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Research Article
Low Compliance with Dietary Recommendations among Older Workers in Southern Thailand

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Abstract

Background and Objective: To maintain good health, older people must fulfill their nutritional needs. This study examined energy and nutrient intake among Thai older workers who were engaged in either informal or formal employment. **Materials and Methods:** A total of 303 Thai older workers aged 45-70 years from urban and suburban areas of Nakhon Si Thammarat province in southern Thailand were recruited using multistage random sampling. Data on dietary intake were collected with three24 h dietary recalls. The prevalence of inadequacy was estimated using the Thai Dietary Reference Intakes (Thai DRIs). **Results:** Of the total, 83.17 and 16.83% were classified as informal and formal workers, respectively. For men, the median iron intake of the formal workers was adequate, at 100.2% of the Thai DRIs but was significantly lower in the informal workers ($p = 0.032$). Overall, compliance with the recommendations was low: only 2.64, 6.60, 5.94, 3.96, 4.95, 0.99 and 4.95% of the older workers complied with the Thai DRIs for dietary fiber, calcium, vitamin A, vitamin B6, vitamin B12, magnesium and zinc, respectively, while none of the participants complied with the recommended vitamin E intake. Daily sodium intake was greater than the recommended (<2,400 mg) in 44.44 and 50.98% of the informal and formal workers, respectively. **Conclusion:** Low compliance with dietary recommendations among older workers calls for the government's intensified effort to formulate effective measures involving the development of health promotion interventions and the contribution of equitable access to healthy food. This study identified the determinants that may be used to guide this effort.

Key words: Nutrients, diet records, dietary recommendations, older workers, Thailand

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Because of the demographic shift from a younger to an older population age structure, Thailand is experiencing an increasing proportion of older workers in the workforce. Since 2007, Thailand has been an aging society in which more than 10% of the population is over the age of 60[1]. Specifically, a considerable proportion of the workforce that is informal remains a major characteristic of developing countries, including Thailand[2]. According to the National Statistics Office of Thailand, informal workers do not receive social security, whereas formal workers have a variety of legal and social security protections[2]. At present, older workers, generally defined as those aged 45 and older[3,4], constitute a vast share of informal workers. In 2018, of the total workforce in Thailand, 31.7% of informal workers were older workers, while only 13.4% older workers were employed in the formal sector[2]. Typically, informal workers face a substantial risk of illness or occupational injury due to surrounding insecurity, their employment status and alack of control over the conditions of their employment[5].

Older people are more likely to develop age-related changes in organs or systems that may interfere with the maintenance of a good nutritional status. These changes typically alter the individual's dietary habits or reduce the availability of energy and nutrients for absorption, which can result in diet-related illnesses[6], such as chronic osteoporosis[7], colorectal cancer[8], cardiovascular disease[9] and dementia[10]. Additionally, this growing population is becoming increasingly diverse in its nutritional requirements, which depend on several factors, including underlying diseases and related organ system limitations; an individual's level of physical activity, energy expenditure and energy requirements and the capability to access, prepare, ingest and digest food.

Public health authorities have used dietary recommendations in Thailand, as in many other countries, to assist consumers in making healthy nutrition-related choices. However, a specific public health intervention with regard to older workers has not been developed, primarily due to insufficient evidence on their energy and nutrient intakes. Therefore, the objective of this study was to estimate the energy and nutrient intakes and prevalence of inadequate dietary intake among older people who are currently working for pay in either an informal or formal employment system. The results of this study may provide information that is useful for preventive public health interventions focusing on nutrition-related diseases that affect rapidly growing proportion of older workers in Thailand's workforce.

MATERIALS AND METHODS

Participants: A cross-sectional study was conducted from February to August 2019 in 13 villages and in two districts (Mueang and Tha Sala) of Nakhon Si Thammarat province, which is located in southern Thailand. This province lies 780 km south of Bangkok, the capital of Thailand, along the Gulf of Thailand. These districts were selected due to the high proportion of older inhabitants, according to registered population data from the National Statistical Office of Thailand[11]. The population of interest was older workers, defined in this study as individuals aged 45 and over currently working for pay[3]. Thus, all participants in this study were older workers aged 45-70 years who were working in a paid job or were self-employed. The sample size was determined in the finite population using a previously described formula[12]. Following the statistical procedure, a total of 309 participants were recruited using a multistage random sampling technique. In each district, villages were selected at random, with probability proportional to size. Within each village, individuals were chosen based on randomly selected addresses received from municipal registry offices. After the data collection was performed, six participants who missed and did not show up for scheduled appointments for the anthropometric measurements were excluded from the study.

Ethics statement: The research protocol was approved by the Human Research Ethics Committee of Walailak University (WUEC-18-146-01; dated 28/12/2018). Permission to enter the villages was obtained from the heads of the villages. Written informed consent was obtained from the participants after the purpose of the study was explained to them and they were informed that the data would remain confidential.

Anthropometric measurements: Anthropometric measurements were taken by two full-time research assistants who were graduates from health science programs using standard equipment and standard procedures. Body weight[13], arm span[14] and waist circumference (WC)[15] were measured. The participants were weighed in light clothing and without shoes with calibrated mechanical body scales (RICE LAKERL-330HHD, Rice Lake Weighing Systems, Wisconsin, USA). The values obtained were expressed in kilograms. Arm span (in cm) and WC (in cm) were measured using non elastic measuring tapes (SECA 201, SECA GmbH AND Co. KG, Hamburg, Germany).

Due to changes in stature that occur with aging, arm span was alternatively used to predict the standing height of Thai

older adults[14] and to calculate their body mass index (BMI)[16]. According to the guidelines of the Regional Office for the Western Pacific (WPRO), overweight/obesity was defined as a BMI ≥23.0 kg m^{-2}, normal weight was defined as a BMI of 18.5-22.9 kg m^{-2} and according to WHO[15] underweight was defined as a BMI of<18.5 kg m^{-2}. To detect abdominal obesity, the WC cut-off values for Asian men and women were 85 and 80 cm, respectively[17].

Dietary assessment: The dietary assessment for energy and nutrient intakes included three interactive 24 h dietary recalls (24 h DRs) that were conducted on nonconsecutive days[18]. The 24 h DRs were conducted by research assistants who were trained and acquainted with the procedure protocol. Each participant was interviewed three times and each interview occurred 15 days apart. The first interview was a direct face-to-face interview in the participant's home, while the second and third interviews were telephone interviews. The participants were asked to recall and report all the foods and drinks that they consumed in the past 24 h. To obtain as much detail as possible regarding the portion sizes of the foods consumed, measuring spoons and cups, food photographs, detailed recipe ingredients and calibrated digital food scales (SUPER 3S-6K, SUPER, Taiwan) were used during the face-to-face interviews. The calculations of energy and nutrients were performed by using INMUCAL-Nutrient software version 4 (Institute of Nutrition, Mahidol University, Thailand). All entries were checked for accuracy by the researchers.

To identify inaccurate energy intake (EI) reports, the ratio of the reported Ei to the individual's basal metabolic rate (BMR) was calculated to determine whether the EI was consistent with the individual's energy requirement. The BMR was estimated using the Oxford predictive equations based on the weight, height, gender and age of the individuals[19]. For the EI/BMR ratio, a cut-off value of 0.9 was used to define under reported EI[20]. The participants were categorized into EI under reporters (EI/BMR ratio <0.9) and non-under reporters (EI/BMR ratio ≥0.9).

Comparison of energy and nutrient intakes with the dietary recommendations: The dietary intake was interpreted as showing compliance or noncompliance after it was compared with the Thai Dietary Reference Intakes (Thai DRIs) for adults (aged 45-70 years) provided by the Nutrition Division in the Department of Health in the Ministry of Public Health of Thailand[21] (Table 1). The Thai DRIs are a set of age- and gender-stratified science-based standards that are used to make recommendations for the Thai population with regard to the adequacy of nutrient intake. However, the Thai DRIs did not provide the estimated average requirement (EAR) or the tolerable upper intake levels (ULs), except for the ULs for calcium (UL = 2,500 mg day^{-1}), sodium (UL = 2,400 mg day^{-1}) and vitamin C (UL = 2,000 mg day^{-1})[21]. In this study, compliance with recommendations was defined as the level of energy and nutrient intakes falling within 80-120% of the Thai DRIs[22]. Noncompliance was defined as either in sufficient

Table 1: The Thai dietary reference intakes for adults aged 45-70 years

	Male		Female	
Energy and nutrients	Aged 45-50	Aged 51-70	Aged 45-50	Aged 51-70
Energy (kcal day^{-1})	2,100	2,100	1,750	1,750
Protein (g day^{-1})	57	57	52	52
Dietary fiber (g day^{-1})	25	25	25	25
Calcium (mg day^{-1})	800	1,000	800	1,000
Phosphorous (mg day^{-1})	700	700	700	700
Sodium (mg day^{-1})	475-1,450	475-1,450	400-1,200	400-1,200
Potassium (mg day^{-1})	2,450-4,100	2,450-4,100	2,050-3,400	2,050-3,400
Iron (mg day^{-1})	10.4	10.4	24.7	9.4
Vitamin A (µg day^{-1})	700	700	600	600
Vitamin C (mg day^{-1})	90	90	75	75
Vitamin E (mg day^{-1})	15	15	15	15
Thiamine (mg day^{-1})	1.2	1.2	1.1	1.1
Riboflavin (mg day^{-1})	1.3	1.3	1.1	1.1
Niacin (mg day^{-1})	16	16	14	14
Vitamin B6 (mg day^{-1})	1.3	1.7	1.3	1.5
Vitamin B12 (µg day^{-1})	2.4	2.4	2.4	2.4
Magnesium (mg day^{-1})	320	300	260	260
Selenium (µg day^{-1})	55	55	55	55
Zinc (mg day^{-1})	13	13	7	7

or excessive intake. Insufficient energy and nutrient intakes for each participant by age and gender were defined as intake values less than 80% of the Thai DRIs. Excessive intake was defined as intake values higher than 120% of the Thai DRIs and above the ULs for calcium, sodium and vitamin C.

Statistical analyses: The data obtained were coded and entered into Epi-info™ version 7.1.5, 2015 (Centers for Disease Control and Prevention, Atlanta, Georgia). All statistical analyses were completed using R software version 3.5.1, (2018)[23]. To determine whether the data were derived from a normal distribution, the Kolmogorov-Smirnov test was performed. The differences between informal and formal workers were analyzed using an unpaired t-test for comparing the means of normally distributed data and a Mann-Whitney U test for identifying median differences in non normally distributed data. The Chi-square test was used to assess the associations between categorical variables. Statistical significance was achieved when the p-value was less than 0.05.

RESULTS

Characteristics of informal and formal workers: A total of 303 participants, consisting of 252 (83.2%) informal workers and 51 (16.8%) formal workers, were interviewed. The informal older workers included agricultural workers, self-employed workers and service workers with a similar numerical distribution (n = 88, n = 84 and n = 80, respectively). Most of the formal workers were government officers and employees (n = 44), with the rest being government teachers (n = 7).

Table 2 presents the sociodemographic factors and anthropometric profiles of the informal and formal workers participating in this study. Significant differences in the gender ratios ($p = 0.001$), age groups ($p<0.001$), educational levels ($p<0.001$) and monthly income levels ($p<0.001$) between the informal and formal workers were found. However, significant differences in marital status between the informal and formal workers were not observed ($p = 0.180$). Based on the anthropometric profiles, the BMI and WC of the male formal workers were significantly higher than those of the male informal workers ($p = 0.002$ for the BMI and $p = 0.040$ for WC). Among the female workers, there were no significant differences in the BMI and WC between the informal and formal workers. Regarding nutritional status, the prevalences of overweight/obesity and abdominal obesity were not significantly different between the informal and formal workers.

The mean BMR and EI/BMR ratio between the informal and formal workers are presented in Table 2. The mean BMR (Mean±SD) was higher in the formal workers (1,395.6±167.1 kcal) than that of the informal workers (1,287.3±163.5 kcal) and the difference was significant ($p<0.001$). The mean EI/BMR ratio was similar for the informal (1.12±0.34) and formal workers (1.12±0.39). The percentages of EI under reporters were 36.11 and 43.14% of the informal and formal workers, respectively. With respect to the BMI, the percentage of EI under reporters was highest among participants with overweight/obesity (39.58%), followed by those with normal weight (33.69%) and underweight (31.58%).

The reported energy and nutrient intakes and comparison to the Thai DRIs: The daily energy and nutrient values determined by the three nonconsecutive-day 24 h DRs were successfully obtained for all 303 participants. The comparisons of the median energy and nutrient intake values with the Thai DRIs between the informal and formal workers are presented in Table 3 for the men and Table 4 for the women.

The median levels of energy, macronutrient (carbohydrate, protein and fat), dietary fiber and selected micronutrient intake values for the men in the formal worker group were higher than those for the men in the other worker group but the differences were not statistically significant ($p>0.05$), with the exception of those for sodium ($p = 0.037$) and iron ($p = 0.032$) (Table 3). When the median observed intake values for the men were compared with the Thai DRIs, the intake of energy, dietary fiber and most micronutrients was found to be below the Thai DRIs in both worker groups. At 100.2% of the Thai DRIs, the intake of iron by the formal workers was adequate but in the informal workers, the intake was 69.1% of the Thai DRIs, indicating a statistically significant difference in iron intake between the two groups ($p = 0.032$). The intake of calcium and vitamin B6 was substantially below the Thai DRIs in both groups of men, with a statistically significant difference between the groups ($p<0.05$). The sodium intake considerably exceeded the Thai DRIs in both groups of men and a significant difference in the groups was observed ($p = 0.035$).

With respect to the female participants (Table 4), there were no significant differences in the median daily intake of energy, macronutrients and most micronutrients between the informal and formal workers. Notably, the median intake values of vitamin B6, selenium and zinc in the female informal workers were significantly higher than those in the female

Table 2: Characteristics of the older workers (n = 303) between the informal and formal workers

Variables	Total (n = 303)	Informal workers (n = 252)	Formal workers (n = 51)	p-value[a]
(1) Gender, n (%)				
Male	100 (33.00)	73 (28.97)	27 (52.94)	0.001
Female	203 (67.00)	179 (71.03)	24 (47.06)	
(2) Age in years, n (%)				
45-50	93 (30.70)	72 (28.57)	21 (41.18)	<0.001
51-60	112 (36.96)	84 (33.33)	28 (54.90)	
61-70	98 (32.34)	96 (38.10)	2 (3.92)	
(3) Marital status, n (%)				
Single	24 (7.92)	19 (7.54)	5 (9.80)	0.180
Currently married	229 (75.58)	187 (74.21)	42 (82.35)	
Widowed/separated	50 (16.50)	46 (18.25)	4 (7.85)	
(4) Education, n (%)				
Only read and write	5 (1.65)	5 (1.98)	0 (0.00)	<0.001
Primary school	180 (59.41)	170 (67.46)	10 (19.61)	
High school	74 (24.42)	53 (21.03)	21 (41.18)	
Diploma	10 (3.30)	7 (2.78)	3 (5.88)	
Bachelor degree or higher	34 (11.22)	17 (6.75)	17 (33.33)	
(5) Monthly income, n (%)				
<5,000 Baht	115 (37.95)	105 (41.67)	10 (19.61)	<0.001
5,000 to <15,000 Baht	108 (35.64)	91 (36.11)	17 (33.33)	
15,000 to <25,000 Baht	42 (13.86)	32 (12.70)	10 (19.61)	
>25,000 baht	38 (12.55)	24 (9.52)	14 (27.45)	
(6) BMI (kg m^{-2}), Mean±SD				
Men	23.40±3.95	22.66±3.76	25.40±3.80	0.002
Women	25.36±4.90	25.41±5.08	25.00±3.37	0.700
(7) WC (cm), Mean±SD				
Men	86.74±9.67	85.53±9.88	90.00±8.39	0.040
Women	88.02±11.21	88.26±11.52	86.21±8.54	0.400
(8) BMI weight status[b], n(%)				
Normal weight	92 (30.37)	77 (30.56)	15 (29.41)	0.113
Overweight/obese	192 (63.36)	156 (61.90)	36 (70.59)	
Underweight	19 (6.27)	19 (7.54)	0 (0.00)	
(9) WC[c], n (%)				
Normal waist	83 (27.39)	72 (28.57)	11 (21.57)	0.306
Abdominal obesity	220 (72.61)	180 (71.43)	40 (78.43)	
(10) BMR (kcal), mean±SD	1,305.54±168.75	1,287.3±163.5	1,395.6±167.1	<0.001
(11) EI/BMR ratio, mean±SD	1.12±0.35	1.12±0.34	1.12±0.39	0.926

[a]p-values are for differences in characteristics between the informal and formal workers (Chi-Square test used for categorical variables or Unpaired *t*-test used for continuous variables). [b]Underweight: BMI <18.5 kg m^{-2}, Normal weight: BMI 18.5-22.9 kg m^{-2}, Overweight/obese: BMI ≥23 kg m^{-2}. [c]Abdominal obesity: WC ≥80 cm for Asian women and WC ≥85 cmfor Asian men

formal workers (p<0.05). Correspondingly, the deviations in the consumption of these micronutrients compared to the Thai DRIs were significantly different between the groups of women (p<0.05). As in the male workers, the median sodium intake from foods exceeded the Thai DRIs for both groups of women (median and interquartile range: 188.3, 124.2-285.3% for the formal workers; 180.5, 131.6-257.4% for the informal workers).

Compliance with dietary recommendations: The proportions of study participants conforming to the Thai DRIs for energy and nutrient intakes are shown in Table 5. Because the number of formal workers was relatively small, we did not perform an independent evaluation of these data by gender. There were no significant differences in compliance with there commended energy and nutrient intake values between the informal and formal worker groups (p>0.05). Less than half of the participants in both groups complied with the energy recommendations (26.6% for the informal workers; 35.3% for the formal workers). With regard to protein intake, 44.5% of the informal workers and 37.3% of the formal workers complied with the Thai DRIs. The value for compliance with there commended fiber intake was very low: 2.4% for the informal workers and 3.9% for the formal workers.

In terms of micronutrients, the proportions of older workers who complied with the recommendations were

Table 3: Daily energy and nutrient intakes and comparison to DRIs of male participants (n = 100) between the informal and formal workers

	Energy/nutrient intake, Median (IQR)			%DRI, Median (IQR)		
Energy and nutrients	Informal (n = 73)	Formal (n = 27)	p-value	Informal (n = 73)	Formal (n=27)	p-value[a]
Energy (kcal)	1,386.00 (496.40)	1,663.10 (1,096.80)	0.173	66.00 (23.65)	79.20 (52.30)	0.174
Carbohydrate (g)	210.60 (92.35)	242.40 (144.50)	0.300	NA	NA	
Protein (g)	56.60 (23.65)	70.50 (52.40)	0.114	99.30 (41.55)	123.80 (92.00)	0.115
Animal protein (g)	33.80 (21.05)	41.20 (28.90)	0.284	NA	NA	
Fat (g)	38.60 (16.20)	42.00 (36.90)	0.356	NA	NA	
Cholesterol (mg)	219.00 (169.10)	283.10 (138.00)	0.067	NA	NA	
Carbohydrate (% of energy)	61.90 (8.35)	61.10 (10.70)	0.880	NA	NA	
Protein (% of energy)	15.40 (3.40)	15.80 (4.10)	0.227	NA	NA	
Fat (% of energy)	23.00 (7.65)	22.40 (9.80)	0.721	NA	NA	
Dietary fiber (g)	7.80 (5.25)	9.40 (6.40)	0.061	31.40 (20.85)	37.70 (25.50)	0.060
Calcium (mg)	284.10 (250.15)	427.90 (354.00)	0.088	28.70 (27.60)	47.20 (32.30)	0.023
Phosphorous (mg)	539.20 (240.45)	683.10 (428.40)	0.050	77.00 (34.30)	97.60 (61.20)	0.050
Sodium (mg)	2,203.00 (1,240.90)	2,811.00 (1,558.80)	0.037	151.90 (85.55)	193.90 (107.50)	0.035
Potassium (mg)	1,249.70 (592.75)	1,399.70 (798.10)	0.131	51.00 (24.20)	57.10 (32.60)	0.129
Iron (mg)	7.20 (3.55)	10.40 (6.80)	0.032	69.10 (34.05)	100.20 (65.50)	0.032
Vitamin A (µg)	178.30 (135.60)	179.40 (352.20)	0.269	25.50 (19.35)	25.60 (50.30)	0.270
Vitamin C (mg)	38.40 (37.55)	47.40 (46.40)	0.886	42.70 (41.65)	52.70 (51.60)	0.889
Vitamin E (mg)	0.90 (1.00)	1.20 (1.10)	0.297	6.30 (6.75)	8.30 (6.80)	0.334
Thiamine (mg)	0.70 (0.55)	0.80 (0.80)	0.106	60.20 (42.40)	67.40 (67.40)	0.075
Riboflavin (mg)	0.70 (0.35)	0.80 (0.60)	0.247	54.60 (27.40)	60.70 (47.90)	0.178
Niacin (mg)	12.90 (6.80)	16.20 (10.40)	0.227	80.40 (42.65)	101.10 (64.60)	0.224
Vitamin B6 (mg)	0.50 (0.30)	0.70 (0.30)	0.154	35.10 (24.40)	43.70 (20.70)	0.046
Vitamin B12 (µg)	0.60 (0.75)	0.70 (0.80)	0.274	25.90 (32.50)	31.10 (33.10)	0.296
Magnesium (mg)	47.80 (29.85)	60.50 (53.50)	0.111	15.90 (9.80)	20.20 (16.80)	0.143
Selenium (µg)	47.60 (29.00)	53.10 (27.80)	0.199	86.5 (52.8)	96.60 (50.60)	0.199
Zinc (mg)	4.00 (1.85)	4.50 (3.50)	0.150	31.0 (14.30)	35.00 (27.30)	0.153

NA: Not determined. [a]p-values are for differences in median of energy and nutrient intake or %DRI between the male informal and formal workers (Mann-Whitney U test)

Table 4: Daily energy and nutrient intakes and comparison to DRIs of female participants (n = 203)between the informal and formal workers

	Energy/nutrient intake, Median (IQR)			%DRI, Median (IQR)		
Energy and nutrients	Informal (n = 179)	Formal (n = 24)	p-value	Informal (n = 179)	Formal (n = 24)	p-value[a]
Energy (kcal)	1,297.00 (551.90)	1,285.70 (581.03)	0.646	74.10 (31.60)	73.45 (33.25)	0.641
Carbohydrate (g)	190.90 (85.70)	187.10 (103.10)	0.348	NA	NA	
Protein (g)	51.30 (23.20)	44.80 (21.68)	0.216	98.60 (44.60)	86.05 (41.70)	0.215
Animal protein (g)	31.00 (19.60)	26.80 (14.33)	0.477	NA	NA	
Fat (g)	35.20 (20.60)	38.25 (22.85)	0.456	NA	NA	
Cholesterol (mg)	219.80 (163.10)	212.9 (185.03)	0.878	NA	NA	
Carbohydrate (% of energy)	60.50 (10.00)	59.05 (13.50)	0.182	NA	NA	
Protein (% of energy)	15.60 (4.60)	14.70 (5.63)	0.569	NA	NA	
Fat (% of energy)	23.50 (9.40)	26.55 (12.00)	0.065	NA	NA	
Dietary fiber (g)	8.80 (5.40)	8.90 (6.43)	0.996	35.10 (21.70)	35.65 (25.90)	0.993
Calcium (mg)	332.00 (210.50)	322.70 (172.20)	0.480	35.40 (24.40)	34.25 (25.25)	0.485
Phosphorous (mg)	562.70 (273.70)	527.65 (148.65)	0.260	80.40 (39.10)	75.40 (21.23)	0.259
Sodium (mg)	2,165.90 (1,509.10)	2,259.85 (1,933.08)	0.684	180.50 (125.80)	188.30 (161.13)	0.665
Potassium (mg)	1,218.20 (660.00)	1,245.40 (621.50)	0.387	59.40 (32.20)	60.75 (30.33)	0.380
Iron (mg)	7.50 (3.80)	7.80 (4.48)	0.706	69.10 (53.70)	59.05 (55.65)	0.594
Vitamin A (µg)	198.40 (176.00)	165.90 (183.28)	0.300	33.10 (29.3)	27.65 (30.55)	0.299
Vitamin C (mg)	50.80 (52.40)	51.40 (63.45)	0.919	67.70 (69.8)	68.55 (84.55)	0.919
Vitamin E (mg)	1.20 (1.60)	1.00 (1.65)	0.420	8.10 (10.20)	6.50 (10.85)	0.403
Thiamine (mg)	0.80 (0.50)	0.80 (0.48)	0.954	69.60 (49.10)	71.40 (43.33)	0.982
Riboflavin (mg)	0.70 (0.30)	0.70 (0.35)	0.260	67.60 (30.60)	63.50 (30.80)	0.335
Niacin (mg)	11.50 (5.60)	9.80 (5.98)	0.380	81.80 (40.00)	69.95 (42.48)	0.390
Vitamin B6 (mg)	0.40 (0.30)	0.30 (0.28)	0.015	31.00 (17.30)	21.60 (15.83)	0.015
Vitamin B12 (µg)	0.60 (0.90)	0.50 (0.55)	0.359	23.20 (35.30)	21.70 (22.98)	0.341
Magnesium (mg)	46.40 (40.50)	40.55 (41.00)	0.294	17.90 (15.50)	15.60 (15.80)	0.295
Selenium (µg)	36.20 (21.80)	28.25 (17.23)	0.034	65.80 (39.70)	51.30 (31.20)	0.034
Zinc (mg)	3.50 (1.80)	2.70 (1.28)	0.004	49.50 (26.20)	38.60 (18.68)	0.004

NA: Not determined. [a]p-values are for differences in median of energy and nutrient intake or %DRI between the female informal and formal workers (Mann-Whitney U test)

Table 5: Proportion of participants in compliance with dietary recommendations between the informal and formal workers[a]

	Total (n = 303), n (%)			Informal worker (n = 252), n (%)			Formal worker (n = 51), n (%)		
		Noncompliance			Noncompliance			Noncompliance	
Energy and nutrients	Compliance	Excessive	Insufficient	Compliance	Excessive	Insufficient	Compliance	Insufficient	Excessive
Energy (kcal)	85 (28.05)	188 (62.05)	30 (9.90)	67 (26.58)	160 (63.50)	25 (9.92)	18 (35.30)	28 (54.90)	5 (9.80)
Protein (g)	131 (43.23)	88 (29.04)	84 (27.73)	112 (44.45)	72 (28.57)	68 (26.98)	19 (37.26)	16 (31.37)	16 (31.37)
Carbohydrate (% of energy)	212 (69.97)	9 (2.97)	82 (27.06)	175 (69.44)	7 (2.78)	70 (27.78)	37 (72.55)	2 (3.92)	12 (23.53)
Protein (% of energy)	126 (41.58)	5 (1.65)	172 (56.77)	106 (42.06)	4 (1.59)	142 (56.35)	20 (39.22)	1 (1.96)	30 (58.82)
Fat (% of energy)	192 (63.37)	95 (31.35)	16 (5.28)	162 (64.28)	79 (31.35)	11 (4.37)	30 (58.82)	16 (31.37)	5 (9.81)
Dietary fiber (g)	8 (2.64)	291 (96.04)	4 (1.32)	6 (2.38)	242 (96.03)	4 (1.59)	2 (3.92)	49 (96.08)	0 (0.00)
Calcium (mg)	20 (6.60)	282 (93.07)	1 (0.33)	14 (5.56)	237 (94.05)	1 (0.39)	6 (11.76)	45 (88.24)	0 (0.00)
Phosphorous (mg)	101 (33.33)	156 (51.49)	46 (15.18)	86 (34.13)	130 (51.59)	36 (14.28)	15 (29.41)	26 (50.98)	10 (19.61)
Sodium (mg)	165 (54.46)	0 (0.00)	138 (45.54)	140 (55.56)	0 (0.00)	112 (44.44)	25 (49.02)	0 (0.00)	26 (50.98)
Potassium (mg)	58 (19.14)	242 (79.87)	3 (0.99)	48 (19.05)	201 (79.76)	3 (1.19)	10 (19.61)	41 (80.39)	0 (0.00)
Iron (mg)	75 (24.75)	181 (59.74)	47 (15.51)	61 (24.21)	156 (61.90)	35 (13.89)	14 (27.45)	25 (49.02)	12 (23.53)
Vitamin A (µg)	18 (5.94)	272 (89.77)	13 (4.29)	14 (5.56)	227 (90.08)	11 (4.36)	4 (7.84)	45 (88.24)	2 (3.92)
Vitamin C (mg)	95 (31.35)	208 (68.65)	0 (0.00)	82 (32.54)	170 (67.46)	0 (0.00)	13 (25.49)	38 (74.51)	0 (0.00)
Vitamin E (mg)	0 (0.00)	291 (96.04)	12 (3.96)	0 (0.00)	243 (96.43)	9 (3.57)	0 (0.00)	48 (94.12)	3 (5.88)
Thiamine (mg)	75 (24.75)	195 (64.36)	33 (10.89)	64 (25.40)	164 (65.08)	24 (9.52)	11 (21.57)	31 (60.78)	9 (17.65)
Riboflavin (mg)	47 (15.51)	226 (74.59)	30 (9.90)	41 (16.27)	188 (74.60)	23 (9.13)	6 (11.77)	38 (74.51)	7 (13.72)
Niacin (mg)	105 (34.65)	143 (47.20)	55 (18.15)	90 (35.71)	118 (46.83)	44 (17.46)	15 (29.41)	25 (49.02)	11 (21.57)
Vitamin B6 (mg)	12 (3.96)	290 (95.71)	1 (0.33)	9 (3.57)	242 (96.03)	1 (0.40)	3 (5.88)	48 (94.12)	0 (0.00)
Vitamin B12 (µg)	15 (4.95)	277 (91.42)	11 (3.63)	14 (5.56)	229 (90.87)	9 (3.57)	1 (1.96)	48 (94.12)	2 (3.92)
Magnesium (mg)	3 (0.99)	300 (99.01)	0 (0.00)	3 (1.19)	249 (98.81)	0 (0.00)	0 (0.00)	51 (100.00)	0 (0.00)
Selenium (µg)	75 (24.75)	183 (60.40)	45 (14.85)	59 (23.41)	156 (61.91)	37 (14.68)	16 (31.37)	27 (52.94)	8 (15.69)
Zinc (mg)	15 (4.95)	280 (92.41)	8 (2.64)	12 (4.76)	233 (92.46)	7 (2.78)	3 (5.88)	47 (92.16)	1 (1.96)

[a]No statistically significant differences in proportion of participants' compliance with dietary recommendations between the informal and formal workers (Chi-square test)

substantially low for most micronutrients-particularly calcium, vitamin A, vitamin B6, vitamin B12, magnesium and zinc-and ranged from 0.99-6.60% for both worker groups. None of the participants in either group complied with the vitamin E intake recommendations. Approximately half of the informal workers (44.4%) and formal workers (51.0%) had an excessive sodium intake.

DISCUSSION

The present study investigated the typical intake of energy and nutrients among Thai older workers engaged in either informal or formal employment. Our study suggests that compliance with national dietary recommendations was rather low in both informal and formal workers. This low compliance with dietary recommendations may reflect unhealthy eating habits and the inability to access healthy foods among older workers.

The median levels of daily EI by both male and female participants were lower than those recommended in the Thai DRIs[21]. The relatively low EI for both genders is similar to the results reported by the Thai National Health Examination Surveys (NHES IV, 2008-2009),whose estimates were based on a 24 h DR[24]. In part, the reason may be due to a common limitation of many dietary surveys: people are likely to under report their dietary intake through either 24 h DR interviews[25,26] or self-reported dietary intake tools[27,28]. Moreover, previous studies revealed that EI under reporting is more common among overweight or obese people than those of normal weight[22,25]. This study also found a higher proportion of EI under reporters in participants who were overweight and obese.

The intake of dietary fiber and micronutrients by older workers in this study did not meet the Thai DRIs. More than 90% of the older workers did not comply with the Thai DRIs for dietary fiber, calcium, vitamin A, vitamin B6, vitamin B12, magnesium and zinc. These findings are similar to those reporting a high risk of inadequate intake of dietary fiber and micronutrients in adult workers[22,29,30]. Moreover, almost half of all participants consumed ≥2,400 mg of sodium per day, which is in accord with the results of excess sodium intake that have been reported in many studies in Southeast Asia[31], including the NHES IV[24]. One possible explanation for this excess sodium intake is the fact that dried salted sh and fermented sh products, which are considered high-sodium foods, are used ubiquitously in Thai cooking[32]. Inadequate micronutrient intake is related to a greater risk of developing several chronic noncommunicable diseases, e.g., heart disease, stroke, cancer,

diabetes and dementia[33]. These diseases are the leading causes of mortality in the Thai population[34]. Thus, it is necessary for older workers to realize the link between low compliance with dietary recommendations and the risk of chronic diseases.

In terms of the worker groups, differences in nutrient intake between the informal and formal workers were found. However, low compliance with dietary recommendations was observed in both groups. This finding is in line with the results of a national nutrition survey of 8,978 US workers in different occupations, which showed differences in nutrient intake with poor compliance with dietary recommendations across all groups[30]. In this study, the majority of older informal workers had lower levels of education and income and chose to stay longer in the workforce than the formal workers who were protected by social security. Thus, this problem of poor nutrition, affecting both informal and formal workers, did not discriminate based on socioeconomic status. Nevertheless, this result is not consistent with the findings of studies in European adult workers, which showed the effect of socioeconomic status on dietary intake among different worker groups[35,36]. Workers with a higher socioeconomic status were likely to consume more fiber and less total fat and saturated fat than workers with a lower socioeconomic status[35,36].

The low compliance with dietary recommendations among participants may reflect a lack of access to sufficiently nutritious food. There is evidence suggesting that greater availability of healthy foods is related to higher consumption of such foods[37]. Many studies have revealed that individuals in high-income communities had greater access to supermarkets and reported higher consumption of fruit and vegetables[38-39]. However, the food environment in some low-income communities primarily consists of convenience stores and smaller markets, which may offer a limited variety of food products[38,40]. In Thailand, there are scarce data that are important for identifying areas that lack access to healthy food or food deserts. The lack of such data may lead to inappropriate policy planning and public intervention actions in the country.

This study had some limitations. First, a high proportion of participants underreported their EI through the 24 h DR. This underreporting is also a well-documented problem of nutrition surveys conducted in Thailand[22,24]. Therefore, three 24 h DRs, as opposed to a single 24hDR, were carried out in this study for a more accurate estimation of typical intake[41]. Second, it is difficult to determine whether the dietary behaviors of participants are changing or consistent over time based on data collected at a specific point in time. The association among eating behaviors, nutrition knowledge and awareness of dietary recommendations is also unclear. Third, the generalizability of our findings may be limited because of the small sample sizes. In contrast, the important strength of this study is the quality of the data on dietary intake and anthropometric parameters that was ensured by using a standardized protocol, validated tools and well-trained field personnel during the data collection and processing stages. The inclusion criteria used in this study further strengthened the quality of the findings.

CONCLUSION

This study examined the extent to which the energy and nutrient intakes of a sample of Thai older workers, including both informal and formal workers, in the southern region of Thailand conforms to the Thai DRIs. Both groups showed poor compliance with the recommended intake values for dietary fiber and most micronutrients, primarily calcium, vitamin A, vitamin B6, vitamin B12, magnesium, zinc and sodium. This study suggests that it is necessary to initiate public health interventions to inform and educate older workers about the importance of a healthy and balanced diet. Based on our study, the large shortfalls of intakes for many nutrients and the excessive intake of sodium could guide the implementation of intervention programs aimed at improving compliance in this population.

SIGNIFICANCE STATEMENT

This study showed that compliance with most dietary recommendations was rather low in Thai older workers. This study will help researchers understand that the majority of older workers likely need ongoing support in their effort to improve their eating behavior, even with having nutrition knowledge about how to eat properly. Thus, continued efforts to promote awareness of proper eating behavior and recommendations should be made.

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