75 g, respectively.

The snack consisted of pandan jelly, sweet pumpkin, and glutinous rice with perilla seed. In the intervention snack, coconut milk/ground peanuts were added, and a box of soy milk (250 ml) was offered. Energy, protein, lipid and carbohydrate in the intervention and control snacks were 267 - 471 and 44 - 222 kcal, 7 - 11 g and 0 - 3 g, 11 - 21 g and 1- 10 g and 7 - 34 g, respectively.

A five-point facial hedonic scale was used to evaluate acceptability test (appearance, aroma, texture, taste and overall) of foods.

Body weight and body composition were assessed about 2 hours or more after breakfast, using bioelectrical impedance analysis (Model HBF214, Omron, Japan). Height was measured using a portable, free-standing stadiometer. Triceps skinfold (TSF) was measured by using a Fat-O-caliper (Takei Kikai Kogyo Co., Ltd.). Hand grip strength was measured by a digital handgrip dynamometer (Camry, South El Monte, CA, USA). All the measurements above were assessed before the study.

A 24-hour recall method dietary survey was conducted 3 days before the study and in each of the two periods. However, to ensure that the participants provided complete data, they were also requested to keep an estimated record of all foods and beverages consumed in the dietary record form. In addition, all participants were instructed to place all food leftovers and containers in a labeled plastic bag and to show them to the researchers to determine intakes. All data were entered and calculated for energy and nutrient intakes (protein, lipids, carbohydrate, saturated fatty acid, cholesterol and dietary fiber) using the INMUCAL-Nutrient version 4.0 (Institute of Nutrition, Mahidol University, Thailand).

This study was done in accordance with the Helsinki Declaration and was approved by the Committee of Research Ethics in the Faculty of Public Health, Chiang Mai University, Thailand. Project number ET019/2020.

Descriptive statistics such as mean, standard deviation and percentage were used to quantify the characteristics of the participants and dietary intakes. Data were analyzed using

SPSS version 22. Results from the two diets' differences were confirmed using Wilcoxon signed ranks tests. All tests were two-tailed and a *P*-value less than 0.05 was considered as statistically significant.

Example some food ingredients

Example some meal boxes

Food preparation

Delivery foods

Figure 1. Food preparation and delivery

RESULTS

The participants were six females (75%), two males (25%), who had an average age of 70.8±4.1 years, body mass index 17.8±2.0 kg/m^2, body fat 24.8±8.1%, muscle mass 28.1±1.4%, calf circumference 21.9±3.3 cm, triceps skin fold 16.3±3.7 mm, hand grip strength 18.9±3.0 kg (Table 1). No participants had specific diseases.

Table 1. Baseline characteristics

Characteristics	Mean ± SD
Gender (number male/female)	2/6
Body mass index (kg/m^2)	17.8 ± 2.0
Body fat (%)	24.8 ± 8.1
Muscle mass (%)	28.1 ± 1.4
Calf circumference (cm)	21.9 ± 3.3
Triceps skin fold (mm)	16.3 ± 3.7
Hand grip strength (kg)	18.9 ± 3.0

Although the energy supply at meal in the intervention period was increased to about 700 kcal from about 600 kcal in the control period, the intake was similar between the two periods, being about 450 kcal, suggesting that the subjects could not eat increased lipids, maybe because the portion size was quite large. Average energy intakes from snack increased about 2.5 times (191 kcal) the control (from 122 ± 34 to 313 ± 48 kcal, $P = 0.012$), maybe because the portion size was small enough for stomach volume.

In addition, lipid, protein, carbohydrate, saturated fatty acid, cholesterol and dietary fiber intakes were increased from 3.9 ± 0.9 to 13.0 ± 1.7 g, 1.4 ± 0.5 to 7.0 ± 1.0 g, 20.2 ± 6.0 to 41.9 ± 7.2 g, 3.1 ± 0.7 to 4.9 ± 1.0 g, 0.0 ± 0.0 to 6.1 ± 1.5 g and 0.9 ± 0.2 to 1.2 ± 0.3 g, respectively, as shown in Table 2. This resulted in an increase of about 200 kcal a day from 1,312 ± 153 to 1,511 ± 190 kcal, $P = 0.012$, as shown in Table 3.

Table 2. Comparison of energy and nutrient intakes during control and intervention periods at meal and snack

	Meal		*P value*	Snack		*P value*
	Control	**Intervention**		**Control**	**Intervention**	
Energy (kcal)	449±67	454±137	1.000	122±34	313±48	0.012*
Lipid (g)	11.2±2.4	14.5±4.6	0.161	3.9±0.9	13.0±1.7	0.012*
Protein (g)	22.5±3.2	20.8±7.0	0.674	1.4±0.5	7.0±1.0	0.012*
Carbohydrate(g)	64.6±11.1	60.0±19.1	0.484	20.2±6.0	41.9±7.2	0.012*
Saturated fat (g)	3.2±0.8	3.8±1.3	0.327	3.1±0.7	4.9±1.0	0.012*
Cholesterol (mg)	100.8±25.7	131.7±33.3	0.036*	0.0±0.0	6.1±1.5	0.011*
Dietary fiber (g)	3.7±0.7	3.2±1.0	0.327	0.9±0.2	1.2±0.3	0.017*
% distribution of P:F:C	20:22:58	18:29:53		3:30:67	9:37:54	

Note Data are shown in mean ± SD. *P<0.05, control vs. intervention periods, Wilcoxon's signed rank test
P:F:C: The percentage of protein, fat amd carbohydrate to total caloric intake.

Table 3. Energy and nutrient intakes at before the study, control and intervention periods

	Before the study	**Control period**	**Intervention period**	***P value***
Energy (kcal)	1,299±205	1,312±153	1,511±190	0.012*
Lipid (g)	28.3±6.7	32.9±6.3	45.9±8.9	0.012*
Protein (g)	48.1±5.4	51.7±5.0	53.7±6.9	0.674
Carbohydrate(g)	213.1±38.4	203.7±27.7	220.9±27.4	0.036*
Saturated fat (g)	7.7±2.4	10.4±4.8	15.5±3.0	0.012*
Cholesterol (mg)	116.7±49.9	166.2±74.5	202.2±41	0.575
Dietary fiber (g)	8.4±2.6	10.1±2.8	7.9±1.8	0.036*
P:F:C	15:19:66	16:23:61	14:27:59	

Note Data are shown in mean ± SD. *P <0.05, control vs. intervention periods, Wilcoxon's signed rank test. P:F:C: The percentage of protein, fat amd carbohydrate to total caloric intake.

The energy and major nutrient intakes from meals were much lower than the supply**.** On the other hand, the energy and major nutrient intakes from the snacks were more similar to the supply, as shown in Figures 2 and 3**.**

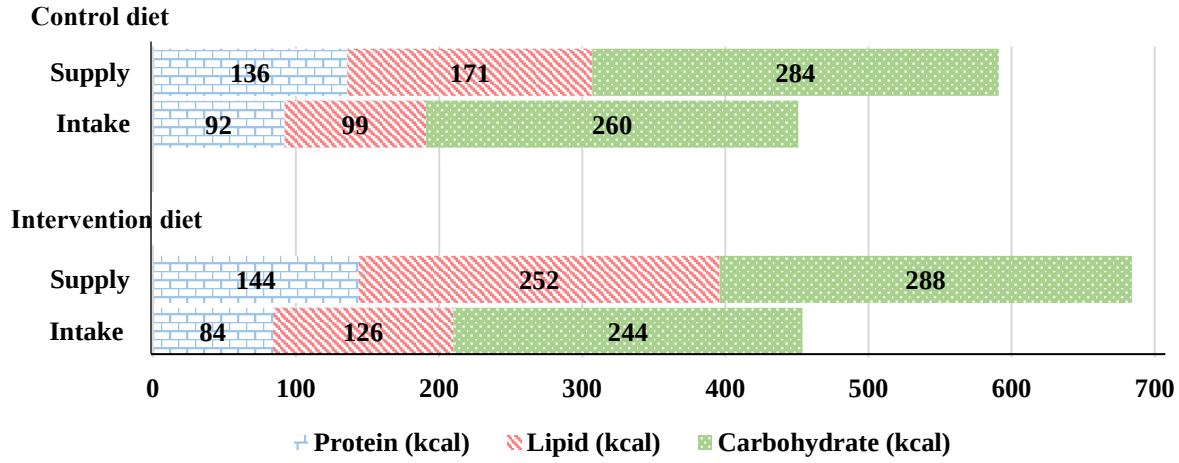

Figure 2. Energy and major nutrient intakes from meals

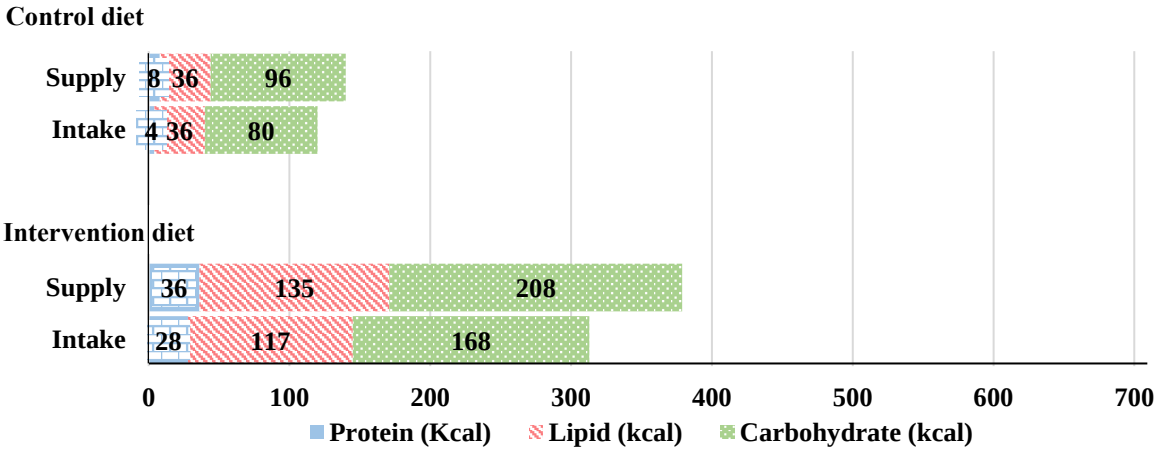

Figure 3. Energy and major nutrient intakes from snacks

The acceptability scores of appearance, aroma, texture, taste and overall of both diets were found to be similar (control diet: 4.1 ± 0.2; 4.2 ± 0.1; 4.3 ± 0.2; 4.3 ± 0.2 and 4.3 ± 0.2, intervention diet: 4.2 ± 0.1; 4.2 ± 0.2; 4.4 ± 0.1; 4.3 ± 0.2 and 4.3 ± 0.2, respectively, as shown in Table 4. No difference in acceptability scores between either control diet compared with the intervention diet were identified. During the study, no adverse effects or side effects were reported associated with the intervention diet.

Table 4. Comparison the acceptability test between control and intervention diet

Menus	Diet	Appearance	Aroma	Texture	Taste	Overall
Chili paste, ground pork with tomato	Control	4.1±0.6	4.3±0.7	4.4±0.5	4.3±0.7	4.5±0.5
	Intervention	4.3±0.7	4.3±0.7	4.4±0.5	4.4±0.7	4.5±0.5
Wax gourd soup with chicken	Control	4.0±0.5	4.4±0.5	4.3±0.5	4.4±0.7	4.3±0.5
	Intervention	4.3±1.0	4.0±0.6	4.4±0.8	4.0±0.8	4.0±1.7
Cabbage soup with pork	Control	4.1±0.6	4.3±0.7	4.4±0.7	4.4±0.7	4.4±0.5
	Intervention	4.4±0.5	4.3±0.7	4.4±0.5	4.6±0.7	4.4±0.5
Chili paste with dried fish	Control	4.4±0.9	4.1±0.8	4.4±0.7	4.8±0.5	4.8±0.5
	Intervention	4.3±0.7	4.3±0.5	4.3±0.7	4.3±0.9	4.4±0.7
Spicy soup with fish	Control	3.9±0.4	4.0±0.0	4.4±0.5	4.1±0.4	4.4±0.5
	Intervention	4.1±0.6	4.4±0.5	4.4±0.5	4.5±0.5	4.3±0.5
Mixed vegetable soup with chicken	Control	3.9±0.4	4.3±0.7	4.3±0.5	4.4±0.5	4.0±0.0
	Intervention	4.1±0.4	4.0±0.8	4.3±0.5	4.4±0.5	4.1±0.4
Pandan jelly	Control	4.3±0.9	4.1±0.6	4.8±0.5	4.4±0.5	4.4±0.5
	Intervention	4.1±0.4	4.5±0.8	4.4±0.5	4.4±0.5	4.3±0.5
Sweet pumpkin	Control	4.1±0.8	4.0±0.8	4.4±0.7	4.4±0.7	4.4±0.7
	Intervention	4.3±0.7	4.1±0.8	4.4±0.5	4.1±0.8	4.1±0.6
Glutinous rice with perilla seed	Control	4.1±0.8	4.4±0.7	3.9±0.8	4.0±0.5	4.1±0.6
	Intervention	4.3±0.7	4.4±0.7	4.4±0.5	4.1±0.6	4.4±0.7
Average	Control	4.1±0.2	4.2±0.1	4.3±0.2	4.3±0.2	4.3±0.2
	Intervention	4.2±0.1	4.2±0.2	4.4±0.1	4.3±0.2	4.3±0.2

Note Data are shown in mean ± SD. There were no statistically difference between control and intervention diets in each dish by Wilcoxon's signed rank test at $P < 0.05$.

DISCUSSION

This study was a pilot study conducted before the main study. The main purpose was finging how to increase energy and nutrient intakes in older adults at risk of malnutrition. However, we found that in undernourished older adults, increasing energy from energy fortified meals was difficult but that snacks were acceptable.

We tried to use oils, e.g. rice bran oil for fortifying in the meal dishes, and ground peanuts were used in some snacks because there were reports that showed they is more acceptable in older people with poor appetites (3, 4). However, before we designed the type of lipid for the meal dishes and snacks, we tried to use various types and amounts of lipid and conducted an acceptability test a small number of elderly and researchers; after that the recipes with the highest acceptance scores were chosen for the intervention study.

However, our present study was not successful in increasing energy intake at meal. In the regular meal diet, we gave about 600 kcal and the intake was about 455 kcal. We increased the intervention meal to about 700 kcal but the actual intake was about 450 kcal. Intake of all the three major nutrients was the same, indicating that the increased lipids were not taken. Conversely, the study of Faxén-Irving et al (4) showed the positive effect of energy-dense oleic acid-rich supplement (30 ml, 3 times/ day), which increased energy intake about 390 kcal higher in the intervention group compared to the control group and indicated better appetite. This may be because offering the small but frequent energy dense oleic acid-rich supplement stimulated appetite and resulted in increased energy intake.

Our present study reported that energy rich snacks with coconut milk/ ground peanuts and a box of soy milk were successful and energy intakes became 2.5 times higher than the regular snacks (control 122 ± 34, intervention 313 ± 48 kcal, $P = 0.012$).

The above results may indicate that the participants could not consume large portions of high energy foods, especially lipids, suggesting the digestion of lipids is not smooth but if the lipid amount is less than about 125 kcal in each meal and snack, they could eat the whole amount. Therefore, we concluded that for the older people, small portions are easier than large amounts in a few meals and the upper limit of lipids may be approximately 125 kcal (25 - 30% of total energy).

This is supported by some reports that mention that although foods high in energy from lipids tend to be more palatable, the older people may not eat them in large amounts because of some symptoms such as gastric distention and emptying rates (5). Some studies showed that the older people have significantly reduced enzyme secretions such as lipase, chymotrypsin, and amylase compared with younger people (3, 6).

On average older adults eat more slowly, are less hungry, and consume smaller meals than young people do. Small meals or snacks have been used to improve dietary intake. For example, Kruizenga et al (7) reported that if they offered two snacks per day to frail malnourished hospital patients, they found that the intervention group increased intake by approximately 600 kcal and 12 g protein/day compared to the control group (no snacks).

The taste, variety, familiarity, and portion size of the fortified foods and snacks may lead to a higher rate of consumption and preference (8). In this study, the average acceptability of appearance, aroma, texture, taste, and overall appeal of both the control and intervention diet were found to be similar. All of the participants were satisfied with the portion size of the supply of snacks. On the other hand, some of them informed us that the portion size of the supplied meales was too large.

In the current study, there was decreased dietary fiber intake during the intervention period. The following were some of the possible explanations: firstly, there was a chance that the participants would be full and reduce their usual food intake at the next meal, which could contain fiber by accident. Similar events have been reported in some previous researches. However, we found that the intervention group consumed higher daily energy and major macronutrients than the control group (P<0.05) at the end of study. Furthermore, there was small number of participants; it may be difficult to calculate an accurate P-Value, and especially regarding fiber.

This study was the preliminary study for the following main study to find a good method for increasing energy and nutrient intakes. We found a higher energy meal was not effective but increasing energy and nutrient with slightly higher energy snacks may be preferable is significant.

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STUDY 4
A TRIAL TO INCREASE ENERGY AND NUTRIENT INTAKES, AND IMPROVE ANTHROPOMETRIC INDICES BY SNACKS

INTRODUCTION

Prior to the current study, a pilot study (Study 3) was conducted (1). It was found that enhancing energy via meal from about 600 kcal, to about 700 kcal was not successful, perhaps because the meal was already substantial. While it was successful via snacks with slightly higher energy, from about 140 kcal, to about 380 kcal, perhaps because it was given between meals when people were hungry, resulting in a gain of about 200 kcal. To confirm this finding, Study 4 was conducted. This study aimed to determine the effects of snacks on energy and nutrient intakes, and nutritional status in older adults at risk of malnutrition in a village in Chiang Mai, Thailand. Such information could help health care professionals to plan appropriate nutritional recommendations and interventions.

METHODS

A randomized controlled study was conducted on older adults at risk of malnutrition recruited from a suburban community in Chiang Mai, Thailand, from November 2020 to March 2021. The participants from two villages were randomly assigned to either a control group or an intervention group, and they were matched-pair by age and gender.

This study was designed to detect a statistically significant ($P<0.05$) effect of serving snacks versus the control without snacks on energy intake with a power of 80% if the effect exceeded 200 kcal. The expected difference of 200 kcal was based on our previous study (1) in older adults at risk of malnutrition who were provided energy-rich snacks resulting in an increased daily intake of 200 kcal/day. The standard deviation (SD) of energy intake among an intervention group was used to calculate sample size based on Sakpal's study (2). The number of participants was at least 15 per group, and the sample size required 17 per considering a drop-out of 20%.

The inclusion criteria included people aged 65 to 79 years, at risk of malnutrition that was classified by BMI less than or equal to 20 kg/m^2 and/or unintentional weight loss of 5 to 10% within the past 6 months, capable of eating by mouth, not having any illness that may affect taste or appetite (e.g., cancer and chronic kidney disease), having no dementia or depression recorded in the medical history, capable of communicating in Thai, and capable of taking part in activities for 7 weeks.

An intervention snack consisted of 2 desserts and a box of milk (total 548 kcal) was used. For the first 3 weeks, an intervention snack was provided every day, but there was a relatively large amount of leftovers, therefore, after the 4th week, the snack was provided every other day. They were recommended to consume snacks between meals. The control group did not receive

an intervention snack, but they were supplied with equivalent desserts and drinks and provided with recipes and cooking class at the end of the study. All participants were encouraged to keep their usual diet and physical activity unchanged during the study.

For the intervention, 34 kinds of desserts were prepared according to participants' opinions on their favorite snacks. The ingredients were locally available, and older adults' favourite seasonal ingredients were also provided such as banana, taro, purple sweet potato, pumpkin and perilla seeds, flour, sugar, and coconut milk along with a good source of energy. However, coconut milk is rich in saturated fatty acid (17%), and excessive consumption of dietary saturated fats may increase the risk of coronary heart disease (3). Therefore, we reduced the amount of coconut milk (approximately 50%) and substituted soy milk since most of the fatty acids (80%) in soy milk were unsaturated fatty acids (4). Furthermore, participants liked soy milk which is nutritious and economical. The snacks could be divided into 5 types according to the cooking method, including boiling (53%), steaming (24%), stirring (21%), and syrup (2%).

A 24-hour recall by interview method was conducted in 3 consecutive days at baseline (week 0), week 3, and week 7, and then the intake was averaged over the 3 days of each period. However, to ensure that the participants provided complete data, they were also asked to keep an estimated record of all foods and beverages consumed in a dietary record form.

In addition, the intervention group was instructed to place all food leftovers and containers in a labeled plastic bag and to show them to the researchers to determine intakes. Dietary compliance was monitored using a daily snacks consumption record. All data were entered and calculated for energy and macronutrient intakes (e.g. protein, lipids, and carbohydrate) using the INMUCAL-Nutrient version 4.0 (Institute of Nutrition, Mahidol University, Thailand).

Body weight was evaluated using a calibrated electronic scale (Omron model HBF214, Japan). The participants were asked to wear light clothes without socks. Height was measured using a portable free-standing stadiometer and recorded to the nearest 0.1 cm. BMI was calculated using body weight (kg) divided by the square of height (m).

Triceps skinfold (TSF) was measured using a FatO-caliper (Takei Kikai Kogyo Co., Ltd.), and mid-arm circumference (MAC) was measured by a tape. The participants were in a standing position with their arm hanging relaxed during the measurements. TSF and MAC were performed at the midpoint between the tip of the acromion and olecranon process of the arm, measured three times for each participant, and the mean value was recorded. A TSF of less than 5 mm reflects low body fat stores (5). A MAC of 24.3 cm is the suggested cut-off to identify underweight in both men and women (6).

Grip strength was measured by a digital handgrip dynamometer (Camry, South El Monte, CA, USA) in a standing position and with the elbow in 90° flexion close to the body. Participants were allowed three maximal efforts, and the mean value was used. Low muscle strength is defined as handgrip strength <28 kg for men and <18 kg for women (7). All of the above measurements were assessed at weeks 0, 3, and 7.

Before the experiment, participants were asked to express their opinions about snack consumption. Opinions were assessed by the following questions: "How often do you eat snacks?" (1 = Do not eat, 2 = 1-2 times/week, 3 = 3-4 times/week, 4 = 5-6 times/week, 5 = Every day, and 6 = Other), "What are the top 3 snacks you like?", and "How much do you usually spend for a snack?" (1 = less than 10 baht, 2 = 10-15 baht, 3 = 15-20 baht, 4 = 20-25 baht, and 5 = more than 25 baht). In the last week of the intervention, they were asked about their willingness to eat snacks in the future by the following question: "Would you like to eat these desserts and drink soy milk in the future?" (1 = Yes, 2 = No) at the end of the study.

A five-point facial hedonic scale was used to evaluate the acceptability of desserts, including appearance, aroma, texture, taste, and overall acceptability (1= Very bad, 2=Bad, 3= Okay, 4= Good, 5= Very good) (8).

The study protocol and procedures were approved by the Ethical Committee of the Faculty of Public Health, Chiang Mai University, Thailand. Protocol number ET019/2020 was conducted in accordance with the Helsinki Declaration of 1975.

Statistical analyses were performed using SPSS Version 22 (IBM SPSS Statistics, Chicago, IL, USA). The Shapiro Wilk test of normality was run to determine whether data variables met parametric assumptions. Data were presented as mean±SD for normal distribution or median and interquartile range (IQR) for non-normal distribution. The chi-square test or Mann-Whiney U test was used to examine the difference in characteristics between groups at baseline. Friedman test was employed for a within group comparison of the effects of the intervention on anthropometry indices at different time points. Concerning significant differences, a pairwise Dunn-Bonferroni Post-hoc test was applied to detect these differences. Wilcoxon signed-rank test was used to compare dietary intakes at baseline and during the intervention within groups. All tests were two-tailed, and a *P*-value less than 0.05 was considered statistically significant.

RESULTS

Figure 1 Flow chart of participants, five hundred and seventy participants were assessed for eligibility. Five hundred and thirty-six participants were excluded due to not met inclusion criteria (n=336) and refused to participate (n=200). Out of 34 participants, 29 completed the study (85%). Dropouts were participants who failed to complete the study because of acute illness (intervention group, n=2), relocation (intervention group, n=1), and personal reasons (control group, n=1 and intervention group, n=1).

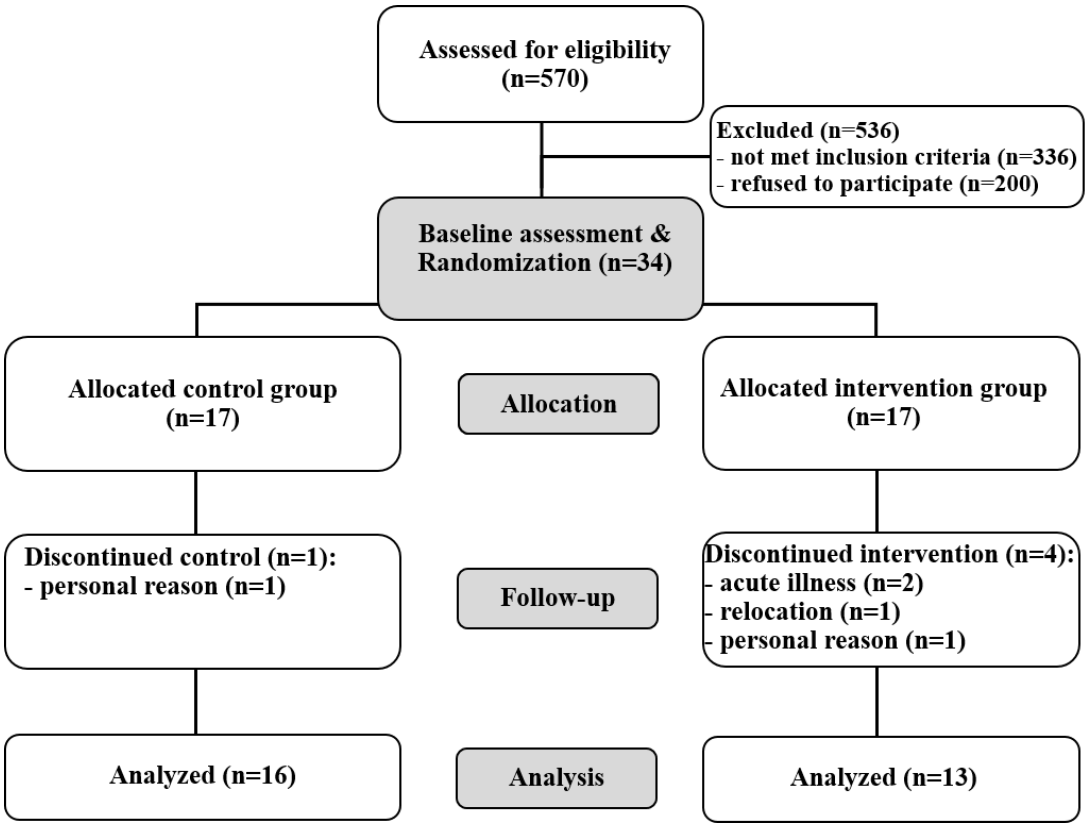

Figure 1. Flow chart of participants

Table 1 showed baseline characteristics of participants, 77% and 23% of the participants were females (n=22) and males (n=7), respectively, with average age of 71.8±4.9 years. Out of 29 participants, 22 had chronic diseases (76%): 15 hypertension (52%); 5 dyslipidemia; 2 gastrointestinal diseases (7%). Mean body weight and height was 43.5±5.8 kg and 151.1±6.4 cm, respectively. Furthermore, mean BMI, TSF (median ± IQR), MAC, and grip strength were 19.1±2.2 kg/m^2, 18.7±3.9 mm, 23.9±2.1 cm, and 17.5±3.4 kg, respectively. All anthropometric parameters were not different for the control and the intervention groups at baseline (week 0).

In addition, the average daily energy intake was 1284±189 kcal, and no differences were observed in the mean of energy, protein, and lipid intake between the control and the intervention groups at baseline except for carbohydrate intake (P=0.029).

Table 1. Baseline characteristics of participants

Variable	All (n=29)	Control (n=16)	Intervention (n=13)	P value
Age (years), mean±SD	71.8 ± 4.9	71.5±4.7	72.1±5.3	0.372
Gender (female/male)	22/7	13/3	9/4	0.451
Chronic diseases, n (%)	22 (76)	11 (69)	9 (69)	0.978
Hypertension, n (%)	15 (52)	6 (38)	7 (53)	0.379
Dyslipidemia, n (%)	5 (17)	4 (25)	1 (8)	0.219
Gastrointestinal diseases, n (%)	2 (7)	1 (7)	1 (8)	0.879
Body weight (kg), mean±SD	43.5± 5.8	44.4±5.0	42.5±6.6	0.358
Height (cm), mean±SD	151.0±6.4	151.4±5.1	150.5±7.9	0.322
BMI (kg/m^2), mean±SD	19.1±2.2	19.4±2.4	18.7±1.9	0.347
TSF (mm), median±IQR	18.7±3.9	18.1±3.8	19.4±3.9	0.322
MAC (cm), mean±SD	23.9±2.1	23.9±2.1	23.8±2.2	0.810
Grip strength (kg), mean±SD	17.5±3.4	17.4±3.2	17.5±3.8	0.897
Energy (kcal/day), mean±SD	1284±189	1242±211	1336±152	0.153
Protein (g), median±IQR	48.6±8.0	47.7±8.4	49.7±7.5	0.646
Lipid (g), mean±SD	29.9±8.4	30.8±9.1	28.7±7.8	0.596
Carbohydrate (g), mean±SD	206.2±33.6	195.1±36.6	219.8±24.2	0.029

Note. SD: Standard deviation; IQR: Interquartile range; BMI=body mass index; TSF=triceps skinfold, MAC=mid- arm circumference.Chi-square test or Mann-Whiney U test was used to exam the difference in characteristics between groups at baseline, $P<0.05$.

The intervention group had high dietary compliance (94% consumed), and their mean energy intake from the intervention snack was similar to the supply. Table 2 presents daily energy and macronutrient intakes at week 0 and week 1 to 7. With the intervention snack, there were increased daily intakes of energy by 280±118 kcal (P=0.001); of lipid by 16±6 g (P=0.001); of protein by 7±7 g (P=0.025); and of carbohydrate by 29±17 g (P=0.001), compared to week 0. Such increases were not observed in the control group. Figure 2 illustrates the daily energy intake (mean±SD) at weeks 0, and week 1 to 7. As a result of the intervention snack, the intervention group's daily energy intake was significantly higher than the control group's (P<0.001).

Table 2. Daily energy and major macronutrient intakes at week 0, and week 1 to 7

Variable	Control group (n=16)		P	Intervention group (n=13)		P
	Week 0	Week 1 to 7	value	Week 0	Week 1 to 7	value
Energy (kcal)	1242±211	1290±190	0.180	1336±152	1616±178	0.001
Protein (g)	47.7±8.4	52.1±9.0	0.099	49.7±7.5	55.7±10.0	0.025
Lipid (g)	31.0±9.1	37.2±10.1	0.050	28.7±7.8	44.6±9.1	0.001
Carbohydrate(g)	195.1±36.6	191.6±26.0	0.873	219.8±24.2	248.5±28.0	0.001

Note. SD: Standard deviation; Data are expressed in mean±SD. Wilcoxon signed-rank test was used to exam the difference in energy and major macronutrient intakes with-in groups between week 0 and week 1 to 7, $P<0.05$.

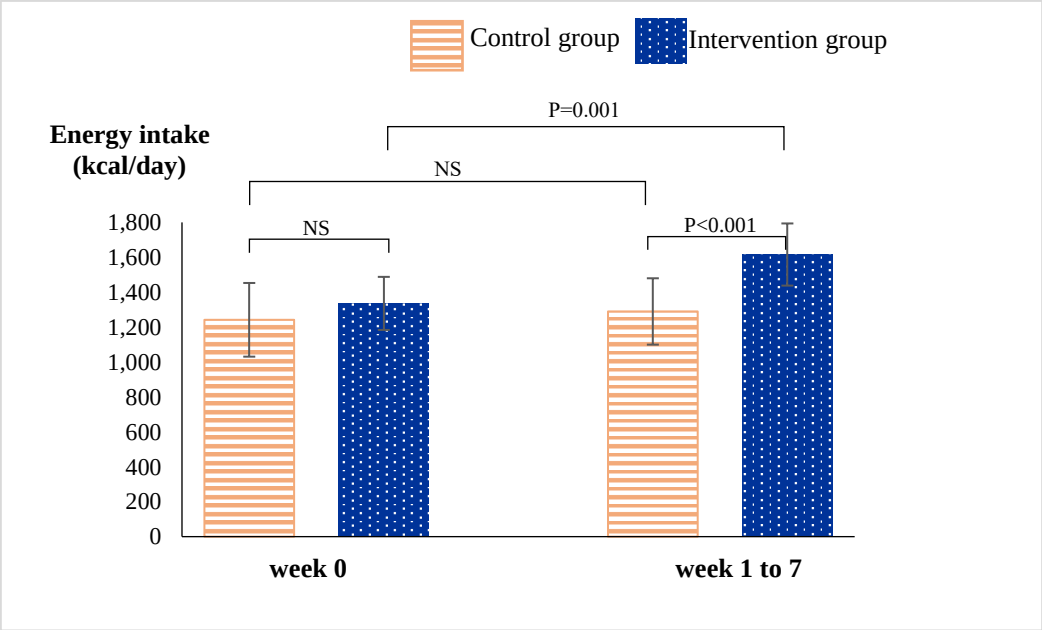

Figure 2. Daily energy intake (mean±SD) at week 0 and week 1 to 7.

Note. SD: Standard deviation; Data are expressed in mean±SD, significant difference within the group and between the group based on Wilcoxon signed-rank test and Mann-Whiney U test, $P<0.05$.

Table 3 presents anthropometric parameters at weeks 0, 3, and 7. In the intervention group, there were 2%, 2%, and 4% increases in average body weight (P<0.001), BMI (P=0.009), and MAC (P<0.001), respectively, while, TSF and grip strength remained stable. In the control group, all the anthropometric parameters remained unchanged. Figure 2 shows a change of mean body weight (kg) at weeks 3 and 7 compared with week 0. In the intervention, the mean body weight increased nearly 0.8 kg at weeks 3 and 7 (P=0.019 and P=0.041, respectively), but it did not increase in the control group.

The participants' opinions about snack consumption were evaluated by the following

questions: "How often do you eat snacks?" Most participants (44%) and 24% of them ate a snack every day and 3-4 days/week, respectively, while 18%, 12%, and 2% did not eat snack, eat 1-2 days/ week, and eat snack 5-6 days/week, respectively. Concerning the question "What are the top 3 snacks you like?" the answers were categorized into four groups: The favorite snacks were traditional Thai dessert (34%), bread and crackers (28%), drinks such as soy milk, cows' milk, cocoa powder in milk, and the like (21%), and seasonal fruit (17%). With regard to the question "How much do you usually spend for a snack?", it was found that more than half of the participants (55%) usually spent 10-15 baht for a snack (per serving), less than 10 baht (27%), and 15-20 baht (18%).

An intervention snack provided mean daily energy of 548±20 kcal, 10.7±2.7 g protein, 20.3±3.8 lipids, 80.7±10.0 g carbohydrate, and a protein, lipids, carbohydrate energy ratio of 7:33:60. An example of some desserts, ingredients, energy, and macronutrient contents is provided in the appendix. The overall acceptability scores in 34 kinds of desserts were found to be good with a mean ± SD of 4.19±0.59. Appearance, aroma, texture, and taste scores were 3.95±0.55, 3.92±0.58, 4.08±0.60, and 4.06±0.62, respectively. Participants were asked for their opinion about their willingness to eat snacks and milk in the future, and the results indicated that all of them were willing to continue eating these items.

Table 3. Anthropometric parameters at week 0, 3 and 7

Variable	Control (n=16)			P value	Intervention (n=13)			P value
	Week 0	Week 3	Week 7		Week 0	Week 3	Week 7	
Body weight (kg)	44.4±5.0	44.4±5.3	44.5±5.4	0.814	42.5±6.6[a]	43.3±6.7[b]	43.2±6.9[b]	<0.001
BMI (kg/m^2)	19.4±2.4	19.4±2.4	19.4±2.4	0.662	18.7±1.9[a]	19.0±1.9[b]	19.0±2.1[b]	0.009
TSF (mm) [*]	18.1±3.8	19.3±4.8	19.5±5.1	0.362	20.7±4.0	21.0±5.3	21.0±5.0	0.620
MAC (cm)	23.9±2.1	24.0±2.2	24.2±2.4	0.066	23.8±2.2[a]	24.4±2.0[a,b]	24.7±2.0[b]	<0.001
Grip strength (kg)	17.4±3.2	17.7±3.7	16.8± 3.7	0.117	17.5±3.8	17.7±3.9	17.7±3.8	0.679

Note. SD: Standard deviation; IQR: Interquartile range; BMI: body mass index; TSF; triceps skinfold; MAC: mid-arm circumference. Data are expressed in mean±SD, [*]median±IQR. Different superscripts [a, b, c] mean significant difference within the group comparison based on Friedman test, $P<0.05$.

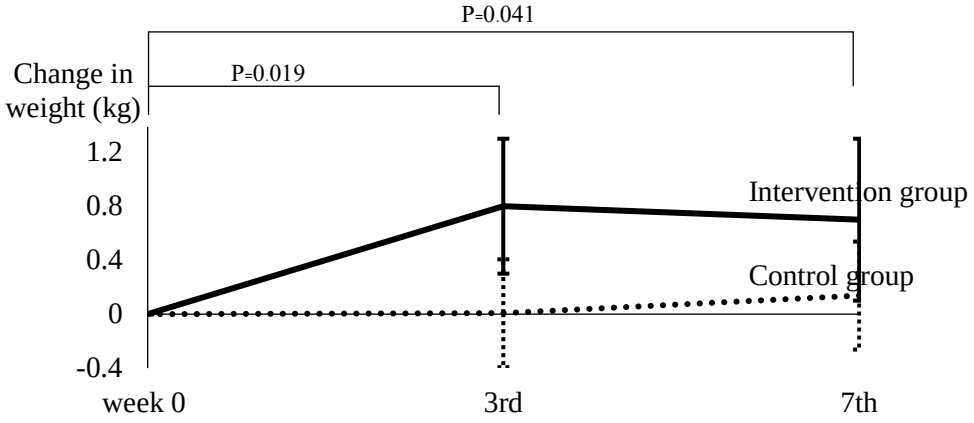

Figure 3 . Change of mean body weightk ,g at week 3 and 7 compared with week 0

Note. SD: Standard deviation; Data are expressed in mean±SD. Significant difference within the group based on pairwise Dunn-Bonferroni Post-hoc test, $P<0.05$

DISCUSSION

This randomized controlled study with a 7-week intervention period investigated the effects of snacks on energy and nutrient intakes, and nutritional status in community-dwelling older adults at risk of malnutrition. We found that providing snacks was an effective way to improve energy and nutrient intakes, and nutritional status.

In the current study, in the intervention group, there was an increased of daily energy intake ($P=0.001$) and the energy requirements were met, recommending 1539 and 1744 kcal/day for female and male adults aged 71 years and older with light activity, respectively (9). On the other hand, the control group had an average daily energy intake that remained consistently lower than the recommended requirements (consumed 1242±211 to 1290±190 kcal/day) during the study. This may be due to the beneficial effect of snacks as a good source of energy and nutrients. Generally, older adults have less appetite with early satiety and consume smaller meals than young adults due to physiological changes, including gastrointestinal dysfunction such as maldigestion and malabsorption, dental problems such as loss of teeth that impact oral function, and dry mouth syndrome that affects the perception of taste and smell (10, 11). These may suggest that older adults are unable to meet their nutritional requirements through the regular 3 main meals Therefore, providing snacks may be a good choice for undernourished older adults as snacks can contribute up to nearly a quarter of daily energy intake.

A variety of intervention snacks with different colors and appearances was prepared in this study, which may have contributed to the participants' satisfaction and encouraged them to consume more. This is reflected in the current study that the compliance with the intervention snacks was considerable, and the intervention group consumed almost all of them, accounting for 94% of supplied calories. This is consistent with previous studies that reported the variety and palatability of snacks contribute to the satisfaction of older adults and increase of intake

(12-14).

In this study, the intervention snacks were prepared based on participants' preferences and familiarity. They had soft or tender textures and were easy to chew by cutting ingredients into small pieces or bite-sizes, cooking methods (e.g., boiling, steaming, stirring, and syrup until the texture was softened or tender), being broken apart with the side of a fork. These methods may have been appropriate for our participants who had dental problems such as tooth decay, loss of teeth, and gingivitis. We found that the participants were well satisfied with the texture of the snacks. A small number of the participants were sensitive to the smell of soybeans and disliked it. Therefore, we tried to improve the aroma through a simple and common method by adding fresh pandan leaves, while cooking it helped reduce the smell of soybean and increase the pleasant aroma in the snacks. Using this method, the participants accepted the smell of soybean-based snacks to a great extent. After evaluating the acceptability of the snacks, we found that the participants were well satisfied with the taste and overall appeal of the snacks.

Some studies have reported that snacks were associated with increased energy and protein intake and prevented weight loss in hospitalized older adults at risk of malnutrition (15-17). Results of this study are in line with some studies. For example, a study provided energy-rich and protein-fortified snacks (approximately 500 kcal and 30 g of protein per day) in 46 hospitalized older adult patients with mean age of 68.7±13.2 years. Through the intervention, daily energy intake and protein intake increased from 74% to 109% ($P<0.00$) and from 49% to 88% ($P<0.00$) of requirements, respectively (18). The protein provided by that study was almost 3 times higher than that provided in our study which may be due to the fact that the participants in that study were hospitalized patients with more serious health conditions, needing more protein than those in our study who were community-dwelling older adults without serious health conditions.

Another study evaluated the influence of snacking on energy intake in 2002 older

Americans aged 65 and over using 24-hour recall data from the National health survey. Results showed that, in older adults at risk of malnutrition, snacking contributed to higher daily intakes of energy carbohydrate, lipid, and protein compared to no snacking (19). We assume that snacking is a crucial dietary pattern of older adults that may encourage them to eat adequate energy and nutrients.

Although, in this study, the intervention group was found to slightly decrease its basic meals (usual diet) consumption from baseline to the last week of each experimental phase, the total energy intake in the intervention group still increased by approximately 300 kcal per day and met the recommended level. This may be because of the fact that the participants preferred snacks and ate almost 500 kcal/day, leading to a satiety feeling and reduced consumption at the next basic meal. A similar trend was reported in some studies (20).

In the present study, older adults at risk of malnutrition provided with snacks for the first 3 weeks exhibited the significant gain body weight of almost 0.8 kg. However, other parameters such as TSF, MAC, and grip strength were tended to increase but were not significant. Therefore, we continued the study for a total of 7 weeks. The results by the intervention snack indicated that there was an increase in body weight ($P=0.005$), BMI ($P=0.001$), and MAC ($P=0.039$), while no statistically significant changes were observed in anthropometric parameters in the control group.

These findings are consistent with a study (30) that provided snacks (approximately 145 kcal and 6.3 g of protein/5 days per week) for 4 weeks among community-dwelling older adults (mean age of 81.3±10.9 years). After intervention, mean body weight increased approximately 0.7 kg ($P=0.008$), and BMI increased by 0.78±1.16 kg/m^2 ($P=0.039$).

In this study, we did not separate the data by gender (male and female). The following reasons were considered: firstly, this study was an intervention study that examined changes in main dependent variable (energy intake). In opposite to survey study that collect data from a

sample of individuals, gender differences may affect the expression of the population. Secondly, the number of participants was quite limited, with more than 70% of participants being women, male participants were difficult to find, especially during the COVID-19 pandemic. Thirdly, the baseline characteristics of participants were similar or homogenous, such as similar age, health status, anthropometry data and daily energy intake. Finally, the results showed that the intervention group had a significantly increased in energy intake compared with the control group ($P<0.001$) with a power of 99.7%.

The considerable strengths of the current study are as follows. The first point is that this study sufficiently showed that the cost of snacks was affordable similar to the possible price that participants usually spent on snacks, and all participants were willing to continue eating snacks in the future. Therefore, this may be an alternative strategy to suggest in community-dwelling older adults at risk of malnutrition to increase energy and nutriets intake, and nutritional status.

Another remarkable strength of the current study is that participants' snack preferences were studied and used in the planning of the intervention snack, while this was not found in other previous studies. Furthermore, according to the findings, this is the first study conducted in Chiang Mai in the northern region of Thailand. The current study has also obvious strengths in terms of adapting local menus and employing readily available and familiar local ingredients. For all items in this study, we followed a traditional cooking method taught by local cookers. The general characteristics of all the adapted menus are similar to the local traditional menus. As a result, the sample group readily accepted these items.

On the other hand, the current study suffers from some weaknesses as we discovered. The created menus may have a flavor that slightly differed from the original as a result of some ingredients added to enrich the nutritional value. The next limitation is related to the small sample size which may decrease the strength of the study; further, the intervention period was

only 7 weeks that may be too short to detect changes in the body composition or functional status such as TSF and grip strength. Therefore, further study is suggested to confirm these results in a larger group with longer duration. However, these findings are crucial due to the high prevalence of undernutrition and its risks among older adults. Dietitians and other health care providers can apply this information to effective meal planning and dietary counseling among community-dwelling older adults at risk of malnutrition.

Given the results of the current study over a 7-week intervention period, we have shown a simple way of providing snacks that were effective to increase energy and nutrient intakes, meet recommended requirements, and improve nutritional status in community-dwelling older adults at risk of malnutrition.

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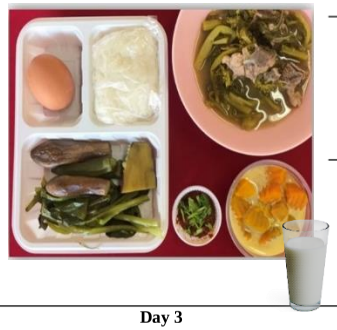
Lastly, I would be remiss in not mentioning my family, especially my parents, brother, spouse, and colleagues. Their belief in me has kept my spirits and motivation high during this process.

Yupa Chanwikrai

July 28, 2022

APPENDIX

Appendix 1. Food composition, energy, and major nutrients content of the three-day lunches and snacks during control and intervention periods

Control period	Composition	E kcal	P g(%)	F g(%)	C g(%)	Intervention period	Composition	E kcal	P g(%)	F g(%)	C g(%)
Day 1	**Total lunch + snack**	**643**	**31 (20%)**	**21 (29%)**	**82 (51%)**	**Day 1**	**Total lunch + snack**	**958**	**44 (18%)**	**38 (36%)**	**111 (46%)**
	**Lunch** :wax gourd soup with chicken	210	13	13	11		**Lunch**:w ax gourd soup with chicken	245	13	16	11
	Chili paste with ground pork, tomato	127	13	6	6		Chili paste with ground pork, tomato, egg	185	18	10	6
	Boiled vegetables	26	1	0	5		Boiled vegetables	26	1	0	5
	Glutinous rice	235	5	0	54		Glutinous rice	235	5	0	54
	Total lunch	**598**	**31**	**19**	**75**		**Total lunch**	**691**	**37**	**26**	**76**
	Snack: Pandan jelly	**44**	**0**	**2**	**7**		**Snack**: Pandan jelly, soymilk	**267**	**7**	**11**	**35**
Day 2	**Total lunch + snack**	**802**	**30 (15%)**	**32 (36%)**	**99 (49%)**	**Day 2**	**Total lunch + snack**	**1,170**	**37 (13%)**	**55 (42%)**	**131 (45%)**
	**Lunch**: cabbage soup	224	14	16	6		**Lunch**: cabbage soup	303	14	24	6
	Chili paste	20	1	0	4		Chili paste	60	1	4	4
	Boiled vegetables	26	1	0	5		Boiled vegetables	26	1	0	5
	Boiled egg	76	7	5	1		Boiled egg	76	7	5	1
	Glutinous rice	235	5	0	54		Glutinous rice	235	5	0	54
	Total lunch	**580**	**28**	**22**	**68**		**Total lunch**	**699**	**29**	**34**	**70**
	Snack: Sweet pumpkin	**222**	**2**	**10**	**31**		**Snack**: Sweet pumpkin topping with coconut milk, soymilk	**471**	**8**	**21**	**62**
Day 3	**Total lunch + snack**	**739**	**46 (25%)**	**16 (20%)**	**102 (55%)**	**Day 3**	**Total lunch + snack**	**1,059**	**55 (20%)**	**36 (31%)**	**129 (49%)**
	**Lunch**:m ixed vegetable soup, chicken	220	12	13	13		**Lunch** :mixed vegetable soup, chicken	279	12	20	13
	Spicy soup with fish	126	26	2	2		Spicy soup with fish	146	26	4	2
	Glutinous rice	235	5	0	54		Glutinous rice	235	5	0	54
	Total lunch	**581**	**43**	**15**	**68**		**Total lunch**	**660**	**43**	**24**	**69**
	Snack: Glutinous rice, perilla seed	**158**	**3**	**1**	**34**		**Snack**: Glutinous rice, perilla seed, soymilk	**399**	**11**	**13**	**60**

E = energy; P = protein; F =f at; C = carbohydrate

Appendix 2. Examples of some desserts, ingredients, energy and macronutrient contents

Menu	Ingredient (weight %)	E(kcal)	P(%)	F(%)	C(%)
 Purple sweet potato coconut milk (150 g)	34% purple sweet potatoes, 13% coconut milk, 13% soy milk, 34%water, 6%sugar, <1%salt	200	6	36	58
 Sweet glutinous rice with custard (100 g)	43% glutinous rice, 18% egg, 25% coconut milk, 6% coconut oil,<1%rice flour, 9%sugar, <1%salt	222	7	40	53
 Tapioca pearl with coconut milk (150 g)	12%tapioca pearl, 12%sweet corn, 8% coconut milk, 8%soy milk, 40%water, 20%sugar, <1%salt	208	4	17	79
 Milk custard with fruit salad (150 g)	40% coconut milk, 35% soy milk, 1% agar, 1% gelatin, 14% mixed fruits, 5%sugar, <1%salt	218	5	57	38
 Coconut jelly (100 g)	19%coconut milk, 19% soy milk, 39% coconut water, 12% coconut meat, 1%agar, 9%sugar, <1%salt	153	3	41	56
 Mung bean flour and coconut dessert (50 g)	7% mung bean flour, 2% rice flour, 7% coconut milk, 7% soy milk, 12%sugar, <1%salt,	152	3	24	73

Menu	Ingredient (weight %)	E(kcal)	P(%)	F(%)	C(%)
 Egg jelly (100 g)	21% egg, 1% agar, 12% coconut milk, 11% soy milk, 43% water, 13% sugar, <1%salt	175	11	36	53
 Sweet potatoes in heavy syrup (100 g)	37%sweet potatoes, 7% coconut milk, 7% soy milk, 25% water, 25% sugar, <1%salt	187	2	14	84

Note. E = energy, P, F and C: The percentage of protein, fat and carbohydrate to total energy. The estimated dessert cost per 1 serving was 13 baht.

Examples of some desserts in the study

Appendix 3. 24-Hour Food Recall Form

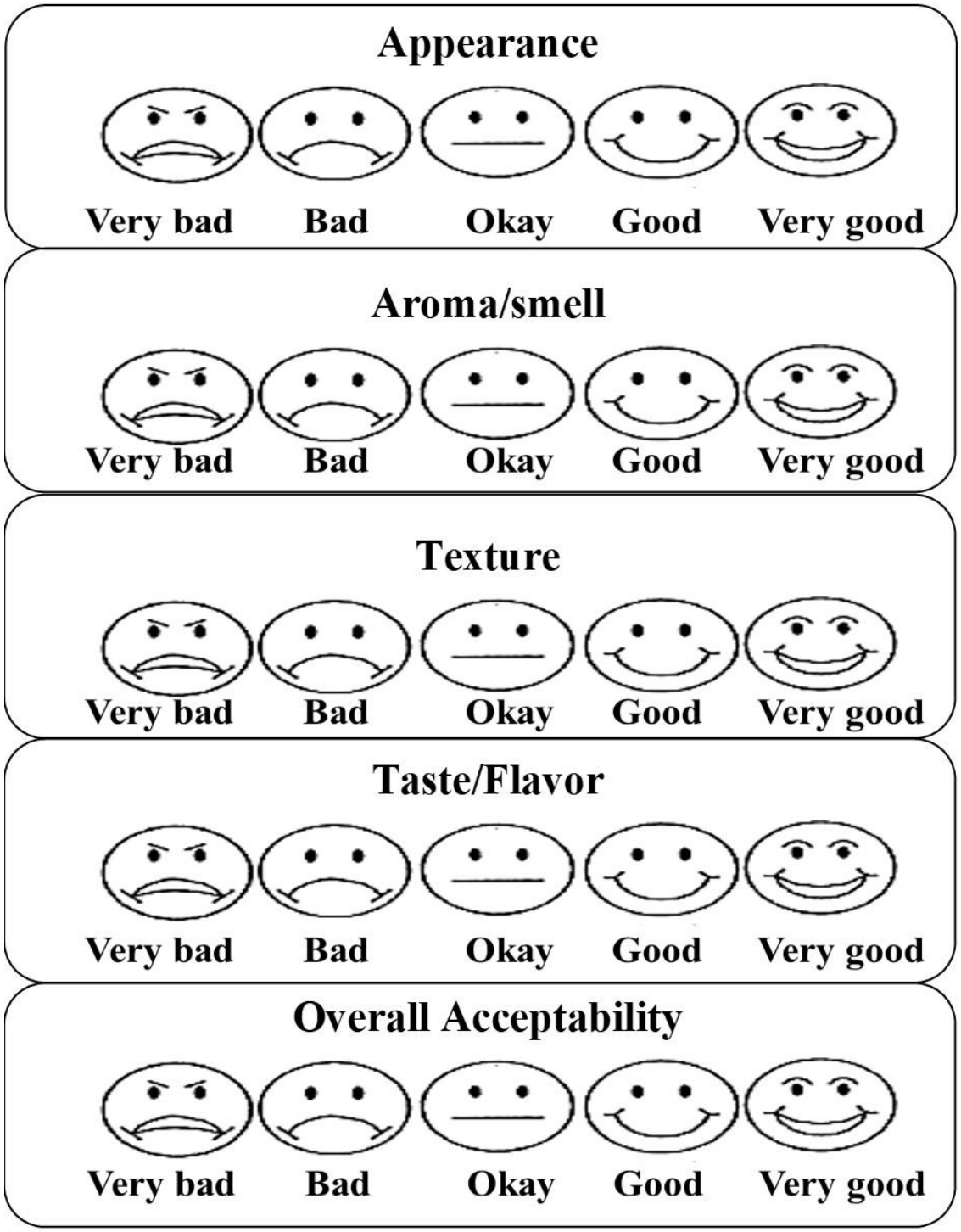
Date of interview...............................

Participant Name..........................…........……………………….…..............Age..........years
Date Food Record..................☐ Weekday ☐ Weekend; ☐ Ordinary meals ☐ Extra meals

Meal/Time	**Food or beverage consumed**	**Composition**	**Amount consumed**	**Comment**

Appendix 4. Sensory evaluation form

Participant Name.....
Menu Name..... Date of interview.....
Direction: Please circle one rating in the facial for each of the following:



Appendix 5. Survey of snack consumption

Participant Name.....

1. How often do you eat snacks?
   1= Do not eat
   2= 1-2 times/week
   3=3-4 times/week
   4= 5-6 times/week
   5= Every day
   6=Other
2. What are the top 3 snacks you like?
   1……..
   2……..
   3……..
3. How much do you usually spend for a snack?
   1= less than 10 baht
   2= 10-15 baht
   3= 15-20 baht
   4= 20-25 bah
   5=more than 25 baht
4. Would you like to eat these desserts and drink soy milk in the future?
   1 = Yes
   2 = No

Appendix 6. Academic Publication (1)

Yupa Chanwikrai, Jukkrit Wungrath, Sunard Taechangam, Chanida Pachotikarn, Shigeru Yamamoto. Frequent Snacks Improved Energy Intake and Nutritional Status in Community-Dwelling Older Adults at Risk of Malnutrition, Chiang Mai, Thailand. Journal of Education and Community Health. 9(1) p.11-17. 2022.

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Nutritional Behaviors

Original Article

Frequent Snacks Improved Energy Intake and Nutritional Status in Community-Dwelling Older Adults at Risk of Malnutrition, Chiang Mai, Thailand

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Abstract

Background: Inadequate dietary intake and malnutrition are commonly found in older adults. They tend to have early satiety that limits intake from main meals. Some reports indicated that small frequent meals may promote higher intake. From that point of view, snacks may be useful. Therefore, this study aimed to determine the effects of frequent snacks on energy intakes and nutritional status in older adults at risk of malnutrition.

Methods: A randomized controlled study was conducted among older adults at risk of malnutrition in a suburban community from November 2020 to March 2021 in Chiang Mai, Thailand. Two villages were randomly assigned to either a control group (n=17) or an intervention group (n=17), and they were matched pairs by age and gender. An intervention snack consisted of 2 desserts and a box of milk (total 548 kcal) was used. For the first 3 weeks, an intervention snack was provided every day although it was too heavy for some participants. Therefore, after that, the intervention snack was provided every other day for 4 weeks. A nutrition survey by the 24-hour recall method for 3 days, body weight, mid-arm circumference (MAC), triceps skinfold (TSF), and grip strength were assessed at weeks 3 and 7 as baseline.

Results: Thirty-one participants completed the study (91%). The average age was 71.8±4.8 years, and body mass index (BMI) was 19.0±2.1 kg/m^2. In the intervention snack group, there was an increased daily energy intake by 316 kcal and 214 kcal at weeks 3 and 7, respectively, (P<0.001, effect size: 0.884), with a body weight of 0.8 kg (P<0.001, effect size: 0.314), BMI of 2% (P=0.009, effect size: 0.314), and MAC of 4% (P<0.001, effect size: 0.265) compared with baseline, but such energy intake was not observed in the control group.

Conclusion: Providing frequent snacks was an effective way to improve energy intake and nutritional status in community-dwelling older adults at risk of malnutrition.

Keywords: Age, Nutritional intake, Energy intake, Snack food

Appendix 6. Academic Publication (2)

Yupa Chanwikrai, Jukkrit Wungrath, Sunard Taechangam, Chanida Pachotikarn, Shigeru Yamamoto. Energy Rich Snacks May be Preferable to Lunch with High Lipid to Increase Energy Intakes in Older Adults at Risk of Malnutrition, Northern Thailand. Asian Journal of Dietetics. 3(2) p.49-54.2021.

Research Note

Energy Rich Snacks May be Preferable to Lunch with High Lipid to Increase Energy Intakes in Older Adults at Risk of Malnutrition, Northern Thailand

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ABSTRACT *Background:* Our previous studies have shown that undernourished older adults in Northern Thailand had low lipid intake, resulting in energy deficiency. To increase energy intake, perhaps we could suggest two methods, one is to increase lipid in lunch and the other is an energy rich snack. *Aims:* To investigate effects of lunch with high lipid or an energy rich snack on energy intakes in older adults at risk of malnutrition. *Method:* Participants were 8 elderly people (average age 70.8±4.1 years) with risk of malnutrition (body mass index 17.8±2.0 kg/m^2). A randomized cross-over design was used to compare dietary intake under two diets: control (regular diet) and intervention (energy enhanced with lipids in meal and snack) on three days. Washout period was two days. In this study, energy was enhanced only for lunch and snack, but not breakfast and dinner. Energy for lunch was increased with rice bran oil. Energy in the snack was increased with coconut milk/peanuts and a box of soy milk. A 24-hour dietary survey using the recall method was conducted for the 3 days before, and during each of the two periods. *Results:* Although the energy supply at lunch in the intervention period was increased to about 700 kcal from about 600 kcal in the control period, the intake was similar between the two periods, being about 450 kcal, suggesting that the subjects could not eat increased lipids, maybe because of the large portion size. Average energy intakes from energy-rich snacks increased by about 2.5 times of the control (from 122±34 to 313±48 kcal, P=0.012), maybe because the portion size was small, resulting in about a 200 kcal increase per day (from 1,312±153 to 1,511±190 kcal, P=0.012). *Conclusion:* From the present study, we found that in older adults at risk of malnutrition, increasing energy from snacks is more acceptable than lunch with high lipid.

Key words: energy intakes, snacks, meals, older adults, risk of malnutrition

INTRODUCTION

Inadequate energy and protein intakes are frequently reported in the elderly (1), thereby increasing the risk of malnutrition. The Thai National Health Examination 2014 reported the prevalence of malnutrition in older aged 60 - 69 years as approximately 10% in males and 4% in females and this increased at advanced ages (2).

Our previous study (3) that showed older adults dwelling in community settings in northern Thailand had inadequate energy consumption, with estimated daily energy and lipid intakes accounting for 92% and 40% of the Thai recommended dietary allowances (RDA).The prevalence of underweight as determined by body mass index (BMI) < 18.5 kg/m^2 was reported as 18% in males and 9% in females, which was two times as high as underweight in the survey of the Thai National Health Examination.

This study was conducted before the main study. The first reason was that we did not know whether our undernourished participants could consume higher lipid than their current intake. We tried to find from various studies what kind of lipids are better accepted by malnourished elderly. In some papers the advantages of oleic acid were reported. Oleic acid has a lower satiating effect than other fatty acids such as saturated and long-chain polyunsaturated fatty acids (4). We looked for oleic acid-rich foods common in Northern Thailand and found that they are peanut oil (45-53%) (5) and rice bran oil (43.9%) (6). Therefore, in the present study, for the intervention lunch, we used rice bran oil. Soybean oil was used in the control diet because it is the most common oil.

In our previous study, we observed that the frequency and the energy of snacks were low. Therefore, in this study we tried to increase the energy from snacks by adding ground peanuts that contain high oleic acid and also used coconut milk, which is rich in energy and tasty. In addition, soy milk was offered as a substitute for milk by people who are lactose intolerant as well as low cost and nutritious.

It is important to explore the effective strategies to promote adequate dietary intake in community dwelling elderly. This will be helpful in preventing or slowing progression of chronic diseases and diminish hospitalization. The Objective of this study was to investigate effects of lunch with high lipid and energy rich snack on energy intakes in older adults at risk of malnutrition.

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Appendix 7. Poster Presentation Report (1)

The Silver Jubilee

PENSA CONGRESS 2021

Joining Hands to Improve Quality of Nutrition Support Practices

CERTIFICATE OF PRESENTATION

[POSTER PRESENTATION]

Effects of snacks on energy and nutrient intakes and anthropometric indices in older adults at risk of malnutrition, northern Thailand

YUPA CHANWIKRAI

For presenting at the Silver Jubilee of The Parenteral and Enteral Nutrition Society of Asia (PENSA), the 21st PENSA Congress 2021
[Virtual Congress]
October 14-16, 2021

Assoc. Prof. Soranit Siltharm	Dr. Winai Unpinitpong	Prof. Kaweesak Chittawatanarat	Assist. Prof. Pornpoj Pramyothin
PENSA DIRECTOR	CONGRESS PRESIDENT	CHAIR, SCIENTIFIC COMMITTEE	RESEARCH COMMITTEE

Appendix 7. Poster Presentation Report (2)

[ACD 2022] Notification of Poster Acceptance

ACD2022 Program Office <acd2022-p@jtbcom.co.jp>
Tue 4/19/2022 9:16 AM
To: da19501 CHANWIKRAI YUPA <da19501@jumonji-u.ac.jp>

Dear Ms. Yupa Chanwikrai,

We would like to take this opportunity to express my sincere thanks to you for submitting your abstract to the 8th Asian Congress of Dietetics (ACD 2022).

On behalf of the Program Committee, we are pleased to inform you that your following abstract has been accepted for **poster session**. Also, your abstracts will appear in the online abstracts to be published during the congress.

Abstract Reference No.: **0142**
Abstract Title: **Nutrition-Balanced Snack Increased Energy and Nutrient Intakes and Improved Nutritional Status in Community-dwelling Older Adults at Nutrition Risk, Chiang Mai, Thailand**

[Poster Viewing & Discussion]
Poster sessions will be held by using an interactive virtual event platform. No poster will be displayed at the onsite venue.
Congress participants can view the posters above on the virtual platform.
There is NO opportunities of the oral presentation by poster presenters (presenting authors).

All presenting authors are required to come to the congress venue in Yokohama for the discussion time as follows.

Poster No.: **PS-3-21**
Poster Topic: **Nutrition Education and Nutrition Through Life Course**
Your Discussion Date: **Friday, August 19, 2022 JST**
Your Discussion Time: **13:30-14:30 (60 minutes) JST**

You can discuss with congress participants in either way; face-to-face with onsite participants or remotely by video calling with online participants. Also, a multilingual translation tool will be available for communications (voice or chat) by native languages.
*Presenting author: ONSITE participation is required.
*Co-author or Congress participant: Online participation is acceptable.

[Poster Submission]
For the poster viewing during the congress, the presenting authors are required to submit their poster in English (e.g. 1 powerpoint slide without sound) on July13, 2022.
A poster template (in powerpoint format) is available at the website below. Please make your poster by using this template.
https://www.acd2022.org/files/ACD2022_poster_template.pptx

*The URL of online poster submission will be notified in June.

ACD2022

The 8th
Asian Congress of Dietetics

A000170

Certificate of Attendance

This is to certify that

Ms. Yupa Chanwikrai

has attended
The 8th Asian Congress of Dietetics (ACD 2022)
on August 19 - 21, 2022
at PACIFICO Yokohama, Japan.

Teiji Nakamura
Chair
Organizing Committee of the 8th Asian Congress of Dietetic