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Soy Flour-Based Snack Bar as Potential Snack Alternative for Diabetes Mellitus

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ABSTRACT

This study aimed to determine the Glycaemic Index (GI), Glycaemic Response (GR) and Glycaemic Load (GL) of soy flour-based snack bars in healthy volunteers. An open label randomized controlled trial with crossover study design was done involving eighty adults aged 18–50 years. The glycaemic index was calculated using Incremental Area Under the Blood Glucose Response Curve (iAUC). Friedman's test was used to determine difference of glucose iAUC between WF and SF. Wilcoxon test was used to determine difference of blood glucose peak, time to blood glucose peak, GI and GR between snack bars. The result observed that median (Q1–Q3) of GI were 88.4 (42.3–115.8); WF: 36.6 (21.8–47.9) (Product SF3, Banana); 36.3 (18.9–49.2) (Product SF6, Crispy White Chocolate Macadamia); 29.9 (22.0–43.3) (Product SF5, Crispy Vanilla); 25.9 (17.8–35.4) (Product SF4, Strawberry); 20.2 (15.3–22.2) (Product SF1, Almond Chocolate); and 7.1 (5.4–17.0) (Product SF2, Raisin Almond). We found that GL of WF was (17.7). While, the GL of snack bars made from SF were 4.9 (Product SF3, Banana), 4.1 (Product SF4, Strawberry), 1.9 (Product SF1, Almond Chocolate); 1.8 (Product SF6, Crispy White Chocolate Macadamia), 1.6 (Product SF5, Crispy Vanilla), and 0.9 (Product SF2, Raisin Almond). Friedman statistical test showed significant differences on the blood glucose iAUC between SF and WF ($p<0.001$). SF snack bar showed different GR results, where the area of each products (SF1–SF6) curve was significantly lower than WF. Based on Wilcoxon test, the GI and GR of SF were significantly lower than WF ($p<0.05$). In conclusion, SF snack bars can be classified as a low GI-source snack bar with a low category of glycaemic load; and had relatively high fibre, protein, and fat content which contributed to a lower GI value. Thus, it is a potential snacks alternative for people with blood glucose concerns.

Keywords: diabetes, glycaemic index, glycaemic load, snack bar, soy flour

INTRODUCTION

Globally, the prevalence of diabetes in adults continue to increase (Cho *et al*. 2018). The prevalence of diabetes in 2017 was estimated to be 8.4% and it is expected to rise to 9.9% in 2045 (Cho *et al*. 2018). In Indonesia, the prevalence of diabetes is also increasing. Basic Health Research (2013) showed that prevalence of diabetes in people aged ≥15 years were 6.9%, based the 2011 Perkeni (Indonesian Endocrinology Association) criteria (Kemenkes RI 2013). However, using the criteria of Perkeni 2015, Basic Health Research (2018) found that the prevalence was 10.9% (Kemenkes RI 2018).

Diet plays an important role in diabetes management. In the dietary intervention, alongside with the main foods, the use of appropriate snacks are positively associated to blood glucose control throughout the day (Morris *et al*. 2020). Especially, food with low-Glycaemic Index (GI), high fibre and protein are widely recognized to improve insulin sensitivity or stimulate insulin secretion, slow down the food movement in the digestive tract and improve enzyme activity; thus it is useful in blood glucose regulation (Manullang *et al*. 2020). In addition, diets low in Glycaemic Load (GL) have been found relevant to the prevention and management of diabetes (Augustin *et al*. 2015).

A recent systematic review and meta-analysis showed that low-Glycaemic Index (GI) diets were effective in decreasing Fasting Plasma Glucose (FPG) and Glycated Haemoglobin (HbA1c) (Zafar *et al*. 2019). Another systematic review and meta-analysis study by Reynolds *et*

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al. (2020) observed that increased daily fibre intake (15–35 g) was able to improve in measures of glycaemic control, e.g. HbA1c, FPG, insulin, Homeostatic Model aAssessment of Insulin Resistance (HOMA-IR). While in the other hand, high protein diets were also effective in improving Glycemic Control (HbA1c) (Ajala *et al*. 2013).

Soy is a food with low GI (Blair *et al*. 2006) and a source of protein, fibre, vitamin, mineral, good fat, isoflavone and phytoestrogen (Lokuruka 2010). Several studies suggested that soy is both beneficial in lowering the risk of type 2 diabetes mellitus in healthy subjects (Mueller *et al*. 2012) and improving glucose response in patients with type 2 diabetes mellitus (Sun *et al*. 2017).

Indonesian people usually consume soy in the form of tempeh, tofu, soy sauce, and soy milk which were usually included as side dishes in a meal. A current study conducted in Indonesia found that products made from tempeh are proven to improve blood glucose (Maya *et al*. 2020). Other product such as soy flour based snack bar could be a potential alternative product for healthy or diabetic people. In a trial study involving normal healthy subjects with normal fasting blood glucose, a normal range of glycaemic response by consumption of snack made from soy flour as additional ingredients after 120 min, has been observed (Agustia *et al*. 2019). A study in Japan indicated that the blood glucose and blood insulin response of diabetic patients after ingestion of a soy nutrition bar made of whole soy flour were significantly lower than test cookie (Urita *et al*. 2012).

Taken together, these mentioned study results suggest that soy flour snack bar has a potential glucoregulatory effect in healthy or diabetic people, but further clinical trial study needs to be performed to strengthen the available evidences. Therefore, this study was aimed to determine the Glycaemic Index (GI), Glycaemic Response (GR) and Glycaemic Load (GL) of soy flour-based snack bars in healthy volunteers, compared to Wheat Flour-based snack bar (WF).

METHODS

Design, location, and time

This study used an open label randomized controlled trial with a crossover study design, which determine the GI and GL of snack bars by investigating the response change of blood glucose after the ingestion of snack bars. Glycaemic index and response test were done at Chemical and Nutrition Analysis Laboratory and Nutrition Clinic Department of Community Nutrition, Faculty of Human Ecology, IPB University. The study protocol was approved by Human Research Ethics Committee of IPB University No. 142/IT3.KEPMSM-IPB/SK/2019. Written informed consent was signed and obtained from all volunteers in Bahasa Indonesia. The study was conducted in March 2019 to December 2019.

Sampling

Eighty healthy subjects were recruited into the study. The inclusion criteria were man or woman aged 18–50 years with normal body mass index (BMI) of 18.5–22.9 kg/m^2 (Asia-Pacific criteria), no history of Diabetes Mellitus (DM), no gastrointestinal disorder, did not consume medication, oral contraceptive and supplement, did not consume alcoholic beverage, did not smoke and willing to participate in the study. The exclusion criteria were history of food allergy and/or intolerance and fear of needles or not willing to be punctured on the fingers.

Screening for participants recruitments was conducted 1 week prior to the first meal glucose tolerance test. Subjects were interviewed on individual and family health history using a structured questionnaire by a general physician. Physical examination, measurement of body height and weight were also done. Body height was measured using stadiometer and body weight was measured using digital weighing scale (Omron BF508). For the participants who met the inclusion criteria in this screening phase, measurements of weight and height were done twice and the average value was used in the analyses.

Data collection

Test snack bar. The test snack bars were six variants of Soy Flour (SF) based snack bar (SOYJOY®): product SF1 (Almond Chocolate); product SF2 (Raisin Almond); product SF3 (Banana); product SF4 (Strawberry); product SF5 (Crispy Vanilla) and product SF6 (Crispy White Chocolate Macadamia). Wheat flour (WF, Strawberry) was used as the test snack bar. The nutrition profiles of test snack bars per 100 g is described in Table 2. Proximate analysis of test

snack bars was done at an accredited laboratory, PT. Saraswanti Indo Genetech Bogor, Indonesia. Standard glucose (glucose anhydrous, D-glucose MERCK®, SG) were used as the reference food.

SF1–SF6 has been registered in Indonesia National Agency for Drug and Food Control (NADFC) under BPOM RI and certified halal under LPPOM MUI No. 00100086950118. In contrast, the comparison product, WF was not registered and a handmade product developed in R&D Laboratory of PT. Amerta Indah Otsuka, Sukabumi, Indonesia.

The composition of SF were vary depend on its variant. In general, the composition consists of soy flour (25–46%), fruit ingredients (4–14%), margarine, egg, sugar, soluble food fibre, salt, and synthetic flavor. While, WF was made with the same form and ingredients with the SF4 product, except wheat flour was used instead of soy flour. The SF4 was chosen as the basic formula to developed WF considering the GI result from PT. Otsuka Japan study (Murakami *et al*. 2006).

Glycaemic index test. Measurement procedure for glycaemic index test was conducted according to ISO 26642:2010 Food products – Determination of the Glycaemic Index (GI) and recommendation for food classification (ISO 2010). The procedure consisted of two steps, accordingly preparation and blood glucose measurements.

The preparation steps including room preparation and subject preparation. Room for taking blood samples should be cool with maximum temperature 20°C. Subjects were required to fast 10-h overnight. During fasting, subjects were only allowed to consume plain water. Blood glucose measurement was done in the next morning between 8 to 10 a.m., thus subjects were required to fast since 8 p.m. the previous night. Subjects were prohibited to exercise in the morning before test.

Blood samples were taken by trained medical professional (general physician). Before intervention, fasting blood glucose was taken. Then, subjects were given reference food and test snack bar, which was consumed equal to 25 g available carbohydrate per oral. According to ISO 26642:210 (ISO 2010) recommendation, the use of 25 g available carbohydrate can be provided for low GI food, and under certain condition such as for some of the snack bars, portion sizes providing 50g available carbohydrate were found to be too large for subjects to consume comfortably within 10–15 min. Therefore, portions tested provided 25 g available carbohydrate. Calculation of food weight used the following formula:

Carbohydrate per serving size: Serving size (g) x available carbohydrate (g)/100

The snack bar should be consumed within 10 min for reference food and 10–15 min for test snack bar. Each snack bar were given in separate days as follows: 1). Week 1: glucose standard (25 g); 2). Week 2: SF (product SF1: ±84 g; product SF2: ±60 g; product SF3: ±58 g; product SF4: ±47 g; product SF5: ±90 g; product SF6: ±126 g); 3). Week 3: WF (±37.5 g). During 120 min after consumption of test snack bar, blood samples was taken as much as 2 µl using finger-prick capillary method at 30, 60, 90, and 120 min. Blood glucose concentration were analysed using finger prick capillary blood samples by Accu-check Active®.

Data analysis

Glycaemic response obtained from every point of time were plotted into curve correlating x-axis and y-axis. Time (min) as x-axis and blood glucose concentration (mg/dl) as y-axis. Incremental Area Under Curve (iAUC) approach was used. Calculation ratio used was f:r which was calculations for each subject. The f represented areas under curve for test food of each subjects and r represented areas under curve for reference food of each subjects. The mean value of f:r of each subjects multiply by 100% were calculated to obtain glycaemic index of test food (Brouns *et al*. 2005). The calculation was done using Microsoft Excel 2019. According to Eleazu (2016), GI value is classified into high (>70), moderate (55–70) and low (<55). Glycaemic load is derived by multiplying the GI value by carbohydrate per serving size (g) of the snack bar and then dividing the results by 100. Then, GL value is categorized into high (≥20), moderate (11–19) and low (≤10).

Data analysis was conducted using IBM Statistical Product and Service Solution (SPSS) version 20.0 for Windows. Friedman's test was used to determine difference of glucose iAUC between glucose standard, WF and SF. Wilcoxon test was used to determine difference of blood glucose peak, time to blood glucose peak, GI and GR between test snack bars. The p-value less than 0.05 was considered as significant.

RESULTS AND DISCUSSION

Characteristics of subjects

A total of 96 healthy subjects joined the screening phase. Of 96 screened subjects, 16 were excluded because they had underweight, overweight or obese BMI. Therefore, in total, 80 healthy subjects were recruited for the study with the mean age of subjects was 21.9±0.9 years. The mean body height and body weight were 163.8±7.2 cm and 55.7±5.5 kg, respectively. The subjects had a normal BMI 20.7±1.2 kg/m^2 and fasting blood glucose 84.6±6.4 mg/dl.

Glycaemic index and glycaemic load

Table 1 describes the GI/GL values for snack bars. The median GIs measured for SF were low, ranging from 7.1 (5.4–17.0) to 36.6 (18.9–49.2), with the lowest value come from product SF2. On the other hand, WF had the highest GI value of 88.4 (42.3–115.8). Based on Wilcoxon test, there was significant difference between all SF snack bars (SF1–SF6) and WF, indicating the glycaemic index of SF was lower compared to WF ($p<0.05$).

In particular, the lower GI of SF snack bar assessed in the current study is similar with that observed in the previous study in which low GI category was observed (Natalia & Astawan 2010). In addition, GL values from SF snack bar were multiple times lower than WF snack bar. The present study results strengthen the available evidence on the potential of GI/GL as a predictor for glycaemic response. Research finding has shown that low GI-source foods with a low category of GL is correlated with a better glycaemic control (Vlachos *et al*. 2020). In addition, foods with low GI and/or low GL may have a beneficial effect on health, especially in reducing risk factors for diabetes mellitus (Agustia *et al*. 2019). Their finding indicated that all products with additional soybean flour have a low GI value (50.2±21.6). Also, considering the GL value per serving size, the value obtained was also classified as low (13.8±5.9). Overall, the present study results for SF snack bars support this outcome; with all variants had a low GI/GL value.

Glycaemic response

Blood glucose response (0–120 min) to test snack bar (SFs and WF) is described in Figure 1. There were significant differences between blood glucose responses at 15, 30, 45, 60, and 120 min after ingestion of SF compared with WF ($p<0.05$). The magnitude of the blood glucose iAUC was significantly lower in subjects who consumed SF snack bar with product SF2 and product SF4 had the greatest difference, followed by product SF1, product SF5, product SF6 and product SF3; than in those who consumed WF snack bar. Also, the change in blood glucose

Table 1. Glycaemic index and glycaemic load of test snack bars

Test Snack bars	Serving size (g)	GI†	Category‡	Available carbohydrate per serving size (g)	GL§	Category¶
SF1	30.0	20.2 (15.3–22.2)[a]	Low	9.3	1.9	Low
SF2	30.0	7.1 (5.4–17.0)[a]	Low	12.3	0.9	Low
SF3	30.0	36.6 (21.8–47.9)[a]	Low	13.5	4.9	Low
SF4	30.0	25.9 (17.8–35.4)[a]	Low	15.9	4.1	Low
SF5	25.0	29.9 (22.0–43.3)[a]	Low	5.2	1.6	Low
SF6	25.0	36.3 (18.9–49.2)[a]	Low	5.0	1.8	Low
WF	30.0	88.4 (42.3–115.8)[b]	High	20.0	17.7	Moderate

†Data are median (Q1–Q3); [ab]Different letters within the same column indicates difference between snack bar ($p<0.05$)
GI: Glycaemic Index; GL:Glycaemic Load

‡Glycaemic indexes were categorized as high (>70); moderate (55–70) and low (<55)

§Glycaemic loads were calculated by GI value x carbohydrate per serving size (g)/100 and ¶categorized as high (≥20); moderate (11–19); low (≤10)

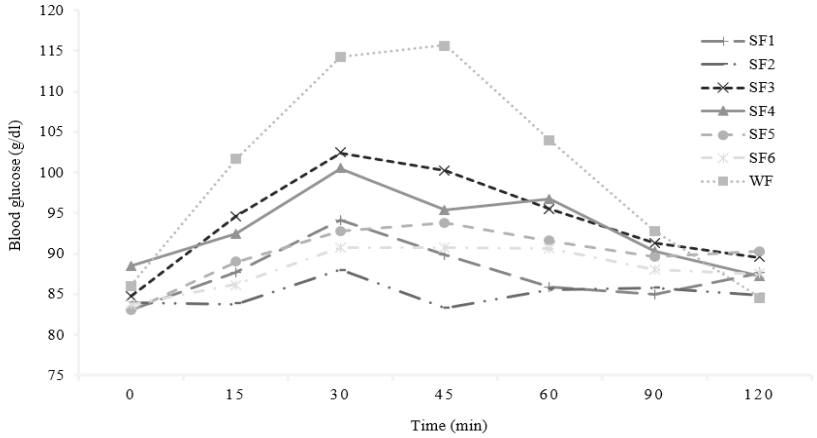

Figure 1. Changes in blood glucose concentration after the ingestion of soy flour snack bar (SF) and wheat flour snack bar (WF).

concentration after consumption of product SF1, SF2, SF5, and SF6 tend to be stable for 120 min and did not increase blood glucose more than 10 mg/dl. This is consistent with the observed GI value on the four snack bars which classified as products with lower GI/GL values compared to other products (GI <55; GL≤10).

The previous study explained that the variation of glycaemic responses to carbohydrate foods are influenced by the GI/GL value, which then is assumed to be associated to several factors, such as the quantity and type of carbohydrate, food processing method, rate of gastric emptying, and nutrition profiles in food such as fiber, fat, and protein (Gao & Chilibeck 2019). In the present study, SF snack bar was assumed to be able to maintain a steadier blood glucose level, due to nutrition profile of this snack bar was specially composed to offer a low glycaemic response. For instance, product SF1, SF5 and SF6 has the highest average of nutrition profiles with approximately 30:20:10 ratio of proportion of energy from total fat, protein and fibre, respectively (Table 2). The high total fat content tends to delay gastric emptying, allowing slower digestion in the gut (Forouhi *et al*. 2014); which in turn may lead to lower glycaemic index and positively affects glycaemic response. In addition, protein and fibre favorably influence shape and extend of postprandial blood glucose

Table 2. Nutrition profiles of the test snack bars

	Per 100 g serving						
	SF1	SF2	SF3	SF4	SF5	SF6	WF
Total energy (kcal)	526	462	460	433	510	559	414
Food fibre (%)	9.3	8.8	8.6	8.9	10.5	13.9	5.1
Total fat (%)	32.8	21.9	21.4	15.2	30.7	37.2	11.9
Protein (%)	17.3	15.5	13.2	12.1	27.1	22.4	4.8
	Per test portion[†]						
	SF1	SF2	SF3	SF4	SF5	SF6	WF
Total energy (kcal)	424	275	255	204	611	706	155
Food fibre (%)	7.5	5.2	4.8	4.2	12.6	17.6	1.9
Total fat (%)	26.5	13.0	11.9	7.2	36.8	47.0	4.5
Protein (%)	13.9	9.2	7.3	5.7	32.4	28.2	1.8

[†]Different weights of the snack bars were given to subjects to provide 25 g of available carbohydrate for GI determination

as a consequence of the better glucose absorption (Çakir *et al*. 2019; Bell *et al*. 2015).

Blood glucose peak and time to peak. In comparison to WF, SF snack bar showed lower blood glucose peak with product SF2 and SF6 had the lowest value, 94 (91, 97) and 95 (92, 102) mg/dl (Table 3). There were significant discrepancies between SF snack bars: SF1-SF6 and WF ($p< 0.05$).

According to Lim *et al*. (2020), normal blood glucose peak value in healthy or subject without DM occurred at 30 min and reached at the lowest value at 120 min. Moreover, a delay in glucose peak time also suggests a higher glucose peak value and a decrease in insulin sensitivity and secretion; in which indicates impaired glycaemic control usually seen in T2DM (Wang *et al*. 2018). The present study volunteers had median blood glucose peaks occurring within 30-45 min after ingesting neither SF nor WF snack bar (Figure 1).

Taking all these findings together, consuming SF snack bars may offer distinctive benefits to human health. Firstly, the current study is phase one of the clinical trials where the subjects were healthy volunteers, not in diabetic individuals with insulin resistance problem. A blood glucose-regulating effect of SF snack bars were clearly observed with normal value of glycaemic response, glucose blood peak and time to blood glucose peak. Secondly, diet with lower GI/GL can be recommended to healthy individuals as a convenient alternative for a proportionate serving of a higher GI/GL snack bar; and can be considered as a reliable source of high-quality protein, fiber, and other nutrients, which may help with blood glucose regulation. This is important because unhealthy snacking is reported to be pervasive in Indonesia as well as among adolescent girls (Blum *et al*. 2019). Within the study, it was reported that adolescent girls snack multiple times daily on foods high in sugar, salt, and fat (Blum *et al*. 2019).

Table 3. Blood glucose peak after ingestion of soy flour snack bar (SF) vs. wheat flour snack bar (WF)

Snack bars	Blood glucose peak (mg/dl)[1]
SF1	96 (92.5–99)[a]
SF2	94 (91–97)[a]
SF3	109 (95–113.5)[a]
SF4	103.5 (101.5–107)[a]
SF5	97.5 (89.5–102)[a]
SF6	95 (92–102)[a]
WF	127 (122–135)[b]

Data are median (Q1–Q3); *$p<0.05$ by Wilcoxon test

[1]Maximal blood glucose excursion from the fasting value over the 120-min postprandial period

[ab]Different letters within the same column indicates difference between snack bar

CONCLUSION

The glycemic response of soy-flour (SF) based snack bar is lower than wheat-flour (WF) based snack bar. The glucose peak in SF is also lower compared to WF. Based on glycaemic index and load value, WF is categorized as a high GI-source snack bar with a medium level of glycaemic load. While, all SF snack bars are classified as a low GI-source snack bar with a low category of glycaemic load.

To conclude, SF snack bars had met the requirement of low GI food source and can be a potential snacks alternative for healthy people. But, the glycaemic response to the SF snack bars in diabetic people requires further investigation.

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AUTHOR DISCLOSURES

The authors have no conflict of interest. All authors disclose that the sponsor company had no influence in the execution of the study, including no input into the study design, in the data collection, analyses, or interpretation of the data, in the writing of the manuscript, and in the decision to publish the results.

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Association of Nutritional Status and Physical Activity Level with Pneumonia in Indonesian Urban Area

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ABSTRACT

The study aimed to overview and analyze the relationship between nutritional status, physical activity and pneumonia in a community in South Jakarta. We analyzed the secondary data from the 2016–2018 The Programme of Knock on Doors and Serve with Heart (*Ketuk Pintu Layani Dengan Hati*) (KPLDH) census for the Tebet District in South Jakarta. The census involved 58,627 samples, which were divided into three age groups: children <5 years old, adolescents, and adults. We measured the nutritional status of children <5 years old using the Weight/Height Ratio (WHR) category (z-score), adolescents with Body Mass Index (BMI)/age (z-score) and adults with BMI (kg/m^2). Physical activity was measured for adults and adolescent only and categorized as "routine" and "non-routine". The highest prevalence of pneumonia was found in samples with non-routine physical activity and in adults. Most of the adults who had pneumonia were also had normal nutritional status. Adults with Chronic Energy Deficiency (CED) and Severe CED (S-CED) had a higher risk of having pneumonia OR=8.465; 95% CI:5.478–13.081 for S-CED and OR=3.210; p<0.05; 95% CI:1.895–5.438 for CED respectively compared to those with normal weight. Adults and adolescents with routine physical activity had a lower risk of having pneumonia (OR=0.496; 95% CI:0.320–0.767). Further studies are also needed concerning the relationship of pneumonia with other determinants such as socio-economic status, environmental issues, and nutritent intake.

Keywords: nutritional status, physical activity, pneumonia

INTRODUCTION

Pneumonia is a dangerous inflammatory condition of the lungs that can cause death. The prevalence of pneumonia increases along with age, however an annual of 920 thousand child deaths can be attributed to pneumonia (UNICEF 2016; McAllister 2019). In Indonesia, the 2018 estimated number of pneumonia-related deaths in children under the age of five was 19 thousand cases (UNICEF 2018). The national capital, DKI Jakarta was one of the seven provinces with the highest number of pneumonia cases (Kemenkes 2013). The prevalence of people with pneumonia in DKI Jakarta is around 2.3% which is higher than the national prevalence (2%).

The emergence of pneumonia can be caused by poor nutritional status and low physical activity (Nurnajiah 2016; Pape 2016). Children and adults suffering from malnutrition are more susceptible to infection than those with good nutritional status (Nurnajiah 2016; Tongo 2017). Lack of protein in people with malnutrition can cause thymus atrophy, which disrupts the T cell production. This in turn also disrupts the antibodies as humoral immunity. Lack of protein can also lead to the lack of certain kinds of micronutrients (Darwin 2006; Cripps 2008; Nurnajiah 2016).

On the other hand, low physical activity is associated with an increased risk of developing respiratory infections and acute pneumonia (Pape 2016; Sato 2016). Almost half (47.8%) of the DKI Jakarta population had low physical activity level (Kemenkes 2018). This has increased from 44.2% in the previous national survey (Kemenkes 2013).

The DKI Jakarta Provincial Health Office has taken a family approach in developing a program called The Programme of Knock on Doors and Serve with Heart (*Ketuk Pintu Layani Dengan Hati*) (KPLDH). This health

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service program aims to restore the concept of community support for health promotion and prevention activities. The KPLDH started with household level data collection on 12 indicators of a healthy family, family planning data and Riskesdas data (PERGUB 2016). The KLPLDH analysis showed high prevalence of pneumonia in Tebet community in South Jakarta. Thus, based on the above-mentioned associations between nutritional status, physical activity level with pneumonia the researchers were interested in exploring these associations in the community of Tebet, in South Jakarta.

METHODS

Design, location, and time

This study was a secondary data analysis of the KPLDH family data survey conducted in Tebet District, South Jakarta from January 2016–December 2018.

Sampling

The survey population were 233,237 people who resided in Tebet sub district for more than 5 years in 2016–2018 (BPS Jaksel 2018). A total of 82 thousand (35.16%) of the population were surveyed, however 23,373 of the respondents dropped out from the study. Subsequently, we analyzed the remaining data from 58,627 subjects.

Data collection

The KPLDH survey was done door to door where the enumerators brought weight and height/length scales of the same brand for each team. They came to eight villages, where one team collected data from up to ten thousand subjects from each village. Data obtained for this study included the characteristics of the respondents, their physical activity, and the nutritional status of the children, adolescents and adults in the households.

Data analysis

The subjects were grouped based on sex and age. The age groups were: children <5 years old, adolescents (9–18 years old) and adults (19–66 years old). Physical activity data was taken only for adolescent and adult respondents and categorized into routine and non-routine. Routine physical activity was defined as conducting physical activity more than five days a week.

The nutritional status of children <5 years old was measured based on Weight/Height Ratio (WHR) category (z-score). Whereas the nutritional status of adolescents was measured using BMI/age (z-score) and BMI (kg/m^2) for adults aged 19–66 years. These are the standard categories of nutritional status according to the Decree of the Ministry of Health Indonesia Anthropometry 2010 (Kemenkes 2010).

The statistical analysis was performed using the SAS software. The Univariate analysis was used to describe the distribution of age, gender, nutritional status, physical activity and pneumonia. Chi-square test was conducted to identify the relationship between physical activity and pneumonia, and nutritional status (children <5 years old, adolescents and adults) and pneumonia. A significance was set at p-value of 0.05).

RESULTS AND DISCUSSION

Subject characteristics, nutritional status, physical activity

The study subjects were mostly adult (73.60%), followed by adolescents (21.01%) and under-fives (5.39%). The male and female subjects was of equal number (Table 1). The nutritional statuses for the children <5 years old and adolescents were categorized as normal (55.34% and 66.10%) respectively. While for adults almost half (48.32%) were in the normal category (Table 2).

Despite the fact that most of the subjects aged <5 years old had normal body weight, we found that almost a quarter (24.03%) of all subjects were underweight or severely-underweight. The prevalence of severe underweight was 12.95%, while the national prevalence was 10.2% in 2018 and 12.1% in 2013 report (Kemenkes 2018; Kemenkes 2013). On the other hand, the prevalence of overweight in this age group was 20.64% and this is above the national prevalence (11.8% in 2013 and 8% in 2018). This indicates that Tebet had a higher prevalence of under-fives who were severely-underweight and overweight compared to the national prevalence both based on the 2018 and 2013 national prevalence in the same age group.

For the adolescents and adults, overweight and obesity were a more common nutrition issue. The prevalence of obesity and overweight in

Table 1. Subject distribution based on age and sex

Characteristics		Total	
		n	%
Age			
	Under five years	2,951	5.39
	Adolescents	11,490	21.01
	Adults	40,242	73.59
Sex			
	Female	27,620	50.51
	Man	27,063	49.49

adolescent was 30.32% and it was 42.19% in adult. While the prevalence of Chronic Energy Deficiency (CED) and severe CED in adolescent was 3.58% and 9.5% in adult. In addition to the overweight and obesity prevalence, the majority of subjects (78.28%) had non-routine physical activity (Table 2). This finding is in line with the Kemenkes (2018) research results, indicating a high number of low physical activity (44.70%) in the DKI Jakarta.

Pneumonia

There were 408 subjects with pneumonia in the study; 13 children (0.44%); 34 adolescents (0.30%) and 157 adults (0.39%). The nutritional status of the adolescents and adults who had pneumonia was mostly in the normal weight category. The prevalence of pneumonia in adolescent and adult with normal nutrition status were 0.19% and 12.9% respectively. However, in adult we found 54 subjects with pneumonia who had severe and Chronic Energy Deficiency (CED). This is in line with Dobner and Kaser's research (2018), which states that adolescents and adults living in developing countries tend to be at risk of developing infectious diseases, especially pneumonia, if they are severely underweight.

The relationship between nutritional status, physical activity and pneumonia

Adult with Severe Chronic Energy Eeficiency (S-CED) had a statistically significant risk of having pneumonia (OR=8.465; p<0.05; 95% CI:5.478–13.081) compared to those with normal weight. We also found that underweight adults (CED) also had a higher risk of suffering from pneumonia (OR=3.210; p<0.05; 95% CI:1.895–5.438) compared to adults with normal weight, although the risk was lower than the S-CED (Table 2). Thus, adult with low nutritional status, indicated by S-CED and CED had an increased risk of having pneumonia compared to adults with normal nutritional status. These results are consistent with previous studies showing that pneumonia was more commonly found in adults with malnutrition (Dobner & Kaser 2018; Tongo 2017).

Malnutrition can reduce the strength of the abdominal muscles and diaphragm during the process of respiration, resulting in the impaired ventilation function in the respiratory tract, so that the ability to expel phlegm is disrupted and exudates accumulate in the bronchi. Disruption of this expectoration process will aggravate the condition and can cause bronchopneumonia (Arisman 2010; Adriani 2012).

Patients with malnutrition also showed a decrease in IgA levels, where IgA serves to protect the upper respiratory tract from infection by pathogenic organisms. Therefore, a decrease in IgA levels results in a decrease in the immune system of the airways, exacerbating the degree of respiratory tract infection (Rodriguez 2011).

In addition, lack of protein in malnutrition can lead to thymus atrophy, disrupting the T cell production as well as the antibody production as humoral immunity. Furthermore, lack of protein can also leads to micronutrients deficiency including vitamin A, vitamin E, vitamin B6, vitamin C, folate, zinc, iron, copper and selenium. The deficiency of these micronutrients results in decreasing antibody formation (Darwin 2006; Cripps 2008; Nurnajiah 2016).

When comparing between non-routine physical activity and routine physical activity amongst adult and adolescent, we found that physical activity lowers the odd of having pneumonia (OR=0.496; p<0.05; 95% CI:0.320–0.767). This shows that people who routinely performed physical activities will be 50% less likely to develop pneumonia compared to people who do not routinely engage in physical activity. This finding is in accordance to Katzmarzyk 's research (2015), which shows that people who had low physical activity are at risk of developing respiratory infections compared to those who often exercise. In addition, low physical activity is associated with an increased risk of the recurrence of contracting respiratory tract infections (Tomatala 2019). Doing exercise is

Table 2. Subject distribution based on physical activity, nutritional status and pneumonia

Variables	Total		Pneumonia		OR	p	95% CI	
	n	%	n	%				
Physical activity								
Non-routine	42,806	78.28	174	0.318	-	-	-	-
Routine	11,877	21.72	30	0.101	0.496	0.002	0.320	0.767
Children body mass index								
Severe-underweight	382	12.95	4	0.136	0.553	0.577	0.069	4.436
Underweight	327	11.08	7	0.237	0.643	0.677	0.080	5.155
Normal**	1,633	55.34	2	0.068	-	-	-	-
Overweight	609	20.64	0	0.000	1.011	0.987	0.268	3.823
Adolescents body mass index								
Severe-underweight	275	2.39	0	0.000	-	-	-	-
Underweight	137	1.19	2	0.017	2.567	0.358	0.344	19.171
Normal**	7,595	66.10	22	0.191	-	-	-	-
Overweight	1,776	15.46	2	0.017	0.411	0.228	0.096	1.748
Obese	1,707	14.86	8	0.070	1.718	0.191	0.764	3.865
Adults body mass index								
Severe –underweight (S-CED)	1,621	4.03	35	0.087	8.465	0.000	5.478	13.081
Underweight (CED)*	2,202	5.47	19	0.047	3.210	0.000	1.895	5.438
Normal**	19,444	48.32	52	0.129	-	-	-	-
Overweight	7,612	18.92	25	0.062	1.215	0.425	0.753	1.959
Obese	9,363	23.27	26	0.065	1.016	0.944	0.635	1.629

*Underweight or Chronic Energy Deficiency (CED); **Normal as standard on measurement

one way to maintain the immune system, optimal physical activity will help boost the immune by increasing the blood flow to the brain during activities (James *et al*. 2008).

However, we found conflicting evidence regarding the associations between nutritional status and pneumonia in children under the age of five (p>0.05; OR=0.553; 95% CI:0.069–4.436) and adolescents (p>0.05; OR=2.567; 95% CI:0.344–19.171). Several studies also found no significant correlation between nutritional status and pneumonia in children (Rachmawati 2013; Widayat 2014; Pramono & Purwati 2018). However, Rohimah *et.al* (2015) and Saha *et.al* (2016) showed that infectious diseases in children were related to the low weight for age and nutritional status (weight/age). This evidence however, does not indicate that malnutrition is not an important factor for developing pneumonia in children and adolescent. Hence, this evidence suggests that there are many other factors that more strongly associated to pneumonia in children and adolescent in our study area thus in need of further study.

The strength of this study was the use of big data from the KPLDH family data survey. Meanwhile, its limitations were that the data was only for limited variables such as the nutritional statuses of children 0–5 years old, adolescents aged 9–18 years old, and adults aged 19–66 years

old, as well as physical activity data for only adolescences and adults.

CONCLUSION

This study revealed that in Indonesian urban area, there was a high prevalence of pneumonia found in adults and underweight was significantly associated with higher risk of pneumonia. In addition, routine physical activity was associated with lower risk of pneumonia in adults and adolescents. This study suggests the need to encourage people to attain normal nutritional status and increase their physical activity to curb the rise pneumonia in urban communities. This can be achieved by conducting massive health promotion program. Further studies are also needed concerning the relationship of pneumonia with other determinants such as socio-economic status, environmental issues, and nutritional intake.

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AUTHOR DISCLOSURES

The authors have no conflict of interest.

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A Research Protocol of Hands-On Healthy Meal Preparation Intervention (Kidchen Study) to Improve Children's Nutritional Outcomes

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ABSTRACT

The objective of this paper is to describe the protocol of a 12-week hands-on healthy meal preparation intervention among children, up to a 3-month follow-up. The aim of KidChen Study (kids in kitchen) is to improve children's nutritional outcomes. In this randomized-controlled trial, simple random sampling will be used to select schools in Kuala Lumpur, Malaysia. Subsequently, the selected schools (n=2) will be assigned randomly to either the intervention or control group. The current study will include healthy Malaysian children aged 10–11 years old with no serious disease or food allergy. The intervention is based on Social Cognitive Theory that addresses personal and environmental factors for changing children's behaviour. Children from the intervention group will receive a 60-minute home food environment module with their parents consisting of nutrition talk, healthy food tasting, parent-child quiz; and five 60 minute interactive hands-on healthy meal preparation modules focusing on core food groups coupled with storytelling sessions to incorporate nutrition education. Outcome measures are children's psychosocial factors towards healthy meal preparation (knowledge, attitude, practice, self-efficacy), dietary behaviour, food consumption pattern, home food availability and anthropometric measures (BMI-for-age z-score, body fat percentage, waist circumference). Repeated measures ANOVA will be used to evaluate the intervention outcomes. KidChen Study is an experiential learning approach to instil a positive attitude towards nutrition and empower children with nutrition skills. We anticipate that the intervention will advocate healthy eating behaviour among children, impacting their nutritional outcomes over time.

Keywords: children, healthy meal preparation, intervention, Malaysia, nutrition

INTRODUCTION

Globally, 340 million children are affected by overweight/obesity problem (WHO 2018). Many did not achieve the recommended dietary guideline for whole grains, vegetables, fruits, legumes and milk (Banfield *et al.* 2016; Faught *et al.* 2017). Further, unhealthy eating habits such as snacking, high intakes of fried foods, sugary foods, fast foods and low intakes of fruits and vegetables among school-aged children are now very common (Febriani & Sudarti 2019; Hoque *et al.* 2016). The health consequences to this serious epidemic include increased vulnerability of children affected by chronic diseases, adverse effect on a child's development and reduced quality of life, which can track into adulthood (WHO 2018). Other negative implications include the effect on children's academic performance and psychological health (Rankin *et al.* 2016).

According to a systematic review and meta-analysis of school-based nutrition interventions among children, nutrition lessons, improvement in the school environment and food marketing did not increase vegetable intake by a useful amount (Evans *et al.* 2012). In Asia, most studies frequently target behavioural modification through health education lectures and/or physical activity sessions which demonstrated a lack of effect in anthropometry outcomes (Uijtdewilligen *et al.* 2016). Further, interventions are largely approached in the same way and only repackaged slightly, which is inadequate to address key barriers (The Academy of Medical Sciences

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2017). The main basis of interventions is often to increase knowledge and nutrition awareness but the emphasis on experiential learning, increasing motivations and enhancing skills for long term health benefits are minimal.

Since obesity is the result of people responding normally to the obesogenic environment (Swinburn *et al.* 2011), it is important to equip children with the skills to counteract this epidemic and for the sustainability of healthy behaviours. Recently, there is a global interest to involve children in healthy meal preparation to improve their nutrition. When children prepare healthy meals, there were increased nutrition knowledge, attitude and self-efficacy towards cooking, fruits and vegetable preferences/ consumption as well as communication to family about healthy eating (Cunningham-Sabo & Lohse 2013; Jarpe-Ratner *et al.* 2016). However, none of these interventions involved populations other than in the US, Europe, Australia and New Zealand (Battjes-Fries *et al.* 2016; Black *et al.* 2018; Caraher *et al.* 2013; Chen *et al.* 2014; Cunningham-Sabo & Lohse 2013; Jarpe-Ratner *et al.* 2016). Due to the cultural differences between Western and Asian countries, interventions should be tailored to the needs of the population of interest (Barrera *et al.* 2013). Overall, there is a lack of high-quality interventions on childhood cooking programs, especially with a long-term effect on nutritional outcomes (Hersch *et al.* 2014).

KidChen Study implies the "kids in kitchen" study. The idea of KidChen Study is to allow children to obtain the first-hand experience in preparing their own healthy meals incorporating all 5 senses-touch, sight, taste, hearing and smell. This current protocol aimed to describe the design of KidChen Study, a hands-on healthy meal preparation intervention involving all the core food groups among Malaysian children.

METHODS

Design, location and time

KidChen Study is a randomized-controlled trial located at Kuala Lumpur, the national capital of Malaysia. The study location, Kuala Lumpur consists of various zones; Bangsar-Pudu, Sentul and Keramat. A zone will be randomly selected, and subsequently, two primary schools from the selected zone will be randomly assigned to either intervention or control group using Research Randomizer. Inclusion criteria include: (1) healthy Malaysian children aged 10–11 years; (2) can understand English/Malay language and with; (3) parent's informed consent and individual assent. Children with: (1) food allergies (e.g.: wheat/gluten, dairy or peanuts); (2) any serious diseases that require medical attention; (3) physically/mentally disabled children and/or; (4) are exposed to preparing healthy meals at home will be excluded.

Sampling

The sample size for present trial is determined using a formula by Chan (2003): $m = \frac{2c}{\delta^2} + 1$, where m= size per group, c= 7.9 for 80% power, $\delta = \frac{|\mu_2 - \mu_1|}{\sigma}$ is the standardised effect size, μ1 and μ2 are the means of the two treatment groups σ is the common standard deviation $= \sqrt{\frac{SD_1^2 + SD_2^2}{2}}$ SD1 and SD2 is the standard deviation for group 1 and 2 respectively. Based on a randomized-controlled trial by Fulkerson *et al.* (2011), SD1 and SD2 are 3.2. The sample size required for the present study is 32 per group. Taking into account of non-compliance and dropout rate of 50% (Koo *et al.* 2018), the required sample size for each group is increased to 48; therefore, the total number is 96. Any children that wish to drop-out can do so, with the reasons being noted for documentation.

Intervention framework and modules development

KidChen Study is designed based on the Social Cognitive Theory (SCT) and experiential learning theory (Bandura 1999; Kolb *et al.* 2001). According to the SCT, learning occurs through social context with dynamic interactions between environmental factors (home food availability) and individual factors (knowledge, attitude and self efficacy towards healthy meal preparation) that eventually influences an individual's behaviour (e.g. the practice of healthy meal preparation, dietary behaviour and food consumption pattern). As applied to KidChen Study, this theory holds that children's psychosocial factors and home food environment will influence their health related behaviour, in relation to their nutritional status.

Experiential learning theory involves processes where the learner actively experiences an activity, attempts to conceptualize what is observed, reflects on that experience and

finally tries to plan for a forthcoming experience (Seel 2012). In KidChen Study, intervention children will experience hands-on healthy meal preparation continuously in which they acquire various skills such as self-reflection, problem solving and abstract thinking (Efstratia 2014). No nutrition intervention will be conducted for children and parents from the control group. However, for ethical reasons, delayed KidChen intervention modules will be conducted for the control group after the study has ended.

The content of current intervention modules was already developed and validated. It was designed using evidence-based nutrition information, comprising all the core food groups needed by children for healthy growth and development. Literature searches were conducted in scientific databases namely Google Scholar, PubMed, Science Direct and Scopus for development of the modules. Reports, research articles and books were referred to develop evidence-based modules. Each module comprises nutrition education and hands-on healthy meal preparation tasks, aimed to achieve the specific learning outcomes and objectives. Content validity of the intervention modules was established by 2 academicians in the nutrition field, an academician expert in child psychology, a primary school teacher, a parent of a 10- and 11-year old child and a nutritionist. The expert panels were selected due to their experience in the development of nutrition modules for children and/or experience in understanding children's behaviour. Content validity form was provided to each of the experts. Every expert was required to rate the modules to ensure that the modules are in line to achieve the specific objectives and learning outcomes set. Every module was rated based on content, language (sentence structure, readability) and design/layout with a score of 1 as poor (to reject), 2 as average (major revision) and 3 as good (minor/no revision). Suggestions were given to improve the module in terms of content, language and design. Feedbacks from the expert panels were discussed among the research team and necessary changes to the intervention modules were made accordingly.

Data collection

Assessment will be made at pre-, post-intervention and a follow-up after 3 months. Outcomes measurements include children's psychosocial factors towards healthy meal preparation, home food availability, dietary behaviour, food consumption pattern and anthropometric measurement.

Children's psychosocial factors (knowledge, attitude, practice and self-efficacy) towards healthy meal preparation will be assessed using a validated, self-administered, guided questionnaire (Ng *et al.* 2020a). Parents will receive a validated home food availability questionnaire (Couch *et al.* 2014; Glanz & Steffen 2008; Marsh *et al.* 2003). Sociodemographic characteristics such as monthly household income, highest educational attainment in the family and parents' age are collected in the first section of the questionnaire. Subsequent information includes the availability of various fruits, vegetables, healthy and unhealthy foods at home during the past 1 week. Apart from those foods from the validated questionnaires, several fruits, vegetables and foods will be included, reflecting Malaysians' usual foods consumption (Institute for Public Health (IPH) 2014). The home food availability questionnaire was tested for internal consistency (unpublished data, n=200, Cronbach's alpha= 0.72).

Dietary behaviours namely breakfast consumption and fast food consumption will be self-reported using a guided questionnaire. The same questionnaire assessed children's food consumption pattern (frequency of usual food groups consumption). Questions are adapted, with consideration of Malaysian Dietary Guidelines for Children and Adolescents (Ainuki *et al.* 2013; Ministry of Health Malaysia 2013; Wilson *et al.* 2008). Children will be asked the number of times they consume breakfast, morning snack, lunch, afternoon snack, dinner and supper in a week, and the food groups that they usually consumed for each specific meal. They will be allowed to select more than one food group or none if they usually skipped their meals. Pictures and food models will be utilized to assist children.

Children's anthropometric measurements include height, weight, waist circumference, and Body Mass Index (BMI)-for-age. Height will be measured to the nearest 0.1 cm using portable stadiometer Seca 213. As the standard height measurement protocol, children will stand straight without shoes, head in Frankfurt plane, arms at side with palms facing the thighs, heels together and shoulder blades, buttocks and heels

touching the vertical surface of the stadiometer (Gibson 2005). Tanita Body Composition Analyzer SC-330 will be used to measure body fat percentage and weight to the nearest 0.1kg. Children will stand straight barefooted in the center of the platform, looking straight ahead in light indoor clothing during measurement (Gibson 2005). Weight and height will be computed into body mass index-for age (BMI z-score) using AnthroPlus software as per World Health Organization (WHO) growth reference. Waist circumference will be measured to the nearest 0.1 cm over the skin midway between the tenth rib and the iliac crest at the end of normal expiration using a non-stretchable measuring tape and further classified using percentile charts for the Malaysian childhood population to define abdominal obesity (Poh *et al.* 2011). All measurements will be taken twice to obtain an average reading.

Evaluation of KidChen intervention modules

After each module, children will be given a set of questions for providing insights and evaluation of the intervention modules. The evaluation includes their overall acceptance of the storytelling/drama as well. Questions are developed and revised by the research team to ensure its simplicity, relevance and appropriateness for children and parents.

Data analysis

Statistical analysis will be conducted using Statistical Package for Social Science (SPSS) Version 20. Data will be entered, cleaned and checked before proceeding to data analysis. All variables will be tested for normality distribution. Categorical variables are presented as number (percentage), meanwhile continuous variables are reported as mean (standard deviation). The differences between intervention and control group's psychosocial factors towards healthy meal preparation, home food availability, dietary behaviour, food consumption pattern and anthropometric measurements will be assessed using independent t-test. Differences within groups will be determined using dependent sample t-test. Association between categorical variables items will be determined using the Chi-square test. Repeated measures ANOVA will be used to determine will be used to determine the effectiveness of KidChen intervention on changes of psychosocial factors, home food environment, dietary behaviour, food consumption pattern and anthropometric measurements among children (within-group to assess the effect of time: pre-, post-intervention and 3-months follow up; and between-groups to assess the effect of groups: intervention versus control group). Significance value is set at $p<0.05$.

RESULT AND DISCUSSION

This current protocol describes the design of KidChen Study, a hands-on healthy meal preparation intervention among children. To the best of our knowledge, KidChen Study could be the first family-based experimental study on hands-on healthy meal preparation involving all core food groups with the element of storytelling/ drama in nutrition education, aimed to improve the nutritional outcomes of children. The overview of KidChen intervention components is displayed in Table 1.

Table 2 displays the content validity of the intervention modules. All experts rated that the content and design of the modules are suitable (maximum score of 3, good with minor revision). In terms of language, 3 and 2 experts rated that 'home is where the (healthy) food is' and 'vibrant vegetables' module respectively as average (score of 2 with major revision needed). Meanwhile, the remaining experts rated the modules as good with minor revision in terms of language. Subsequently, changes are made to the modules according to the panel's comments to ensure that the content is in line with the aim, language is simple and easy to understand, while the design is suitable for children.

Generally, the intervention consists of a home food environment module (parent-child session) and 5 hands-on healthy meal preparation sessions among children. The main basis of KidChen Study is to allow children to learn about foods through experience and incorporate the concept of having fun while learning through storytelling/drama. In addition, parental involvement is included as the gatekeeper of home food availability. Given that parents are responsible for the physical and social development of their child, parental involvement can potentially improve intervention effectiveness (Ritchie *et al.* 2005; Black *et al.* 2017). Table 3 displays the specific nutrition education topics

Table 1. Overview of KidChen intervention component

Component	Details
Home food environment modules (parent-child)/"Home is where the (healthy) food is"	This is the first module for parents to come along with their child. • 15 minutes of interactive nutrition talk on the role of parents and home food availability • 15 minutes of learning how to use food labels and food labels quiz (parent-child pair activity) • 15 minutes of healthful food tasting (meal consisting of core food groups) • 15 minutes of apron fitting, interactive food and kitchen safety talk
Hands-on healthy meal preparation modules for children	Five modules with a focus on a food group: (1) good grains; (2) power protein foods; (3) vibrant vegetables; (4) amazing dairy; (5) fit fruits; each consisting of 15 minutes of storytelling and drama related to nutrition principles, 30 minutes of hands-on activity and lastly, 15 minutes of meal sharing and discussion. After each module, children will be given a nutrition booklet containing meal preparation information, recipe and healthful food ingredients to bring home, depending on the main food group of the module. Children will also receive a set of measuring cups and spoons.

incorporated during the storytelling/drama session and the hands-on healthy meal preparation activities for every module.

In KidChen Study, every children module begins with storytelling/drama using fictional characters to deliver nutrition education. Storytelling/drama is a simple yet powerful method in education (Seipel *et al.* 2014) that allows the essence of complex concepts to be conveyed in a meaningful and non-threatening manner (Suzuki *et al.* 2018). In KidChen Study, a main story is written which centres around kids' adventure to unlock various food groups. The main story is divided into 5 different parts, each representing a main food group whereby nutrition principles are incorporated into these stories to enhance learning and span throughout the 5 modules for children. Continuity element in the story is important to get the children excited for the following module and to remember the nutrition concepts. Helpers with a nutrition background will be assigned to various characters. Drama rehearsal will be conducted prior to the nutrition module to ensure that the drama/story would be an entertaining and educational for children. The duration of nutrition education and storytelling/drama sessions are 15 minutes as it was demonstrated that children typically have a short attention span (Bunce *et al.* 2010). Foods to be prepared by children will be hinted during drama session and at the end, it will be revealed to children their hands-on healthy meal preparation task for the session. The connection between storytelling/drama with the later hands-on healthy meal preparation activity was crucial for increasing curiosity in children and familiarity towards various foods.

As for the hands-on healthy meal preparation sessions, emphasis will be made on one specific food group according to the recipe's main ingredient. Food and kitchen safety are important factors to consider when implementing the hands-on sessions. Hence, children will be equipped with food and kitchen safety knowledge during the first module (parent-child session) and reinforced at every hands-on session. Besides, the hands-on sessions are designed from basic meal preparation tasks namely washing and serving food, to a higher level of using the knife, stirring hot foods and usage of equipment such as oven and blender. This will help children to learn from basic, before transitioning to tasks with increased difficulty. Additionally, children will participate in meal-related tasks with adult's supervision; guidance from one main moderator (certified food handler with nutrition background) and helpers with nutrition background (ratio of 1 helper: 5 children). It was shown that a ratio of 1 adult: 4 children were needed as reported by a previous study (Jarpe-Ratner *et al.* 2016).

Table 2. The average score of every module rated by the expert panel

Module	Criteria		
	Content	Language	Design
Home is where the (healthy) food is	3	2.5[a]	3
Good grains	3	3	3
Power protein foods	3	3	3
Vibrant vegetables	3	2.7[b]	3
Amazing cairy	3	3	3
Fit fruits	3	3	3

All modules were rated good (a maximum score of 3) based on the respective criteria by all experts unless stated
[a]Three experts (academician in the nutrition field, teacher and parent) rated the module with a score of 2 (average) while the remaining experts rated the module with a score of 3 (good)
[b]Two experts (academician in the nutrition field and teacher) rated the module with a score of 2 (average) while the remaining experts rated the module with a score of 3 (good)

Considering the feasibility factor in the number of nutrition helpers needed, level of children's understanding towards healthy meal preparation in needs assessment, group discussion from intervention subsample, we deemed a ratio of 1:5 as sufficient. Further, emphasis is made to encourage children to be advocates and leaders during the hands-on meal preparation activity and to guide each other as peer support, in line with SCT. Hence, too much assistance from an adult may not be suitable. In additions, helpers will be equipped with the programme flow, modules content and are trained prior to every module to ensure standardization in the method of delivery. During each module, helpers ensure that all children perform the hands-on activity as stated in a task checklist.

After each hands-on session, an ingredient from a specific food group is provided to encourage children to prepare meals using those ingredients with their parents. Providing children with free, accessible fruits and vegetables have been experimentally shown to positively affect long-term dietary behaviour due to increased exposure and preferences, thereby suggesting that this approach is worth pursuing (DeCosta *et al.* 2017). In the current study, such approach will be implemented comprehensively with the hands-on healthy meal preparation session, nutrition education (storytelling/drama) and parental involvement to improve effectiveness, as suggested earlier (Coyle *et al.* 2009). Past study has highlighted the facilitators in the provision of healthy ingredients, including sufficient funds and coordination among partners/suppliers (Bai *et al.* 2011). Therefore, it is highly recommended to involve stakeholders and partnerships link for the sustainability of such approach. In the present study, we are not only providing fruits and vegetables, but also other ingredients such as whole grains, seeds, nuts and dairy foods. While research usually emphasized fruits and vegetables as target foods (Van der Horst *et al.* 2014), children need a variety of food groups in their diet for healthy growth and development. Hence, we concentrate on all core food groups.

Previously, it was shown that nutrition education programs that have a long-term effect on dietary behavior are those that offer children the opportunity to engage with food in different ways and incorporating experiential, contextual knowledge and social networks, such as parents which allows nutrition knowledge and positive attitude towards healthy foods to be created (Chen *et al.* 2014; Dudley *et al.* 2015). In learning to cook, children can be empowered to prepare healthful meals, learn about ingredients, gain a strong sense of personal achievement and the knowledge that allows them to judge more healthful alternatives when eating away from home (Levy & Auld 2004). Although it was reported that children had poor knowledge and practice towards healthy meal preparation (Ng *et al.* 2020b), they had positive attitude and self-efficacy, suggesting that hands-on healthy meal preparation is liked by children and could be a potential health-promotion strategy.

The National Nutrition Policy of Malaysia highlighted that good health goes beyond access to nutritious food and the nutrition knowledge to make informed and healthy dietary choices. In the same context, KidChen Study goes beyond providing knowledge by targeting long-term nutritional behavior change, equipping children with lifelong skills needed for healthy eating and includes the development of interactive educational modules on healthy eating for schoolchildren as outlined as priorities in National Plan of Action for Nutrition of Malaysia III 2016–2025. On an international level, KidChen Study is aligned with the 2030 Sustainable Development Goals (SDG) by United Nations and Global Nutrition Targets

Table 3. Nutrition education topics and hands-on activities of KidChen intervention

Module	Hands-on activities/skills	Nutrition education
Home is where the food (healthy) is	• Interactive nutrition talk • Quiz • Apron fitting • Healthy food tasting from various food groups	• Role of parents home food availability • Using the food labels • Food safety • Kitchen safety
Good grains	• Cooking demonstration: fried brown rice • Food and kitchen safety: wearing proper attire and washing hands • Washing rice & serving food • Usage of rice cooker	• "*Suku-Suku Separuh"* (quarter quarter half) • Benefits of whole grains vs refined grains • Source of whole grains
Power protein foods	• Assemble own sandwich (egg & peanut butter sandwich) • Deciding own ingredients • Basic knife skills (to spread peanut butter and cut soft food) • Usage of toaster	• Protein (benefits) • Source of plant & animal protein • Good fats • Drawbacks of processed meat
Vibrant vegetables	• Touching and seeing real vegetables • Following recipe directions and working in groups • Washing vegetables • Cutting vegetables (higher levels of knife skills-cutting different textures of food) • Measuring ingredients • Boiling & stirring food • Using peeler, ladle and spatula	• Vegetables for superkids (importance of veg etables for health) • Eat a rainbow of colours (benefits of different colours of vegetables)
Amazing dairy	• Making smoothies • Preparing ingredients (washing and cutting) • Measuring ingredients • Incorporating dairy into food preparation • Usage of blender	• Dairy (benefits) • Source of dairy food • Flavoured vs original dairy products • Use of dairy in cooking • Drawbacks of carbonated drinks • Importance of breakfast
Fit fruits (children)	• Washing and cutting fruits • Using muffin tray, muffin liner, baking powder and baking soda • Making dough • Usage of oven • Baking fruits muffins	• Fruits (benefits) • Different taste of fruits (sweet, sour, sweet & sour) and how to eat them • Fresh fruits vs fruits drinks, canned fruits, fresh fruit juice

2025 by World Health Organizations (WHO) to ensure healthy lives, promote well-being, improve nutritional status, and prevent obesity and non-communicable diseases. KidChen Study aims towards the common goals of SDG and WHO to empower vulnerable groups such as children and youth in providing support and to provide evidence of behavioural change from direct interventions which are keys for informing health and education policies.

We anticipate that this study will reveal the effectiveness of an innovative experiential learning strategy in improving the nutritional outcomes of children. Findings of KidChen Study is important to understand the approach of hands-on healthy meal preparation in affecting children's food-related attitude, behavior, in addition to providing insights on children's acceptance towards hands-on healthy meal preparation.

This innovative experiential learning approach including parent's support is based on scientific evidence and represents a way forward in nutrition education. We foresee that the

output would be well-received on a national and international level. Since this is an ongoing study, research findings will be published elsewhere once data are collected and analyzed.

TRIAL REGISTRATION

The trial is registered at https://www.irct.ir/trial/40804 (IRCT20190626044024N1). Medical Research and Ethics Committee (MREC) has reviewed and approved the study protocol [NMRR-18-725-41268, KKM/NIHSEC/P18-815 (11)]. Approval to conduct the study in schools is obtained from the Ministry of Education Malaysia (MoE) and Kuala Lumpur Federal Territory Education Department [KPM.600-3/2/3 Jld 45 (91)]. With permission from principals of the selected primary schools, consent form and information sheet are provided to parents. The study has commenced.

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AUTHOR DISCLOSURES

The authors have no conflict of interest.

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Use of Instagram® to Educate Adolescents on Nutrition Labelling: A Feasibility Study in Selangor, Malaysia

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ABSTRACT

This study was undertaken to assess the demand and acceptance of an Instagram-based nutrition labelling education (Info-Nutriteen®) among adolescents. In this quasi-experimental study, a series of educational messages was developed and was uploaded on Instagram for 12 weeks. Participants were recruited and randomized into the intervention group or control group. Feasibility was assessed through participants' demand and acceptance of the program. Changes in nutrition knowledge and Knowledge, Attitudes, and Practices (KAP) on nutrition labels were measured at pre- and post-intervention. A total of 125 participants completed the program. Overall, 92.7% of the participants reported positive acceptance towards Info-Nutriteen®. In terms of demand, they suggested using current and trending songs for the videos and bright colours for the info-graphics. The study showed good demand and acceptance of the Instagram based education for adolescents. The Info-Nutriteen® program also effective to improve their attitude and practice on nutrition labels. Thus, this approach is feasible. Nevertheless, Info-Nutriteen® should be improved further to enhance its impact on nutrition labels knowledge and usage among adolescents.

Keywords: adolescents, feasibility study, instagram, nutrition labelling, social media

INTRODUCTION

Social media is a popular means of interaction among adolescents and young adults. It allows them to create, share, and exchange information in virtual communities and networks. Social media platforms are diverse and are continually evolving. Typical platforms include social networking sites, internet forums, blogs and microblogs, photograph or video sharing, crowdsourcing, podcasts, and virtual game or social worlds (Wong *et al.* 2014). Platform users can view and share information in both traditional formats (e.g., text, photos) and interactive formats (e.g., polls, chats, live video), which are free to all the users (Arigo *et al.* 2018).

Social media has transformed social communication immensely, and social communication is no longer limited to keeping in touch with friends and family. A study has shown that many users nowadays use social media to seek and share healthcare and health-related issues (Househ *et al.* 2014). Indeed, the 2017 Internet Users Survey found that 77.2% of users relied on the Internet to seek health-related information online (MCMC 2017). The most common form of health-related information that users sought after was on symptoms and signs of diseases, health care tips, and available treatment methods.

Social media encourages participation and discussion, allowing the spread of key messages and promoting behaviour change in the community. Social media also helped in reaching people at their convenience, thus improving content availability, and possibly

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influencing satisfaction towards and trust in the health messages delivered (Neiger *et al.* 2012). Furthermore, several studies found that social media interventions improved participant motivation as well as their knowledge, attitude, and practices in various fields of healthcare (Perdana *et al.* 2018; Miller *et al.* 2017; Patel *et al.* 2015).

Social media, therefore, offers an attractive way of disseminating health-related information to adolescents. Currently, limited evidence is available on social media's impact on health communication in specific population groups, particularly among adolescents. As a popular social networking site for photo and video sharing, especially among users 24 years of age or younger, Instagram has attracted more than 1 billion active users since its introduction in 2010 (Statista 2019; Boulos *et al.* 2016). According to Boulos *et al.* (2016), Instagram has a high potential in conveying health information, especially among adolescents based on its user-friendly features that can give health information quickly and more widely. For example, Paul *et al.* (2018) conducted a study to see the effects of using different social media (Facebook, Twitter, Instagram) to raise awareness among youth in reducing the consumption of the foods high in fat and sugar. The study found that participants' engagement on Instagram was the highest based on the number of likes for each health message.

Nutrition labelling is one of the strategies implemented as an effort in the prevention of NCD, especially obesity. In 2013, WHO listed nutrition labeling as one of the key methods in the NCD Prevention Action Plan 2013–2020, which serves to improve individual food choice behavior. According to Miller and Cassady (2015), adequate nutritional knowledge can increase consumer awareness of nutrition labels. Thus, nutrition education on the importance of nutrition labels usage is important to assist consumers in selecting and consuming healthier foods.

This study's scope was to examine the feasibility of an Instagram-based nutrition education media for adolescents using compelling infographics and short videos. Feasibility research was used to assess the practicality of the new media to determine if the participant considered the media to be usable, exciting, and useful for delivering nutrition education among adolescents. According to Orsmond and Cohn (2015), feasibility studies are important to evaluate the process of developing and implementing an intervention as well as a preliminary examination of participant responses to the intervention. This study was, therefore, aimed to assess the demand and acceptance of an Instagram-based nutrition labelling education (Info-Nutriteen®) among adolescents.

METHODS

Design, location and time

This 12-week study used a quasi-experimental, pre-post design to evaluate the feasibility of an Instagram-based nutrition labelling education (Info-Nutriteen®) among adolescents. It was conducted in Gombak, Selangor, from June to October 2018. Ethical approval was received from the Research Ethics Committee of Universiti Kebangsaan Malaysia (Project code: NN-2017-124).

Sampling

Participants were recruited from five public secondary schools in Gombak, Selangor, with permission from the Ministry of Education, Malaysia, and the Selangor State Education Department. Inclusion criteria were adolescents aged 13–14 years old; with the ability to communicate and understand Malay language; with smartphone and Internet access; Instagram active (at least twice a week); and owned a text message or Whatsapp application. Exclusion criteria included having physical or mental health problems that limited participation in data collection. Written parental permission and adolescent assent were obtained prior to participation.

One hundred and ninety-eight participants were screened at the beginning of the study; however, only 144 eligible and interested participants were invited to participate in this 12-week intervention. Participants were randomly assigned to either the intervention group (n=76) or the control group (n=68).

Data collection

Description of the Info-Nutriteen®. The 12-week intervention was grounded in nutrition labelling to introduce nutrition labels and the skills to interpret nutrition labels to choose healthier foods among adolescents. Content in

Info-Nutriteen® was developed based on the need analysis before this study (Jefrydin *et al.* 2019). Researchers used Microsoft PowerPoint, Affinity Designer, and Powtoon to design the infographics and videos used in this intervention. The educational media was presented to individuals with expertise in health, nutrition and food science, and health education for content validation and verification. The educational messages were divided into 7 main topics, including: (1) Introduction to Nutrition labelling; (2) Serving size and macronutrients; (3) Nutrition Information Panel; (4) Nutrition claims; (5) Energy labelling; (6) Healthier Choice Logo; and (7) Nutrition labelling usage on food choices. Each topic contains one or more lessons in Malay language depending on the content and scope of learning.

Procedures. Participants in both groups initially completed a baseline data collection involving socio-demographic survey; knowledge, attitude and practice (KAP) questionnaires on nutrition labelling; and anthropometry measures (weight, height, and waist circumference). The intervention group additionally received a detailed presentation on the study procedures. Mobile numbers, as well as Instagram accounts of participants, were verified. At the onset of the intervention program, participants were invited via text message or Whatsapp to "follow" an Instagram page created for this study. Researchers, who acted as the page administrators, posted weekly messages to educate participants on nutrition labelling using interesting infographics and short videos.

Weekly education messages were uploaded on the Friday following the entry into the program. Participants received a reminder via text message or Whatsapp from the administrator every time new messages were posted on the Instagram page. Participants were also instructed to turn on Instagram's notifications when they first followed Info-Nutriteen® page. Additionally, researchers used different Instagram features (Instastory and Instadirect) to encourage more participation through questions and answers sessions, short quizzes, polls, and feedback on the weekly message. Each lesson was followed by invitation to complete a web-based quiz. These quizzes tested participants' understanding of the lesson covered in each topic and their feedback on the lesson. Meanwhile, participants in the control group did not receive any form of nutrition education.

Feasibility criteria. The following criteria were established to determine project feasibility: demand and acceptability. Demand examines the extent to which participants will use a new program. Acceptability reflects the degree to which the participants view a program as satisfactory. Researchers also assessed every step of the study procedures (recruitment, intervention, data collection) and the intervention's effectiveness by keeping a daily log book. A set of close- and open-ended program evaluation survey questions were employed to assess this study's feasibility. Feasibility was evaluated after completion of the program among the intervention group.

Measurements. Three types of data were collected where two were measured during pre- and post-intervention, namely: (1) anthropometry measures (weight, height, and waist circumference) as well as; (2) self-report questionnaires assessing demographic characteristics, nutrition knowledge, and KAP on nutrition labels; and one during post-intervention which was (3) program evaluation survey using a 24-item questionnaire to assess the intervention group's acceptance on the entire program, infographics, and videos used in the media; with a 4-point Likert scale and three open-ended questions to assess participants' demand (feedback, experiences, and suggestions). All of these tools were developed and tested for validation and reliability before the beginning of this study. The maximum score for each domain in the KAP questionnaire was 16 (nutrition knowledge), 8 (knowledge), 40 (attitude), and 12 (practice). Weight, height, and waist circumference were measured twice without shoes and were averaged. Study procedures were monitored through logs maintained by the main researcher.

Data analysis

Descriptive statistics were used to explain the baseline characteristics and the frequency of participant involvement in intervention activities. Changes in anthropometry measures, nutrition knowledge, and KAP on nutrition labels were all assessed using one-way ANCOVA, with group as a between variable, pre to post as within variables, and baseline data as the covariate. Data entry and analysis for the quantitative measures

were conducted using IBM SPSS Statistics for Windows, version 23.0.

Data from the program evaluation survey were analyzed quantitatively by calculating the percentage of subjects who answered 'strongly agree' and 'agree' for each item, indicating that they received the Info-Nutriteen® program well. Meanwhile, the three open-ended questions from the survey were analysed qualitatively. The analysis was done manually (open-coding) using Microsoft Excel by identifying key themes and quantifying instances of specific responses. Two researchers independently coded the open-ended feedbacks from the participants and generated a list of themes. Then, the main researcher reviewed and evaluated for recurring themes regarding barriers and other observations. Results from the analysis were presented in three parts: (1) socio-demographic profile; (2) feasibility-acceptability and demand from the program evaluation survey; and (3) effectiveness from the self-reported questionnaires on nutrition labels' KAP.

RESULTS AND DISCUSSION

Socio-demographic profile

A total of 125 participants (63 in the control group; 62 in the intervention group) completed the program. The majority of participants were females (72.8%) and were from middle-income families (44%). The mean age of participants was 13.7±0.5 years. BMI Z-scores indicated that most participants were normal weight (61.6%), however, 18.4% of the participants were obese. Table 1 shows the baseline characteristics of the study participants.

Acceptability and demand

A total of 13 educational messages have been posted on Instagram in the form of videos (8), infographics (4), and a Googleform quiz. Overall, the results indicated that adolescents receiving the intervention reported positive acceptance of the usage of Instagram to deliver educational messages on nutrition labelling. On analysis, 92.7% of the participants from the intervention group reported positive acceptance towards the information uploaded on the Instagram page. As for the video, 95.6% of participants agreed that videos in Info-Nutriteen® educational media were interesting and easy to understand. Results also showed a positive reception of the messages in the form of an infographic where 94.4% of participants were satisfied. demand (feedbacks, experiences, and suggestions).

The qualitative analysis further revealed the participants' demand concerning their feedback, experiences, and suggestions on the program. The participants viewed the program as motivating and effective; in parallel to a study done in Saudi Arabia, which concluded that the use of Instagram for the promotion of home exercise program could be attractive and effective in reinforcing adherence and maintaining an appropriate level of physical activity among female undergraduate students (Al-Eisa *et al.* 2016). As a popular social network site for photo and video sharing, especially among users aged 24 years of age or younger, Instagram has drawn more than 1 billion active users since its start in 2010 (Statista 2019). Consequently, Instagram has become one of the most recommended social media platforms to promote a healthier lifestyle among youth (Santarossa & Woodruff 2018; Carceller-Maicas *et al.* 2016).

Two themes arose from the participants' feedback on the Info-Nutriteen® program: nutrition knowledge and health consciousness. Participants indicated that the program enhanced their knowledge on nutrition labels and helped them choose and eat healthier food.

Nutrition knowledge. Some of the participants indicated that Info-Nutriteen® increased their knowledge of nutrition and helped them understand and interpret the nutrient content of packaged food. Some of the responses were:

"I gain my knowledge on nutrition labelling especially on how to interpret the information on nutrition labels." (14-year old boy) ."

"This program was interesting because I learned on how to choose healthier food using the knowledge from the lessons. Moreover, I now could understand more about nutrition labels. I hope that this program will be continued to educate others". (14-year old girl)."

Health conscious. Participants also described Info-Nutriteen® as a good program that motivated them to eat healthier. For example, one participant commented:

"I am very satisfied with this program. I can finally limit my unhealthy snacking habit

Table 1. Baseline characteristics of study participants

Characteristic	Intervention (n=62)	Control (n=63)	Total (n=125)
Age (years; mean±sd)	13.61±0.49	13.70±0.46	13.66±0.48
Sex			
Male	17 (27.4)	17 (27.0)	34 (27.2)
Female	45 (72.6)	46 (73.0)	91(72.8)
Household income (RM)	3,844.35±2,635.00	4,912.70±4,031.00	4,382.80±3,439.00
Low (<RM2,300)	19 (30.7)	18 (28.6)	37 (29.6)
Middle (RM2300–<5,300)	32 (51.6)	28 (44.4)	60 (48)
High (≥RM5,300)	11 (17.7)	17 (27)	28 (22.4)
BMI for age (z-score)[1]	0.31±1.33	0.51±1.58	0.41±1.46
Underweight (z<-2sd)	1 (1.6)	4 (6.3)	5 (4.0)
Normal (z≥-2sd; z≤1sd)	42 (67.7)	35 (55.6)	77 (61.6)
Overweight (z>1sd; z≤2sd)	11 (17.7)	9 (14.3)	20 (16.0)
Obese (z>2sd)	8 (13.0)	15 (23.8)	23 (18.4)
Waist circumference (cm)[2]	69.41±9.79	73.17±11.57	73.17±11.57
Normal	54 (87.1)	50 (79.4)	50 (79.4)
Abdominal obesity	8 (12.9)	13 (20.6)	13 (20.6)

Data are expressed as n (%).
[1]WHO Growth Reference 5–19 years; BMI for age 5–19 years
[2]Poh *et al.* (2011)

and eat healthier food when I read the nutrition labels. This program taught me the importance of reading nutrition labels before purchasing food." (13-year old boy)."

In addition, another participant responded,

"This program helped me to choose healthier food. Besides, Info-Nutriteen® educates me on nutrients content of a food product and how to choose a healthier food between different brands." (13-year old girl)."

This observation was parallel to other studies that showed that using Instagram as a health communication tool can motivate people towards a healthier lifestyle (Fardouly *et al.* 2018; Chung *et al.* 2017). Chung *et al.* (2017) also found that people used Instagram because they wanted to improve their health behaviours and keep a record of activities relevant to their health goals while obtaining and providing social support and information to communities.

Participants also commented on some features of the media (infographics and videos) for Info-Nutriteen® that they dislike, as well as duration of the program, and then provided suggestions for improving the program. Participants suggested using bright colours and readable font sizes for the graphics to attract more attention to the educational messages.

"The infographics will be more interesting if using brighter colours and larger font size to encourage more participants to read and understand the contents." (14-year old boy)."

They also proposed using trending and current songs as the background music for the Powtoon videos to attract more viewers.

"In my opinion, to make the videos more efficient in delivering the messages, it requires using of the latest and trending tunes as the background music." (13-year old girl)."

Several participants stated that the program's duration was too time-consuming, and they lost interest in the middle of the program.

"For me, this program was too long. I had to wait for a week for the next message to be posted on the Instagram page." (13-year old boy)."

Several important considerations were identified to improve the program to encourage more participation and engagement for the future based on the participants' feedback and suggestions. First, the infographics must be redesigned using interesting graphics, bright colours and readable font sizes to better understand. Furthermore, the use of trending and latest tunes will increase adolescents' interest in watching these videos and comprehending the message better. Studies have revealed that most social media users preferred content in the form of attractive infographics and short videos on a specific topic. The infographics and videos should be able to graphically illustrate a concept or generate emotion to draw the users' attention to the messages because image and video sharing has become popular among social media users for knowledge translation, peer-to-peer learning and education in healthcare (Otten *et al.* 2015; Ramsay *et al.* 2012; Grajales *et al.* 2014). Moreover, according to Otten *et al.* (2015), well-designed infographics allowed viewers to discover patterns quickly, and they are more effective in communicating information than messages with text alone.

Secondly, the program's duration should be revised to maintain participants' motivation and interest throughout the program. One of the viable strategies is to post different educational messages more frequently instead of once a week. According to Wakefield *et al.* (2010), frequent discussion about a particular health issue within social networks in combination with personal exposure to different messages might reinforce specific behaviour changes.

Nutrition knowledge, and knowledge, attitude and practice on nutrition labels

One-way ANCOVA test was used to assess the effectiveness of Info-Nutriteen® on nutrition knowledge and KAP on nutrition labels. Results showed that the intervention program had significant effects on participants' attitudes [$F(1.122) = 17.392$, $p<.001$] and practices [$F(1.122) = 8.206$, $p<.001$] on nutrition labels. However, the intervention program had no significant effect on nutrition knowledge [$F(1.122)=3.046$, $p>.001$] and nutrition labels knowledge [$F(1.112)=2.296$, $p>.001$]. Although there was an increase in the nutrition knowledge and KAP on nutrition labels for both groups after the program, the intervention group showed slightly better scores than the control group. Nutrition knowledge and KAP post-intervention score percentage among participants in the intervention group showed increment to 79%, 76%, 75% and 82% from the baseline percentage of 76%, 69%, 72% and 76%, respectively (Figure 1). This data indicated that the intervention group showed improvement in their nutrition labels understanding and use after exposure to Info-Nutriteen® program.

The intervention program had significant effects on the participants' attitudes and practices on nutrition labels in the present study. These findings were consistent with the previous works done among different target populations. A study carried out in South Korea reported a significant improvement in attitudes on nutrition labels among the intervention group participants after participating in nutrition labelling education (Park *et al.* 2010). Different studies also showed increased nutrition labels use and practices among school children and adults at the end of education programs (Wolfe *et al.* 2018; Kollannoor-Samuel *et al.* 2016).

Nonetheless, this study found that the intervention program had no significant effect on nutrition knowledge and nutrition labels knowledge. These findings conflicted with previous studies that reported that nutrition labels educational interventions were effective in improving participants' nutrition knowledge and understanding of nutrition labels (Gavaravarapu *et al.* 2016; Katz *et al.* 2014). The difference may come from the fact that this study was conducted

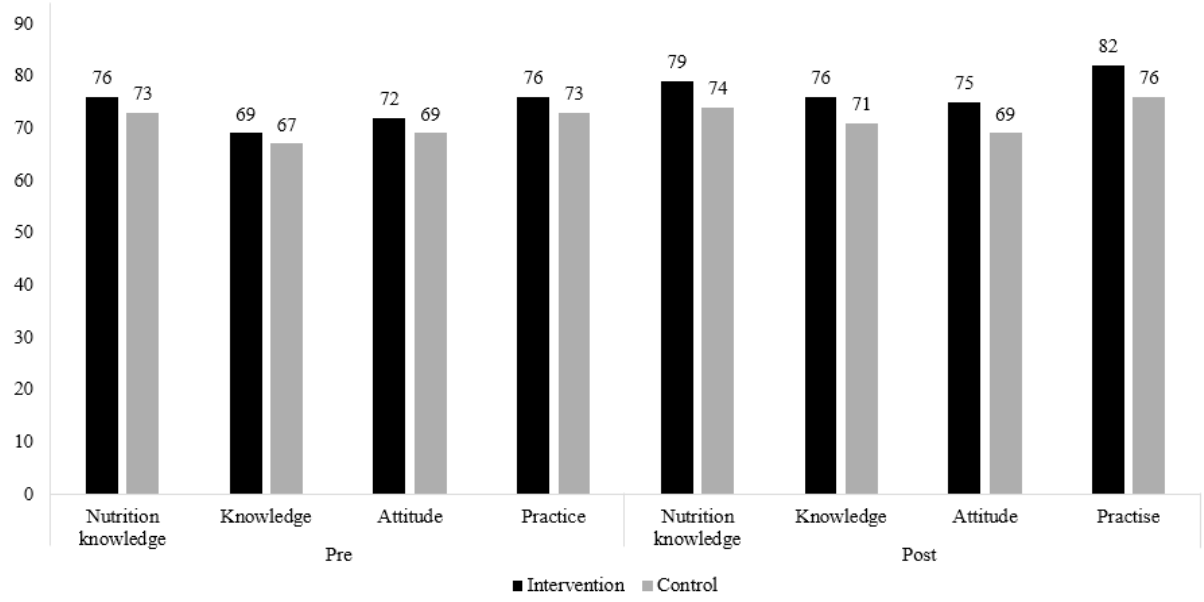

Figure 1. Comparison of nutrition knowledge and KAP score percentage before and after Info-Nutriteen® program between intervention and control groups

in the schools located in the same district where the participants may have known each other or followed each other on Instagram. Nevertheless, a study on Nutrition Detectives and ABC for Fitness programs conducted in the USA also found no significant difference between children in the intervention group and control group on Food Literacy and Label Nutrition Knowledge (FLANKK) score (Treu *et al.* 2017).

Strength and limitation

To our knowledge, this study is the first study to use Instagram as a medium to deliver nutrition education focused on nutrition labels to adolescents in Malaysia. Also, all assessment instruments used in this study have undergone validity and reliability tests before use. Besides, program evaluation has been carried out optimally involving quantitative and qualitative assessment to obtain participants' overview and opinion on the study's feasibility.

However, some limitations should be noted. First, the nutrition education contents must be reorganized so that the participants are not overflowed with information in each lesson. For example, one topic or lesson can be divided into several infographics or videos. According to Pagoto *et al.* (2016), posts with a graphic, video, or link to an article usually include a brief headline describing the content to attract viewers to read or click on it. Furthermore, a study among adult viewers found that the participants preferred a short and simple video rather than lengthy video segments, without seeing too many words (Ramsay *et al.* 2012).

Second, it is necessary to validate that the participants are familiar with the protocol of the study: from the start of the program i.e., following the Instagram page, prompts, reminders, notifications, commenting, post sharing to the completion of the intervention. Cavallo *et al.* (2016) stated that social media-based interventions should build familiarities between participants at the outset of the intervention to ensure their chances of being completely exposed to the contents. This could be accomplished by providing participants with some guidance on sharing their experiences, thoughts, and comments.

CONCLUSION

The study results showed good demand and acceptance toward the Instagram based nutrition education among adolescents, hence nutrition education using Instagram is seen as

feasible and effective to improve their attitude and practice on nutrition labels. Nevertheless, this study also demonstrated that Info-Nutriteen® should be improved further to enhance its impact on nutrition label knowledge and usage among adolescents.

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AUTHOR DISCLOSURES

The authors have no conflict of interest.

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Consumption of Canola Oil vs. Other Common Oil(s) in Dyslipidemia Management among Urban Indian Adults

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ABSTRACT

The present study was conducted to determine the effect of consuming canola oil vs. other common oil(s) on the lipid profile and anthropometric parameters of dyslipidemic adults. Eighty urban affluent dyslipidemic adults (40 experimental, 40 control) of age 30–45 years were enrolled from hospital based preventive health check programs for a 16-week non-randomized intervention trial. Dietary and lifestyle modification advice for management of lipid levels was provided to both the groups. Canola oil was provided for routine consumption only to the experimental group whilst the control group was advised to consume their usual oil(s) in recommended amounts (15 ml/day). Height, weight, Body Mass Index (BMI), Waist Circumference (WC), Low Density Lipoprotein (LDL), High Density Lipoprotein (HDL), Total Cholesterol (TC) and Triglycerides (TG) were measured at the beginning of the study (0 weeks), post run-in period (4 weeks) and post intervention period (12 weeks). Self-reported checklist was used to measure monthly compliance. Mixed effect linear regression and quantile linear mixed models were used to analyze the change in the parameters over time. There was no significant difference in the compliance towards dietary and lifestyle advice between both the groups (p=0.525; 0.795). The difference of changes in the lipid profile and anthropometric measurements between the groups observed over time was not statistically significant (Weight: p=0.206, BMI: p=0.553, WC=0.40, TC: p=0.505, TG: p=0.167, LDL: p=0.271, HDL: p=0.504). Hence, there was no difference in the effects of consuming canola oil vs. other common oil(s) in managing dyslipidemia. Similar beneficial changes were observed with consumption of both canola as well as other common oil(s).

Keywords: canola, cholesterol, dyslipidemia, management, oil(s)

INTRODUCTION

Cardiovascular diseases (CVDs) have a major share in global Non-Communicable Diseases (NCD) related mortality (WHO 2018). Indians in particular are at a greater risk owing to their genetic predisposition (Sai *et al.* 2012). CVDs occur a decade earlier among Indians (Mean age: 53±11.4 years) as compared to their European, American, Middle Eastern, even African counterparts (Mean age: 58.8±12.2 yrs), mainly because of lower prevalence of protective factors such as moderate to high intensity exercise, consumption of fruits and vegetables (Joshi 2007; Xavier 2008). Other leading risk factors such as high systolic blood pressure (≥140 mmHg), fasting plasma glucose (≥126 mg/dl) levels and total cholesterol (≥200 mg/dl) have also been identified for CVD deaths in India, which have only increased in line with the CVD deaths (Prabhakaran *et al.* 2018). In fact, these risk factors increase exponentially with age once Indians reach the 30-39 years age group (Gupta *et al.* 2009).

As CVDs and their related risk factors continue to rise, India in particular will suffer the economic impact of this trend, if preventive measures are not taken (Chauhan & Aeri 2015). Hence, the most effective combative strategy in this regard would be to focus on alleviating these risk factors. The present study focussed on one such risk factor, i.e. dyslipidemia, defined as the occurrence of total cholesterol, TC levels ≥200 mg/dl; Triglycerides, TG levels ≥150 mg/dl, Low density lipoprotein, LDL levels ≥130 mg/dl and high-density lipoprotein, HDL ≤40 mg/dl alone or in combination (Chandra *et al.* 2014).

In 2008, the global prevalence of raised cholesterol (≥190 mg/dl) among 25+ year old adults were 38.9% (females-40.2%, males-37.3%) and that of India were 27.9% (females-29.5% and males-26.3%) (WHO

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2008). More recent prevalence data can be found in Indian studies. In 2014, the age adjusted prevalence were: TC ≥200 mg/dl- 25.1% and 24.9%, LDL-c ≥130 mg/dl- 16.3% and 15.1%, HDL-c <40 mg/dl-men and <50 mg/dl-women- 33.6% and 52.8%, total: HDL-c ≥4.5- 29.4% and 16.8% and TG ≥150 mg/dl- 42.1% and 32.9% males and females respectively (Guptha *et al.* 2014). In the ICMR INDIAB study, prevalence of high TC levels was 13.9%, high TG- 29.5%, low HDL-c-72.3% and high LDL-c-11.8%. At least one abnormal lipid parameter was seen among 79% of men and women (Joshi *et al.* 2014). More recently, prevalence of elevated TC was reported in 25.4% and 35.6%, LDL-c in 28.1% and 35.1%, TG in 33.9% and 26.8%, low HDL-c in 54.9% and 64.4% and total: HDL-c in 45.1% and 36.4% men and women respectively (Gupta *et al.* 2016). Hence, the prevalence varies across studies but is definitely very high when translated into numbers.

Both Indian (Chandra *et al.* 2014) as well as international guidelines for treatment of dyslipidemia recommend modifications in terms of diet, physical activity, smoking, alcohol consumption etc. (NHLBI 2005; Catapano *et al.* 2016). Within these guidelines, the quality and quantity of dietary fats to be consumed have been focused upon. Even the WHO/FAO expert consultation report advises <10% of total calorie intake from saturated fatty acids (SFAs), about 6–10% from polyunsaturated fatty Acids (PUFAs; 1–2% n3 and 5–8% n6) and rest of the fat derived energy intake from monounsaturated fatty acids (MUFAs) (Report of the Joint WHO/FAO 2003). Given the criteria, many edible oils have been promoted on the basis of their fatty acid profiles as cholesterol lowering agents, including canola oil. Canola oil is low in SFAs, high in MUFAs and PUFAs specifically n-3 PUFAs as compared to many commonly consumed oils such as soybean, rice bran, safflower, sunflower etc. (ICMR 2010). Several research studies have documented the beneficial effects of consuming canola oil in diet.

A meta-analysis conducted to study the effect of various fatty acids concluded that substitution of canola oil into the diet starting at only 2% can produce an overall Coronary Artery Disease (CAD) risk reduction of 21% (Mozaffarian & Clarke 2009). In a study, replacing dairy fat with rapeseed oil (canola oil) led to reduced levels of serum cholesterol (-17%), TG (-20%) and LDL-c (-17%), TC:HDL-c (-21%), apolipoprotein (apo) B/apo A-I ratio (-4%) from baseline and also modestly increased serum lipoprotein(a) (+6%) (Iggmann *et al.* 2011). Similar benefits have also been reported among obese males. After daily supplementation of 50 g of canola oil vs. olive oil over 4 weeks, there was an increase in serum n-3 fatty acids (from 3.59±0.26% to 4.17±0.21%) and a reduction in TC (by 0.55±0.14 mmol/l), LDL levels (by 0.45±0.11 mmol/l) along with certain pro-inflammatory markers as compared to olive oil (Kruse *et al.* 2015). Most recently, two systematic review and meta-analysis studies have also reiterated the beneficial effects of consuming canola oil. One of them concluded that consuming canola oil for >30 days can reduce TC and LDL levels among >50-year-old individuals specifically in comparison with sunflower oil and saturated fat (Ghobadi *et al.* 2019). The other specifies improvement in several cardiometabolic markers compared with saturated fat, sunflower and olive oil with greatest benefits occurring when ~ 15% of the total energy intake was consumed from canola oil (Amiri *et al.* 2020).

At the same time, beneficial effects of many other oils have also been documented. In a review comparing olive oil, sunflower oil, fish oils and palm oil for their cardiovascular effects, it was concluded that all these oils have beneficial effects on cardiovascular health if supplemented in appropriate proportions. Considering only those that are used for cooking, both olive and sunflower oil were found to be effective in lowering serum cholesterol while palm oil was found to have a neutral to mild effect. Further, olive oil reduced oxidative stress and both sunflower and palm oil were found to have some anti-arrhythmogenic benefits. Sunflower oil was found to be less desirable due to its pro-oxidant effect when used for frying (Bester *et al.* 2010). However, in another study, palmolein oil consumption increased plasma and total LDL-c levels compared with olive oil while intake of olive oil demonstrated reduced LDL concentration and slight tendencies in reduction of total:HDL ratio but no change in HDL levels were seen in either (Tholstrup *et al.* 2011). Similar effect of olive oil consumption has been documented elsewhere (Oliveras-López *et al.* 2013). Its capability of increasing the HDL levels, its size, promoting its stability and enhancing the HDL oxidative status have also been documented (Hernáez 2017). Consumption of rice bran

oil (30 ml/day) can improve LDL levels as well as the antioxidant status significantly in hyperlipidemic individuals (Bumrungpert *et al.* 2019). Hence, many other commonly consumed oils can also favorably change lipid levels.

With this background, the present study was conducted to determine any effects of consuming canola oil vs. other commonly consumed oil(s) in managing dyslipidemia in terms of any change in lipid profile (LDL, HDL, TC and TG) and anthropometric measurements (Weight, BMI, WC).

METHODS

Design, location, and time

Non-randomized intervention trial of 16 weeks: 4 weeks of run-in period and 12 weeks of intervention period. Participants were enrolled for the study from selected preventive health check-up centres in Delhi-National Capital Region, India during 2012–2015.

Sampling

Sample size was computed to be 40 (each for experimental and control group) considering a drop-out rate of 20% (level of significance 5% and power 80%). The sample size was calculated on the basis of the mean and standard deviation values from a cross over study conducted on adult participants (Kuriyan *et al.* 2005). The formula used was (Rosner 1995):

$$\frac{(\sigma 1^2 + \sigma 2^2) + (z1\text{-}\alpha/2 + z1\text{-}\beta)^2}{\Delta^2}$$

where, $\Delta = \mu 2 - \mu 1$, ($\mu 1$, $\sigma 1$) and ($\mu 2$, $\sigma 2$) are means and variances of the two respective groups, $z1\text{-}\alpha/2 = 1.96$, $z1\text{-}\beta = 0.84$

A total of 112 participants gave a written informed consent to participate in this study. They were requested to come for a follow up visit after a month's run-in period. Only 88 participants came for the follow up visit. At this point, their lipid profile and anthropometric data were re-collected (post run-in). These participants were then divided into experimental and control group using the alternation technique. All participants whose identification/serial number was odd were assigned to the experimental group (n=45) while those with even numbers were assigned to the control group (n=43). During the intervention period, there were 8 more drop-outs; 5 from experimental group and 3 from control group due to a frequent travelling schedule that did not allow adherence to the intervention for long periods of time.

The inclusion criteria for the study subjects were; age: 30–45 years; TC ≥200 mg/dl and/or TG ≥150 mg/dl and/or LDL ≥130 mg/dl and/or HDL ≤40 mg/dl; willingness to participate and written informed consent. Those with liver disease, kidney disease, diabetes, heart disease or malignancy, pregnant and lactating mothers as well as those on lipid lowering drugs were excluded.

Intervention

Diet and lifestyle advice for lipid lowering based on the NCEP-ATP III (2002) guidelines was provided to both groups through a personalized diet plan. Counselling for maintaining optimum physical activity, stress management, smoking cessation and restricting alcohol intake was also given. Experimental group was provided canola oil in vacuum packaged bottles bought directly from the seller by the investigators for daily cooking of any kind while the control group consumed their usual edible oil(s) which were mustard, olive, sunflower, soybean, rice bran oil, clarified butter or ghee and coconut oil. They did not consume canola oil as ascertained through a survey with the sample population and continued using the oil(s) they were using at the beginning of the study throughout the study period. Advised dosage was 15ml/day for both the groups.

The study protocol was approved by the scientific committee of Max Healthcare, Institutional Ethics Committee, Institute of Home Economics and the Max Healthcare Ethics Committee. The study was also registered with the Indian Council of Medical Research (ICMR) clinical trial registry (REF/2013/04/004857).

Data collection

Standard techniques were used to collect anthropometric data i.e. height, weight (Seth & Singh 2005) and waist circumference; WC (WHO 2011) and data on lipid profile i.e. TC using CHOD-PAP method (Roeschlau *et al.* 1974); TG using GPO Trinder method (McGowan *et al.* 1983); LDL calculated using the Friedwald's equation (Tietz *et al.* 2006) and HDL levels ascertained using the phosphotungsticacid

method (Rifai & Warnick 1994) were collected three time periods: at 0 weeks, the beginning of the study (pre-intervention stage), after 4 weeks of run-in period (post run-in stage) and then again after 12 weeks of intervention with canola oil/commonly consumed oil(s) (post-intervention stage). Height and weight data were used to calculate Body Mass Index, BMI of the participants (WHO 2019).

Compliance to the intervention was assessed using a monthly self-report checklist wherein the participants marked the number of days they deviated from the dietary and lifestyle advice as well as canola oil consumption (for experimental group only). The compliance of the participants (during run-in period of 4 weeks, intervention period of 12 weeks and overall study period of 16 weeks) was calculated in terms of mean number of days the advice was adhered to. Percentage compliance was computed by dividing the mean no. of complaint days with the total no. days. Compliance was considered to be good if the participants consumed canola oil/other oil(s) for at least 30 days during the substitution period. This criterion was derived on the basis of similar intervention studies that have documented an effect of such interventions in as less as 4 weeks (Kruse *et al.* 2015; Ghobadi *et al.* 2019; Bumrungpert *et al.* 2019).

Data analysis

Independent t-test was used to assess difference between the groups on the basis of compliance. The outcome variables were tested for normality and were found non-normal. Hence, log transformations were applied. All variables except WC and BMI followed normality post transformation hence, their mean values were reported. Thus, independent t-test and Mann Whitney U test were used to determine any difference in the LDL, HDL, TC, TG levels and BMI and WC values at the beginning of the study respectively. Both the study groups were also tested for age and gender matching using a chi square test.

To study the effect of the intervention among both the study groups, the main outcome variables of the study were statistically analyzed for change over time. Mixed effect linear regression models were used to test the difference in the change of mean values of LDL, HDL, TC and TG over time between experimental and control group as these variables followed normality after log transformation. However, BMI and WC values did not follow the normality assumption even after the transformation hence, Quantile Linear Mixed Models (QLMM) were used to assess the difference in change of median values of BMI and WC over time between the two study groups. These models were used to analyze the difference of values between two groups and the within participants variations of values over the three time periods. In both types of analysis, three models were applied: (1) Model 1: The change was measured over time by study groups only; (2) Model 2: Age and gender were adjusted in the model while assessing the change over time; (3) Model 3: Effect of days of compliance for diet and exercise were also included along with age and gender in the models.

Different statistical analysis software was used for this analysis. Linear mixed effect model and multinomial logistic regression model analysis were carried out using SPSS 17.0 while the Quantile Linear Mixed Model (QLMM) analysis was carried out using software R 3.1.3

RESULTS AND DISCUSSION

The experimental and control group were age and gender matched (p=0.382 and 1.00). There was no significant difference between the two groups in weight, median BMI, median WC, mean TC, TG, LDL and HDL levels at the pre-intervention stage (p=0.510; 0.697; 0.913; 0.713; 0.223; 0.363; 0.929 respectively). Thus, both the study groups were essentially similar at the pre-intervention stage.

Table 1 shows the mean numbers of days for compliance of both the groups towards dietary and lifestyle advice. With an overall compliance of approximately 70–75%, no significant difference was observed between the groups (dietary advice: p=0.525, lifestyle advice: p=0.795). In addition, the compliance of the experimental group for canola oil consumption was 105±14.18 days i.e. 87.5%. The results have been reported with reference to the parameters at the beginning of the study.

Change in anthropometric parameters

At the end of the first month i.e. the run-in period, there was significant decline in the weight and BMI of experimental group as well

Table 1. Comparison of study groups on the basis of the mean number of days of compliance

Compliance	Total number of days	Experimental		Control		p
		Mean±SD	%	Mean±SD	%	
Dietary advice						
Run-in period	30	20±7.62	66.66	20.08±8.79	66.93	0.802
Intervention period	120	91.83±18.35	76.53	89.80±26.02	74.83	0.661
Total study period	150	111.83±23.26	74.55	109.88±31.98	73.25	0.525
Lifestyle advice						
Run-in period	30	18.95±7.68	63.17	19.20±8.52	64	0.754
Intervention period	120	92.90±17.41	77.42	87.23±29.13	72.69	0.761
Total study period	150	111.85±22.65	74.57	106.43±34.78	70.95	0.795
Canola oil						
Canola oil consumption	120	105±14.18	87.5	-	-	-

as the control group (p-experimental<0.001; p-control<0.001 and p-experimental<0.001, p-control=0.001 respectively) (Table 2, Table 3). WC decreased in the control group but not significantly (p=0.278) while no change was observed in the experimental group. However, at the end of the intervention period, a significant decline in the weight, BMI and WC was observed in both the groups. Further, on comparing the extent of decline between the two groups, no significant difference was observed (Table 2, Table 3).

Change in lipid levels

By the end of the run-in period, both the groups exhibited a significant decline in the TC levels (p-experimental=0.035; p-control=0.003). Even the LDL levels declined significantly but with a marginal significance in the experimental group (p-experimental=0.055; p-control=0.003). On the other hand, both the TG as well as the HDL levels did not change significantly (p-experimental=0.669; p-control=0.830 and (p-experimental=0.181; p-control=0.753 respectively). In the next four months i.e. by

Table 2. Overall change in the anthropometric parameters and lipid profile levels

	Experimental group			Total % change	Control group			Total % change
	Pre -intervention 0 weeks	Post run-in 4 weeks	Post intervention 16 weeks		Pre-intervention 0 weeks	Post run-in 4 weeks	Post intervention 16 weeks	
Weight (kg)	74.66±12.34	73.94±12.07	72.66±11.28	-2.68	72.89±11.05	71.86±10.71	70.2±9.84	-3.69
BMI (kg/m^2)	25.8 (24.47–27.75)	25.3 (24.11–28.09)	25.2 (23.52–27.38)	-2.33	25.92 (23.89–27.34)	25.52 (23.47–27.17)	24.57 (23.42–26.42)	-5.21
WC (cms)	91 (86–95.88)	91 (86–94)	87.5 (84–91)	-3.85	91 (86–94)	87.5 (86–94)	86 (81–93.25)	-5.49
LDL (mg/dl)	155.01±26.81	149.54±23.8	138.22±19.54	-10.83	161.75±33.22	153.51±32.77	139.82±28.29	-13.56
HDL (mg/dl)	38.87±8.62	38.28±7.83	38.43±6.7	-1.31	39.5±11	39.5±10.81	38.86±10.08	-1.62
TC (mg/dl)	232.48±25.59	226.53±24.12	211.53±20.57	-9.01	236.6±37.35	229.49±38.71	212.23±34.71	-10.3
TG (mg/dl)	195.43±57.98	194.25±46.86	171.95±44.78	-12.01	183.33±62.51	181.1±55.87	169.48±57.94	-7.55

BMI: Body Mass Index; WC: Waist Circumference; LDL: Low Density Lipoprotein; HDL: High Density Lipoprotein; TC: Total Cholesterol; TG: Triglycerides

Table 3. Change in the anthropometric parameters of the participants

Experimental (n=40)				Control (n=40)		
Study period	Estimate[↑]	Standard error	p[ϕ]	Estimate[↑]	Standard error	p[ϕ]
Weight[1]						
Pre-intervention	Reference	Reference		Reference	Reference	
Post run-in	-0.009	0.002	<0.001**	-0.014	0.004	<0.001**
Post intervention	-0.026	0.005	<0.001**	-0.036	0.007	<0.001**
Difference change between the groups			p#= 0.206			
Body mass index[2]						
Pre-intervention	Reference	Reference		Reference	Reference	
Post run-in	-0.285	0.061	<0.001**	-0.361	0.105	0.001**
Post intervention	-0.738	0.136	<0.001**	-0.923	0.172	<0.001**
Difference of change between the groups			p#=0.553			
Waist circumference[2]						
Pre-intervention	Reference	Reference		Reference	Reference	Reference
Post run-in	-0.462	0.237	0.057*	-0.751	0.228	0.001**
Post intervention	-2.34	0.487	<0.001**	-2.92	0.577	<0.001**
Difference of change between the groups			p#=0.40			

*Significant (p<0.05); **Highly significant (p<001); [↑]Estimates are beta coefficients indicating the change in parameters unit time; pΦ: Shows the significance of change in the parameters; p#: Shows the significance of difference of change between the groups; [1]Mean log transformed values; [2] Median values

the end of the intervention period, there was a significant decline in all the lipid levels except HDL (TC: p-experimental<0.001; p-control<0.001; TG: p-experimental<0.001; p-control=0.029; LDL: p-experimental<0.001; p-control<0.0001; HDL: p-experimental=0.016; p-control=0.831). Further, the extent of decline in TC, TG and LDL levels was not found be significantly different between the two groups (Table 2, Table 4).

Hence, the study participants were age and gender matched, similar in terms of their anthropometric parameters and lipid levels at the beginning of the study and also had similar extent of compliance to the intervention. The only difference between the groups was the type of oil they consumed. By the end of the study period, it was observed that the weight, BMI, WC, TC, TG and LDL levels of both the groups decreased significantly.

Further, it is worth noting that while the mean HDL levels did not change desirably in both the groups i.e., they did not increase, the levels also did not decrease by the end of the study period. Since HDL is known to be cardio-protective, a decline in its levels is not desirable (Nagao *et al.* 2018).

Key observation of the study is that the difference of these changes between the two study groups was not statistically significant (p>0.05) i.e. the changes observed were similar in both the groups whether they consumed canola oil or their usual oils in routine.

As discussed in the introduction section, several studies have documented the beneficial effects of canola oil consumption over other oil(s) in terms of reduction in lipid profile level and even other cardiovascular risk markers such as Apo b: Apo A-I ratio (Iggmann *et al.* 2011; Kruse *et al.* 2015; Ghobadi *et al.* 2019; Amiri 2020).

Table 4. Change in the lipid profile of the participants

Experimental (n=40)				Control (n=40)		
Study period	Estimate[↑]	Standard error	p[ϕ]	Estimate[↑]	Standard error	p[ϕ]
Total cholesterol						
Pre-intervention	Reference	Reference		Reference	Reference	
Post run-in	-0.026	0.012	0.035*	-0.031	0.018	0.003**
Post intervention	-0.093	0.015	<0.001**	-0.109	0.026	<0.001**
Difference of change between the groups			p[#]= 0.505			
Triglycerides						
Pre-intervention	Reference	Reference		Reference	Reference	
Post run-in	-0.007	0.016	0.669	-0.005	0.025	0.830
Post intervention	-0.119	0.022	<0.001**	-0.070	0.031	0.029*
Difference of change between the groups			p[#]= 0.167			
Low density lipoprotein						
Pre-intervention	Reference	Reference		Reference	Reference	Refer-ence
Post run-in	-0.034	0.017	0.055*	-0.055	0.018	0.003**
Post intervention	-0.109	0.021	<0.001**	-0.147	0.026	<0.001**
Difference of change between the groups			p[#]=0.271			
High density lipoprotein						
Pre-intervention	Reference	Reference		Reference	Reference	Refer-ence
Post run-in	-0.012	0.009	0.181	-0.002	0.007	0.753
Post intervention	-0.003	0.016	0.834	-0.003	0.015	0.831
Difference of change between the groups			p[#]=0.504			

*Significant (p<0.05); ** Highly significant (p<0.01); [↑]Estimates are beta coefficients indicating the change in mean value of log transformed lipids per unit time; p[Φ]: Shows the significance of change in mean of log transformed values; p[#]: Shows the significance of difference between the groups

However, our study did not confirm this finding. Instead, we found that effect of consuming canola oil was not superior to consuming usual oil(s) like mustard, olive, sunflower, soybean, rice bran oil, clarified butter or ghee and coconut oil as seen in our control group participants. These results are in line with an intervention with hypoenergetic diet enriched in rapeseed oil vs. an olive oil diet among individuals with metabolic syndrome. The investigators observed a significant reduction in body weight of both the rapeseed oil and olive oil group (-7.8 v. -6.0 kg). There were significant decreases in the TC (-0.30 mmol/l and -0.38 mmol/l) and LDL-c (-0.22 mmol/l and -0.28 mmol/l) levels also with no inter-group differences. Here, too the HDL levels did not change in both the study groups. However, rapeseed oil group did show a distinction of improved TG levels (-0.045 mmol/l) that did not occur in the olive oil group (Baxheinrich *et al.* 2012). Our results also concur with a recent randomized control trial that reported no difference between two groups that consumed canola oil or, in this case a specific oil i.e. sunflower oil for 6 weeks. Both the groups showed significant decline in LDL (Canola

group: 129.54±39.74 mg/dl to 116.12±35.83 mg/dl and Sunflower group: 140.55±41.29 mg/dl to 122.95±32.97), TC (Canola group: 220.13±41.94 mg/dl to 194.31±39.45 mg/dl and sunflower group: 223.95±43.81 mg/dl to 196.45±35.28 mg/dl) and TG levels (197.14±103.23 mg/dl to 172.49±78.25 mg/dl and sunflower group: 189.02±110.02 mg/dl to 171.04±88.69 mg/dl) with the only exception being an elevation in the HDL levels (Canola group: 44.24±12.31 mg/dl to 47.28±11.90 and sunflower group: 44.82±12.29 mg/dl to 46.73±11.35 mg/dl) but no significant change in the anthropometric parameters of the participants as compared to our study probably because the study did not involve giving dietary and lifestyle advise to the participants (Saedi *et al.* 2017). This was another key observation of our study since obesity (increased weight, BMI and WC) is a known risk factor for CVDs.

CONCLUSION

There are several studies that have documented evidence of beneficial effects of canola oil consumption as against other edible oils. However, a few others have also shown no difference in the benefits conferred by consuming canola oil or other commonly consumed oil(s) as in the case of our study. We observed similar improvements in the lipid levels and anthropometric parameters in both the groups implying no additional benefits of consuming canola oil in specific. Thus, our results imply that similar improvements in lipid levels and anthropometric parameters can also be brought about by using commonly available oils with lower price points and this can help in managing dyslipidemia more economically. Future research studies can focus on the role of following dietary and lifestyle modifications as against consumption of specific oil(s) in managing dyslipidemia among adults.

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AUTHOR DISCLOSURES

The authors have no conflict of interest.

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Nutritional Status, Health Status, and Work Productivity of Cocoa Farmers in Polewali Mandar, Indonesia

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ABSTRACT

The objective of this study was to analyze the associations between nutritional status, health status, other determining factors with work productivity of cocoa farmers. This cross-sectional study involved 58 male cocoa farmers aged 18–65 years old in two districts of Polewali Mandar. Data on food consumption and habit as well as health status were collected via structured interviews. While, blood pressure and anthropometric parameters were measured using standard equipment of blood pressure meter, weight scale, and height scale. Spearman's test and Principal Components Regression (PCR) analysis were implemented to explore factors associated with farmers' work productivity. There was no relationship between Body Mass Index (BMI) and work productivity. However, there was a significant positive association between central obesity with days of absent (r=0.275; p=0.037). We also found negative association between blood pressure and the amount of cocoa picked daily (r=-0.366; p=0.005). PCR statistical analysis results showed that the amount of cocoa picked per day were significantly associated with smaller waist circumference, coffee consumption, and good exercise habit. While, decrease in consumption of fruits and vegetables was significantly associated with the number of absence days due to health problems. Thus, it can be concluded that work productivity of male cocoa farmers was associated with food consumption, physical activity, and lifestyle factors.

Keywords: cocoa farmer, health status, nutritional status, productivity

INTRODUCTION

The agricultural sector absorbs the largest labor force in Indonesia, however, the sector only contributed 10.60% of the total GDP (BPS 2017). This indicates low productivity in the agricultural sector. Cocoa is one of the leading commodities in the plantation sub sector. It contributes consistently as a source of foreign exchange revenue (Arsyad *et al.* 2011), the third largest after palm oil and rubber (Hasibuan *et al.* 2012). West Sulawesi is one of the centers of cocoa production in Indonesia since the 1980s.

Previous study showed that nutritional status and health status influenced work productivity (Bustillos *et al.* 2015; Businginye *et al.* 2014). Work productivity was dependent upon many factors, aside from the two aforementioned, including weather, technology, work motivation, and more. Some studies have also explored the relationship between the size of health risk and the percentage of time impaired at work (presenteeism) (Boles *et al.* 2014). Brumby *et al.* (2012) showed that there was a high prevalence of risk factors for coronary heart disease and psychological stress in the farming communities in Australia. This combination of physical and mental health factors had a direct influence on the increase of abdominal obesity and co-morbidity of coronary heart disease in the study population, which later would have an impact on labor productivity. Another study conducted by Nwaiwu *et al.* (2017) on farmers in Ahiauzu Imo, Nigeria, showed that 18.33% of the subjects suffered high blood pressure (hypertension). Conditions of diseases such as hypertension are related to food consumption, lifestyle, and lack of physical activity. Poor health status will negatively affect farmers' productivity.

Based these findings on associations of nutritional status and health status with farmers' work productivity, this study aimed to explore

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the associations of these factors with the work productivity of cocoa farmers in Polewali Mandar, West Sulawesi, Indonesia. The result will offer insight on strategy to improve the farmer's productivity.

METHODS

Design, location, and time

This study is a cross-sectional study conducted at cocoa plantations in 2 sub-districts (Anreapi District and Mapilli District) in Polewali Mandar Regency, West Sulawesi Province, Indonesia. It was conducted in July–August 2017 as a part of the study entitled "Sustainability and Provitability of Cocoa-based Farming Systems in Indonesia" in a collaboration between the AIC (Australian-Indonesian Center) and InterCafe LPPM of IPB University, Hasanuddin University, and Syndey University of Australia. Ethical approval was granted by the Ethics Committee of the IPB University (4758/IT3.26.1/KEPMSM/PL/2017).

Sampling

The subjects were male cocoa farmers in 2 sub-districts of Polewali Mandar. The inclusion criteria of the subjects were 1) male aged 18–65 years; 2) cocoa farmers; and 3) willing and staying in the study sites during the study for interviews and direct anthropometric, body composition, and blood pressure measurements. The minimum sample size was calculated using the formula from Sujarweni (2012) and resulted in a minimal sample size of 45 male cocoa farmers, and we recruited 58 male cocoa farmers who satisfied the inclusion criteria.

Data collection

Primary data collected were the subjects' characteristics and measures of body mass index (weight and height), waist circumference, waist hip ratio, blood pressure, food consumption (2x24 hours food recall), eating habits and lifestyle, physical activity (2x24 hours activity recall), family health history, and work productivity data. Work productivity data in this study were obtained in two ways: measuring the amount of cocoa picked per day (in kilograms) and counting the number of absence days at the plantations in the last 1 month for illness/health reasons. Data regarding food consumption, lifestyle, physical activity, family health history, and work productivity were collected by interviewing farmers directly using structured questionnaires by trained enumerators. Body mass index, waist circumference, waist hip ratio, body composition, and blood pressure were measured with standard weight scale, height scale, tape measure, blood pressure meter, and body composition monitor (Omron HBF-375 Karada Scan).

Data analysis

The analysis used in this study involved descriptive analysis, Spearman's test to analyze the relationship of nutritional status and health status to work productivity, and Principal Component Regression (PCR) for analyzing the factors associated with work productivity.

RESULTS AND DISCUSSION

Characteristics of the subjects

Table 1 shows that most farmers (74.1%) were 40–65 years old, with a mean age of 45.05 years. Risk of non-communicable diseases and other chronic diseases increases in above 40 years old. Therefore, farmers over the age of 40 years were expected be more aware of their health by maintaining a healthy diet, exercise, and starting to avoid risky lifestyle such as smoking, consuming excessive alcohol and coffee, and limiting consumption of foods high in sugar, salt, and fat. Most of the subjects (53.4%) had a medium family size (4–5 persons per family) and had an elementary school level education (53.4%).

Almost 40% of all subjects had normal nutritional status. Research by Susanto *et al.* (2017) pointed out the variations in nutrition and health problems that occurred in farmers in Jember, namely, underweight (28.5%), overweight (10.6%), and anemia (62.6%). In addition, most of the cocoa farmers in the study had normal abdominal circumference (89.7%), and 10.3% of the subjects had central-obesity with abdominal circumferences greater than the threshold of 90 centimeters for men. Most of the subjects (58.6%) also had Waist Hip Ratio (WHR) in the normal category, while the rest (41.4%) had WHR in the at-risk category. The higher the waist circumference and WHR, the higher the risk of Non-Communicable Diseases (NCDs) and chronic non communicable diseases

such as cancer, cardiovascular disease, diabetes, hypertension, and others.

The blood pressure measurement showed that 46.5% of the subjects were categorized as pre-hypertensive, 34.5% had hypertension, and 19% had normal blood pressure. The study conducted by Nwaiwu *et al.* (2017) on farmers in Ahiauzu Imo, Nigeria, showed that 18.33% of the subjects suffered high blood pressure (hypertension). Regarding to risk of chronic non communicable diseases, previous research by Nurjanah (2015) in Citeureup showed that the dominant markers of metabolic syndrome among male workers were central obesity (96.6%), followed by hypertriglyceridemia (82.8%), low HDL cholesterol (72.4%), high GDP (62.1%), and high blood pressure (55.2%).

Table 1. Characteristics of the subjects

Characteristics of the subjects	n	%
Age		
18–40 years	11	25.9%
40–65 years	43	74.1%
Mean±SD	45.05±9.79 years	
Family size (persons)		
Small (≤4)	21	36.2%
Medium (5–6)	31	53.4%
Large (>7)	6	10.3%
Mean±SD	4.93±1.34 persons	
Educational level		
Elementary school	31	53.4%
Junior High School	10	17.2%
Senior High School	13	22.4%
College	1	1.7%
Not attending school	3	5.2%
Body mass index		
Underweight	6	10.3%
Normal	23	39.7%
Overweight	15	25.9%
Obesity	14	24.1%
Mean±SD	22.77±3.18	
Waist circumference		
Central obesity	6	10.3%
Normal	52	89.7%
Mean±SD	78.15±9.51 cm	
Waist to hip ratio (WHR)		
At risk	24	41.4%
Normal	34	58.6%
Mean±SD	0.88±0.05 cm	
Blood pressure		
Hypertension	20	34.5%
Pre-hypertension	27	46.5%
Normal	11	19.0%

Studies have shown that high blood pressure is associated with risky lifestyles, such as smoking, coffee consumption, lack of exercise, and high consumption of sodium. Thus, increasing physical activity, increasing consumption of fruits and vegetables, and reducing risky lifestyles and habits such as smoking, consuming alcohol, and excessive coffee consumption can prevent central obesity and hypertension.

Work productivity

Productivity is an average measure of the efficiency of production. Workers are considered productive if they are capable of producing outputs or products that are larger than those produced by other workers for the same time unit (Yadav & Marwah 2015). Work productivity in this study was measured in two ways: measuring the amount of cocoa picked per day (in kilograms) and counting the number of absence days to the plantations in the last 1 month due to illness/health reasons. Data in Table 2 show the work productivity of cocoa farmers in Polewali Mandar.

Table 2 shows that the mean weight of cocoa picked per day amounted to 26.69 kilograms. The minimum weight on a day was 4.2 kilograms, and the maximum was 75 kilograms. Most of the subjects (58.6%) never skipped any day of work at the plantation for reasons related to illness in the past 1 month (0 day). The average number of absence days in the last 1 month for illness/health reasons was only 1.33 days.

Relationship of nutritional status, health status, work productivity and other factors work productivity of cocoa farmers

The statistical analysis indicated that there was no relationship between nutritional status and work productivity of cocoa farmers. These results were in line with the research of Mahardikawati (2008), which showed that there was no relationship between nutritional status,

Table 2. Work productivity of cocoa farmers

Work productivity		
Amount of cocoa picked/day (kg)	n	%
1–25 kg	36	62.1
26–50 kg	17	29.3
51–75 kg	1	1.7
76–100 kg	4	6.9
Mean±SD	26.69±3.21	
Number of days absent for health reasons (days)	n	%
0 days	34	58.6
1–3 days	20	34.5
More than 3 days	4	6.9
Mean±SD	1.33±0.51	

reflected by the Body Mass Index (BMI), and level of work productivity. This was presumably because level of work productivity was influenced more by the consumption of nutrients, especially iron. Hence, BMI was not related directly to work productivity. In addition, both absenteeism and presenteeism were associated with obesity. However, our finding highlighted that being overweight based on BMI was weakly associated with work productivity. However, previous study by Bustillos *et al.* (2015) found otherwise, that obesity (BMI>30) was an independent risk factor for reduced work productivity.

Table 3 shows the relationships of nutritional status and health status to work productivity. Regarding health status, there was a significant relationship between health status as reflected by blood pressure and the amount of cocoa picked per day (in kilograms). The results of this study indicated that individuals who had higher blood pressure (suffering from pre-hypertension or hypertension) had lower work productivity based on the amount of cocoa picked per day (in kilograms). Some mild symptoms of high blood pressure might cause weaker physical strength than those with normal blood pressure as found by Businge *et al.* (2014). Another study conducted by Nwaiwu *et al.* (2017) on farmers in Ahiauzu Imo, Nigeria, showed that 18.33% of the subjects suffered from high blood pressure (hypertension). Hence, poor health status was also found to negatively affect the farmers' productivity. Individuals with high blood pressure had a greater potential to engage in absenteeism for health reasons, which would then affect work productivity.

In addition, we found that farmers who suffered from central obesity had a higher number of absence days than those who did not. It was because individuals who suffered central obesity had the potential to have a bigger risk of disease, affecting to number of absence days. Results of this study were in line with previous research by Robroek *et al.* (2010) on 10,624 workers in 49 Dutch companies in 2005–2009, which stated that obese workers had higher numbers of days for sick leave compared to normal-weight workers (OR=1.27; 95% CI:1.11–1.46). Another study from Pronk NP *et al.* (2004) on 683 workers showed that work performance was related to obesity. The study found several reasons for this association. First, obesity is significantly associated with interpersonal relationships. Individuals with obesity were reported to have a higher difficulty to work together with a work partner. Second, obesity was more significantly correlated with a higher number of work-loss days compared to normal weight.

In this study, work productivity was defined by two indicators, namely, the amount of cocoa picked per day and the number of absence days related to health problems. Table 4 summarizes some factors that influenced work productivity (amount of cocoa picked per day), namely, waist circumference, exercise habit, and coffee consumption. Further, based on our analysis, the number of absence days related to health problems was influenced by consumption of fruits and vegetables.

Table 4 shows the results of the analysis PCR (Principal Analysis Regression) of factors that influenced work productivity (amount of cocoa picked per day and number of absence days). The

Table 3. Relationships of nutritional status and health status to work productivity of cocoa farmers.

Variables	Work productivity			
	Cocoa picked per day		Number of absence days	
	r	p	r	p
Body mass index	0.087	0.516	-0.230	0.083
Central obesity	0.114	0.392	0.275	0.037[a]
Blood pressure	-0.366	0.005[a]	-0.085	0.525

[a] Spearman's test significant at $p<0.05$

Table 4. Factors influencing work productivity

Variables	Value	p
Amount of cocoa picked per day		
Waist circumference	-0.33	0.02[a]
Exercise habit	12.20	0.01[a]
Coffee consumption	16.35	0.01[a]
Number of absence days		
Consumption enough fruits and vegetables	-1.92	0.03[a]

[a] Significant at p<0.05

factors are waist circumference, exercise habits coffee consumption and consumption of fruits and vegetables. Waist circumference variable has a significant effect on work productivity. Increase by 1 cm in waist circumference will decrease productivity by 0.33 kilograms. Then, exercise variable has a significant effect on work productivity. Farmers who exercise have a greater weight of 12.20 kg in cocoa picked per day than people who don't exercise. The same for coffee consumption, where farmers who consume coffee picked 16.35 kgs more of cocoa daily than those who don't consume coffee. While, people who consume fruits and vegetables has less days of absence as much as 1.92 days compared to those who do not consume enough fruits and vegetables.

Study by Sjøgaard *et al.* (2016) on workers in Denmark showed that there was an 8% increase in productivity among workers after 3 months of exercise intervention. Sickness and absenteeism, in relation to improved or maintained productivity and work ability, were reduced. A regular exercise routine could make the farmers happier and more energetic, affecting their productivity. Then, regarding coffee consumption, a study by the EFSA Panel on Dietetic Products, Nutrition and Allergies (2011) showed that caffeine may also help to improve motor and physical performance. Caffeine improves motor performance, helping increase the speed of physical movement. With frequent consumption, tolerance develops the effects of caffeine, but the degree of tolerance varies, with near complete tolerance to caffeine's alerting effect and little or no tolerance to its effect on physical performance

Related to the intake of fruits and vegetables, the results of this study were in line with the research by Robroek *et al.* (2010) on 10,624 workers in 49 Dutch companies in 2005–2009, which showed a loss of productivity, with work being related to inadequate intake of vegetables and fruits and the presence of disease at a young age. The individuals who consumed fruits and vegetables would have better immune response and better health conditions compared with those who did not. It could reduce the number of health-related absence days in individuals who consumed fruits and vegetables and affect their work productivity (Robroek *et al.* 2010).

However, this study did have some limitations. This study was a cross-sectional study with a limited number of participants and only involved male farmers. Hence, it could not determine cause and effect, but it could identify potential associations and could not represent larger population. Thus, larger longitudinal data are needed to provide a better assessment of the cause and effect relationships between nutritional status, health status, and work productivity in cocoa farmers.

CONCLUSION

This study showed that intake of fruits and vegetables, coffee consumption, physical activity were positively associated with work productivity among male cocoa farmers. While hypertension and central obesity showed negative associations. Therefore, nutrition and health interventions such as food consumption and healthy lifestyle education are needed to improve the cocoa farmers work productivity both in term of sick leave and the amount of cocoa picked per day.

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AUTHOR DISCLOSURES

The authors have no conflict of interest.

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The Development of Food and Nutrition Security Index at Provincial Level in Indonesia

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ABSTRACT

This study aimed to develop a novel Food and Nutrition Security (FNS) index to be implemented at provincial level in Indonesia. Principal component analysis was used to calculate food and nutrition security index based on 23 indicators, data were obtained from provincial and national public report published in 2010 and 2013. These indicators were further grouped into three different dimension of food availability, food accessibility and food utilization. Principal Component Analysis (PCA) was then used to calculate each aspect and the FNS indices. The index was later used to categorize food and nutrition security performance of a region into one of three levels, namely secure, vulnerable or insecure. The application of this new FNS index found that most of Indonesia's regions (87.5%) were categorized as vulnerable (50.0%) and insecure (37.5%) and only 12.5% had high food and nutrition security performances in 2013. Among all provinces, Bali had the best performance in 2013, while East Nusa Tenggara had the lowest performance in 2010 and 2013. In 2013, the food availability status of all the provinces were categorized as secure. However, their status on food accessibility and food utilization showed many of them fell into vulnerable and insecure categories. Hence, the effort to increase the national food and nutrition security performance should focus on improving food accessibility and food utilization.

Keywords: food accessibility, food availability, food utilization, Indonesia

INTRODUCTION

Global efforts to reduce hunger and nutrition problems, as well as to increase food security, have started since 1948 (Pangaribowo *et al.* 2013; Capone *et al.* 2014; Hjelm *et al.* 2016). Food and nutrition security concept is used by Food and Agriculture Organization (FAO) and other international to integrate nutritional aspect in food security development (Committee on World Food Security (CFS) 2012; Aliaga & Chaves-Dos-Santos 2014; Fanzo 2014).

A number of food security indicators have been established at global level, FAO classified the food security indicators into four dimension, of food availability, food accessibility, food utilization and stability (FAO 2016; Headey & Ecker 2013). World Health Organization (WHO) also determined 17 indicators to assess the nutritional acheivement (WHO 2015). Another study by Pangaribowo *et al.* (2013) classified food and nutrition security indicators into different level, of individual, household, and regional levels. In Indonesia, at the national level the Food Security Council issued a strategic policy document of Food and Nutrition Action Plan (SP-FNAP) in 2016, which determined the matrix of food and nutrition achievement covering 28 indicators (Suryana *et al.* 2016).

Food and nutrition security is multidimensional (Suryana 2014), thus the indicators to assess food and nutrition security achievement should include a set of indicators (Pemberton *et al.* 2016). The study results from Leroy *et al.* (2015) indicated that composite indicators were better for measuring food security achievement. Several indicies have been developed globally, there are The Global Hunger Index by International Food Policy Research Institute (IFPRI 2014), Rice Bowl Index (RBI), and Human Development Index (HDI). Related to assessment of FNS level, various measures have also been developed at global level (Herforth & Ballard 2016), one of them was the Global Food Security Index (GFSI) which was developed by The Economist Intelligence Unit

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(EIU) (Pangaribowo *et al.* 2013). This measure is approriate to evaluate food security situation at country level, whereas for assessment at provincial level the GFSI needs to be adjusted due to the lack of data for some indicators.

The GFSI developed by EIU can only be used for country level. At national level, the food security indicators and measures have also been established by The World Food Programme (The Food Security and Vulnerability Atlas of Indonesia (FSC & WFP 2009 & 2015a); Faharuddin (2012); Nurhemi *et al.* (2014). However, these tools and measures need to be redeveloped to suit relevant data available at the provinsial level. Based on the pausity of multi dimensional assessment tools for provincial level data, this study aimed to develop a novel FNS index, integrating the many food and nutrition security dimensions for provincial level in Indonesia. The index can be used by local government to evaluate the performance of their food and nutrition security progress and development.

METHODS

Design, location and time

This was an explanatory study, using a cross sectional study design. The secondary data was collected between March to August in 2017. The research was conducted following several stages; identification of potential indicators, selection of indicators, assessment of index and clusteritation of provinces.

Sampling

This study used secondary data published in year 2010 and 2013. The sampling method was convenience sampling, involving data from 32 provinces which reflect the Food and Nutrition Security (FNS) dimension (food availability, food accessibility, and food utilization). The food utilization dimension data is available in the national basic health survey reported every three years (the latest are year 2010 and 2013), hence this study used data published in 2010 and 2013 for all the other FNS dimension.

Data collection

Food availability dimension data was collected from publication of National Food Balance Sheet from 32 Provinces published in 2010 and 2013, gathered from the Food Security Agency-Ministry of Agriculture of Indonesia. The data of food accessibility dimension was collected from The National Socioeconomic Survey by Statistics Indonesia year 2010 and 2013. Data on the rice prices were collected from publication of food prices in 2010 and 2013 gathered from the Ministry of Trade. Dimension of food utilization data was collected from publication and website of related institution. The food consumption level was taken from the Indonesian Food Directory published in 2015 by the Food Security Agency-Ministry of Agriculture. Access to clean water and sanitation were collected from Statistics Indonesia, and data on nutritional status was collected from the Basic Health Research published in 2010 and 2013. Data on food safety and foodborne diseases was collected from the National Agency of Drug and Food Control/NA-DFC yearly report published in 2010 and 2013.

Data analysis

Identification of potential indicators. Potential indicators were identified based on published literature (FAO, WHO, National Action Plan for Sustainable Development Goals, National Medium-Term Development Plan and SP-FNAP).

Selection of indicators. There are 78 indicators identified in the first step, the research team then conducted a group dicussion and consultation to screen the and narrow down the indicators to 51 potential indicators as long-list indicators of food and nutrition security dimension. Further, the research team conducted a qualitative selection process to narrow down the potential indicators using the following criteria: the relevance to food and nutrition security concept, redundancy elimination, data availability and representation of meanings this process resulted in 23 selected indicators. These indicators were grouped into three dimension of food security, according to FAO-STAT food security indicators classification (FAO 2016) (Figure 1).

According to FAO-STAT food security indicators classification (FAO 2016), 23 selected indicators then were grouped into three food security dimension: (a) five indicators for food availability dimension (X_1: percentage of irrigated land; X_2: energy availability level/EAL; X_3:protein availability level/PrAL; X_4:proportion

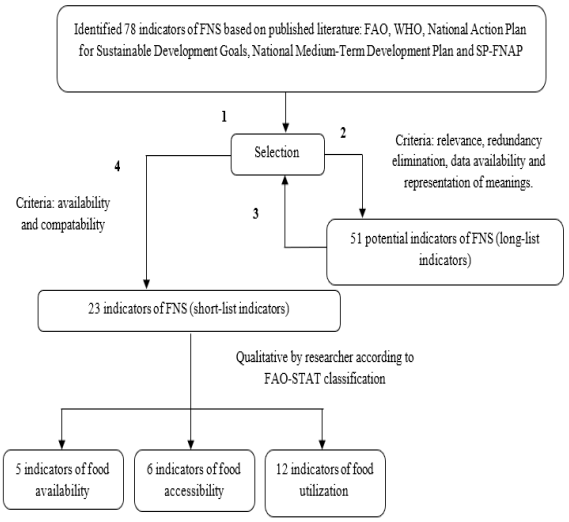

Figure 1. Stages of FNS indicators selection

of energy availability from cereals (non-wheat) and tubers, X_5: availability of animal source foods/ ASF); (b) six indicators of food accessibility dimension (X_6: percentage of paved road; X_7: GDRP/Gross Regional Domestic Product per capita; X_8: CPI/Consumer Price Index of the foodstuffs; X_9: proportion of people with energy intake >1800 kcal/day; X_{10}: percentage of people living above the poverty line; and X_{11}: stability of rice prices (1/% CV)); (c) 12 indicators of food utilization dimension (X_{12}: energy intake level; X_{13}: protein intake level; X_{14}: Desirable Dietary Pattern Score; X_{15}: percentage of households with access to clean water; X_{16}: percentage of households with adequate sanitation access; X_{17}: prevalence of non-wasted under-five children; X_{18}: prevalence of non-stunted under-five children; X_{19}: prevalence of non-underweight under-five children; X_{20}: prevalence of exclusively breastfed infants at the age of <6 months; X_{21}: percentage of non-underweight adults; X_{22}: percentage of healthy and safe food; and X_{23}: frequency of foodborne diseases).

Index calculation. The Principal Component Analysis (PCA) was used to calculate the food availability index (5 indicators), food accessibility index (6 indicators), food utilization index (12 indicators), and the provincial food and nutrition security index (23 combined indicators of all dimension). Index development using PCA had also been used by Ariawan (2006) to calculate socioeconomic index using Indonesia Demographic and Health Survey data in 2002-2003. Napoli *et al.* (2011) used PCA to calculate the food insecurity multidimensional index of 61 countries in the world using 1995–2009 time series data. PCA method is an algorithm with an orthogonal principle, which is used to transform the allegedly correlated variables resulting in a set of uncorrelated linear values (Karamizadeh *et al.* 2013; Jollife & Cadima 2016).

The calculation of food and nutrition security index was performed through the following steps: (1) a set of food and nutrition security variables was analyzed using PCA, resulting in αij eigenvector value (indicator coefficient/weight); (2) the values of origin variables were standardized to z-score with the formula $z_{ij} = \frac{x_{ij} - \bar{x}_{ij}}{s_j}$ in which z value was the standard variable, x_{ij} was the initial variable, $\bar{x}_{ij}$ was the mean of i^{th} variable j^{th} matrix, and s_j was the standard deviation of the j^{th} matrix; (3) calculation of food and nutrition security index total score of each province; i.e. multiplication result of standard variable (z-score) with its variable coefficient (α_{ij}). Normalizing the variable into z-score resulted in zero mean and standard deviation of 1, with negative to positive total score (index). The mathematical models used to calculate the Availability Index (AV), Accessibility Index (AC), Utilization Index (UT), and Food and Nutrition Security Index (FNSI) were written in equations 1–4.

$$AV=\alpha_{1j}X_1+\alpha_{2j}X_2+\ldots\ldots+\alpha_{5j}X_5\ldots\ldots\ldots\ldots(1)$$
$$Ac=\alpha_{6j}X_6+\alpha_{7j}X_7+\ldots\ldots+\alpha_{11j}X_{11}\ldots\ldots\ldots\ldots(2)$$
$$UT=\alpha_{12j}X_1+\alpha_{13j}X_2+\ldots\ldots+\alpha_{23j}X_{23}\ldots\ldots\ldots(3)$$
$$FNSI=\alpha_{1j}X_1+\alpha_{2j}X_2+\ldots\ldots+\alpha_{23j}X_{23}\ldots\ldots\ldots(4)$$

X_1–X_{23} is food and nutrition security variables and alpha ij (α_{ij}) is the coefficient of i^{th} variable j^{th} matrix (eigenvector value).

The first principal component always performed the determination of PCA, although it was subjective (Jollife & Cadima 2016). According to Jollife and Cadima, this study used the first principal component (PC1) with a maximum variance value, it could explain the original information. The food and nutrition achievement were classified based on each indicator cut off. The cut off was decided by desk study analysis referring to the standards or targets of FNS indicators.

Dimension of food availability cut off referring to Food and Nutrition Action Plan 2010–2014, FSVA gathered from Food Security Agency (FSA) 2009 & 2015a, The cut off of food

accessibility dimension referring to National Food and Nutrition Action Plan Document (Suryana *et al.* 2016), Statistics Indonesia report 2014 and FSA (2015a). Dimension of food utilization cut off referring to the standards or targets of Mid-term Development Planning 2010–2014 (MoNDP 2010), Strategic Planning of MoA 2010–2014 (MoA 2010), Strategic Planning of MoH 2010–2014, Nutrition Information Landscape System (WHO 2012), and Strategic Plan of NA-DFC (2010). Based on these standards or targets, each indicators of this study were categorized into: high (secure), middle (vulnerable), and low (insecure). The value of each categorized were classified based on researcher analysis. Then all of data of each categorized proccesed with PCA and resulted FNS criteria, as seen in Table 1. These criteria were then used to classified the provincial food and nutrition security achievement. Data processing and analysis were performed using Microsoft Excel version 2010 and SAS program version 9.4.

Table 1. Cut-off values and index categories

Index	Cut-off values		Categories
	2010	2013	
Food and nutrition security	2.13–4.63	2.68–8.18	Secure
	0.31–2.12	-1.45–2.67	Vulnerable
	<0.31	<-1.45	Insecure
Food availability	-2.48–3.72	-2.99–3.95	Secure
	-3.26–-2.49	-3.72–-3.00	Vulnerable
	<-3.26	<-3.72	Insecure
Food accessibility	3.12–6.86	2.23–4.09	Secure
	0.44–3.11	-0.25–2.22	Vulnerable
	<0.43	<-0.26	Insecure
Food utilization	-0.23–3.74	1.19–6.57	Secure
	-1.80–-0.24	-2.38–1.18	Vulnerable
	<-1.81	<-2.38	Insecure

Source: Ministry of National Development Planning (2010); Food Security Agency (2009 & 2015a); Statistic Indonesia (2014); National Agency of Drug and Food Control of Republic Indonesia (2010); Ministry of Agriculture (2010); World Health Organization (2012) analyzed using PCA

RESULTS AND DISCUSSION

Food and nutrition security index

The index was calculated for each pillar and for the food and nutrition security composite.

Food availability index (AV). Food availability index was calculated using the following mathematical models:

AV_{2010}=0.232 Irrigated Land + 0.564 EAL + 0.549 PrAL + 0.519 Cereals + 0.239 animal protein

AV_{2013} = 0.086 Irrigated Land + 0.573 EAL + 0.57 PrAL + 0.539 Cereals + 0.214 animal protein

The national food availability index was -0.002 in 2010 and decreased to -0.29 in 2013 (Table 2). National level assessment showed that food availability domain is secure. However, provincial level assessment showed diverse result with Gorontalo Province occupied the top position in food availability aspect in 2010 and 2013. The main drivers were the high energy and protein availability levels, high proportion of energy availability from cereals (non-wheat) and tubers, as well as the animal protein availability.

Food accessibility index (AC). The calculation of food accessibility index used the following mathematical models:

AC_{2010}=0.489 paved road + 0.221 capita GRDP -0.486 CPI + 0.256 food secure + 0.532 non poor -0.352 rice price

AC_{2013}=0.547 paved road -0.132 capita GRDP + 0.293 CPI + 0.627 food secure + 0.415 non poor -0.178 rice price

X_{12}–X_{23}=variables' values as stated in method

The national food accessibility index was slightly increased in 2013 (Table 2), from insecure category in 2010 to vulnerable category in 2013. This achievement was influenced by the alighting of the poor population in 2013. Based on the data of Statistics Indonesia (2016), the proportion of people living below the poverty line has decreased to 11.37 percent in March 2013 or around 28.07 million people. In terms of food accessibility index, the top province are Bali (index value of 3.67 in 2013) and Bangka Belitung (index value of 4.2 in 2010) (Table 2). The low proportion of the poor population in the two provinces indicated that the economic access to food was good. The increased of Bali GDRP/capita (IDR 28,129.7 in 2013) and the decreasing proportion of people living below the poverty line influenced the Bali province food accessibility achievement (Finkayana & Dewi 2016).

Food utilization index (UT). Food utilization index was calculated using the following mathematical models:

UT_{2010}=0.069X_{12}+ 0.138X_{13}+ 0.108X_{14}-0.214X_{15}+ 0.399X_{16}+ 0.293X_{17}+ 0.468X_{18}+ 0.497X_{19}+ 0.105 X_{20}-0.389X_{21}-0.206 α22jX_{22}-0.006X_{23}

UT_{2013}=0.155X_{12}+ 0.332X_{13}+ 0.236X_{14}+ 0.391X_{15} + 0.437X_{16}+ 0.214X_{17}+ 0.405X_{18}-0.019X_{20}-0.299 X_{21}-0.041 α22jX_{22}+ 0.099X_{23}

X_{12}–X_{23}=variables' values as stated in method

The national level food utilization index falls into the vulnerable category (0.73) in 2013. Bali Province (2013) and Riau Islands Province (2010) are the provinces with the highest food utilization performance. This due to their energy and protein intake levels (FSA 2015b), people's access to adequate sanitation and high prevalence of non-stunted under-five children in the two provinces (MoH 2013). The lowest performance of food utilization was found in East Nusa Tenggara Province (Tabel 2). Two-thirds of all households in Papua and East Nusa Tenggara had no adequate access to sanitation (proportion of >70%) (MoH 2013). A study by Tono *et al.* (2016) also found high ratio of households without adequate toilet facilities in most villages in the province which associated with the low nutrition status in the region.

Composite index (FNSI). Food and nutrition security index was calculated by the following mathematical models:

$FNSI_{2010}$=-0.065X_1-0.181X_2+ 0.063X_3-0.261X_4 + 0.193X_5+ 0.241X_6+ 0.253X_7-0.257X_8+ 0.079X_9 + 0.3X_{10} – 0.169X_{11}-0.056X_{12}+ 0.085X_{13}+ 0.023X_{14} -0. 188X_{15}+ 0.354X_{16} + 0.06X_{17} + 0.369X_{18}+ 0.374 X_{19}-0.185$_{20}$-0.184X_{21} – 0.143X_{22}-0.004X_{23}

$FNSI_{2013}$=0.082X_1-0.144X_2-0.053X_3-0.177X_4+ 0.0 42X_5 + 0.259X_6 + 0.189X_7+ 0.091X_8 + 0.217X_9 + 0.264X_{10}+ 0.016X_{11}+ 0.103X_{12}+ 0.276X_{13}+ 0.182 X_{14}+ 0.346X_{15} + 0.377X_{16} + 0.138X_{17} + 0.352X_{18}+ 0.354X_{19} + 0.016X_{20}-0.211X_{21} – 0.05X_{22} + 0.084X_{23}

X_1–X_{23}=variables' as stated in method

Based on the above calculation, the Food and nutrition security performance in Indonesia is categorized as vulnerable (FNSI 0.63) in 2013 (Table 2). Although the national food availability index performance is secure, the food accessibility index was categorized as vulnerable on both of the physical and economic access to food. Suryana *et al.* (2016) explained that food availability aspect (the income inequality problem, variability of food prices and poverty problem) are persitent obstacles for the national food and nutrition development.

The application of this novel index showed that four provinces (Bali, Jakarta, Yogyakarta and Riau Island) have the highest performance on food and nutrition index in 2013 (Table 2). The high FNS achievement in the provinces were influenced by the relatively good achievement on the dimension of food accessibility. This condition indicated that food accessibility aspect is a significant determinants for food and nutrition security achievements, after the food availability aspect was fulfilled. While at the same time in these provinces, the slightly good achievement of food accessibility dimension also contributes to their achievement in the food utilization dimension.

Profile of food and nutrition security at provincial level in Indonesia

At the national level, most of the regions in Indonesia (84.4%) were categorized as vulnerable and insecure in 2010 (Figure 2). The low score was associated with the low achievement in the food accessibility dimensions as reflected by the proportion of food-secure population, people living below the poverty line, and the increase in food prices that triggered the inflation rate, especially in Papua, Maluku and Nusa Tenggara.

Food and nutrition security achievement in 2013 was slightly better than in 2010, as can be seen in Figure 2 and 3 that the food and nutrition security index scores increased at the national level and in some provinces in 2013. The improvement from insecure to vulnerable categories was found in 16 provinces, and the secure category was found in four provinces. However, there were still 12 provinces that fell into insecure category (Figure 3).

The low achievement in food accessibility dimension hindered improvement in nutrition, thus affected the human resources development in the country. The Global Food Security Index (affordability, availability, quality and safety) report showed that Indonesia was ranked 71st (EIU 2016) and slightly increased to 69th (EIU 2017) the next year, this achievement still far below Thailand, Vietnam, and Srilanka (EIU 2017).

The performance of provincial food and nutrition security in 2013 slightly different with 2010, which were characterized by the high proportion of households with adequate sanitation access (PC1=0.378), high prevalence of non-underweight under-five children

Table 2. Food and nutrition security indices based on rankings by province

Rank	Province	2010				2013			
		FNSI	AV	AC	UT	FNSI	AV	AC	UT
1	Bali	2.6	-1.1	2.0	1.5	5.7	-1.6	3.7	4.3
2	Special Jakarta	3.7	0.7	1.6	2.0	4.4	0.8	0.6	3.5
3	Special Region of Yogyakarta	1.6	0.4	0.6	2.4	4.2	0.1	2.3	4.2
4	Riau Islands	4.4	-1.9	2.2	3.7	4.1	-1.8	0.01	4.0
5	East Kalimantan	1.6	-1.8	-0.6	1.3	2.4	-1.5	-1.8	1.9
6	Banten	2.4	-2.3	1.4	1.6	2.3	-2.5	1.5	1.5
7	Bangka Belitung	4.2	2.8	2.3	2.1	2.0	-1.1	1.1	1.1
8	North Sulawesi	1.9	0.5	-0.3	3.3	1.9	1.8	1.2	2.4
9	West Java	2.1	-1.0	1.5	1.6	1.1	-0.3	1.2	0.6
10	East Java	-0.3	1.6	1.0	-1.4	0.91	-1.2	0.5	0.3
11	Central Java	0.3	0.7	1.0	-0.3	0.74	0.1	0.5	0.7
12	Southeast Sulawesi	-2.0	-1.2	-1.2	-2.6	0.19	-1.4	0.1	0.03
13	Riau	0.6	-1.7	0.3	-0.8	0.02	-1.6	-0.8	-0.2
14	South Sulawesi	-1.1	1.9	-0.3	0.3	-0.10	1.6	-0.004	0.5
15	North Sumatera	-0.6	-0.3	0.6	-1.2	-0.32	-0.8	-0.5	-0.3
16	Jambi	0.5	-1.4	0.5	-0.2	-0.40	-1.4	-0.3	-0.6
17	South Kalimantan	0.1	1.7	1.3	0.3	-0.71	2.3	1.6	-0.6
18	West Sumatera	0.0	1.3	-0.2	1.4	-0.73	2.8	0.4	-0.4
19	West Nusa Tenggara	-2.4	0.3	-0.5	-2,3	-0.8	1.3	1.6	-1.0
20	Central Sulawesi	-1.9	0.7	-1.6	-0.8	-0.8	1.4	-0.9	-0.1
21	Central Kalimantan	-1.2	-0.9	-0.3	-1.4	-1.5	-0.2	0.1	-1.5
22	South Sumatera	-1.0	-0.8	0.3	-1.2	-1.6	2.6	-0.004	-1.3
23	North Maluku	0.2	-0.6	-0.2	-0.1	-1.6	-1.9	-1.0	-1.9
24	Lampung	0.01	-1.6	0.1	-0.4	-1.7	-1.5	0.003	-2.2
25	West Kalimantan	-1.4	-0.9	-0.5	-1.9	-1.8	-1.1	-0.1	-2.1
26	Aceh	0.2	-0.4	0.5	-0.4	-1.8	-0.9	-1.2	-1.5
27	Gorontalo	-2.2	3.7	-0.7	-0.3	-2.0	4.0	-1.2	-0.4
28	Maluku	-3.4	3.5	-2.9	-1.1	-2.1	2.8	-1.9	-0.8
29	West Papua	-2.3	-1.7	-3.2	-1.3	-2.1	-0.6	-2.1	-1.5
30	Bengkulu	-0.8	-0.6	-0.5	-0.9	-2.4	0.1	0.3	-2.7
31	Papua	-0.7	0.3	-1.6	0.7	-3.6	0.5	-3.7	-2.4
32	East Nusa Tenggara	-5.0	0.1	-2.6	-3.7	-4.6	-0.5	-1.3	-4.4
	Indonesia	0.007	-0.002	0.02	-0.06	0.64	-0.29	0.04	0.73

FNSI: Food and Nutrition Security Index; AV: Food Availability Index; AC: Food Accessibility Index; UT: Food Utilization Index

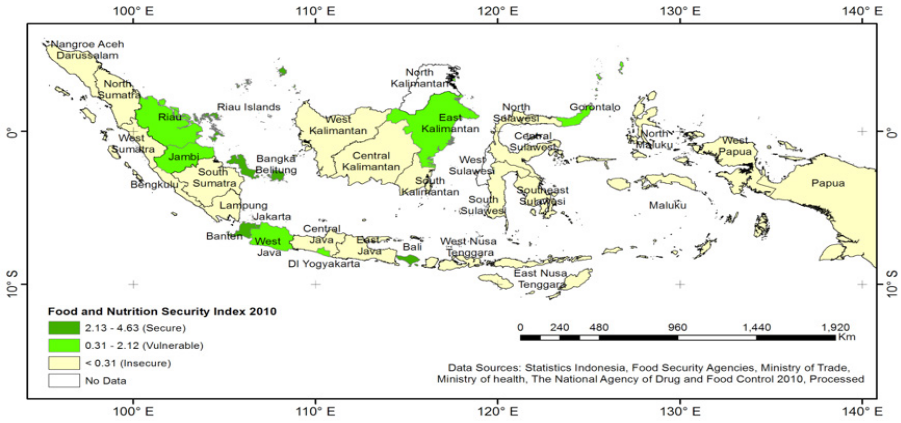

Figure 2. Distribution of regions in Indonesia based on food and nutrition security index in 2010

(PC1=0.354), high prevalence of non-stunted under-five children (PC1=0.353), and the high proportion of households with access to clean water (PC1=0.346). This study showed that the provincial FNS achievement assosiated with nutritional status, food utilization dimension, and food accessibility dimension. Nutritional status of children under five was the outcome indicator of food security development and the key indicator of poverty and hunger alleviation as the global development targets in the achievements of MDGs and SDGs (WHO 2015; Suryana *et al.* 2016; FAO 2016).

The general characteristic of regions that were catagorized as food and nutrition secure indicated by the high proportion of households with adequate sanitation access. Jakarta and Special Region of Yogyakarta had the highest proportion (>80%) among other 32 provinces in 2010, while Bali Province had the highest proportion of water and sanitation access in 2013.

East Nusa Tenggara Province ranked at the last position in FNS achievement in 2010 and 2013. It assosiated with the high food vulnerability at the village level in this province; i.e. 44.9 percent of villages belonged to severe food-vulnerable and food-vulnerable categories (FSA 2015a). This situation was also influenced by the low household access to electricity, clean water, sanitation facilities, and high levels of poverty (Tono *et al.* 2016). Moreover, based on basic health research (MoH 2010 & 2013), East Nusa Tenggara Provinces had the lowest proportion of non stunted under-five children (less than 50%). Pangaribowo *et al.* (2013) stated that a healthy environment indicated by better access to sanitation and hygiene and health service infrastructure is also important. All of these aspects affect on the nutritional status of under five children.

There are several government policy and program to improve nutritional status such as the

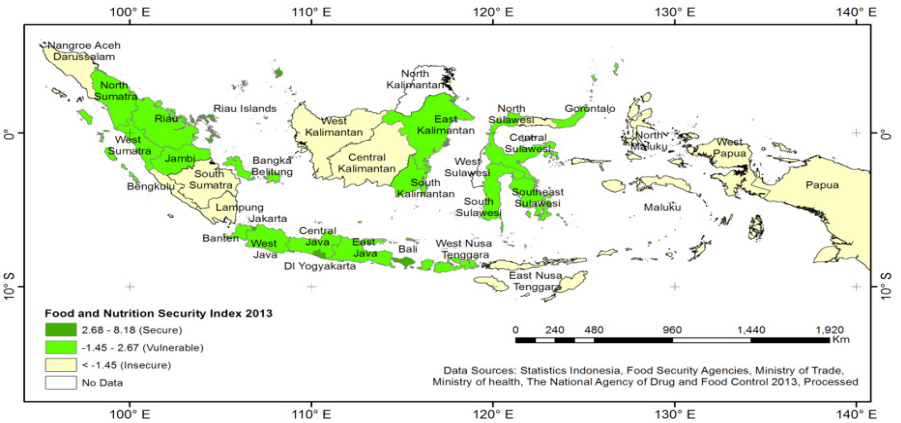

Figure 3. Distribution of regions in Indonesia based on food and nutrition security index in 2013

program of nutrition in the first 1000 days where the government also set priority areas for stunting prevention in 100 districts/cities. In addition, there are other nutrition sensitive program such as the National Action Plan For Food and Nutrition, the government's conditional cash transfer, *Program Keluarga Harapan* (PKH) (Indonesian Conditional Cash Transfer Programme), WASH programs and other programs from related sectors (MoNDP 2010; TNP2K 2019; World Bank Group 2018).

In the past, Indonesia became a role model country for reducing high levels of malnutrition. However, nowadays there are times of stagnant, set-back, loss of attention (World Bank Group 2018). Increase in income equality and purchasing power is one of a key strategy to improve food access.

Applanaidu *et al.* (2014) explained that macroeconomic stability, economic growth and distribution are key factors in achieving food and nutrition security. Analysis from Purwantini (2014) also emphasized the importance of synergistic unification in food security development in Indonesia in line with the handling of nutritional problems. Victora *et al.* (2008) suggested that children aged two years that had suffered from stunting is the predictor for low-quality of human resources, which in turn would have negatively affected the nation's potential. Thus, the efforts to accelerate nutrition improvement require not only a nutrition spesific program but also a nutrition-sensitive programs involving agricultural, social and education sectors, as well as food security (Ruel & Alderman 2013). Therefore, multisector collaboration and nutrition-sensitive programs are essential in the synergy of health, nutrition, food security and food safety developments to achieve sustainable development goals (Black *et al.* 2016).

CONCLUSION

PCA on 23 selected indicators of food and nutrition security showed that the food and nutrition security achievement was still far from the expectation, indicated from the low index score especially in the eastern part of Indonesia. The lowest food and nutrition security achievement was found in East Nusa Tenggara Province in 2010 and 2013, while the best achievement was found in Riau Islands (2010) and Bali (2013). Although the two provinces had the best achievements, the nutritional problems in children under five were still found. The food availability dimension is generaly good nationally, however the food accessibility and utilization are still become the barriers for the food and nutrition security development. Hence, the action plan and strategy in midterm and longterm development to improve FNS performance should focus on improving access and utilization. Nutrition-sensitive program is the largest key component to improve the food accessibility performance and to sustain the food availability dimension, while nutrition-spesific program is a basic curative program to attain better food utilization performance.

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AUTHOR DISCLOSURES

The author have no conflict of interest.

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