THE EFFECTS OF PRICE, INCOME, AND HOUSEHOLD CHARACTERISTICS ON ULTRA-PROCESSED FOOD CONSUMPTION IN JAKARTA, INDONESIA

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Abstract

During the 2010s, ultra-processed food consumption in Indonesia increases and leads to high rates of obesity and chronic non-communicable diseases. DKI Jakarta has the highest ultra-processed food consumption and obesity prevalence in Indonesia. Therefore, raw data from "Core" and "Consumption and Expenditure" modules of March 2019 Susenas (Indonesia National Socioeconomic Survey) are analysed to examine ultra-processed food consumption and how economic factors and household characteristics affect it in Jakarta. The analysis is conducted using M-estimation robust regression due to a large number of influential outliers in the data. The research sample is divided into three classes based on daily per capita expenditure. The results show that ultra-processed food consumption increases with income class. Higher ultra-processed food consumption occurs in households that pay higher price for ultra-processed food, have higher per capita income, have more children or adolescents, and have working female household head or wife. For Class 3 households, formal sector households consume more ultra-processed food than informal sector households. While for Class 1 households, households with female household head or wife with senior high school degree or above consume more ultra-processed food than households with female household head or wife with junior high school degree or below.

Abstrak

Selama tahun 2010 – 2019, konsumsi *ultra-processed food* di Indonesia meningkat. Hal ini menyebabkan tingkat obesitas dan penyakit tidak menular kronis yang tinggi di Indonesia. DKI Jakarta adalah provinsi dengan konsumsi *ultra-processed food* dan prevalensi obesitas tertinggi. Oleh karena itu, data mikro Susenas (Survei Sosial Ekonomi Nasional) Maret 2019 modul KOR (inti) dan KP (Konsumsi dan Pengeluaran) dianalisis untuk meneliti pengaruh faktor ekonomi dan karakteristik rumah tangga terhadap konsumsi *ultra-processed food* di DKI Jakarta. Analisis dilakukan dengan regresi *robust* estimasi M karena banyaknya pencilan yang berpengaruh pada amatan. Sampel penelitian dibagi menjadi tiga kelas berdasarkan pengeluaran per kapita per hari. Hasil penelitian menunjukkan bahwa konsumsi UPF meningkat seiring meningkatnya kelas pendapatan. Konsumsi UPF yang lebih tinggi terjadi pada rumah tangga yang membayar UPF dengan harga yang lebih mahal, memiliki pendapatan per kapita yang lebih tinggi, memiliki jumlah anak atau remaja yang lebih banyak, dan memiliki istri/KRT perempuan yang bekerja. Adapun pada rumah tangga Kelas 3, konsumsi UPF rumah tangga sektor formal lebih tinggi daripada rumah tangga sektor informal. Sedangkan pada rumah tangga Kelas 1, konsumsi UPF rumah tangga dengan istri/KRT perempuan berpendidikan SMA ke atas lebih tinggi daripada rumah tangga dengan istri/KRT perempuan berpendidikan SMP ke bawah.

PENDAHULUAN

Food is an essential and basic human need. High quality and nutritious food can improve health and quality of human resources. However, during the 2010s in Indonesia, ultra-processed food or UPF consumption have increased compared to fresh food consumption [1]. According to *Survei Sosial Ekonomi Nasional* or National Socioeconomic Survey in Indonesia, calorie consumption of grains declined while calorie consumption of prepared food and beverages increased during the years of 2013 - 2019. In 2013, calorie consumption of grains was 3 times of prepared food and beverages, but in 2019 it decreased to only 1.52 times [2]. If we view it by region, in 2017, DKI Jakarta has the highest percentage of UPF calorie consumption in Indonesia.

The rise in UPF consumption can be influenced by three sectors, which are wholesale and retail trade (supermarkets selling UPF), process industry (processed food and drinks industry), and accommodation (restaurants serving UPF). DKI Jakarta is the largest contributor of gross regional domestic product (GRDP) to national GDP in accommodation and trade sector. DKI Jakarta is also the fourth largest contributor of GDRP to national GDP in process industry sector [3]. Therefore, DKI Jakarta is a suitable locus for this study due to its high UPF calorie consumption, its superiority in UPF sector, and its position as the nation's capital city with high access to supermarkets and fast-food outlets.

The increase of UPF calorie consumption in DKI Jakarta has its own consequences, such as obesity and chronic non-communicable diseases (cardiovascular disease, diabetes, joint disease, and several types of cancer). According to the 2018 *Riset Kesehatan Dasar* or Baseline Health Research, DKI Jakarta has the highest obesity prevalence in Indonesia at 45.4% and is followed by a high prevalence of chronic non-communicable diseases. In Indonesia, DKI Jakarta has the third highest prevalence of stroke, the second highest prevalence of hypertension, and the highest prevalence of diabetes and heart disease [4].

In addition to health losses, obesity can also cause economic loss. Economic loss due to obesity in DKI Jakarta is equivalent to 8.66% of Indonesia's total loss due to obesity [5]. It is quite large considering that DKI Jakarta only contributes 3.89% to the nation's population. This means that DKI Jakarta has suffered a huge loss due to obesity.

High UPF consumption causes the obesity pandemic. It is a result of lifestyle shift all over the world. High UPF consumption is also inseparable from urbanization, advancements in transportation and food production technology, modern marketing strategies, and mass media [1]. High UPF consumption is also caused by other factors such as growth of modern food marketing, industrialization of food products, and growth of fast-food and supermarket chains [6].

UPF consumption is part of the household food consumption pattern. One of the most influential factors on consumption is price. UPF price is higher than fresh food price in developing countries but is lower than fresh food price in developed countries [7]. This phenomenon leads to high obesity prevalence in high-income communities of developing countries and in low-income communities of developed countries [8]. In addition to price, UPF consumption is also influenced by household income. This means that UPF consumption will likely increase with income.

Therefore, UPF consumption in Indonesia is high in prosperous provinces, such as DKI Jakarta. DKI Jakarta has the lowest percentage of people living in poverty, highest human development index (HDI), and highest monthly per capita expenditure in Indonesia. Based on Susenas 2017 data, DKI Jakarta also has the highest UPF consumption expenditure in Indonesia. This suggests that people living in DKI Jakarta are very willing to pay for luxury goods. DKI Jakarta's welfare and its high UPF consumption indicates that DKI

Jakarta's lifestyle has shifted from a necessity-based lifestyle to a luxury-based lifestyle. This lifestyle shift is also supported by the superiority of UPF sectors and providers such as restaurants, supermarkets, and malls. The immense UPF accessibility in DKI Jakarta eventually leads to high UPF consumption and high obesity prevalence. Various socializations related to healthy food have been conducted, but they have been drowned out by advertisements showing UPF as a more captivating food.

To make healthy food socializations more effective and improve health quality, it is important to examine factors that influence UPF consumption. The factors studied in this paper include economic factors such as price and income and social factors such as household characteristics. Several similar studies have been conducted, including the study of Passos et al (2020) in Brazil which states that higher UPF price decreases UPF consumption [9]. UPF consumption also increases with higher income class [10]. Several other studies have stated that the employment sector [11], female labor participation [8], maternal education [12], and the number of children [7] also affect UPF consumption.

Based on the description above, the research problem can be stated as: "How do economic variables (price and income) and household characteristics affect UPF consumption in DKI Jakarta, Indonesia?"

LITERATURE RESEARCH

1. Degree of Food Processing

Carlos Monteiro develops a food classification category called *NOVA* which groups food according to degree of processing. Foods are grouped into minimally processed food (MPF), processed ingredients (PI), processed food (PF), and ultra-processed food (UPF) [13].

The first group, which is MPF, consists of fresh foods free from addition of other substances such as salt, sugar, oil, or fat. MPF processing is physical such as cleaning, cutting, drying, cooling, etc. Examples of MPF are fresh fruit and vegetables, fresh meat and fish, fresh milk, eggs, ground coffee and tea, mineral water, and other fresh foods. The second group, which is PI, consists of substances extracted or purified from MPF to produce ingredients for seasoning or cooking food. PI processing can be physical or chemical such as milling, refining, adding enzymes, etc. Examples of PI are flour, starch, oil, salt, sugar, monosodium glutamate (MSG), etc. The third group, which is PF, consists of MPF with addition of two or three other ingredients such as sugar, fat, salt, etc., but not durable and not classified as ready-to-eat or ready-to-cook food like UPF. Examples of PF are tofu and tempeh, salted and cured meat and fish, etc. The fourth and last group is UPF. UPF consists of industrially processed foods with addition

Table 1. List of UPF included in Susenas

UPF subgroups	List of specific foods
Processed meat and fish	Processed and canned fish (pressure cooked milkfish or *bandeng presto*, canned sardines or tuna), other processed meat and fish such as corned beef, sausages, chicken nuggets, Indonesian meatballs or *bakso*, etc.
Any kinds of snacks	Bread (white, sweetened, or other bread), biscuits, cookies, crackers, Indonesian traditional cakes (*kue lapis, bika ambon, kue lumpur*, etc.), chips and crisps, and other snacks.
Instant noodles	-
Other processed foods	Canned vegetables and fruits, margarine, butter, instant coconut milk, sauces (ketchup, chili sauce, soy sauce), instant cooking spices, jam, instant jelly and pudding powder, and other processed foods
Processed milk and baby food	Sweetened condensed milk, industrially processed liquid milk, powdered milk, powdered baby milk, instant baby food, processed cheese, yoghurt, etc.
Other processed drinks	Instant beverages (instant tea, coffee, chocolate drink, fruit essence, syrup, etc), ready-to-drink beverages (ready-to-drink tea, fruit juice, coffee and tea), ice creams and other instant ice dishes, liquor, etc.

of more than five ingredients. UPF usually contains casein, lactose, gluten, food coloring, artificial sweeteners, flavor enhancers, emulsifiers, and other chemical substances. The following table will list specific foods in the UPF category as well as UPF subgroups used in this study.

2. Consumption and demand theory

Consumption is the activity of spending on goods and services. Consumption is closely related to consumer behavior. There are three principles of consumer behavior: consumer preference, budget constraint, and consumer choice [14]. The principle of budget constraint means that consumers have a certain budget that limits their consumption, while consumer choice means that consumers will buy a combination of goods that maximizes their satisfaction or utility by considering preferences, price and income.

The level of consumption of an item can be expressed by the demand theory. An increase in own-price and price of complementary goods will decrease consumption of a good. Meanwhile, an increase in income and price of substitute goods will increase consumption of a good [14].

3. Engel's law

Engel's Law states that poorer families allocate more of their expenditures for food than non-food items. Engel's Law can also be connected with food consumption patterns and two implications are drawn out. The first implication is that the poor, who allocates more of their expenditure for food, tend to buy staple foods in large quantities, in other words, they have a necessity-based food consumption pattern. The second implication is that high-income individuals tend to have greater proportion of spending on luxuries, including consuming more diverse foods such as UPF [15].

RESEARCH METHODOLOGY

1. Research Scope

This study uses secondary data from BPS-Statistics Indonesia, namely the March 2019 Susenas micro data. Susenas consists of multiple modules and this study uses two modules i.e. the core (KOR) and consumption and expenditure (*Konsumsi dan Pengeluaran* or KP) modules. The unit analysis of this research is ordinary households in all regions in DKI Jakarta with total sample size of 4343 households. The KOR module is used to obtain variables such as household occupational sector (formal or informal), female household head or wife labor participation and education, and the number of children or adolescents in a household. While the KP module is used to obtain consumption variables such as per capita income and food prices and expenditure.

2. Data analysis method

This study implements descriptive and inferential statistical analysis. Descriptive analysis, presented in figures, is conducted to get a general description of UPF consumption according to income level and household characteristics. Inferential analysis is conducted by modeling UPF consumption with M-estimation robust linear regression. The following are the steps of inferential analysis implemented in this study.

Dividing the research sample to three groups based on income class.

The research sample is divided into three income class groups based on Asian Development Bank classification [16], [17], [18]. Income class groups are based on daily per capita expenditure. Since expenditure in Susenas is measured in IDR, PPP exchange rate (purchasing power parity exchange rate) is used to convert USD to IDR. The PPP conversion value, which is IDR4743,34 in 2019, is obtained from *data.worldbank.org.*

Constructing price variable using unit value.

The price variable is constructed using unit value approach. Unit value of a commodity is the amount of money spent by households to buy one unit of a certain commodity [19]. The commodity (symbolized by **i**) measured in this study is UPF food group.

Table 2. Division of research sample based on income class

Class	Income class name	Daily Exp (USD)	Daily Exp (IDR)	Number of samples	% from total
1	Poor	< $3.2	< 15.149,90	14	45.2%
	FM (*floating middle*)	$3.2 – $4	15.149,90 – 18.937,36	61	
	LM (*lower middle*)	$4 – $10	18.937,37 – 47.343,40	1894	
2	UM (*upper middle*)	$10 – $20	47.343,41 – 94.686,80	1335	30.9%
3	Upper class	> $20	> 94.686,80	1039	23.9%
Total				**4343**	**100%**

The unit value of group **i** is a weighted average of the prices of all **j** sub-commodities in group **i** and is formulated as follows:

$$\boldsymbol{p_i} = \sum_{\boldsymbol{j=1}}^{\boldsymbol{J_i}} \left[\boldsymbol{p_j} \frac{\boldsymbol{x_j}}{\sum_{\boldsymbol{j=1}}^{\boldsymbol{J_i}} \boldsymbol{x_j}} \right] \quad (1)$$

where $\boldsymbol{p_j} = \frac{\boldsymbol{x_j}}{\boldsymbol{q_j}}$

where

i = commodity or food group

p_i = unit value of group i

J_i = all sub-commodities or items belonging in group i

x_j = household expenditure for sub-commodity j

q_j = household consumption quantity for subcommodity j

j = sub-commodities or items

p_j = unit value of sub-commodity j

The unit value above is biased because it does not represent market prices and is still influenced by other factors such as household characteristics. This bias can be minimized with price instrumental variable, which is the corrected unit value by considering the quality effect and quantity premium of purchased goods. Quality effect is price differences caused by quality differences of goods, while quantity premium is price differences caused by quantity difference of goods per unit [19].

In this study, price variable is measured in natural logarithms in order to make the regression coefficient obtained directly represent the value of price elasticity of demand. The correction is conducted by subtracting the natural logarithm of household unit value for i-th commodity by the difference or deviation of price paid by households from market price. Market price is approached as the average unit value paid by households for i-th commodity in a regency or municipality with the assumption that every household in a particular regency or municipality purchases at the same market. The logarithm of price deviation is calculated by the following formula.

$$\ln Dev_i = \ln p_i - \ln \bar{p}_i \quad (2)$$

Where:

p_i = unit value of i-th commodity

$\bar{p}_i$ = average unit value of i-th commodity in a municipality or regency

Then $\ln Dev_i$ is regressed with household characteristics variables. Household characteristics are considered a proxy for household preferences for quality and quantity of food purchased. This regression is conducted in order to obtain price deviations or price differences that have been influenced by household preferences as a means to correct quality effect and quantity premium. The price deviation regression is formulated by the equation below.

$$\ln Dev_i = \beta_0 + \beta_1 \ln income_i + \beta_2 sector_i + \beta_3 employ_i + \beta_4 edu_i + \beta_5 child_i + \varepsilon_{ih} \quad (3)$$

Where:

$income$ = monthly household expenditure per capita (IDR)

$sector$ = household occupational sector (1 = formal, 0 = informal)

$employ$ = female household head or wife labor participation (1 = working, 0 = not working)
edu = female household head or wife education (1 = senior high school or above, 0 = junior highschool or below)
$child$ = number of children or adolescents (individuals aged 0 – 18 y.o.) in the household

From the regression in equation (3), a fitted value of $\ln \widehat{Dev}_i$ is obtained to correct $\ln p_i$. Correction of p_i results in price instrumental variable or the final price variable (p_i^*) which is free from bias. The price instrumental variable is used to model UPF consumption and is formulated by the equation below:

$$\begin{cases} Consuming\ households & ln\, p_i^* = ln\, p_i - ln\, \widehat{Dev}_i \\ Nonconsuming\ households & ln\, p_i^* = ln\, \bar{p}_i - ln\, \widehat{Dev}_i \end{cases} \quad (4)$$

Choosing between OLS or robust regression model.

Choosing between OLS and robust regression model is implemented in UPF consumption and UPF price deviation regression. The final regression equation which aims to determine the effect of price, income, and household characteristics on household UPF consumption is stated in equations (5) and (6). The purpose of implementing natural logarithm transformation on three variables which are UPF expenditure, UPF price, and per capita income is to directly obtain a regression coefficient that represents the value of UPF price elasticity and income elasticity of demand. Furthermore, the categorization of female household head or wife education in Class 3 model differs from the categorization in Class 1 and 2 models. Categorization in Class 3 model is different because households in Class 3 are upper class individuals with higher income and higher education, so the percentage of population with higher education is much larger than households in Class 1 and 2. Therefore, household UPF consumption regression model is formulated by the equation below.

Household UPF consumption regression model for Class 1 and 2:

$$\begin{aligned} \ln UPF_i = {} & \beta_0 + \beta_1 \ln piupf_i + \\ & \beta_2 \ln income_i + \\ & \beta_3 sector_i + \\ & \beta_4 employ_i + \beta_5 edu_i + \\ & \beta_7 child_i + \varepsilon_i \end{aligned} \quad (5)$$

Household UPF consumption regression model for Class 3:

$$\begin{aligned} \ln UPF_i = {} & \beta_0 + \beta_1 \ln piupf_i + \\ & \beta_2 \ln income_i + \\ & \beta_3 sector_i + \\ & \beta_4 employ_i + \\ & \beta_5 eduSHS_i + \\ & \beta_6 eduUNI_i + \\ & \beta_7 child_i + \varepsilon_i \end{aligned} \quad (6)$$

where:
$piupf$ = UPF price (IDR)
UPF = household UPF expenditure per capita (IDR)
$income$ = monthly household expenditure per capita (IDR)
$sector$ = household occupational sector (1 = formal, 0 = informal)
$employ$ = female household head or wife labor participation (1 = working, 0 = not working)
edu = female household head or wife education (1 = senior high school or above, 0 = junior highschool or below)
$eduSHS$ = female household head or wife education (1 = senior high school, 0 = others)
$eduUNI$ = female household head or wife education (1 = college or above, 0 = others)
$child$ = number of children or adolescents (individuals aged 0 – 18 y.o.) in the household

Below are the hypotheses for UPF consumption models stated in equation (5) and (6).

1. A higher UPF price decreases UPF consumption ($H_1: \beta_1 < 0$).
2. A higher per capita income increases UPF consumption ($H_1: \beta_2 > 0$)
3. Employment sector affects UPF consumption ($H_1: \beta_3 \neq 0$)
4. Female household head or wife labor participation affects UPF consumption ($H_1: \beta_4 \neq 0$)
5. Female household head or wife education affects UPF consumption
   For Class 1 and 2 models (equation 5)
   $H_1: \beta_5 \neq 0$
   For Class 3 models (equation 6)
   $H_1: \beta_5 \neq 0$; $H_1: \beta_6 \neq 0$
6. A higher number of children or adolescents increases UPF consumption ($H_1: \beta_7 > 0$)

Before performing OLS regression, the dependent variable is tested for normality distribution. The normality distribution of $\ln UPF_i$ is tested for UPF consumption regression. In addition, multicollinearity detection is conducted using Pearson correlation coefficient to detect correlations between numerical independent variables. If the dependent variable is normally distributed and there is no multicollinearity, OLS regression is performed. In performing OLS, normality and homoscedasticity assumptions must also be checked. Jarque-Bera test is used for normality test and Breusch-Pagan test is used for heteroscedasticity test. If the dependent variable is not normally distributed or if the normality and homoscedasticity assumptions in the OLS model are violated, influential outliers must be detected to decide whether robust regression is suitable for modeling.

Outlier detection is conducted by calculating the value of studentized deleted residual (SDR), difference in fit statistics (DFFITS), and leverage value. SDR is used to detect outliers in dependent variable, leverage value is used to detect outliers in independent variables, and DFFITS is used to detect influential observations. If most of the influential observations are outliers in dependent variable, robust regression can be used for modeling. However, if there are no influential outliers in dependent variable, other alternative regression models such as ridge regression or logistic regression may be used.

Table 3 below displays the results of the Jarque-Bera normality test on dependent variables. While Table 4 displays multicollinearity detection on the independent variables.

Based on Table 3 below, all dependent variables are not normally distributed. The additive nature of linear regression causes the violation of normal distribution on dependent variable will likely cause the violation on normality assumption of OLS regression. Thus, OLS estimation cannot be used for modeling household UPF consumption regression. Then, based on Table 4, no correlation coefficient value between independent variables exceeds 0.6, which means that there is no multicollinearity between numeric independent variables.

Next, influential outliers in dependent and independent variables are detected using leverage value, SDR, and DFFITS. Based on the calculations, the number of influential outliers in all three UPF consumption regression models are less

Table 3. Normality test of dependent variables

Regression Model		Dependent variable	Jarque-Bera test		
			JB Stat	p-value	Normally distributed?
UPF consumption regression	Class 1	$\ln UPF_i$	269.53	2.2×10^{-16} [a]	No
	Class 2		212.13	2.2×10^{-16} [a]	No
	Class 3		62.61	2.5×10^{-14} [a]	No

[a] *significant at 5% level*

Table 4. Multicollinearity detection between numerical independent variables using Pearson correlation coefficient

UPF consumption regression							
Class 1				Class 2			
	ln *piupf*	**ln *income***	***child***		**ln *piupf***	**ln *income***	***child***
ln *piupf*	1	0.231	- 0.126	ln *piupf*	1	0.180	0.077
ln *income*		1	- 0.321	ln *income*		1	- 0.161
child			1	*child*			1

UPF consumption regression			
Class 3			
	ln *piupf*	**ln *income***	***child***
ln *piupf*	1	0.070	0.070
ln *income*		1	- 0.067
child			1

than 2% of the total observations. Although the number of influential outliers in dependent variable are minuscule compared to the number of total observations, at least 85% of the influential observations are influential outliers in dependent variable. Thus, the robust regression model is suitable to model UPF consumption regression in three income classes.

Estimating and testing the robust regression model.

This study uses iteratively reweighted least squares (IRLS) robust regression with M-estimation with Huber weight function. M-estimation is a robust estimation which is less resistant to influential outliers in independent variables but has the highest efficiency compared to other estimation methods. M-estimation's efficiency is 95% of OLS estimation. Based on outlier detection in the previous section, the number of influential outliers in independent variables are less than 0.5% of the total observations. Thus, it is possible and recommended to use M-estimation robust regression.

After obtaining the model, significance tests are used to examine the simultaneous and partial effect of independent variables on the dependent variable. The simultaneous test is conducted using F-test of overall significance, while the partial test is conducted using t-test of partial significance. If the null hypothesis of F-test is rejected, the model obtained can be used to examine the dependencies between the dependent and independent variables. Then, if all independent variables are significant to the model, the model obtained can be used for prediction. The predictive power of the model is determined by calculating the adjusted coefficient of determination or $\left(R^2_{adj}\right)$.

RESULT AND DISCUSSION

1. Descriptives of household UPF expenditure in Jakarta

In general, household UPF expenditure per capita in Jakarta increases in quantity and variety with increasing income class, as shown in Figure 1 below. This condition is similar to other developing countries such as Brazil [10] and Mexico [7]. The median value of household UPF expenditure per capita is IDR26,850 for Class 1 households, IDR47,814 for Class 2 households, and IDR77,333 for Class 3 households. In Class 1 and Class 2, the maximum value of UPF

expenditure per capita is less than IDR200,000 while in Class 3 the maximum value is above IDR600,000. This result is consistent with research results from Clements & Si (2017) which state that more prosperous countries have higher and more varied UPF consumption than less prosperous countries [15]. In addition, a household is classified as an outlier if its UPF expenditure per capita is above IDR63,379 in Class 1, above IDR112,540 in Class 2, and above IDR184,374 in Class 3. This means that many households have much larger UPF expenditure per capita than most of other households.

Then, Figure 2 below displays percentages of household UPF expenditure per capita based on six UPF subgroups defined previously in Table 1. In general, UPF consumption expenditure in three income classes is dominated by spending on snacks, instant noodles, and other processed drinks. The subgroups of processed meat and fish, instant noodles, and other processed drinks have highest expenditure percentage in Class 1. It indicates that UPF consumption in low-income households tends to be high in substitutes of fresh foods (instant noodles and processed meat and fish). Meanwhile, the subgroups of snacks, processed milk, and other processed food have highest expenditure percentage in Class 3. This indicates that UPF consumption in high-income households tends to be high in nutritious foods (processed milk) and non-staple foods (snacks).

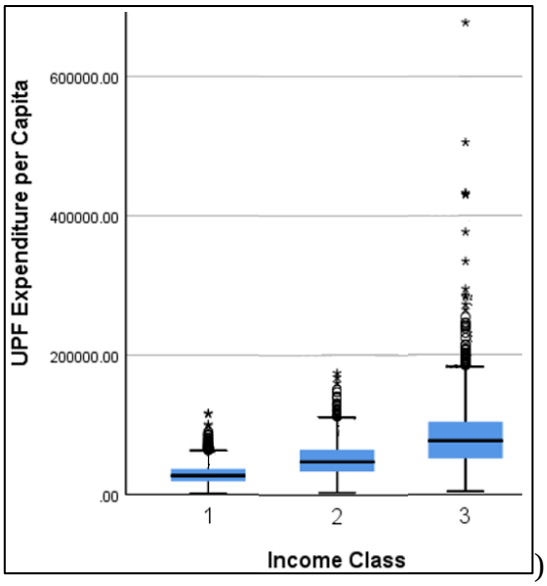

Figure 1. Household UPF expenditure per capita by income class

Next, price distribution across three income class is examined. Based on UPF price boxplot shown in Figure 3, the UPF price paid by Class 2 and 3 households are generally higher and more varied than Class 1. This is consistent with research results from Clements & Si (2017) which state that high-income households tend to have more diverse and luxury-based consumption pattern and are willing to buy UPF at a higher price. The median value of UPF price is IDR7,134 for Class 1 households, IDR10,646 for Class 2 households, and IDR16,178 for Class 3 households. The maximum value of UPF prices for Class 1 and 2 are less than IDR300,000 while in the maximum value in Class 3 is above IDR686,352. In addition, a household is classified as an outlier if that household is willing to pay for one unit of UPF above IDR14,387 in Class 1, above IDR23,381 in Class 2, and above IDR51,143 in Class 3. The huge difference between median, maximum, and outlier boundaries in three income classes indicates that the amount of money willing to be paid for one unit of UPF varies widely between households in Jakarta.

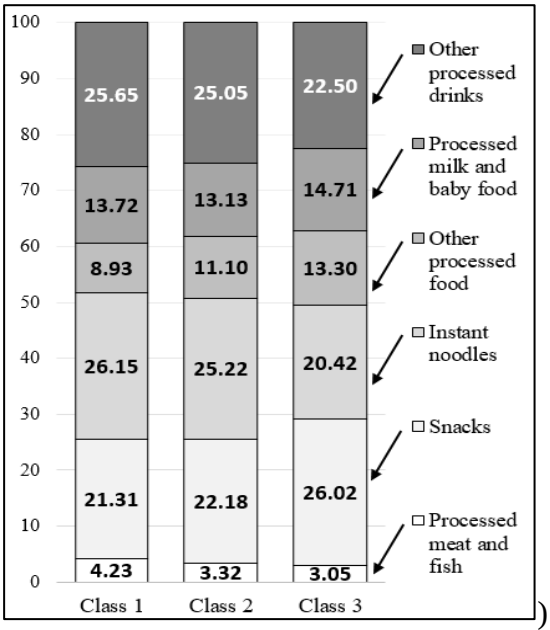

Figure 2. Percentages of UPF consumption expenditure by UPF subgroups and income class.

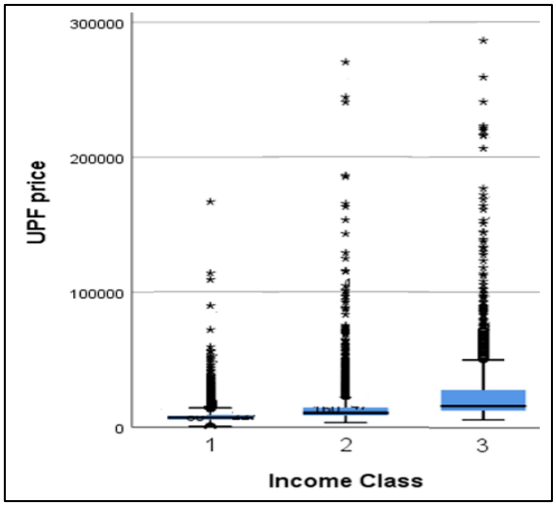

Figure 3. Boxplot of UPF price (unit value approach) by income class

Next, from per capita income perspective, Class 3 per capita income is much higher than Class 1 and 2. The median per capita income is IDR801,191 in Class 1 households, IDR1,626,683 in Class 2, and IDR3,239,351 in Class 3. The median per capita income of Class 3 is much larger than Class 1 and 2, this is in line with Class 3 UPF expenditure which is also much larger than Class 1 and 2.

Besides UPF expenditure and UPF price based on income class, there are several patterns to be observed from UPF consumption based on household characteristics. Figure 4 up to Figure 7 below displays UPF consumption expenditure by income class and household characteristics such as household occupational sector in Figure 4, female household head or wife labor participation in Figure 5, female household head or wife education in Figure 6, and the number of children or adolescents in Figure 7.

As displayed in Figure 4, the variation of UPF expenditure per capita in two occupational sectors increases with income class. The median value of UPF expenditure per capita of the informal sector is IDR26,075 in Class 1, IDR46,000 in Class 2, and IDR68,833 in Class 3. Meanwhile, the median value of UPF expenditure per capita in the formal sector is IDR27,000 in Class 1, IDR48,837 in Class 2, and IDR79.970 in Class 3. Based on the numbers mentioned, it can be concluded that UPF consumption expenditure is always higher in formal sector households.

Then, as displayed in Figure 5, the variation of UPF expenditure per capita in households with working and non-working female head of household or wife increases with income class. The median value of UPF expenditure per capita in households with non-working female household head or wife is IDR26,400 in Class 1, IDR45,022

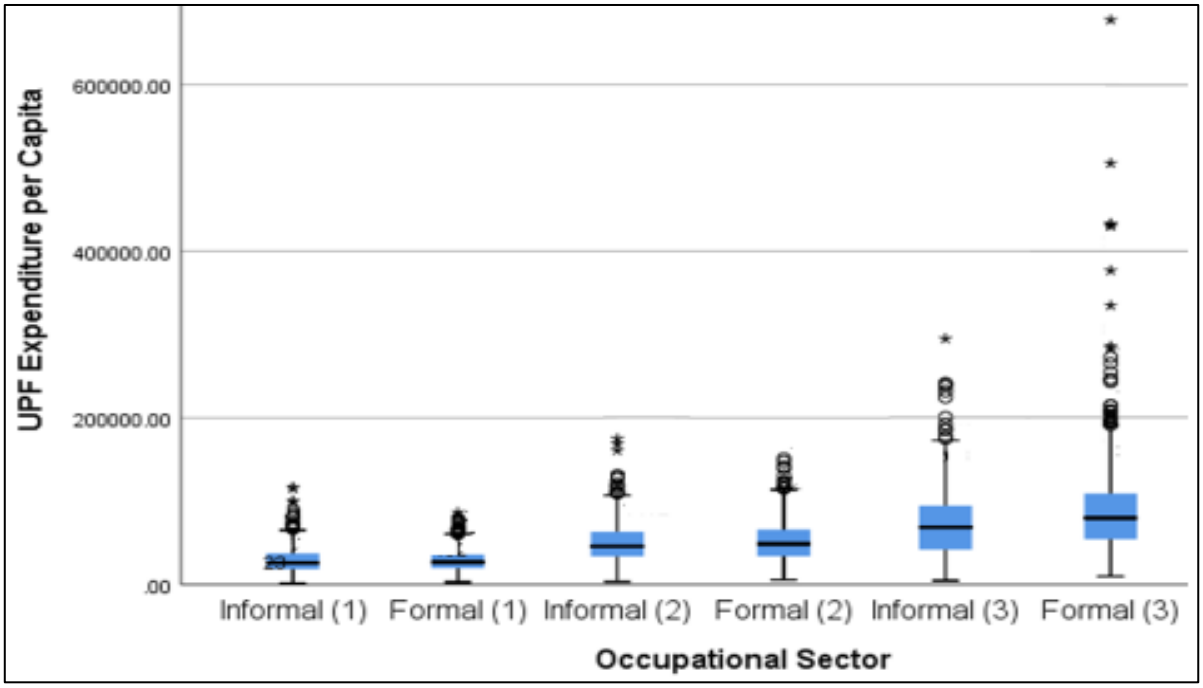

Figure 4. Boxplot of household UPF ex-penditure per capita by occupational sector and income class

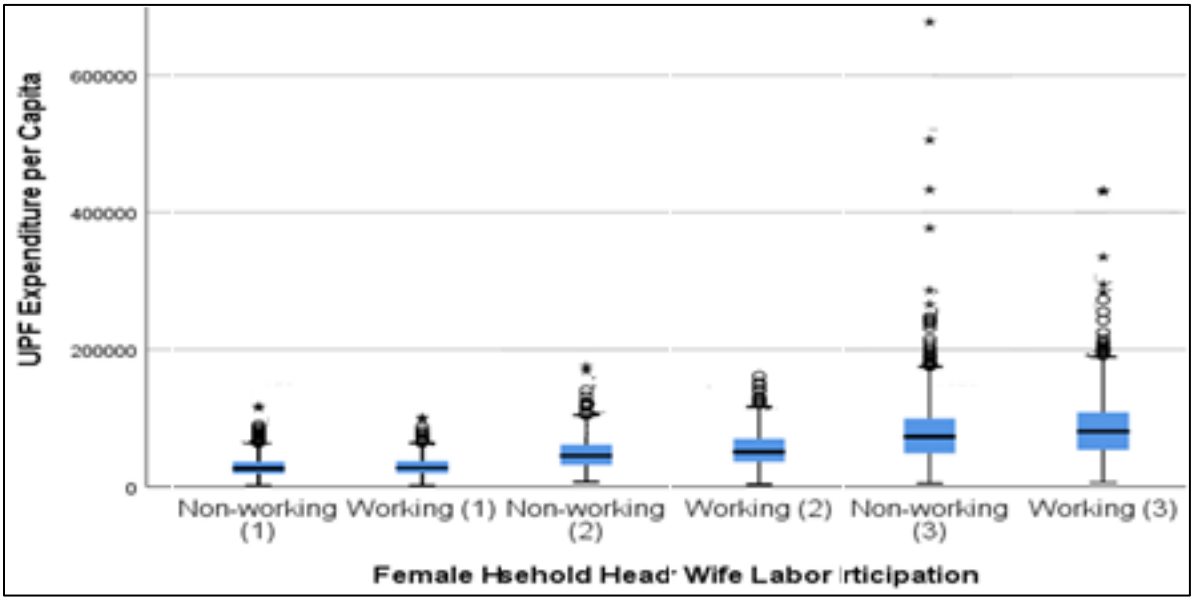

Figure 5. Boxplot of household UPF expenditure per capita by female household head or wife labor participation and income class

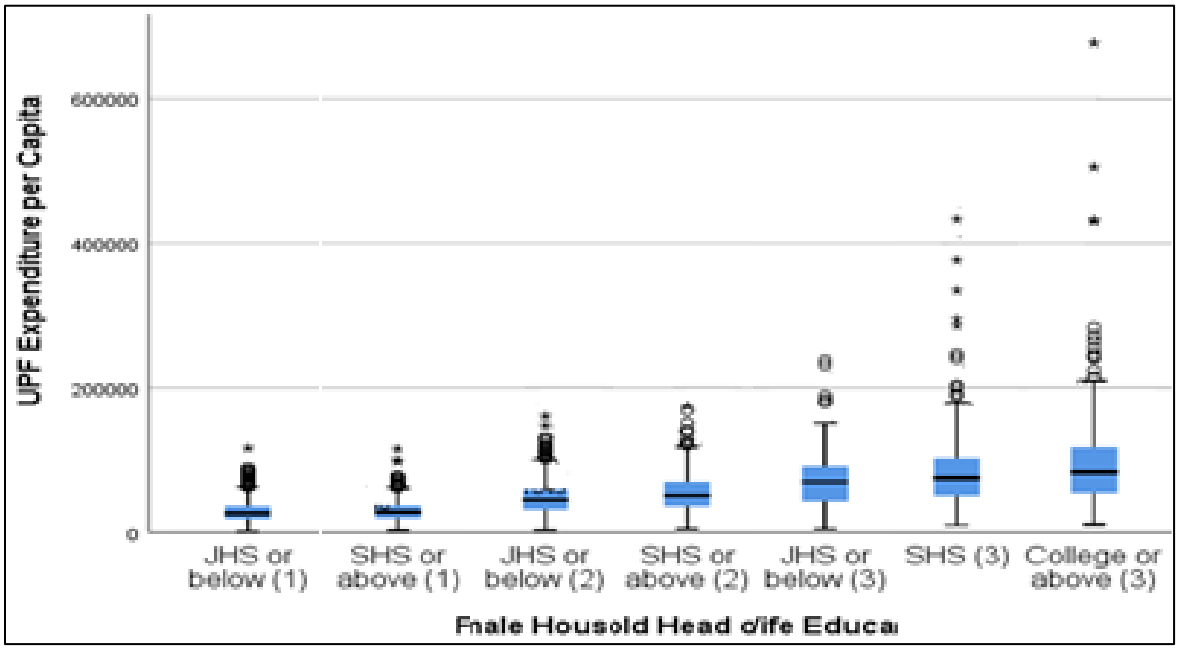

Figure 6. Boxplot of household UPF expenditure per capita by female household head or wife education level and income class

in Class 2, and IDR72,800 in Class 3. Meanwhile, the median value of UPF expenditure per capita in households with working female household head or wife in Class 1 is IDR27,250, IDR50,500 in Class 2, and IDR80,433 in Class 3. From the numbers mentioned, it can be concluded that UPF consumption expenditure is always higher in households with working female household head or wife.

In Figure 6, the variation of UPF expenditure per capita increases with income class and female household head or wife educational level. The median value of UPF expenditure per capita in households with female household head or wife with junior high school degree or lower is IDR26,000 in Class 1, IDR45,000 in Class 2, and IDR69,700 in Class 3. While the median value of UPF expenditure per capita in households with female household head or wife with senior high school degree or higher is IDR27,967 in Class 1 and IDR51,397 in Class 2. Then in Class 3, the median value of UPF expenditure per capita of households with female household head

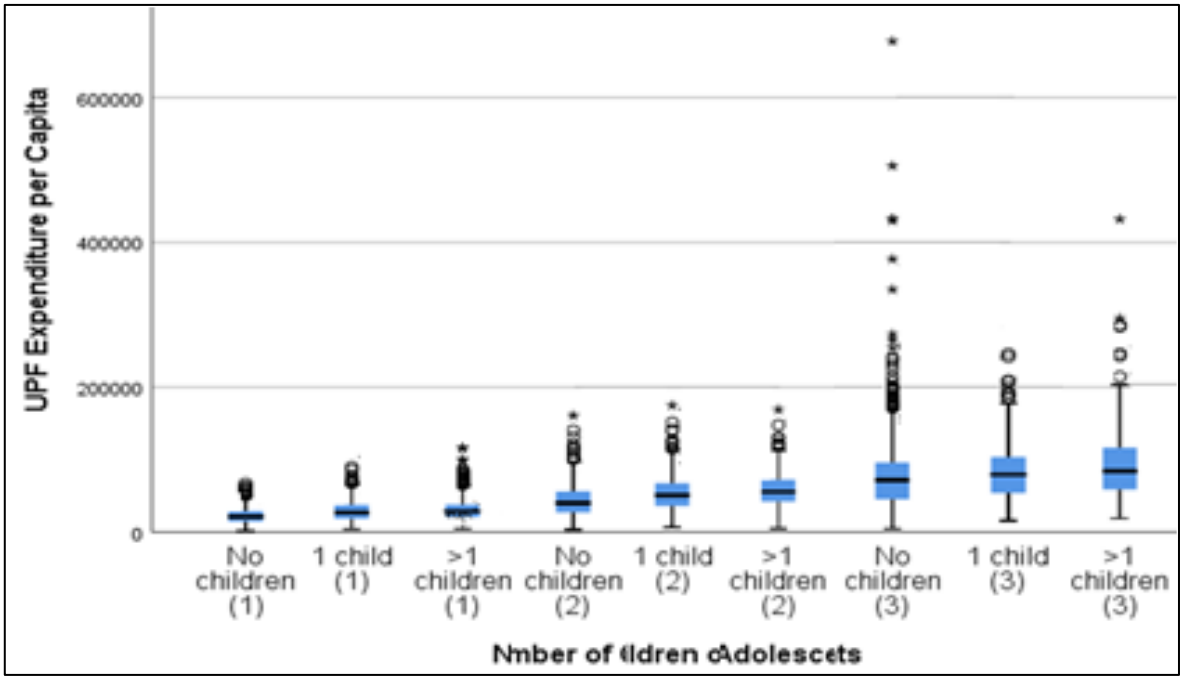

Figure 7. Boxplot of household UPF expenditure per capita by number of children or adolescents and income class

or wife with senior high school degree is IDR74,910 and is IDR83,016 in college degree. It can be concluded that household UPF consumption expenditure increases along female household head or wife educational level.

Lastly, in Figure 7, the variation of UPF expenditure per capita increases with income class and the number of children or adolescents in the household. The median value of UPF expenditure per capita in households without children or adolescents is IDR21,500 in Class 1, IDR40,150 in Class 2, and IDR71,875 in Class 3. The median value of UPF expenditure per capita in households with one child or adolescent is IDR26,900 in Class 1, IDR50,866 in Class 2, and IDR79,466 in Class 3. The median value of UPF expenditure per capita in households with more than one children or adolescents is IDR28,750 in Class 1, IDR55,657 in Class 2, and IDR84,275 in Class 3. The difference of UPF expenditure per capita between households without children or adolescents and households with one child or adolescent is always higher than the difference between households with one child or adolescent and households with more than one children or adolescents. This indicates that children or adolescents are the main consumers of UPF because once a child or adolescent is present in a household, UPF consumption increases to a great extent.

2. Household UPF expenditure regression model

The final model obtained is robust regression model with M-estimation and Huber weights. Regression coefficients and results for F-tests and t-tests for the three income classes is presented in Table 5.

Based on Table 5, F-test results for three models are all significant (reject null hypothesis), which means that all independent variables have simultaneous influence on UPF consumption expenditure. Also, in three models, several t-test results are not significant (fail to reject null hypothesis), hence the UPF consumption expenditure model cannot be used for prediction.

From the directions or signs of regression coefficients, all numerical independent variables have consistent signs in three models. This means that each numerical independent variable always have consistent positive or negative influence toward UPF consumption in three income classes. Looking at the significance of independent variables, the variables of UPF price, per capita income, female

Table 5. The robust regression with M-estimation results for UPF consumption regression for the three income class models

	Class 1		Class 2		Class 3	
	Coef	**p-value**	**Coef**	**p-value**	**Coef**	**p-value**
Intercept	- 4.305	$4x10^{-16}$ [a]	- 0.724	0.6762	3.847	$9x10^{-10}$ [a]
X1 ln*piupf*	0.143	$2x10^{-16}$ [a]	0.183	$2x10^{-16}$ [a]	0.212	$2x10^{-16}$ [a]
X2 ln*income*	0.940	$2x10^{-16}$ [a]	0.658	$2x10^{-16}$ [a]	0.331	$2x10^{-16}$ [a]
X3 *sector*	0.008	0.6762	0.030	0.2130	0.109	0.0020 [a]
X4 *employ*	0.045	0.0195 [a]	0.102	$1x10^{-5}$ [a]	0.084	0.0089 [a]
X5 *edu, eduSHS*	- 0.065	0.0010 [a]	0.0001	0.9966	0.007	0.8748
X6 *eduUNI*	-	-	-	-	0.004	0.9343
X7 *child*	0.161	$2x10^{-16}$ [a]	0.153	$2x10^{-16}$ [a]	0.069	$4x10^{-5}$ [a]
	F-value	**p-value**	**F-value**	**p-value**	**F-value**	**p-value**
F-test	177.690	$7x10^{-99}$ [a]	102.078	$9x10^{-99}$ [a]	47.004	$5x10^{-58}$ [a]

[a] *significant at 5% level*

household head or wife labor participation, and number of children or adolescents in the household are all statistically significant in affecting UPF consumption expenditure. However, the occupational sector variable is only statistically significant in Class 3 model while the female household head or wife education variable is only statistically significant in Class 1 model.

The following are detailed explanations about the effects of each independent variable on household UPF consumption expenditure.

UPF price has positive and significant effect on UPF consumption expenditure in three income class models. It means that an increase in UPF price results in an increase of household UPF consumption. This result is contrary to the study by Passos et al (2020) in Brazil which states that UPF price has negative and significant effect on prevalence of overweight because it decreases UPF consumption [9]. These contradictory results may be caused by the diversity of UPF commodities. As discussed earlier, UPF consists of various types of food with varied unit value prices. It means that household UPF consumption varies greatly both in quantities and types. As a result, it cannot be interpreted that the increase in UPF price will directly cause the decrease of UPF consumption.

For example, in Figure 2, Class 1 households have highest percentage of UPF consumption expenditure for UPF subgroups of instant noodles and processed meat and fish, which are substitutes for staple foods. This indicates that an increase in instant noodles and processed meat price does not necessarily lead to a decrease of UPF consumption in Class 1 if prices of other substitute foods for instant noodles and processed meat are more expensive. In addition, Class 3 households have highest percentage of snack consumption compared to other classes. Snacks are not staple foods and the decision to buy snacks is heavily influenced by other factors besides price such as consumer taste and lifestyle. This indicates that an increase in snack prices does not necessarily lead to a decrease in snack consumption in Class 3 if that particular snack gives high satisfaction and consumers are willing to buy them at higher prices.

Next, per capita income variable has positive and significant effect on UPF consumption expenditure in three income classes. It means that an increase in per capita income causes an increase in UPF consumption. This result is consistent with the Demand Theory and researches conducted by Monteiro et al (2010) [10], Clements & Si (2017) [15], Simões et al (2018) [11], and Passos et al (2020) [9]. As for the regression coefficients or income elasticities of demand, the coefficients are 0.94 in Class 1, 0.66 in Class 2, and 0.33 in Class 3. A large income elasticity coefficient in Class 1 means that Class 1 household UPF consumption is more responsive to changes in income compared

to Class 2 and 3. The relatively small income elasticity coefficient in Class 3 can also indicate that UPF is routinely consumed by Class 3 households.

Employment sector variable is statistically significant on UPF consumption expenditure in Class 3 model. Based on the earlier discussion about median value of UPF expenditure, formal sector households have higher UPF per capita expenditure than informal sector households. This result is consistent with research results from Simões et al (2018) which state that higher occupational social class causes an increase in UPF consumption [11]. The occupational sector in this study that is only statistically significant in Class 3 model also indicates that differences in occupational sector only affect UPF consumption in high-income households. This may be caused by the large difference in per capita income of formal and informal sector households in Class 3, which is IDR216,012. In consequence, the large difference in income also affects household UPF consumption in Class 3 households.

Next, female household head or wife labor participation is statistically significant on UPF consumption expenditure in three income class models. Based on the earlier discussion about median value of UPF expenditure, households with working female household head or wife have higher UPF consumption than households with non-working female household head or wife. This result is consistent with research results from Boysen et al (2019) which state that higher percentage of a country's female labor force increases the country's UPF consumption [8]. These results indicates that UPF is a more practical food alternative that households with working female household head or wife, who have limited cooking time, tend to increase their UPF consumption.

Female household head or wife education is statistically significant on UPF consumption in Class 1 model. Based on the earlier discussion about median value of UPF expenditure, households with female household head or wife with senior high school degree or above have higher UPF consumption than households with female household head or wife with junior high school degree or below. This result is in consistent with research results from Sparrenberger et al (2015) which states that families with college degree maternal education have higher UPF consumption than families with lower than college degree maternal education [12]. This result indicates that high level of formal education does not guarantee high level of knowledge regarding health consequences of excessive UPF consumption. Furthermore, UPF consumption is also heavily influenced by other factors besides education such as lifestyle, tastes, and dietary patterns.

Lastly, the number of children or adolescents has positive and significant effect on UPF consumption expenditure in three income class models. It means that an increase in the number of children or adolescents in a household increases household UPF consumption. This result is in accordance with research results from Ponce et al (2017) [7] and Simões et al (2018) [11] which state that younger age causes an increase in individual UPF consumption. These results also indicates that children and adolescents or household members aged 0 - 18 years old are indeed the main consumers and marketing targets of UPF [6].

CONCLUSIONS AND RECOMMENDATIONS

Based on the research findings and discussions, the following conclusions are obtained:

1. Household UPF consumption increases with income class. Households in Class 1 have the highest percentage of UPF consumption expenditure for instant noodles and processed meat. This means that UPF consumption of the poor and middle class tends to be high in substitutes for healthy fresh food. On the other hand, households in Class 3 have the highest percentage of UPF consumption expenditure for processed milk and instant snacks. This means that UPF consumption of the upper class

households tends to be high in nutritious foods (processed milk) and snacks (non-staple foods).
2. Households with higher UPF consumption generally have higher incomes, work in the formal employment sector, have a higher number of children or adolescents, and have female household heads or wife with active labor participation and higher education.
3. Price, income, and household characteristics influence household UPF consumption differently in each income class. UPF price, per capita income, the number of children or adolescents, and female household head or wife labor participation have significant effect on UPF consumption in three income classes. Then, occupational sector has significant effect on UPF consumption in Class 3 households, while female household head or wife education has significant effect on UPF consumption in Class 1 households.

From the conclusions above, the following recommendations are proposed:

1. For the local government
   The government is advised to conduct public socialization about UPF. Socialization can be directed by relevant government agencies such as Department of Health or Department of Food Security, in collaboration with the Department of Woman Empowerment to organize knowledge transfer about UPF to mothers and female residents as individuals who determine family food consumption. Socialization can also be organized in schools by involving the Department of Education so children have access to knowledge about UPF from an early age. Furthermore, the socialization needs to be focused on households with the lowest income who consume UPF mainly as substitutes for nutritious food, as well as on households with the highest income who have the highest UPF consumption expenditure.
2. For the general public
   a. Doing self-education regarding UPF to be able to consciously limit UPF consumption.
   b. Altering the consumption of processed meat and fish (as a substitute of fresh meat) with other healthier and cheaper protein sources such as tempeh, tofu, eggs, etc.
   c. In households with working female household head or working wife, preparing meal plans may be useful to save time for shopping and cooking.
   d. Limit UPF snack consumption especially for children and adolescents and substitute the snacks with fresh fruit.
3. For further researches
   a. Covering wider and rural areas to compare UPF consumption between regions.
   b. Focusing further researches on individuals with higher UPF consumption such as high income households or children and adolescents.

ACKNOWLEDGEMENTS

The authors would like to thank Dr. Budiasih and Anugerah Karta Monika, S.Si, M.E. for their advice on the design of the analysis and the manuscript; the Statistics Diploma Program in STIS-Polytechnic of Statistics for supporting this research; and BPS-Statistics Indonesia for providing the data used in this study.

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