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Submission date: 02-May-2023 09:50AM (UTC+0700)
Submission ID: 2081608643
File name: Nevi_dkk.pdf (609.2K)
Word count: 4893
Character count: 25607

nutrición clínica y Dietética Hospitalaria

Artículo Original

Nutr Clín Diet Hosp. 2023; 43(1):90-98
DOI: 10.12873/431handayani

Dietary Patterns and Ultra-Processed Foods Consumption in Modern and Traditional Populations in South Sulawesi: An Analysis of Nutritional Status and Body Composition

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Recibido: 30/diciembre/2022. Aceptado: 21/febrero/2023.

ABSTRACT

Backgrounds and aim: Dietary patterns play an important role in the emergence of non-communicable diseases such as obesity, hypertension, and metabolic syndrome. This study aims to examine the impact of ultra-processed food on the nutritional status and body composition of modern and traditional population groups in Indonesia.

Methods: The study has received ethical approval from the Research Ethics Commission of the Faculty of Medicine, Hasanuddin University with ethics number No.633/UN4.6.4.5.31/PP36/2022. The inclusion criteria in this study included: people in the Makassar population > 50 years old. Exclusion criteria were (1) having chronic gastrointestinal disease/chronic inflammation, (2) having Diabetes Mellitus, (3) consuming antibiotics in the last 3 months, (4) consuming prebiotics/probiotics, (5) having income > IDR 3,400.000,-, (6) rarely (<1x/week) consumes UPF.About 100 samples were taken from people over 50 years old, where 50 samples were taken from both the modern group and the traditional group. To evaluate the dietary pattern, the diet of the sampling persons was analyzed by using a semi-quantitative Food Frequency Questionnaire (SQ-FFQ), and a 24-hours food recall (FR) to examine the food intake. Body Mass Index (BMI) and Waist Circumference (WC) were used to determine the nutritional status, while the body composition was assessed by Tanita BC 730.

Results: According to the scatter plot, the higher the ultra-processed food energy consumed, the higher the BMI, Waist Circumference, and Fat Mass results, with the respective effects of 18.3%, 35.3%, and 13.7%. From this study, it was found that there were significant differences ($p<0.05$) between the traditional and modern groups in all variables except for height based on the independent t-test found no significant difference ($p>0.05$).

Conclusions: In conclusion, dietary patterns with higher consumption of ultra-processed foods influence the increase of body mass index, waist circumference, and fat mass.

KEYWORDS

Dietary patterns, ultra-processed food, nutritional status, body composition.

INTRODUCTION

Obesity, hypertension, and metabolic syndrome are examples of non-communicable diseases influenced significantly by dietary patterns. Body composition is a risk factor that is affected by diet and exercise[1].

People who live in modern populations tend to have a sedentary lifestyle. Dietary changes result in unbalanced and unhealthy food products, such as consuming foods that are highly processed, which are harmful to health. The ultra-processed foods which contain a low level of dietary fiber and high levels of calories, sugar, fat, cholesterol, and salt may bring about obesity and the emergence of degenerative diseases such as heart disease, diabetes mellitus, cancer, and hypertension[2]. Moreover, the urban living environment is considered capable to accelerate this trend, as cities generally experience more rapid socio-economic changes and offer higher access to ultra-processed foods compared to rural settings[3,4].

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In contrast, the people in a rural area like the Kajang Tribe in Tana Toa village who conservatively maintain, preserve, and protect their culture from civilization still maintain the use of firewood for daily cooking to symbolize the thrift and get their daily livelihood supply from the plants they grow around their houses[5]. "Home Vegetable Gardening" is a good way to describe the farming practices of the Kajang Population. They grew plants like taro, cassava, and pumpkin that are disease-resistant and have a low risk of failure. The amounts of those goods are also limited to their use. These behaviors were influenced by perceptions that related to local wisdom in preserving nature[6].

The westernized diets adopted by the urbanized community usually tend to be lower in fiber and contain higher amounts of fat and refined carbohydrates compared to the diets of people living in rural settings. The Westernized diet is characterized by a composition with low in fiber and too high in calories and fat especially saturated fatty acids and cholesterol, causing an imbalance in nutritional intake and becoming a risk factor for the emergence of various health problems such as obesity, hypertension, dyslipidemia, and insulin resistance[7].

The result of several studies indicated the association between portions of ultra-processed foods and the prevalence or incidence of several non-communicable diseases, including obesity, cardiovascular, and metabolic diseases[8]. Therefore, this study aims to analyze the differences in diet, nutritional status, and body composition between the modern and traditional groups of people and the impacts of ultra-processed foods on nutritional status and body composition.

METHODS

Research Design

This study utilizes an observational analytic research design with a cross-sectional approach. About 100 samples were taken from populated people over the age of 50, where 50 samples were from the modern group and the other 50 from the traditional group. This study was conducted in the Tana Toa Village, Kajang Subdistrict, Bulukumba Regency, and Makassar City, which commenced from February to November 2022.

The research has received ethical approval from the Research Ethics Commission of the Faculty of Medicine, Hasanuddin University with ethics number No.633/UN4.6.4.5.31/PP36/2022.

Inclusion and Exclusion Criteria

The inclusion criteria in this study included: people in the Makassar population ≥ 50 years old. Exclusion criteria were (1) having chronic gastrointestinal disease/chronic inflammation, (2) having Diabetes Mellitus, (3) consuming antibiotics in the last 3 months, (4) consuming prebiotics/probiotics, (5) having income > IDR 3,400.000,-, (6) rarely (<1x/week) consumes UPF.

Research Procedure

The traditional group is a representative of the population of Tana Toa Village, Kajang Tribe who consumes ultra-processed foods less than 10% of their energy intake. The modern group is a population of Makassar City that consumes ultra-processed foods that account for more than 15% of their energy intake. Dietary patterns were obtained using the semi-quantitative food frequency questionnaire method and food intake with a 24-hour food recall for 3 days (2 weekdays and 1 weekend). The Nutrisurvey program was used to analyze the 24-hour food recall results. Measurement of body weight and body composition using the Tanita BC 730. Height measurement using the SECA height meter. Measure waist circumference using a tape measure.

Statistic Analysis

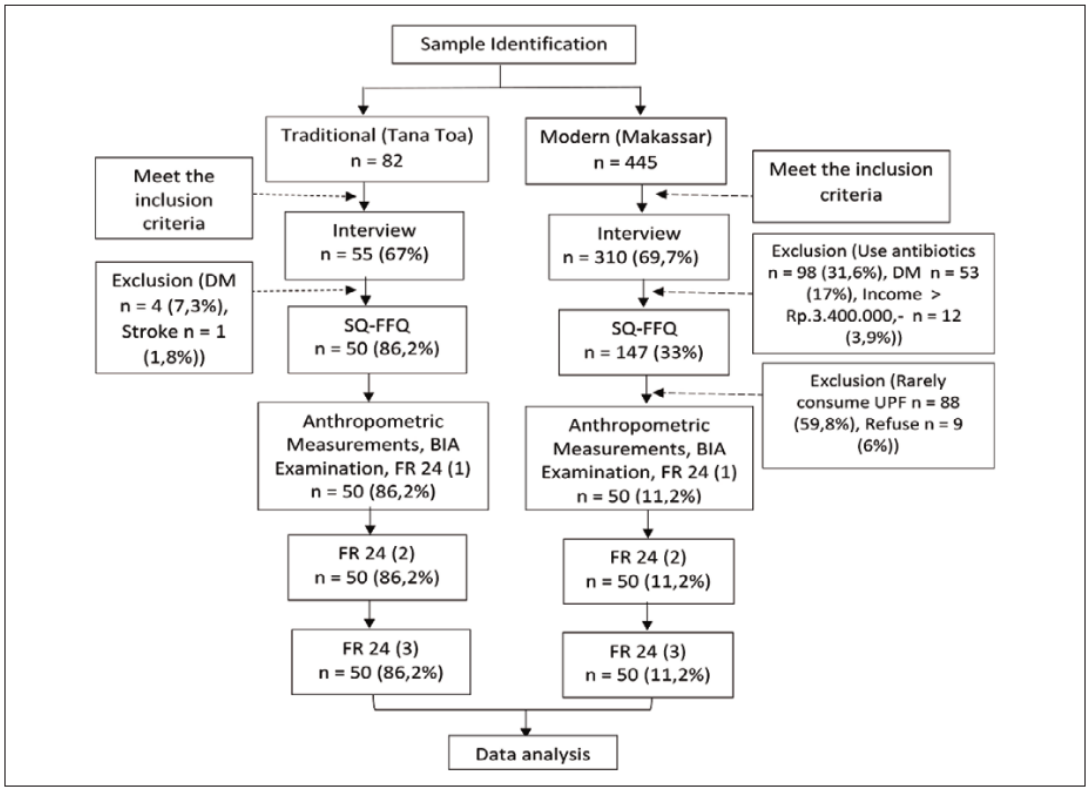
Univariate analysis is used for character descriptions and basic data in the form of frequency distributions presented in tables and graphs. Bivariate analysis using the t-test obtained if the data is normally distributed, or the Mann-Whitney test if the obtained data is not normally distributed. To compare two or more groups on categorized data, the Chi-square test is used. To see the magnitude of the relationship between the dependent and independent variables use the scatter plot graph. A P value < 0.05 is considered statistically significant. All analyses were carried out with IBM SPSS version 25 for Windows (SPSS Inc.).

RESULTS

Table 1 showed the characteristics of the research subjects. There were no significant differences in the characteristics of age and sex between the 2 groups, while in the characteristics of ethnicity, education, income, and disease there were significant differences between the 2 groups with p-value <0.05.

In this study, the SQ-FFQ was carried out in the traditional and modern groups as shown in Figure 2, where it indicated that the average of people in the traditional group consumes rice and corn rice as a staple food, while the modern group consumes only rice as a staple food. Long bean leaves are the common vegetables consumed by the traditional group based on the plants planted around their houses. Vegetable proteins such as tofu and tempeh are rarely consumed by traditional groups because the supply of tofu and tempeh in Kajang was only available recently, so they are not used to consuming them, but they prefer to have animal proteins such as fish. The modern group consumes more ultra-processed foods such as meatballs, crispy chicken, instant noodles, and fried rice than the traditional group. Several things such as availability, access, and exposure to commercial marketing of ultra-processed foods in the modern group can explain the higher consumption of ultra-processed foods in the modern group compared to the traditional group.

Figure 1. Flowchart of the study.



Of the 82 people in the traditional group, 55 people met the inclusion criteria and were subjected to structured interviews, 5 people were excluded (4 people had DM and 1 stroke), and 50 people did SQ-FFQ, anthropometry, BIA, and 24-hour FR. Of the 455 people in the modern group, 310 people met the inclusion criteria and were subjected to structured interviews, 163 people were excluded (98 people used antibiotics, 53 were DM sufferers, and income > Rp. 3,400,000.-), 147 people did SQ-FFQ, 97 people excluded (rarely consumed UPF 88 people and refused to be involved in research 9 people), 50 people did anthropometry, BIA, and 24 hours food recall.

Table 2 shows the difference in the food intake of the traditional and modern groups. In the modern group, the intake of energy, fat, sodium, potassium, and consumption of ultra-processed foods was higher than in the traditional group. As for protein and carbohydrates, there was no significant difference between the two groups. The modern group's fiber intake is indicated to be lower than the traditional group. Calcium intake was found to be lower in the traditional group than in the modern group.

From the measurement results after being tested statistically, it was found that there were significant differences between the traditional and modern groups in variables except for height based on the independent test found no significant difference with p value> 0.05. In the modern group, body weight, body mass index, waist circumference, bone mass, fat mass, and visceral fat were higher compared to the traditional group, while muscle mass was lower than the traditional group as shown in table 3.

Figure 3 shows that higher ultra-processed food consumption was associated with a higher body mass index with an effect of 18.4%.

Figure 4 shows that higher ultra-processed food consumption was associated with higher waist circumference with an effect of 35.3%.

Figure 5 shows that higher ultra-processed food consumption was associated with higher fat mass with an effect of 13.7%.

DISCUSSION

Obesity, hypertension, and metabolic syndrome are non-communicable disorders that are mostly influenced by dietary

Table 1. Characteristics of Research Subjects

Characteristics	Traditional (n = 50)	Modern (n = 50)	Nilai p
Age, y	59.5 (50, 90)	56.5 (50, 68)	0.261**
Sex (%)			
Men	20	10	0.263*
Women	80	90	
Ethnic group (%)			
Kajang	100	0	0.000*
Buginese	0	12	
Makassar	0	88	
Education (%)			
No	100	6	0.000*
Elementary / Junior High School	0	62	
High School	0	24	
Bachelor	0	8	
Income (%)			
Rp.2.500.000,- s/d			0.003*
Rp.3.400.000,-	0	18	
< Rp.2.500.000,-	100	82	
Employment (%)			
Farmers	16	0	0.000*
Traders	2	12	
Others	0	14	
No employment / Housewife	82	74	
Disease History (%)			
No	84	64	0.040*
Hypertension	16	36	

Description: n = number of subjects; *Chi-square test **Mann Whitney test.

patterns. Dietary patterns give an illustration regarding the frequency of meals, food types, and ingredients of food consumed daily[9]. Culture, geography and availability of food determine the selection food[10]. In this study, it was found that the modern group consumed more ultra-processed foods such as meatballs, crispy chicken, instant noodles, and fried rice compared to the traditional group. The higher intake of ultra-processed foods in the modern group compared to the traditional group can be attributed to many factors, including availability, access, and exposure to commercial promotion of ultra-processed foods[11]. This is consistent with the Khandpur study, et al. (2020) finding that people in urban regions consume 1.5 to 1.7 times more calories from ultra-processed foods than people in rural areas[12]. The similar conclusion was reached by Marro et al. (2017), which found that metropolitan areas consume more ultra-processed foods than rural ones[13].

In this study, it was discovered that the higher the ultra-processed food energy consumed was associated with a higher body mass index with an effect of 18.4%. The findings of this study are consistent with the research of Pestoni, et al. (2021), which discovered increasing intake of ultra-processed foods linked to overweight women in Switzerland[14]. According to Laura et al. (2020), eating ultra-processed foods was linked to higher BMIs, larger waist circumferences, and a higher

Figure 2. Differences in the total sample of Traditional and Modern Groups in Consuming Several Types of Food in One Day to One Week with the Chi-square test and p-value <0.001

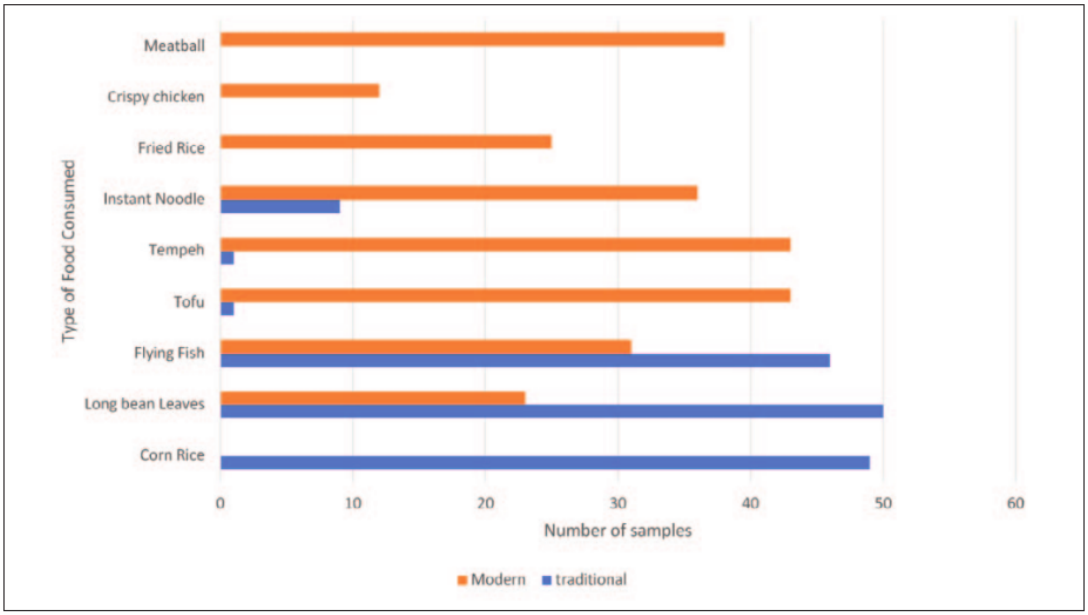


Table 2. Differences in Food Intake of Traditional and Modern Groups

	Tradisional (n=50)	Modern (n = 50)	Nilai p
Energy (kcal)	1,282.72 ± 234.46	1,617.03 ± 239.39	0.000*
Protein (gr)	45.66 ± 7.24	49.74 ± 9.34	0.068*
Carbohydrate (gr)	261.45 ± 50.9	254.22 ± 43.1	0.446*
Fat (gr)	4.05 (1,9, 10,8)	43.42 (13,1, 67,13)	0.000**
Fiber (gr)	16.05 ± 2.79	9.9 ± 3.18	0.000*
Sodium (mg)	869.83 (824,13, 1098,6)	1,645.88 (1054,27, 2696,37)	0.000**
Potassium (mg)	627.38 (307,57, 1181)	1,111.31 (457,4, 2024,13)	0.000**
Calsium (mg)	191.26 (67,1, 379,3)	286.7 (149,97, 744,87)	0.000**
Energy UPF (kcal)	1.08 (0, 112,63)	513.22 (134,37, 1047,07)	0.000**

Description: n = number of subjects; Mean ± SD, Median (Minimum, Maximum), UPF (Ultra Processed Food) *Independent t-test **Mann Whitney test.

prevalence of obesity in both sexes. Both sexes showed a correlation, with a 10% rise in ultra-processed food intake linked to a 17% increase in obesity prevalence in women and an 18% increase in males[8]. In the UK adult population, increased intake of ultra-processed foods are substantially linked to a higher risk of several obesity-related indicators, according to research by Rauber et al. (2020)[15].

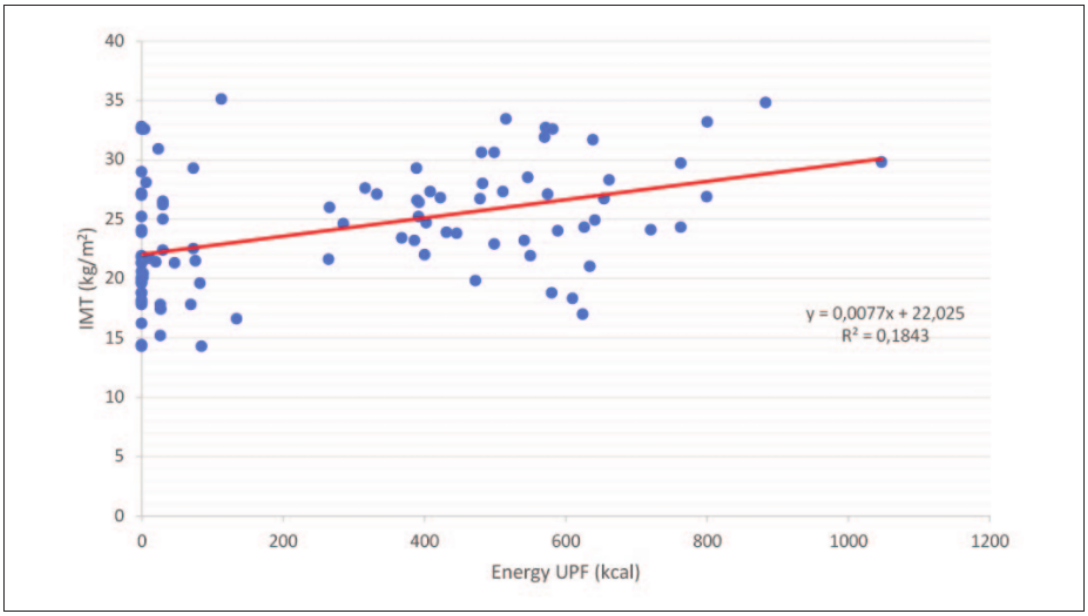
Energy intake and energy expenditure must be balanced to be an energy balance. Energy is stored in bodily tissues when the intake of energy exceeds expenditure. The obesity epidemic being fueled by a persistent positive energy imbalance. Ultra-processed food consumption has been linked to higher total energy intake, according to numerous studies. Foods that have undergone extensive processing are consid-

Table 3. Differences in Nutritional Status and Body Composition of Traditional and Modern Groups

	Traditional (n=50)	Modern (n = 50)	Nilai p
Height (cm)	149.48 ± 7.33	151.84 ± 5,73	0.076*
Weight (kg)	49.6 ± 12.08	59.97 ± 10,19	0.000*
BMI (kg/m^2)	22.22 ± 5.12	26.02 ± 4,3	0.000*
Waist Circumference (cm)	76 (61, 106)	98.5 (70, 112,5)	0.000**
Muscle Mass (%)	67.25 (33,3, 89,8)	58.9 (48,6, 89,2)	0.000**
Bone Mass (kg)	1.9 (0,9, 2,9)	2.2 (1,2, 2,7)	0.000**
Fal Mass (%)	29.4 (5, 48,3)	37.8 (5,9, 48,3)	0.000**
Visceral Fat	6.45 ± 3,5	8.16 ± 2,81	0.008*

Description: n = number of subjects; BMI = Body Mass Index, Mean ± SD, Median (Minimum, Maximum) *Independent t-test **Mann Whitney test.

Figure 3. Effect of Consumption of UPF on BMI



ered to lack micronutrients and contain high calories, saturated and trans fatty acids, and added sugars. Consumers of ultra-processed foods have a higher risk of obesity and weight gain than people who do not, according to several observational studies[16,17].

According to a study by Hall et al. (2019), samples that consumed ultra-processed foods had lower PYY and GLP-1 levels and greater ghrelin levels than samples that did not. Foods that have undergone extreme processing will have higher Firmicute levels, which can lower SCFA levels, particularly propionate, which is involved in triggering the release of PYY and GLP-1. The increased caloric intake and obesity-causing effects of ultra-processed foods may be explained by changes in the hormones PYY and ghrelin after consumption[18,19].

Furthermore, the attributes of ultra-processed meals, such as the addition of additives and modifications to the food matrix, give the food a softer texture, resulting in less chewing and improved sensory properties, which delay satiety signals and lead to excessive food consumption[18]. Additives that are commonly

16
Figure 4. Effect of Consumption of UPF on Waist Circumference

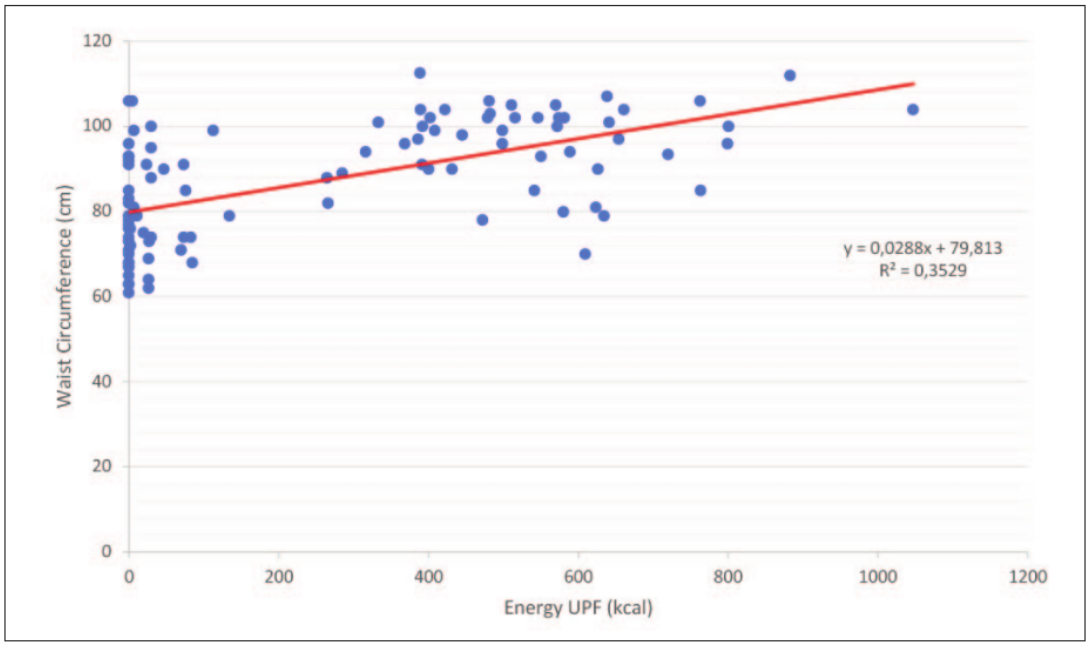


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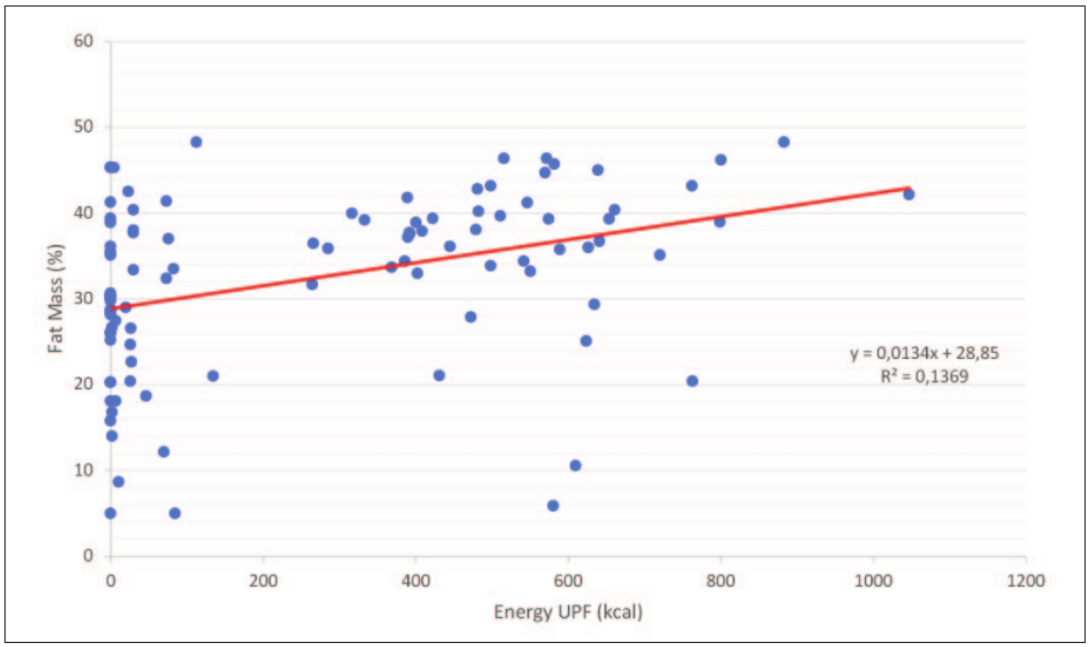
Figure 5. Effect of Consumption of UPF on Fat Mass



used in the manufacture of ultra-processed foods may also be part of the mechanism linking them to obesity[20]. For example, monosodium glutamate, a delicious flavor enhancer used in some ultra-processed foods, can contribute to obesity with potential endocrine disrupting effects. Research by Shannon et al., 2017 shows MSG can cause a decrease in GLP-1 secretion and the potential of the mitochondrial membrane which will disrupt the energy balance which will lead to obesity[21].

In this study, it was found that higher ultra-processed food consumption was associated with higher waist circumference with an effect of 35.3%. This is consistent with a study by Sandoval, et al. (2020), which discovered a positive correlation between increased intake of ultra-processed foods and the prevalence of central obesity in older persons in Spain[22]. A high intake of ultra-processed foods was found to significantly raise the risk of obesity and central obesity by 79% and 30%, respectively, according to research by Rauber et al. (2020). Ultra-processed food consumption also raises the possibility of a 5% or greater follow-up increase in BMI, waist circumference, and body fat (average of 5.6 years)[15]. In comparison to those who consume fewer ultra-processed foods, research by Canhada et al., 2019 demonstrates that persons who consume more ultra-processed foods are more likely to gain weight, increase waist circumference, and develop obesity[23]. In a group of middle-aged adults from Brazil, Silva, et al. (2020) identified a correlation between the consumption of highly processed meals and central obesity. They consumed an average of 22.7% of ultra-processed foods, and higher consumption of ultra-processed foods was associated with higher waist circumferences[24].

There are numerous possible explanations for the link between central obesity and ultra-processed foods. Larger quantities are typically taken while eating ultra-processed foods because of their high energy density, which delays satiety signals[25]. When the body receives more energy than is used or required, the excess energy can lead to central obesity since it will be stored as fat in the form of food. In the form of triglycerides, extra fat will build up in the adipose tissue of the abdomen. Other variables that contribute to central obesity include a high-calorie diet and a modern lifestyle[16].

In this study, it was found that higher ultra-processed food consumption was associated with higher fat mass with an effect of 13.7%. This is consistent with a study by Costa, et al. (2021), which discovered a link between eating ultra-processed foods and an increase in body fat[26]. A long-term rise in fat mass in adult women was linked to excessive consumption of ultra-processed foods, according to research by Carolina et al. (2022)[27]. During a 12-month follow-up, a 10% daily increase in the consumption of ultra-processed foods was linked to a greater accumulation of visceral fat and total fat, according to the study by Konieczna et al. (2022), which showed a correlation between the consumption of ultra-processed foods and the distribution of adiposity[28].

The high total fat and saturated fat content of ultra-processed meals, as well as their low nutritional quality, excessive palatability, and usage of artificial matrices with a subsequent influence on satiety, have all been linked to an increased risk of obesity. The primary factor influencing body adiposity is thought to be the dietary fat content[29]. The more calories consumed, the more fat that is not needed by the body is stored as fat, increasing body fat mass[30].

Our study has several limitations, including cross-sectional study design, causality associations cannot be established, risks of over- or under-reporting, and recall bias in 24-hour food recall cannot be ruled out.

CONCLUSION

Higher consumption of ultra-processed foods found in the modern population compared to the traditional population affects the increase in body mass index, waist circumference, and fat mass.

ACKNOWLEDGMENTS

The authors thank all of the contributors for their outstanding help in paper and also in formatting the paper. Professor Nurpudji would also like to express my gratitude to my two special people, who have provided suggestions-comments in the research and writing of this manuscript, as well as the motivation that has given the authors to keep the passion for research during the pandemic, Fahrul Nurkolis and William Ben Gunawan.

DATA AVAILABILITY STATEMENT

The data datasets generated and/or analyzed in this study are available on request from the corresponding author.

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