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Vitamin D supplementation decreased body weight and body mass index of Iranian type-2 diabetic patients: A randomised clinical trial study

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ABSTRACT

Introduction: Vitamin D as a common deficient micronutrient possibly plays an important role in body weight management. The aim of this study was to assess possible effects of vitamin D supplementation on anthropometric parameters of type-2 diabetic patients. **Methods:** Participants of this randomised controlled trial were 28 type-2 diabetic patients who received 4000 IU/day vitamin D and 30 patients who received placebo for two months. All patients were selected from the Iranian Diabetes Association (IDA), Tehran, Iran. Weight, height, body mass index, waist circumference, hip circumference and waist to hip ratio (WHR) were determined before and after the intervention. Dietary information was obtained using a 3-day food record. **Results:** Results showed a significant decrease in bodyweight (from 75.73±3.09 kg to 74.63±3.04 kg, $p = 0.002$), BMI (from 27.94±0.92 kg/m^2 to 27.544±0.90 kg/m^2, $p = 0.001$); waist circumference (from 92.56±2.33 cm to 91.05±2.27 cm, $p = 0.004$); and hip circumference (from 104.19±1.88 cm to 102.35±1.88 cm, $p = 0.029$) in the vitamin D group. Food record analysis showed that the percent of total calorie intake from dietary carbohydrates increased (from 50.40±1.38% to 53.14±1.53%, $p = 0.023$) and from fat, it decreased (from 38.43±1.30% to 35.22±1.49%, $p = 0.011$) significantly in the vitamin D group at the end of the intervention. **Conclusion:** Supplementation with vitamin D seems to include beneficial effects on bodyweight management in type-2 diabetic patients. However, the percentage of total calorie intake from each macronutrient should be considered.

Keywords: Vitamin D, type-2 diabetes, weight, BMI

INTRODUCTION

Studies have shown that overweight and obesity are the major causes of chronic disorders such as type-2 diabetes, cardiovascular diseases, cancers and other health treating diseases that could result in further morbidity and mortality (Guh *et al.*, 2009). Moreover, studies have demonstrated that serum level of vitamin D decreases in type-2 diabetic patients (Shankar, Sabanayagam & Khalidindi, 2015). Vitamin D plays an important role in glucose homeostasis via regulation of insulin secretion from β-cells (Zeitz *et al.*, 2003). Therefore, vitamin D deficiency is

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possibly associated with impaired insulin secretion and glucose control in diabetic patients. It has been reported that serum 25(OH)D3 concentration, the best indicator of body vitamin D status, has an inverse relationship with bodyweight and the risk of obesity decreases in people with a high concentration of serum 25(OH)D3 (Arunabh *et al.*, 2003).

The presence of vitamin D receptor (VDR) in adipose tissues may suggest that this vitamin possibly plays a role in the control of fat metabolism and is linked to bodyweight management (Sun & Zemel, 2008). A recent meta-analysis has shown that low 25(OH)D3 concentration is independently linked to abdominal obesity and hyper-glycemia (Pittas *et al.*, 2007). One study showed that low circulating levels of calcidiol could predispose individuals to fat accumulation (Grineva *et al.*, 2013), while in another clinical trial, supplementation with calcium and vitamin D did not significantly affect weight of obese women (Holecki *et al.*, 2008). Recently, Kimiagar *et al.* (2010) reported a high rate of vitamin D deficiency in several cities of Iran. However, the effect of vitamin D supplementation on bodyweight and BMI is still conflicting and not clearly explained. Due to the role of vitamin D in insulin function and its possible role in control of bodyweight and due to the widespread rate of vitamin D deficiency in Iran, the current study was carried out to assess the potential effects of vitamin D supplementation on bodyweight loss in type-2 diabetic patients.

METHODS

The participants of this double-blind placebo-controlled randomised clinical trial (RCT) study consisted of 65 type-2 diabetic patients aged 30 to 60 years selected from the Iranian Diabetes Association (IDA), Tehran, Iran. All participants completed an informed consent form. This study was approved by Tehran University of Medical Sciences Ethical Committee (ID: 17112) and registered in *www.clinicaltrial.org* (Reg. No. NCT01876563). Seven of these participants were excluded from the study because they did not consume all supplements; this study was therefore completed with 58 participants (36 women and 22 men). The exclusion criteria included consumption of any supplements having vitamin D within 3 months before the beginning of the study and occurrence of diabetes complications, thyroid disorders and use of insulin, thiazolidindiones or any drugs for treatment of obesity. The antidiabetic drugs used by the participants included metformin and/or glibenclamide. All participants agreed to continue their usual physical activities and not to change their diets during the intervention. Participants of this study were divided randomly into two groups of vitamin D and placebo using random permuted blocks. The vitamin D group received UL level of vitamin D (100 µg/4000 IU) daily and the placebo group received one tablet of the placebo drug daily for two months. Both placebo made from starch and vitamin D were obtained from Minoo Pharmaceutica, Cosmetic and Hygienic. Dietary information was collected in the beginning of intervention and after two months using a 3-day food record and was analysed using Nutritionist 4 Software for calculating the energy, macro-nutrient and micro-nutrient intakes. Blood samples were collected after 12–14 h overnight fasting at the beginning of the study and after two months of supplementation. Sera were separated from the whole blood and stored at -80°C for assessing biochemical parameters.

Height and weight of the participants were measured by a stadiometer (SECA, Germany) and SECA digital scale, respectively. Patients' height and weight

were recorded to the nearest centimetre and kilogram respectively and BMI calculated using "weight divided by the square of height" formula. Waist and hip circumferences were measured at the narrowest part of the torso and in a horizontal plane at the level of the maximal extension of the buttocks, respectively.

Statistical analysis was carried out using SPSS V.18 Software. Data were shown as mean ±SE (standard error). The normality of variables was checked using Kolmogrov-Smirrnof test. For non-normal variables, Wilcoxon test and Mann-Whitney test were used to analyse variables within and between the study groups. Independent sample *t*-test and paired *t*-test were used for the comparison of variables between the study groups before and after the supplementation and within the study groups, respectively. *p* values of ≤ 0.05 were considered statistically significant.

RESULTS

No statistical differences were seen between the two study groups in sex distribution, mean age, disease duration and time of sun exposure at the beginning of the intervention ($p = 0.154$, $p = 0.924$, $p = 0.877$ and $p = 0.580$, respectively). The anthropometric characteristics of the study groups at the beginning of the study and post-intervention are shown in Table 1. As shown in the table, all anthropometric parameters (except WHR) decreased significantly in the vitamin D group.

Table 1. Baseline and post-interventional anthropometric characteristics of study groups

Treatment group		*Vitamin D group (n = 28)*	*Placebo group group (n = 30)*	*p value**
Weight (kg)	Baseline	75.73±3.09	82.32±0.29	0.125
	Post-intervention	74.63±3.04	82.16±2.86	0.076
	Difference	-1.1±0.311	-0.15±2.90	0.035†
	p value**	0.002	0.598	
BMI (kg/m2)	Baseline	27.94±0.92	28.75±0.95	0.541
	Post-intervention	27.544±0.90	28.69±0.92	0.375
	Difference	-0.40±0.11	-0.06±0.10	0.032†
	p value**	0.001	0.557	
Waist circumference (cm)	Baseline	92.56±2.33	96.53±2.23	0.223
	Post-intervention	91.05±2.27	96.47±2.26	0.097
	Difference	-1.51±0.48	-0.05±0.50	0.037†
	p value**	0.004	0.914	
Hip circumference (cm)	Baseline	104.19 ±1.88	106.40 ±1.47	0.356
	Post-intervention	102.35 ±1.88	105.46 ±1.40	0.186
	Difference	-1.84 ±0.80w	-0.93 ±0.43	0.320†
	p value**	0.029	0.036	
WHR	Baseline	0.89±0.014	0.90±0.012	0.348
	Post-intervention	0.89±0.013	0.91±0.014	0.211
	Difference	0.001±0.005	0.008±0.006	0.440†
	p value**	0.841	0.208	

Data are expressed as mean ±SE; *Student *t*-test; **paired *t*-test; †adjusted for total calorie percent from dietary fat and carbohydrate.

Dietary intake and biochemical parameters of the study groups are shown in Table 2 and Table 3, respectively. No significant differences were observed between the two groups in energy, carbohydrate and protein intakes at the beginning and end of the intervention. Although we emphasised that all participants maintain their usual dietary habits during intervention, the mean intakes of dietary carbohydrates and fat and also the percent of total calorie from these nutrients were significantly increased and decreased, respectively in vitamin D group at the end of the intervention. There was no correlation between any anthropometric parameters and dietary intakes of energy, fat, carbohydrate and protein at the beginning of the study and after the 2-month intervention. No significant differences were seen in dietary vitamin D intake between the two groups at the beginning and end of the intervention (data not shown).

DISCUSSION

In general, the results of the current study have revealed that vitamin D supplementation can decrease bodyweight and BMI in diabetic patients. Consistent with our results, Nikooyeh *et al.* (2011) have shown that vitamin D supplementation alone or in combination with calcium could result in a significant decrease in weight, BMI and WC of type-2 diabetic patients. In another study, Rosenblum *et al.* (2012) has shown that vitamin D supplementation can decrease visceral adipose tissues significantly in obese people. In contrast, Mason *et al.* (2014) reported no beneficial effects of vitamin D supplementation on weight reduction in overweight or obese patients. Another study showed that supplementation with 7000 IU/day vitamin D for 26 weeks did not change significantly body fat, percutaneous fat and visceral fat in obese adults (Wamberg *et al.*, 2013). Obesity can decrease bioavailability of vitamin D by trapping it in adipose tissues. In fact, accumulation of vitamin D in adipose tissues can decrease access of the human body to the vitamin for converting it to 25(OH) D3 and the subsequent formation of calcitriol (Heaney *et al.*, 2009).

A possible mechanism for the effects of vitamin D on lowering bodyweight is the suppressing effect of vitamin D on PTH hormone which can promote fat accumulation in adipose tissues by increasing the intracellular level of calcium (Zemel *et al.*, 2000).

Studies have shown that the hormonal form of vitamin D can suppress adipocyte differentiation in pre-adipocytes which can increase the adipogenesis in the absence of VDR (Blumberg *et al.*, 2006) and induce apoptosis in mature 3T3-L1 adipocytes through ca2+-dependent apoptotic proteases, caspase 12 and calpain (Sergeev, 2012).

The VDR can mediate the actions of hormonal form of vitamin D in some body organs including adipose tissue, independent from its classical role in calcium homeostasis (Nagpal Na & Rathnachalam, 2005). Previously, it was revealed that un-coupling proteins such as UCP-1 and UCP-3 were up-regulated in brown adipose tissue of VDR (–/–) mice regardless of their dietary condition (Enerback et al., 1997) and an increase in the gene expression of UCP-1 in white adipose tissue could reduce fat stores in transgenic mice (Kopecky *et al.*, 1995). Experimental studies have shown that energy expenditure, fatty-acid β-oxidation and uncoupling protein (UCP) levels are higher in VDR-deficient mice, in comparison with wild-type counterparts (Narvaez *et al.*, 2009). However, a cross-sectional study has revealed that the rate of REE/ kg of bodyweight is significantly lower

Table 2. Baseline and post-interventional dietary intakes in the study groups

Treatment group		*Vitamin D group (n = 28)*	*Placebo group (n = 30)*	*p value**
Energy	Baseline	2234±69.6	2129±71.9	0.296
	Post-intervention	2225±64.3	2196±68	0.242
	Difference	-10.53±46.21	66.71±54.00	0.535
	p value**	0.637	0.228	
CHO (g/day)	Baseline	270.76±13.42	284.1±13.40	0.488
	Post-intervention	293.33±11.89	276.2±11.0	0.296
	Difference	22.57±10.42	-7.82±8.87	0.032
	p value**	0.039	0.385	
Pro (g/day)	Baseline	72.40±3.85	68.77±3.09	0.469
	Post-intervention	72.44±3.67	68.80±2.65	0.432
	Difference	0.04±3.86	0.04±2.83	0.99
	p value**	0.991	0.990	
Fat (g/day)	Baseline	94.36±4.94	98.41±3.92	0.373
	Post-intervention	83.42±4.66	100.63±3.57	0.011
	Difference	10.94±4.11	2.21±4.13	0.140
	p value**	0.013	0.60	
CHO (%)	Baseline	50.40±1.38	48.21±1.44	0.322
	Post-intervention	53.14±1.53	49.96±1.13	0.104
	Difference	2.74±1.1	1.75±1.49	0.421
	p value**	0.023	0.250	
Pro (%)	Baseline	13.12±0.59	12.91±0.54	0.793
	Post-intervention	12.67±0.49	12.35±0.50	0.654
	Difference	-0.44±0.48	-0.55±0.53	0.882
	p value**	0.362	0.304	
Fat (%)	Baseline	38.43±1.30	39.95±1.35	0.703
	Post-intervention	35.22±1.49	39.15±1.35	0.022
	Difference	-3.21±1.17	-0.8±1.40	0.103
	p value**	0.011	0.571	

Data are expressed as mean ±SE; *Student *t*-test; **paired *t*-test.

in women with vitamin D deficiency, compared to that in women having sufficient levels of vitamin D (Hossein-Nezhad *et al.*, 2013).

In obesity, the volume of adipocytes increases and the cells can secrete significant levels of pro-inflammatory cytokines such as TNF-α and IL-6 as well as IL-1β, which can result in insulin resistance in several organs including liver and skeletal muscles though inhibition of insulin receptor signaling (Hotamisligil, 2006). Effects of nutrients on serum insulin as well as insulin resistance have been shown in previous studies (Rad *et al.*, 2014; Saboori *et al.*, 2016). Vitamin D can regulate glucose-mediated insulin secretion from β-cells and enhance uptake of glucose by skeletal muscles and adipose tissues through glucose transporters and hence is able to improve glycemic control in

Table 3. Fasting biochemical characteristics of study groups at baseline and post-intervention

Treatment group		*Vitamin D group (n = 28)*	*Placebo group (n = 30)*	*p value**
FBS (mg/dl)	Baseline	147.07±10.11	151.23±7.48	0.740
	Post-intervention	147.74±10.16	161.27±7.69	0.288
	Difference	2.70±9.66	10.03±4.61	0.483
	p value**	0.782	0.038	
TG (mg/dl)	Baseline	158.25±12.41	167.43±16.10	0.656
	Post-intervention	145.33±10.28	178.20±14.80	0.080
	Difference	-13.07±13.15	10.76±14.45	0.231
	p value**	0.329	0.462	
TC (mg/dl)	Baseline	201.82±7.91	184.53±6.73	0.100
	Post-intervention	189±7.04	200.87±8.70	0.301
	Difference	-12.88±7.25	16.33±6.93	0.005
	p value**	0.087	0.025	
HDL-C (mg/dl)	Baseline	42.29±1.84	41.17±2.15	0.697
	Post-intervention	49.63±3.28	49±3.03	0.888
	Difference	6.81±3.25	7.83±3.39	0.830
	p value**	0.046	0.028	
LDL-C (mg/dl)	Baseline	88.93±7.23	97.37±7.64	0.427
	Post-intervention	88.37±6.94	98.67±7.22	0.311
	Difference	0.89±7.19	1.30±8.65	0.971
	p value**	0.903	0.882	
HbA1c (%)	Baseline	7.29±0.22	7.84±0.28	0.132
	Post-intervention	6.76±0.18	7.73±0.23	0.002
	Difference	-0.53±0.08	-0.11±0.08	0.001
	p value**	<0.001	0.176	
Insulin (μIU/mL)	Baseline	8.24±0.97	7.49±0.58	0.505
	Post-intervention	6.55±0.28	7.96±0.94	0.171
	Difference	-1.68±0.81	0.47±0.51	0.027
	p value**	0.048	0.367	
MOMA-IR	Baseline	2.50±0.19	2.55±0.16	0.841
	Post-intervention	2.38±0.18	2.78±0.19	0.134
	Difference	-0.14±0.14	0.22±0.13	0.056
	p value**	0.307	0.092	
Calcidiol (ng/ml)	Baseline	15.55±1.91	14.64±2.22	0.759
	Post-intervention	27.50±2.04	15.95±2.20	<0.001
	Difference	11.95±1.44	1.92±0.89	<0.001
	p value**	<0.001	0.040	

Data are expressed as mean ±SE; *Student *t*-test; **paired *t*-test.

obese people (Teegarden & Donkin, 2009).

Results of the present study demonstrate that although the level of energy intake did not change significantly between the study groups, the vitamin D group experienced significant decreases in bodyweight, BMI and WC at the end of the intervention. A possible explanation is that the intake of macronutrients has changed significantly in this group during the study. Although all participants of this study were requested not to change their usual diet during the intervention, the intake of carbohydrates and fat and the percent of total calorie resulting from these two nutrients changed significantly in participants receiving vitamin D at the end of the study. High carbohydrate diets may improve body energy regulation through altering gut microbial composition (Fava *et al.*, 2013). Some studies have revealed that dietary changes for the reduction of diet fat content from 40 to 25–30% of the total calorie can result in 2–4 kg weight loss in people (Bray & Popkin, 1998). Although cross-sectional studies have shown a close relationship between the dietary intakes of carbohydrates and fat and the body fat status (Astrup *et al.*, 1997), longitudinal studies are not able to show the relationship between the reported macronutrient intakes and subsequent weight changes (Kant *et al.*, 1995). It should be noted that the extent of decrease in anthropometric parameters was not clinically significant in the current study. The best explanation probably is that obesity is a consequence of an imbalance between energy intake and its expenditure and as mentioned earlier, the amount of energy intake did not change significantly in our study groups.

One limitation of this study was the short duration of vitamin D supplementation; if the patients had consumed supplements for a longer time, the extent of reduction in anthropometric characteristics could have been clinically significant. Another limitation of this study was the changes in macronutrient distribution in dietary intake of participants, although the energy intake did not change significantly during the intervention.

CONCLUSION

Results from the current study have shown that vitamin D supplementation can significantly decrease anthropometric characteristics of type-2 diabetic patients, although their physical activity level and average energy intake did not change significantly during intervention.

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Authors' contributions

Mahmoud D designed the study; Esmaeil YR and Somayeh S performed the study in the field under the supervision of Mahmoud D; Ebrahim F performed data analysis and interpretation; Esmaeil YR and Somayeh S drafted the manuscript; Ebrahim F and Mahmoud D revised the article for important intellectual content.

Conflict of interest

The authors declare that there is no conflict of interest.

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Short birth length, low birth weight and maternal short stature are dominant risks of stunting among children aged 0-23 months: Evidence from Bogor longitudinal study on child growth and development, Indonesia

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ABSTRACT

Introduction: Stunting remains a predominant global health problem and Indonesia is no exception. This analysis aims to determine the major factors of stunting among children aged 0-23 months, using data from the Bogor Longitudinal Study on Child Growth and Development (BLSCGD). **Methods**: The BLSCGD was conducted by the Center for Public Health Research and Development, Ministry of Health, Indonesia. This analysis used part of the BLSCGD data. A total of 320 children aged above 23 months were included. Anthropometric measurements were performed by trained enumerators each month from the first month of birth until 23 months of age. The analyses of survival resilience was conducted using survival statistics test using life table and Kaplan Meier, whereby the case for this survival analysis was the occurrence of stunting. Factors affecting stunting (including children and maternal characteristics) were tested using cox proportional hazards regression. **Results**: Determinants of stunting were birth weight with hazards regressions (HR) score=1.847; 95% CI: 1.282-2.662), birth length (HR=1.567; 1.034-2.375), and maternal height (HR=1.436; 1.014–2.030). The probability of children not being stunted decreased with increase in age. **Conclusion**: Birth weight and length at birth, and maternal short stature were the dominant risks factors of stunting among the study children aged 0-23 months.

Keywords: stunting, survival resilience, children under two years of age, Indonesia

INTRODUCTION

It was estimated that 23% of children below five years of age were stunting globally in 2015 (WHO, 2016). The highest prevalence of stunting in children was in Africa (38%) followed by Southeast Asia (33%). Stunting in children remains one of the major nutritional problems in Indonesia. It was reported that 20.2% of under-give stunted children in Indonesia were born with short birth length of less than 48 cm (Trihono *et al.*, 2015). This condition remains up to two years old (23 months), leading to the national stunting prevalence of 32.9%, or more than two million children, in 2013.

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Studies have shown that stunting in childhood is associated with high body mass index (BMI) in adulthood, associated with low academic achievement in adolescence, as well as facing a higher risk for non-communicable diseases in adulthood (Andersen *et al.*, 2016). A review suggests that height by age at two years is a good predictor of the quality of human resource, chronic diseases tend to occur more in children who had malnutrition and sharp weight gain after their infancy (Victora *et al.*, 2008). Several studies also mentioned that stunting in children continues into the next generation (intergeneration effect). Children from stunted parents have a lower rate of development compared to children with non-stunted parents (Walker *et al.*, 2015). Stunting is caused by multiple factors including prenatal environment (Schmidt *et al.*, 2002).

MATERIALS AND METHODS

The Bogor Longitudinal Study on Child Growth and Development (BLSCGD) was conducted in Bogor Tengah sub-district, Bogor city, Indonesia. The overall objective of this study was to identify the determinants of growth and development of children from birth until aged 18 years. Data collection began in 2012 and is on-going, as the BLSCGD aims to cover a sample of 2170 pregnant women by 2030.

The BLSCGD recruited all pregnant women aged 18-35 years based on information provided by the community health volunteers' (*kader)* for each area. The *kaders* are part of the community health center system in Indonesia (National Research Council of the National Academies and AIPI, 2013). An inclusion criteria is willing to take part in the study until the child is 18 years of age. Written consent was obtained before they took part in the study. Subjects were interviewed using a questionnaire for household characteristics, age, education and occupation. Anthropometric measurements (weight, height and upper arm circumference) were taken. Clinical examination by a medical doctor was undertaken each month of pregnancy.

For our study, we considered all 650 deliveries out of 798 pregnant women, recorded from 2012 till 2016. We also included all children aged above 23 months (n=320), based on the objective of this analysis to observe the survival resilience among non-stunting children and its determinants. Anthropometric measurements of the children were obtained from the records of midwives or health workers who assisted in childbirth. Birth weight and length were measured within 24 hours of birth. Birth weight was categorized as 'low' if <3,000 g (Barker, 1995) while the birth length was categorised as 'short' if <48 cm (NIHRD, 2013).

Maternal height was categorised as 'at risk' if it was less than 150 cm (NIHRD, 2013). Mother's education achievement level was categorised as 'low education' (never attended school or graduated from elementary school), 'secondary education' (graduated from junior and senior high school), and 'higher education' (graduated from diploma or college). Maternal pre-pregnancy body mass index (BMI) was calculated from maternal pre-pregnancy weight and height, and categorised into 'obese' (BMI ≥27 kg/m^2), 'overweight' (25 kg/m^2≤ BMI <27 kg/m^2), 'normal' (18.5 kg/m^2< BMI <25 kg/m^2) and 'underweight' (BMI ≤18 kg/m^2) (NIHRD, 2013).

Each month, there is an interview with the mothers regarding the child's anthropometric, food consumption, immunisation status, health seeking behaviour, child growth monitoring, and exclusive breastfeeding practice. The anthropometric measurements are done every month until the child

was 23 months of age (i.e. for a total of 23 measurements). Every month on the same date, the respondent comes to the basecamp for measurement. If the sample is unable to attend on that date then there is an allowance to go three days before or three days after the specified date. The body length was measured using length-board with 0.1 cm accuracy. Each child is measured lying down. The children were categorised as 'stunted' if they had *z*-score less than -2 SD based on length for age index (WHO, 2007).

Dietary diversity was assessed based on 24-hour recall method in between the ages of 12–23 months. It was assessed based on food consumption on seven food groups, namely cereals/tubers, beans, milk and processed products, meat/fish/processed, eggs, vegetables and fruit-sources of vitamin A and other vegetables and fruits. Children were categorised as consuming 'diverse foods' if he/she consumed more than or equal to four food groups (WHO, 2008).

The immunisation status of children was based on the compulsory immunisation of children up to the age of one year. The children were considered to be fully immunised if he/she obtain all mandatory immunisations aged 0-1 years established by the government. Health-seeking behaviour was assessed based on the practice of mothers who seek health services when the child was sick, in the period of 0-5 months. The variable of child growth monitoring was based on the regularity of the mother weighing the child each month. Samples were considered to have 'regular growth monitoring' if from the age of 0-23 months the sample is weighed monthly in the integrated health post.

Exclusive breastfeeding practices were asked through questions related to child's breastfeeding patterns, such as consumption of pre-lacteal foods, current breastfeeding and consumption of complementary foods. Assessment of exclusive breastfeeding is derived from 24-hour recall data. Children are categorised as 'exclusively breastfed' if he/she exclusively fed by breast milk from 0-5 months old (WHO, 2008). Child morbidity was assessed according to the frequency of illness experienced by the children during six months period (0-5 months, 6-11 months, 12-17 months and 18-23 months).

Data on length status according to the age (HAZ) of children was processed by using WHO-Antro software. Child survival resilience toward not stunting was analysed by using survival statistic test using life table and Kaplan Meier. In this analysis, 'case' was the occurrence of stunting. The time variable in this analysis was the time (in months) when the children became stunted. Factors affecting stunting were tested using Cox Proportional Hazards Regression. We did multicollinearity assessment between the independent variables before running the regression analysis.

All respondents received an explanation before becoming a research respondent. The study has received ethical approval from the Research Ethics Committee of the Health Research and Development Agency of the Ministry of Health. There is no conflict of interest in the creation of this article.

RESULTS

Based on analysis of sample characteristics (Table 1), the proportion of male infants was 49.7% that was not much different with the proportion of female infants at 50.3%. The percentage of infants with low birth weight (<3,000 g) was 28.4%, while 17.2% infants had short birth length (<48 cm). As much as 17.4% infants were exclusively breastfed, 80.1% were completely immunised, 72.5% were also routinely weighed in growth monitoring programmes at

Table 1. Characteristics of children (0-23 months) (*n*=320)

Factors	*n (%)*
Sex	
Boys	159 (49.7)
Girls	161 (50.3)
Birth weight	
Normal (≥3000 gram)	229 (71.6)
Low (<3000 gram)	91 (28.4)
Birth length	
Normal (≥48 cm)	265 (82.8)
Short (<48 cm)	55 (17.2)
Exclusive breastfeeding practice	
Yes	55 (17.4)
No	261 (81.6)
Complete immunisation	
Yes	249 (80.1)
No	62 (19.9)
Regular growth monitoring	
Yes	229 (72.5)
No	87 (27.5)
Seeking for health services	
Yes	224 (71.6)
No	89 (28.4)
Dietary diversity	
Diverse	183 (57.2)
Non Diverse	137 (42.8)
Experience of illness in 0-5 month	
Never	38 (12.9)
1-3 times	232 (78.9)
>3 times	24 (8.2)
Experience of illness in 6-11 month	
Never	15 (4.9)
1-3 times	170 (55)
>3 times	124 (40.1)
Experience of illness in 12-17 month	
Never	18 (5.8)
1-3 times	166 (53)
>3 times	129 (41.2)
Experience of illness in 18-23 month	
Never	21 (6.7)
1-3 times	205 (65.7)
>3 times	86 (27.6)
Maternal age	
21-35 years	220 (68.8)
Less than 21 years and more than 35 years	100 (31.3)
Maternal height	
Normal (≥150 cm)	211 (65.9)
Short (<150 cm)	109 (34.1)
Maternal pre pregnancy body mass index (BMI)	
Obese	60 (18.9)
Overweight	46(14.5)
Normal	176 (55.3)
Underweight	36 (11.3)
Maternal education	
High	14 (4.4)
Middle	254 (79.4)
Low	52 (16.3)
Maternal occupation	
Housewife	272 (85.0)
Work	48 (15.0)

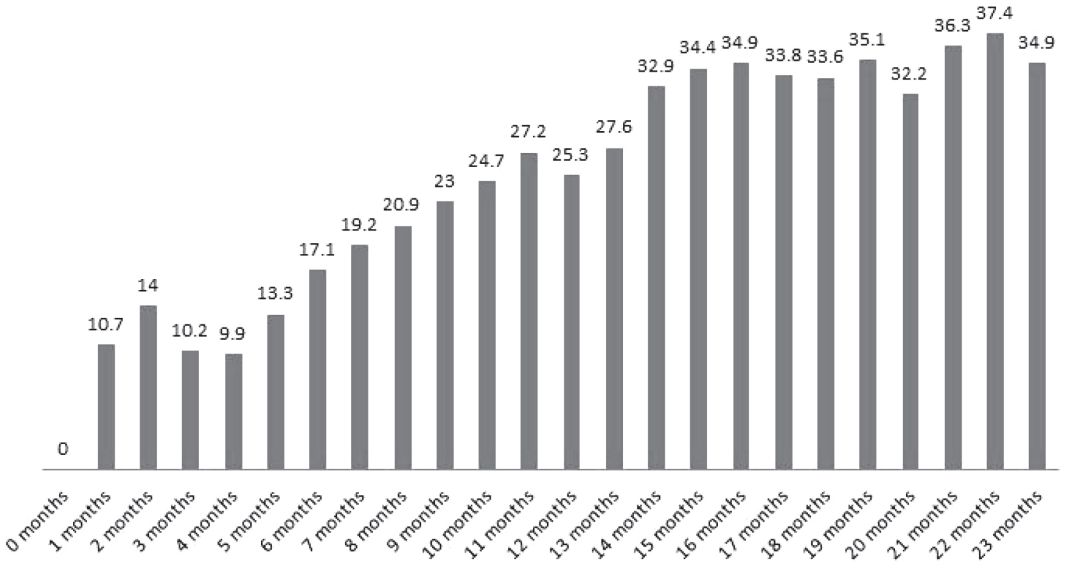

Figure 1. Prevalence of stunting from 0-23 months

Integrated Health Care, and 71.6% respondents sought for healthcare services in the period of 0-5 months of age. There were no differences on child dietary diversity consumption. Results showed that children experienced illness mostly at the age of 0-23 months. Table 1 also showed that approximately 30% of mothers were at the risky age (<21 years and >35 years). Almost one third of the mothers were short (the height less than 150 cm) and more than 10% of mothers were underweight.

Figure 1 shows the prevalence of stunting in children aged 0-23 months. The prevalence of stunting at 0 month was 0%, since only children who were not stunted, or having normal status at birth were included. In the first month of age, the stunting prevalence became 10.7%. This result suggests that the failure of linear growth has begun in the first month of life. The data shows that the prevalence of stunting increases, as the children get older. At the age of 23 months, the approximate ratio is 3:10 for stunted children.

Determinant factors of stunting in children aged 0-23 months

The Cox Proportional Hazards Regression analysis showed that the determinant factors of stunting in children aged 0-23 months old were birth weight with HR (Hazards Regression) score=1.847(1.282-2.662), birth length with HR value=1.567(1.034-2.375), and maternal height with HR value=1.436(1.014–2.030) (Table 2). These results mean that infants with birth weight less than 3,000 g had 1.8 times higher risk to be stunted compared to those with greater than or equal to 3,000 g birth weight. Figure 2 shows that the median survival age to survive toward not stunting in infants with birth weight less than 3,000 g was nine months, and it was lower than those with birth weight greater than or equal to 3,000 g which had median survival age to survive toward not stunting at 18 months. Thus, the infants with normal birth weight can survive from not being stunted twice than those with have low birth weight.

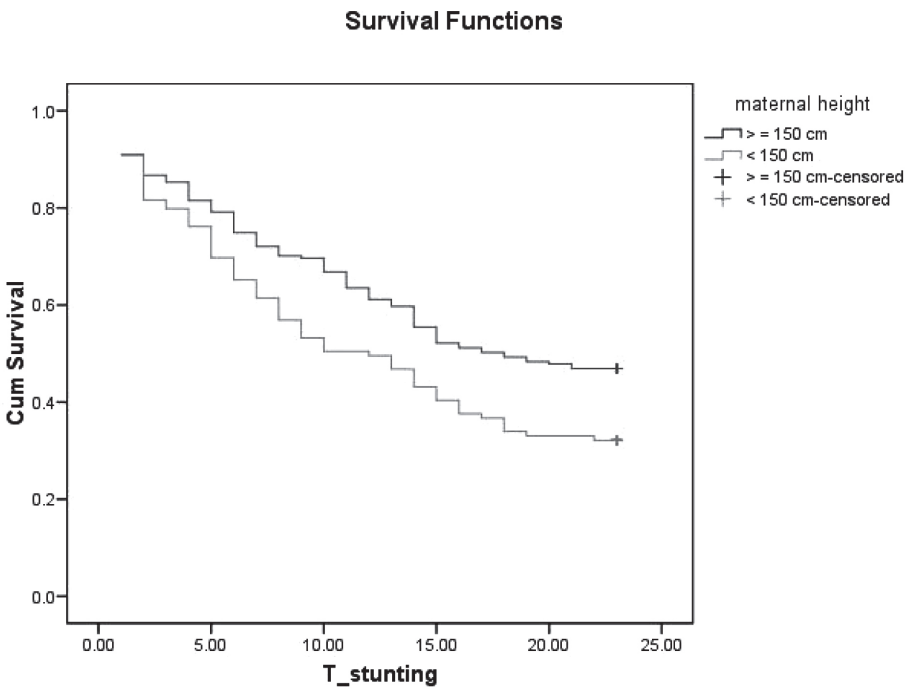

Figure 2. Survival rate in normal nutritional status of children 0-23 month based on birth weight (n=320)

The results also found that infants with short birth length had 1.6 times higher risk to be stunted compared to infants with normal birth length. The survival analysis also indicated that infants with normal birth length could survive toward not stunting for 17 months, which was longer than those with short birth length that could survive toward not stunting for six months.

Table 2 also shows that infants having mothers whose height was less than 150 cm had 1.4 times higher risk to be stunted compared to infants having mothers with the height of at least 150 cm. In addition, the median survival age to survive toward not stunting among infants having mother with the height of less than 150 cm was 12 months, while infants having mother with the height of at least 150 cm can survive from not being stunted for 18 months.

This study also shows that children aged 0-23 months with the birth weight of at least 3,000 g had higher survival rate toward not stunting for each month compared to children with the birth weight of less than 3,000 g (Figure 2). Meanwhile, infants born with normal birth length had a higher survival rate than infants with short birth length toward not stunting (Figure 3). The survival rate toward not stunting among infants with short birth length decreased dramatically in early life. This decreasing rate continues until the age of 23 months and always below the normal birth length children.

In addition, the survival rate of the children having mother with ≥150 cm of height (normal) was higher than children having mother with the height of less than 150 cm (Figure 4). This was consistent from the beginning of observation (0-2 months) to the end of observation (21-23 months).

Table 2. The final model of determinant factors of stunting results in children 0-23 months (*n*=320)

Covariate	*Median survival (month)*	*Analysis multivariate*		
		Hazard ratio	*95% CI*	*p-value*
Sex				
Boys	14	1.418	(0.809 – 2.484)	0.222
Girls	16			
Birth weight				
Low (<3000 g)	9	1.847	(1.282 – 2.662)	0.001*
Normal (≥3000 g)	18			
Birth length				
Short (<48 cm)	6	1.567	(1.034 – 2.375)	0.034*
Normal (≥48 cm)	17			
Exclusive breastfeeding practice (0-6 month)				
No	15	1.451	(0.917 – 2.297)	0.112
Yes	18			
Complete immunisation				
No	21	0.707	(0.461 – 1.084)	0.112
Yes	14			
Regular growth monitoring				
No	14	1.240	(0.656 – 2.346)	0.508
Yes	15			
Seeking for health services				
No	15	1.036	(0. 551 – 1.948)	0.912
Yes	14			
Dietary diversity				
Non Diverse	15	0.911	(0.512 – 1.620)	0.750
Diverse	15			
Experience illness in 0-5 month				
>3 times	13	0.748	(0.225 – 2.488)	0.636
1-3 times	15	0.994	(0.450 – 2.195)	0.988
Never	12			
Experience illness in 6-11 month				
>3 times	14	1.547	(0.279 – 8.502)	0.617
1-3 times	15	0.928	(0.173 – 4.990)	0.931
Never	16			
Experience illness in 12-17 month				
>3 times	15	0.786	(0.184 – 3.36)	0.746
1-3 times	15	0.971	(0.238 – 3.964)	0.967
Never	12			
Experience illness in 18-23 month				
>3 times	14	0.681	(0.222 – 2.089)	0.502
1-3 times	15	0.626	(0.213 – 1.843)	0.395
Never	11			
Maternal age				
Less than 21 years and more than 35 years	15	0.684	(0.378 – 1.240)	0.211
21-35 years	15			
Maternal height				
Short (<150 cm)	12	1.436	(1.014 – 2.030)	0.041*
Normal (≥150 cm)	18			
Maternal pre-pregnancy BMI				
Underweight	15	0.334	(0.099 – 1.126)	0.077
Normal	14	1.006	(0.470 – 2.153)	0.989
Overweight	14	1.318	(0.523 – 3.323)	0.558
Obese	21			
Maternal education				
Low	11	0.926	(0.271 – 3.166)	0.902
Middle	16	0.421	(0.137 – 1.298)	0.132
High	6			
Maternal occupation				
Work	16	1.016	(0.490 – 2.105)	0.996
Housewife	15			

*significant *p<0.05*

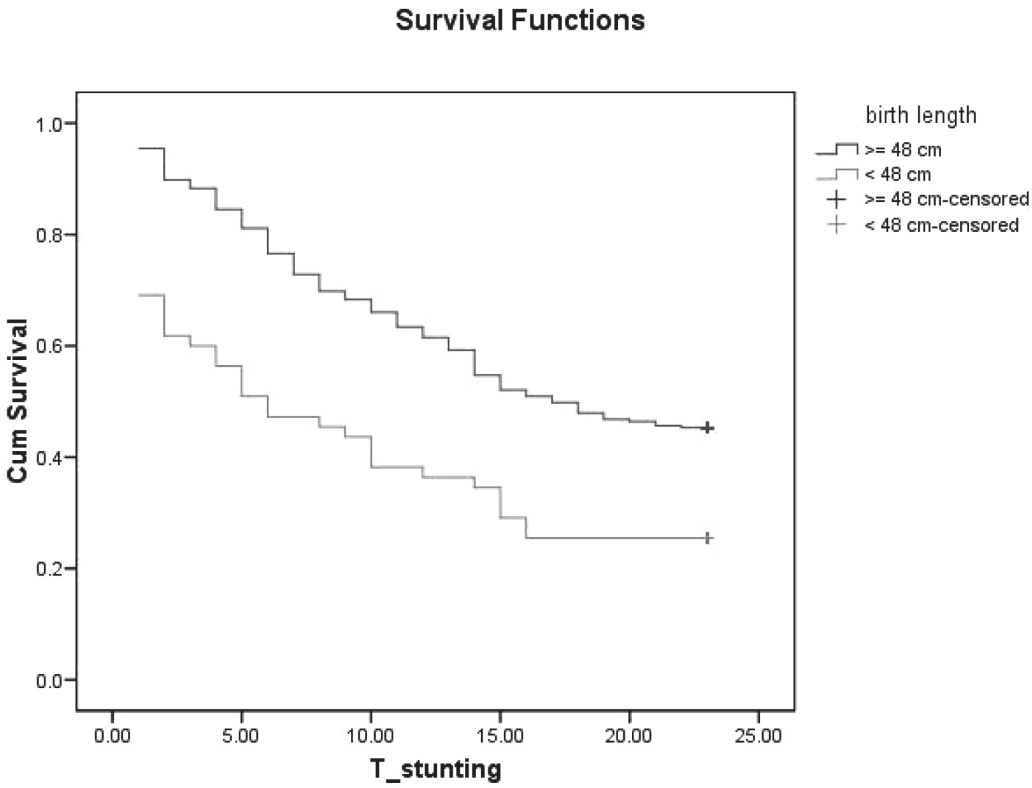

Figure 3. Survival rate in normal nutritional status of children 0-23 month based on birth length (n=320)

DISCUSSION

This study examined the factors affecting stunting among children aged 0-23 months. The main findings were birth weight, birth length and maternal height as dominant risk factors of stunting among children in this age group. This result confirmed previous studies in several Asian countries. This study result is in line with prior longitudinal study in West Java, Indonesia that found the birth weight and length as most important determinants of infant nutritional status (Schmidt *et al.,* 2002). Another analysis on national data conducted in Indonesia also showed that low birth weight was the most dominant predictor for stunting among children aged 12-23 months (Aryastami *et al.,* 2017).

Another study in the Philippines reported that newborn weight and length were the risk factors associated with stunting (Ricci, 2006). Furthermore, a study in Pakistan also suggested that low birth weight was consistently as a dominant factor of growth failure in the first three years of life (Avan *et al.*, 2015). In line with this analysis result, a nation-wide study in India found that growth faltering has occurred even since the child was born which result on the incidence of stunting at the age under five years (Mamidi *et al.,* 2010).

Birth weight is one of predisposing factors to growth attainment after birth. Infants with low birth weight (<2,500 g) are likely to have intrauterine growth restriction even if the infants born at term (Black *et al.,* 2008).

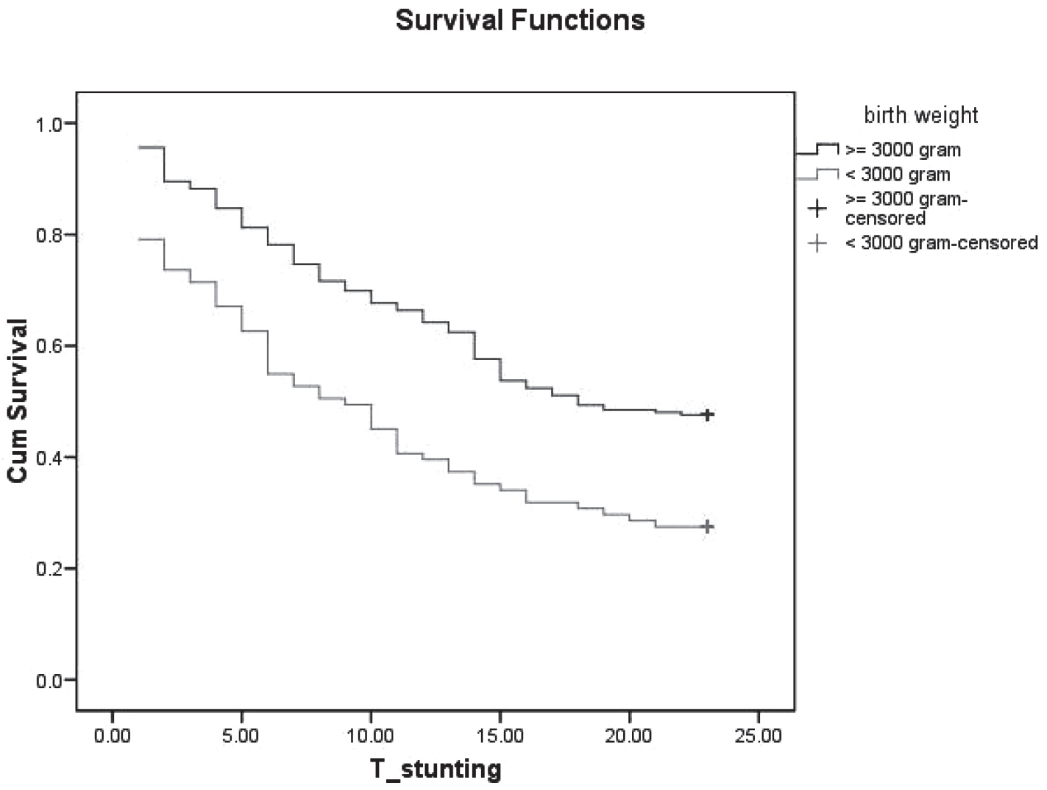

Figure 4. Survival rate in normal nutritional status on children aged 0-23 months based on maternal height (n=320)

Therefore, low birth weight may cause growth faltering in infancy and lead to stunting in childhood. As summarised in Lancet Series of maternal and child undernutrition, adult height is positively associated with birth weight and length in low-middle income countries. It showed that a 0.7-1 cm increase in adults' height is associated with one cm increase in birth length. (Victora *et al.,* 2008).

Important evidences supporting the main findings of this study showed that children with birth weight at least 3,000 g had better resilience towards not stunting. They had longer survival time compared to the ones with birth weight less than 3,000 g. Children with birth length at least 48 cm also could survive longer than children with birth length less than 48 cm. These results emphasised more the importance of adequate nutrition for foetus during the pregnancy for a good healthy pregnancy outcome.

Maternal nutritional status has important contribution to the pregnancy outcome. According to the study findings, having short mother was one of the risk factors of stunting among children. Children who were born by short mother (<150 cm) had higher risk of being stunted. Maternal height is closely related to birth weight and length. A cohort study using the phenotype and genome-wide SNP data from three Nordic countries revealed the causal and strong association between maternal height and birth weight and length (Zhang *et al.,* 2015). These evidences showed

that maternal malnutrition will risk the survival, health, and development among offspring. Thus, there might be an intergenerational cycle of malnutrition in the future where a stunted child would be a stunted mother who would deliver a stunted child (Felisbino-Mendes, Villamor, Velasquez-Melendez, Vikbladh, & Saxtrup, 2014).

Low birth weight and short birth length indicated poor nutritional status during pregnancy. It is including chronic energy deficiency and micronutrient deficiencies that will increase the risk of having baby with low birth weight (Kusharisupeni, 2006 and Svefors *et al.,* 2016). Mother with this condition may have reduced protein and energy stores, smaller reproductive organ system and limited room for foetal development (Addo *et al.,* 2013). Moreover, during lactation, they may not provide sufficient breast milk to their baby which may further affect the child growth (Kusharisupeni, 2006).

Genetic factors play an important role to a child's growth. Maternal height as the result of complex interaction between genetic and environment factors prior to pregnancy has major contributions to the child's height. These results emphasised the importance of having optimal health and nutritional status before and during pregnancy for a healthy pregnancy outcome.

As shown in previous studies in developing countries, this study also confirmed an inverse association between maternal height and stunting child (Özaltin, Hill, & Subramanian, 2010; Subramanian, Ackerson, Davey Smith, & John, 2009). Consistent evidence exist for the association between short maternal height and intrauterine growth retardation and also low birth weight, in which short maternal height plays a role as a predictor of infant death and impaired child growth (Murray *et al.,* 2012). Maternal short height can restrict uterine blood flow and growth of the uterus, placenta, and foetus which later delay the development and height either during childhood or adulthood (Black *et al.,* 2008).

An analysis by Mendes MSF, Villamor E, and Melendez GV using the 2006 Brazilian Demographic Health Survey data also showed that maternal height was positively associated to children's HAZ values. Children having mothers <145 cm tall have 1.2 times lower HAZ than those having ≥160 cm height mother. In addition, the results of those analysis also indicated the risk of child stunting by maternal height categories (<145, 145-149, 150-154, 155-159 and ≥160 cm) were 2.95 (1.51; 5.77), 2.29 (1.33; 3.93), 1.09 (0.63; 1.87), and 0.89 (0.45; 1.77), respectively. This suggests that mothers with the height of <145 cm were at greater risk of having stunted children (2.95 times) than other maternal height categories (Mendes *et al.,* 2014).

This study suggested that low birth weight, short birth length, and maternal stunting have serious implications to child growth and development. In the future, it may lead to irreversible damages, such as shorter adult height, reduced lean body mass, less schooling, reduced earnings, and lower birth weight of their descendant (Victora *et al.,* 2008).

The strength of this analysis includes the use of longitudinal data with growth measure from birth into the age of 23 months. Moreover, this study also gives contribution for the dominant factors of stunting and survival resilience of children aged 0-23 months toward not stunting. However, there were still limitations in this study. First, the length of birth was measured by health personnel at the place of birth in which the methods of measurement may vary between children. Second, methods of the birth length measurement may be different with the measurement of body length method applied in this study.

The third limitation of this study was incomplete records each month due to absenteeism of the respondents, neither body length data nor several variables collected monthly. Thus, this may cause the unexpected results found in this analysis, such as less experience of illness, non-diverse diet, and low-educated mother as the protective factors against the incidence of stunting, although the *p*-value is above 0.05. In case of dietary diversity, it needs to consider more appropriate method of measuring dietary diversity, not just one point of measurement. In term of maternal education, the unexpected results may be due to a less variety of maternal education, especially there are fewer mothers with high education level and low education level.

Many interventions were done on pregnant woman for better pregnancy outcomes, especially to fix stunting, such as micronutrients supplementation which reduced the risk of low birth weight at term by 16% (relative risk 0.84, 0.74-0.95) (Bhutta, 2008), nutrition education and counselling, growth monitoring and promotion, immunisation, water sanitation and hygiene, and social safety nets, usually called nutrition-specific interventions (Ruel, 2013). Yet, to eliminate stunting in the longer term, the interventions should be supplemented by improvements in the underlying determinants, such as poverty and poor education (Bhutta, 2008) which likely influence maternal birth weight and adult height. A systematic review showed that successful interventions which can greatly accelerate on reducing stunting were characterised by a combination of political commitment, multi-sectorial collaboration, community engagement, community-based service delivery platform (Hossain, 2017), women's empowerment, agriculture, food systems, education, employment, social protection, and safety nets, called nutrition-sensitive interventions (Ruel, 2013).

CONCLUSION

Nutritional status at birth (weight and length of birth) as well as maternal short height, are the dominant risk factors that affect stunting among children aged 0-23 months. Thus, this finding supports the previous studies that the incidence of stunting is intergenerational. Furthermore, this study has found that resilience of children to survive toward not stunting is decreasing as the age is increasing.

RECOMMENDATIONS

The importance of having optimal health and nutritional status before and during pregnancy for a healthy pregnancy outcome, normal weight and length of birth is indisputable. This implies that the incidence of stunting is intergenerational, even at the beginning of life, so the nutrition-specific interventions supplemented by nutrition-sensitive intervention must be ensured prior to pregnancy.

Authors' contributions

Nur HU, conducted the study, design the analysis, prepared the draft of the manuscript and reviewed the manuscript; Kencana S, conducted the study, assisted in the data analysis and interpretation and reviewed the manuscript; Rika R, conducted the study, assisted in the data analysis and interpretation and reviewed the manuscript; Bunga CH, conducted the study, assisted in drafting of the manuscript and reviewed the manuscript; Anies I, conceptualized the study, reviewed the manuscript; Besral, led the data analysis and interpretations; Nurillah A, conducted the study, assisted in drafting of the manuscript.

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Association between stunting and obesity among under-five children in urban and rural areas of Oyo State, Nigeria

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ABSTRACT

Introduction: Malnutrition contributes to more than one-third of all child deaths worldwide and accounts for over 50 percent of under-five deaths in Nigeria. Both overnutrition and undernutrition exist among under-five children, leading to double burden of malnutrition, a major risk factor for chronic diseases. The study was conducted to assess the association between stunting and obesity among under-five children in urban and rural areas of Oyo State, Nigeria. **Methods:** A cross-sectional survey was carried out using a four-stage random sampling technique to select 450 (214 males and 236 females) under-five children from Ibadan North (Urban) and Ido (Rural) Local Government Areas (LGAs) of Oyo State. A pre-tested, interviewer-administered semi-structured questionnaire was used to collect information on socio-demographic characteristics of respondents. Weight and height of the children were measured and categorized according to the WHO Child Growth Standards. **Results:** Mean age of children was 29.8±17.0 months (Ibadan North, 29.1±16.8; Ido, 31.9±17.4 months) with 52.6% being female. The prevalence of stunting, overweight and obesity was 32.9%, 14.4% and 20.2%, respectively. A total of 30.7%, 17.2% and 22.1% of children in Ibadan North and 40.6%, 5.0% and 13.9% in Ido LGA were stunted, overweight and obese, respectively. High proportion of obese children (43.5%) was stunted, indicating co-existence of obesity and stunting among the population. **Conclusion:** Double burden of overweight and stunting found in urban and rural young children indicate that public policies should emphasise on targeting both malnutrition conditions to prevent the subsequent health risks and complications.

Keywords: Stunting, obesity, overweight, preschool children, malnutrition

INTRODUCTION

Malnutrition contributes to more than one-third of all child deaths globally and accounts for over 50% of under-five deaths in Nigeria (WHO, 2016; UNICEF, 2015). Over- and under nutrition co-exist within the same population, leading to a dual burden of malnutrition which is a major risk factor for chronic diseases. Childhood obesity is one of the most serious public health challenges of the 21st century (WHO, 2000; WHO, 2015). The problem is global and is steadily affecting many low and middle-income

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countries, particularly in the urban setting (de Onis, Blössner & Borghi, 2010; UNICEF/WHO/World Bank, 2017). Globally, in 2016, about 41 million and 155 million under-five children were overweight and stunted respectively (UNICEF/WHO/World Bank, 2017). One quarter of all overweight and one third of all stunted children lived in Africa (World Bank, 2015; UNICEF / WHO / World Bank, 2017).

The problem of overweight and obesity affect both developed and developing countries. In poor countries, obesity with its associated chronic debilitating diseases co-exists with infectious diseases, which accompany undernutrition, giving a double burden of disease (de Onis *et al.*, 2010). The prevalence of overweight and obesity differs across nations. In Tehran, Iran the prevalence of overweight and obesity among children less than five years of age, were 12.0% and 23.7% respectively (Salehiniya *et al.*, 2016). De Arruda *et al.* (2014) reported that the prevalence of overweight and obesity in Alagoas, Northeast of Brazil was 23.9% and 7.8% respectively. In Africa, the prevalence of childhood overweight and obesity was 8.5% in 2010 and it is estimated to reach 12.7% in 2020 (de Onis *et al.*, 2010). The prevalence of overweight in African increased from 5.0% in 2000 to 5.2% in 2016 (UNICEF/WHO/World Bank, 2017).

Overnutrition in childhood stage will more likely lead to suffering from non-communicable diseases such as heart and kidney diseases, obesity and diabetes later in life (Black *et al.*, 2008). Stunting in children is associated with an increased risk for obesity due to impaired fat metabolism and other metabolic shifts. The main causes of stunting in children are poor maternal nutrition at conception, intrauterine nutrition, inadequate sanitation, inadequate breast feeding, delaying the addition of complementary feeding in addition to quality and quantity of food, and poor absorption of nutrients due to disease or parasites (WHO, 2013). The World Health Organisation (WHO) defines stunting for children as height/length for age less than the 5th percentile or <-2 standard deviation (SD), overweight as a *z*-score value >1 SD or 85th to <95th percentile of BMI-for-age, and obesity as *z*-scores >2 SD or ≥95th percentile of BMI-for-age (WHO, 2008). For stunting among under-five children, all regions of the world had witnessed a reduction in their prevalence rate. Africa witnessed a low decrease in stunting rate from 42.3% in 1990 to 31.2% in 2016 (UNICEF/WHO/World Bank, 2017). Even Nigeria has experienced a reduction from 50.5% in 1990 to 32.9% in 2014, though the rate of reduction is still very low (World Bank, 2015).

In Nigeria, the few studies that are available showed that the prevalence of obesity among preschool children in Enugu Metropolis was 0.5% (Odetunde *et al.*, 2014). Senbanjo & Adejuyigbe (2007) stated the prevalence of overweight and obesity in Ifewara Osun state as 13.7% and 5.2% respectively. Mezie-Okoye (2015) also reported that the prevalence of overweight and obesity among preschool children in Port Harcourt were 15.0% and 8.6%, respectively. However, there is still paucity of data on overweight and obesity among under-five children from many regions of the country. This study was conducted to assess the association between stunting and obesity among preschool children in Ibadan North and Ido Local Government Areas of Oyo State, Nigeria.

MATERIALS AND METHODS

Study area

The study which was descriptive cross-sectional in design was conducted in

Ibadan North (Urban) and Ido (Rural) Local Government Areas (LGAs) of Oyo State in Nigeria.

Sample size determination

The sample size was determined using the sample size formula for single proportion

$$n = \frac{Z^2 P q}{d^2}$$

Where n is the minimum sample size, Z=1.96 corresponding to 95% confidence interval, P=0.052 proportion of obese children in Nigeria (Senbanjo & Adejuyigbe 2007), d=level of precision taken at 5% acceptable margin of error, and q=1 – P.

The sample size was calculated based on statistics from previous studies on the prevalence of obesity in Nigeria. Using the prevalence of 5.2% among under five children in Nigeria (Senbanjo & Adejuyigbe 2007), P=0.052, q=0.948, d=0.05, Z=1.96.

$$n = \frac{1.962 \times 0.052 \times 0.948}{0.05^2}$$

n = 75.72

n = 75.72 + 10% allowance for non-response

n = 75.72+7.572 =82.572 = 83

The sample size calculation using P=0.052 from Senbanjo & Adejuyigbe (2007) yielded a sample size of 83. To have a larger sample size, P=0.5 was used for this study.

$$n \text{ therefore} = \frac{1.96 \times 1.96 \times 0.5 \times 0.5}{0.05 \times 0.05}$$

n = 384.16 + 15% allowance for non-response

n = 384.16 + 57.6 = 441.76

A total of 450 participants were recruited during the study in the two local government areas. The sample size for the LGAs was calculated based on the 2006 Census (NPC 2006) projected population for each of the LGAs proportionately.

Sampling procedure

A total of 450 apparently healthy under-five children (337 from Ibadan North and 113 from Ido LGAs) were recruited for the study using a four-stage systematic random sampling procedure:

(i) First stage: A sampling frame of all the local government areas in Oyo state was drawn and stratified into urban and rural areas based on World Bank classification of Oyo State in 1998. One urban (Ibadan North) and one rural (Ido) local government areas were selected using simple random sampling technique.

(ii) Second stage: A sampling frame of all the communities in the selected local government areas was drawn. Three communities were randomly selected from each of the local government areas using simple random sampling technique.

(iii) Third stage: Four hundred and fifty households were selected from the two communities using a systematic random sampling technique. A landmark was identified in the selected communities where a bottle was being spun (Rose, 2006; Araoye, 2004). The direction where the head of the bottle faced marked the starting point of the systematic random household selection. A household was selected after every K^{th} (9) houses. The K^{th} (sampling interval) was calculated by dividing the number of households in the LGAs (gotten from the national population council Oyo state) by the sample population. In the case where the selected household does not have an eligible child the next house was selected.

(iv) Fourth stage: The eligible child from the selected households was

sampled.

Research instruments and data collection procedure

A pre-tested, interviewer-administered, semi-structured questionnaire adapted from Nigeria demographic health survey (NDHS, 2008; NDHS, 2013), and National Health and Nutrition Examination Survey (NHANES 2007-2008; NHANES 2013-2014), were used. The instrument was administered to the mothers of the under-5 children with the questions being directed to their children (Gibson, 2005). Information was obtained on children's socio-demographic factors and physical characteristics such as anthropometric indices of weight and height. The anthropometric indices were used to calculate the body mass index for age. The height and weights of the children were measured to the nearest 0.1 cm and 0.5 kg respectively. Height was measured using non-stretchable metre rule when the child stands erect on a flat surface with a horizontal gaze. All measurements were taken with children wearing light clothing without shoes.

All instruments used were calibrated at the beginning of every section and readings were taking in duplicate to ensure accuracy and avoid error due to parallax. The readings were also recorded immediately.

Data analysis

The anthropometric data of children were analysed using the WHO Anthro software (WHO, 2010) and expressed as *z*-scores for each of the anthropometric indices of malnutrition against the WHO Child Growth Standards (WHO, 2006). The mean weight-for-age and mean height-for-age were calculated. The cut-off definition of overweight, obesity and stunting among the under-5 children was determined by the WHO Child Growth Standards 2006. Obesity was defined as *z*-score value >2 SD of BMI-for-age, overweight was defined as *z*-score value >1 SD of BMI-for-age, and stunting was defined as *z*-score value <-2 SD of height-for-age. Data were analysed using SPSS software version 19.0 (IBM Corp., USA). Pearson's correlation and multiple regression analysis was used to determine the association of variables with stunting, overweight and obesity. Statistical significance was set at $p<0.05$.

Ethical consideration

Ethical approval was obtained from the University of Ibadan/University College Hospital Institution Ethics Review Board. Permission and consent were also sought from the State Ministry of Health and leaders of the communities involved respectively.

RESULTS

The mean age of the 450 under-5 children was 29.8±17.0 months; Ibadan North LGA (urban area) 29.1±16.8 months and Ido LGA (rural area) 31.9±17.4 months (Table 1). A total of 47.6% of the children were males, 48.0% of the male and 51.6% of the female children were from Ibadan North LGA, while 47.6% males and 52.4% females were from Ido LGA. About one-third (30.6%) of the children (33.5% and 20.2% for Ibadan North and Ido LGAs) were first born while 13.8% were the fourth children. Children from urban LGA had higher mean weight while those from rural LGA had higher mean height with no significant differences in values ($p<0.05$). About two-third (64.4%) of the children (66.8% from Ibadan North, and 56.4% from Ido LGAs) were Christians by birth.

The overall prevalence of overweight and obesity among under-five children in the study area was 14.4% and 20.2%, (17.2% and 22.1% for Ibadan North and 5.0% and 13.9% for Ido LGAs) respectively (Figure 1; Table 2). Logistic Regression revealed a significant

Table 1: Demographic characteristics of the children

Characteristics	*Urban*	*Rural*	*Total*
		N (%)	
Age (months)			
0-6	27 (7.7)	7 (6.9)	34 (7.6)
7-12	43 (12.3)	11 (10.9)	54 (12.0)
13-24	87 (24.9)	23 (22.8)	110 (24.4)
25-36	74 (21.2)	23 (22.8)	97 (21.6)
37-48	62 (17.8)	14 (13.9)	76 (16.9)
49 -59	56 (16.0)	23 (22.8)	79 (17.6)
Sex			
Male	169 (48.4)	45 (44.6)	214 (47.6)
Female	180 (51.6)	56 (55.4)	236 (52.4)
Position of child among siblings			
First	117 (33.5)	20 (20.2)	137 (30.6)
Second	85 (24.4)	31 (31.30	116 (25.9)
Third	78 (22.3)	18 (18.2)	96 (21.4)
Fourth	45 (12.9)	17 (17.2)	62 (13.8)
Five and above	24 (6.9)	13 (13.1)	37 (8.3)
Religion of family			
Christianity	233 (66.8)	57 (56.4)	290 (64.4)
Islam	116 (33.2)	44 (43.6)	160 (35.6)
		Mean±SD	
Age (months)	29.1±16.8	31.9±17.4	29.8±17.0
Length (cm)	83.1±16.4	85.5±13.1	83.6±15.7
Weight (kg)	12.2±3.5	11.7±3.3	12.1±3.4

association between prevalence of obesity and stunting among the study population. High proportion (43.5%) of the obese children was stunted, indicating a co-existence of obesity and stunting (Table 3).

The socio-demographic determinants of nutritional status of children in this study are shown in Table 4. Factors such as sex, place of residence and age of the child were significant determinants of child nutritional status (p<0.05). The male children were 1.5 times more likely to be obese or overweight than the female children (OR=1.59; CI: 1.06-2.42), and obesity and overweight were 2.49 times higher among urban than the rural dwellers (OR=2.49; CI: 1.22-3.89). Apart from children between 12-24 months old, children from all other age groups were at least 2 times more likely to be overweight or obese than children between 0-6 months.

DISCUSSION

The prevalence of overweight in the study area (14.4%) is slightly higher than that reported for preschool children in Ifewara, Osun State (13.7%) by Senbanjo & Adejuyigbe (2007), but slightly lower than 15% reported for Port Harcourt, Nigeria (Mezie-Okoye, 2015). UNICEF/WHO/World Bank (2017) also reported an increase in global prevalence of overweight among under-five children from 5.0% in 2000 to 6.0% in 2016. The reported prevalence of obesity (20.6%) in this study is much higher than the reported values for prevalence of obesity in Ifewara (5.2%) and Port Harcourt

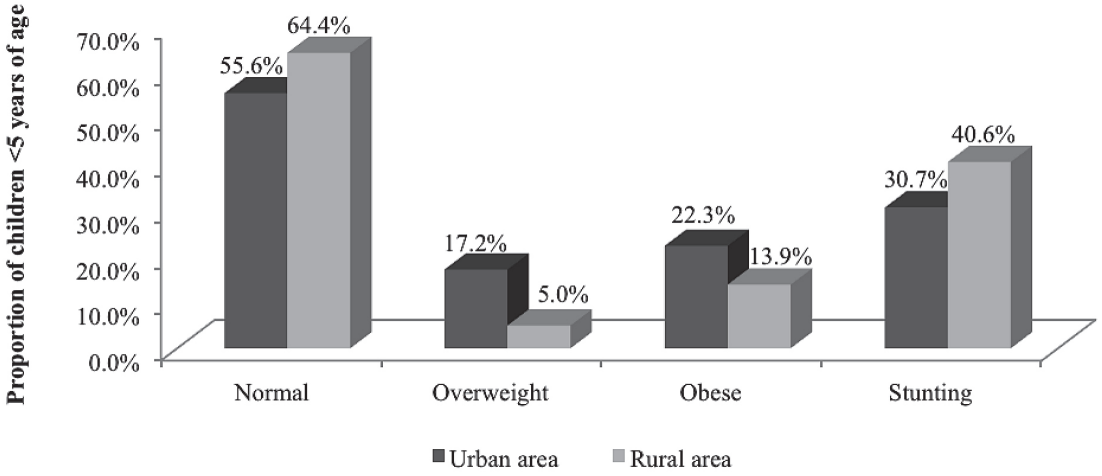

Figure 1. Nutritional status of the under-five children in the two LGAs

(8.6%) by Senbanjo & Adejuyigbe (2007) and Mezie-Okoye (2015) respectively. The National Health and Nutrition Examination Survey (1976-1980 and 2003-2006) report showed that the prevalence of obesity has increased for children aged 2-5 years from 5.0% to 12.4% (CDC, 2006).

Our finding on prevalence of overweight and obesity in the study area contradicts the prevalence of <2.3% in preshool children from developing countries reported by Martorell *et al.* (2009) that it does not appear to be a public health problem among preschool age children in Asia and Sub-Saharan Africa. One factor for the relatively high obesity prevalence among preschool children in this study may partly be associated with the kind of foods that they are provided, especially by busy working spouses. Young children are often given processed or semi-processed foods, which are energy-dense but low in essential nutrients.

The prevalence of stunting (32.9%) found in this study is lower than NDHS 2008 (41%) and 2013 (37%) report but higher than the value of 29.7% among urban and rural children in Nigeria reported by Samuel & Atinmo (2008). The magnitude of stunting in this study reflected that some of the children from the study have been exposed to inadequate nutrition over a long period of time. Since majority of the children

Table 2. Nutritional status of the under-five children

Nutritional status	*Urban*	*Rural*	*p-value*	*Total*
Stunted	107 (30.7)	41 (40.6)	0.041	148 (32.9)
Stunted	242 (69.3)	60 (59.4)		302 (67.1)
Not stunted				
Overweight	60 (17.2)	5 (5.0)	0.01	65 (14.4)
Overweight	289 (82.8)	96 (95.0)		385 (85.6)
Not overweight				
Obese	78 (22.3)	14 (13.9)	0.039	92 (20.4)
Obese	271 (77.7)	87 (86.1)		358 (79.6)
Not Obese				
Total	349 (100)	101 (100)		450 (100)

Table 3. Association between obesity and stunting among the children

	Not obese (%)	*Obese (%)*	*p-value*	*Total (%)*
Stunted	108 (30.2)	40 (43.5)	0.012	148 (32.9)
Not stunted	250 (69.8)	52 (56.5)		302 (67.1)
Total	358 (100)	92 (100)		450 (100)

	Multivariate logistic regression			
	Odds ratio	*p-value*	*95%CI*	
			Lower	*Upper*
Stunting and obesity	1.7	0.01	1.140	2.572

are reported not to have suffered from any prolong illness, it indicates that the prevalence in stunting may be due to inadequate nutrition and infectious disease such as diarrhoea, and not as a result of children being affected by recurrent and chronic illnesses.

The study revealed a significant association and coexistence of overweight and stunting among the sampled under-five children as 44% of the obese children were also stunted. An under-five child who is stunted is 1.7 times more likely to become obese than a non-stunted child in the study population. The finding of coexistence of obesity and stunting in this study is similar to that of Ramoteme *et al.* (2005) report that 19% of 3-year-old black South African children residing in Central Region of Limpopo Province, South Africa were both stunted and overweight; Symington (2015) discovered a significant correlation (r=-0.32) between BMI and height-for-age z-scores (p<0.0001), 68.4% of obese children were stunted, while only 13.6% of the normal and underweight group were stunted; the report of Gebremedhin (2015) also showed that overweight/obesity was three times more frequent in stunted children than in normal children; and also Duru *et al.* (2015) reported the prevalence of overweight/obesity, underweight, wasting and

Table 4. Relationship between socio-demographic factors and prevalence of overweight and obesity

Variables	*Multivariate logistic regression*			
	Odds ratio	*p-value*	*95%CI*	
			Lower	*Upper*
Sex				
Male	1.59	0.027	1.055	2.415
Female	0			
Age group				
0-6 months		0.021		
7-12 months	2.55	0.047	1.012	6.403
13-24 months	1.75	0.192	0.754	4.062
25-36 months	3.37	0.001	1.665	6.828
37-48 months	2.94	0.004	1.419	6.070
49 and above	2.40	0.024	1.125	5.140
Area				
Urban	2.49	0.009	1.217	3.890
Rural	0			

stunting among under-five children in households in rural communities in Imo State was 9.8%, 28.6%, 23.6% and 28.1%, respectively. The coexistence of obesity and stunting in this study shows a double burden of malnutrition in the two LGAs studied. This indicates a need for adequate nutrition and education intervention to prevent associated morbidity and mortality.

Among all the socio-demographic factors considered, only sex and location of the children were significant predictors of overweight and obesity. A male child is 1.5 times more likely to become overweight than a female child, and prevalence of overweight and obesity (combined) is 2.5 times higher in the urban areas (Ibadan North) than in the rural areas (Ido). These differences in the two LGAs may be due to the dietary pattern in this LGAs and level of physical exercise in the LGAs as children from rural areas are more exposed to physical activities such as walking and outdoor play, and may also consume less refined foods and more vegetables and fruits than those in the urban areas. This finding is similar to that of Martorell *et al.* (2009) who reported that overweight is more common among children in urban areas.

CONCLUSION

The prevalence of overweight and obesity among preschool age children in Nigeria is becoming a matter of public health significance and should no longer be handled with levity or be overlooked, as the implication of this increasing trend of overweight and obesity in children is a high burden of non-communicable diseases in the future for Nigeria. Therefore, the need for an urgent intervention cannot be over-emphasised. During the early years of life, focus should be on both under- and overnutrition for sustaining proper growth and development in children less than five years, as the double burden of malnutrition is now a trend in many countries of the world.

The emergence of overweight and obesity, which may be as a result of changes in dietary pattern from traditional foodstuff to convenience, ready-to-eat foods and snacks occurring in Nigeria warrant close monitoring of overweight prevalence in children so that preventive measures can be taken in a timely manner. The positive relationship between obesity and stunting observed in the study emphasised the need for timely nutritional and educational interventions to prevent associated morbidity and mortality.

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Authors' contributions

This study was collaboration between both authors. Bamisaye OB designed the study, supervised data collection, wrote the protocol and drafted the manuscript; Adepoju OT approved, supervised the design and protocol of the study, handled technical aspect and reviewed the manuscript.

Conflict of interest

The authors declare that there is no conflict of interest on the publication of information obtained from our study, as it was self-sponsored with no financial aid from any donor or organisation.

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Influence of maternal autonomy and socioeconomic factors on birth weight of infants in India

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ABSTRACT

Introduction: Child's birth weight (BW) is an important aspect not only during childhood but also affects morbidity and mortality in adulthood. The focus of this study is to examine the role of different socioeconomic factors, along with women's decision-making autonomy on the determination of infant BW. **Methods**: The dataset was obtained from the National Family Health Survey, India (2005-06). The respondents were women of reproductive age (15-49 years) having at least one living child at least five years old preceding the survey. This study considered only the last single live birth child having a recorded BW at the time of delivery. **Results:** The results showed that 19% of the infants were born with low birth weight (LBW) with regional variations ranging from 13% to 27%. The mean BW of infants of mothers from high autonomy category was 2.90±0.645 kg, while that of mothers with low autonomy was 2.75±0.702 kg. The proportion of LBW infants was significantly higher among mothers with low education, short stature, low BMI and poor wealth index category. Percentage of LBW infants were lower among mothers with autonomy including taking care of their own health (18% versus 21% who were not), making large purchases (17% vs 22%), visiting relatives (18% vs 22%), and allowed to go to the market (18% vs 22%). **Conclusion:** The findings indicated that the mother's freedom of movement and financial independence were significantly associated with infant's BW in India. Attention should be given to improving the socio-economic conditions and empowerment of Indian women.

Keywords: Low birth weight, women autonomy, body mass index, wealth index, Indian National Family Health Survey

INTRODUCTION

Infant's birth weight (BW) is an important factor that influences morbidity and mortality, not only during childhood but also during adulthood. Epidemiological observations depicted that infants born with low birth weight (LBW) (lower than 2,500 g; WHO, 2002) is approximately 20 times more likely to die than heavier babies, due to a wide range of poor health outcomes. In spite of constant efforts to improve maternal and child health care (MCH), the number of LBW infants is still remarkable throughout the world. Half of the children with LBW were born in South Asia and among

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these countries, India and Bangladesh have the highest prevalence of LBW (30%) (UNICEF, 2013).

The etiology of BW is the result of complex interactions among various social, economic and reproductive health factors. Several maternal factors are also significantly associated with LBW (Singh *et al.*, 2009; Cleland, 2010). Maternal nutritional status is one of the important determinants of newborn BW, as poorly nourished mothers give birth of higher percentage of LBW infants compared to those of better nourished mothers (Amosu & Degun 2014; Dharmalingam, Navaneetham & Krishna Kumar, 2010). Other studies also recognised that low body mass index (BMI), short stature, anaemia and/or other micronutrient deficiencies of mothers increase the risk of having LBW infants (Ohlsson & Shah, 2008). Variables associated with maternal status, such as education and occupation (Cleland, 2010) and with child nutritional status (Frost, Forste & Hass, 2005) are associated with child survival. However, the association is not universal as mothers, irrespective of their education, may be constrained by gender-biased rules that restrict opportunities to make decisions and mobility (Agee, 2010; Thang & Popkin, 2003). As in other South Asian Countries, Indian women's inferior social status within the household adversely affect their health and that of their children.

Recent studies emphasised on women's decision-making autonomy as a measure of BW. Women's autonomy is a complex and multidimensional phenomenon and in this study it was measured by some household decision-making indicators. A study from Bangladesh documented that women's decision making autonomy has an independent effect on LBW outcome after controlling all other independent variables, indicating that women autonomy has a positive effect on the reduction of LBW (Sharma & Kader 2013).

In India, there are few studies on the association of women autonomy and BW. Chakraborty & Anderson (2011) showed positive association between women's autonomy and infant BW. The present study examines the association between autonomy and BW along with the regional variations in India, given that India is a multi-ethnic, multi-cultured country with regional development disparities.

MATERIALS AND METHODS

The present data set was obtained from the National Family Health Survey 3 (NFHS 3, 2007), which was conducted by International Institute of Population Sciences (IIPS), Mumbai, in collaboration with the Ministry of Health and Family Welfare, in 2005-06. The study was conducted among the women of reproductive age (15-49) having at least one living child at least five years old preceding the survey.

The present study considered only the last single live birth child having a recorded BW at the time of delivery. No pregnant women were considered for this study. A total of 15,130 children along with the socioeconomic and demographic backgrounds of the mothers were taken. The factors that were considered here are residence pattern, mother's education and occupation, mother's age at birth, wealth index (as a proxy of household economic status), religion and ethnicity[1]. Wealth index[2] was generated on the basis of some household assets and evolved by IIPS as poorest, poorer, middle, richer and richest (NFHS 3, 2007). Wealth index is categorised as poor, middle and rich, while for regression analysis, it was grouped as poor (poor or middle) and rich. Women's autonomy is a multidimensional concept and in this study, women's decision

making autonomy is defined as women's personal power in the household and her ability to make and execute independent decisions for herself or her close family members. This was seen to be closely associated with maternal and child health outcomes (Woldemicael, 2007; Shroff et al., 2009; Senarath & Gunawardena, 2009). Decision making on autonomy was questioned for the following eight aspects:

1) own health care,
2) making household purchases for household daily needs,
3) making household large purchases
4) visiting relatives
5) going to a health facility
6) going to market
7) having bank account
8) having money for her own use

These questions were originally developed by NFHS 3 (2007). Questions 1-4 are grouped here as household decision, Questions 5-6 are grouped as mobility-related autonomy and Questions 7-8 are grouped as financial autonomy. For the household decision, the responses are given as

a) three points for 'respondent alone decision'
b) two points for 'joint decision' and
c) one point for 'no involvement in these matters'.

The same coding was used for mobility. For financial autonomy, three points for 'having bank account' and 'money for own use' and one point for no financial autonomy. The scores were then added so that the range becomes 8-24 with a mean score 14.7. For the autonomy index, scores ≤13 are considered as low autonomy, scores between 14-18 are medium autonomy and scores ≥19 are considered as high autonomy.

In India, wide regional variations were observed in infant and maternal mortality (Singh *et al.*, 2011). The states were grouped into zones: North Zone North-East East Central West and South (NFHS 3, 2007).

Chronic Energy Deficiency (CED) (BMI as proxy indicator) and height of the mother (nutritional effect of long-term undernutrition) were determined. as an explanatory variable in the regression model. According to WHO (1995) classification, BMI <18.50kg/m2 is termed as underweight, in between 18.50 and 24.99 kg/m2 as normal and ≥25.00 kg/m2 as overweight and obese. A cut-off point of 145 cm was used for short stature (NFHS 3, 2007). Mumbare *et al.* (2012) termed a person to be short or non-short according to the height is <145.0 cm or ≥145.0 cm respectively.

Bivariate association of BW with each covariate was found through percentage distribution. Logistic regression was undertaken to determine the association between various independent socio-economic and autonomy-related factors with the LBW of the infants. Binary logistic regression was done with BW as a categorical dependent variable with a value as '1' for LBW and '0' for non-LBW.

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[1]Three groups for religion – Hindu Muslim and Others. Ethnicity is defined only for Hindu religion: General Castes (GC), Scheduled Castes (SC) and Scheduled Tribes (ST).

[2]Wealth index represents the economic status of the households. This index is based on 33 household assets and housing characteristics. Each household asset is assigned a weight (factor score) generated through principal component analysis, and the resulting asset scores are standardized to make the mean to be as zero and the variance as one (Gwatkin *et al.*, 2000). Each household is then assigned a score for each asset and the scores are summed for each household and individuals are ranked according to the score of the household. The sample is then divided into five quintile groups starting from lower strata to higher strata like --- poorest, poorer, medium, richer and richest. Thus, there are 20 percent of the household population in each wealth quintile.

Odds ratio >1 indicates probability of being LBW is higher than the reference category and if it is <1, then the result is reverse i.e. probability is lower than the reference category and if odds are close to 1, then no difference from reference category is observed. The statistical analyses were conducted using SPSS version 16.0 (IBM Corp., USA).

RESULTS

This study showed that among 15,130 children, 19.3% were of LBW (Table 1). The proportion of LBW infants was higher among mothers residing in rural areas (21.2%) compared to urban areas (17.8%). LBW infants were more prevalent among teenage mothers aged ≤19 years (26.4%) compared to other age groups. The proportion of LBW was higher among Hindu (20.2%) and Muslim (20.6%) mothers compared to the other religions (13.6%). The prevalence of LBW decreases with increase in mother's educational level and wealth index grades.

The proportion of low LBW was high among mothers working in the labour (23.2%) and agro-related (22.2%) categories, compared to professional jobs (e.g. teachers, doctors, lawyers). While the overall prevalence or LBW was 19.3%, this study found LBW varied from 27.2% in North zone followed by Central (22.7%), West (21.7%) and East (20.4%) zones. The prevalence of LBW was lower (17.9%) among the mothers who had completed at least four antenatal visits during their pregnancy compared to others. Sex of the infant plays a role in the determination of BW. LBW prevalence was higher among female (20.8%) than male (18.1%). The proportion of LBW with respect to socio-economic and demographic variables were all statistically significant.

Association of BW with mother's autonomy and health are depicted in Table 2. LBW outcome was high among the mothers with independent or joint autonomy about their own health care compared to mothers without autonomy. For household daily or large purchase, the proportion of LBW was high among the women with no autonomy. The proportion of LBW was the lowest among the mothers with independent mobility.

Women having money for their own use or bank account are of lower risk of giving birth of LBW babies. LBW was statistically higher among underweight (24.9%), and short height mothers (26.5%) than mothers with normal BMI. Table 3 shows the association between LBW (dependent variable) and different explanatory variables along with regional variations using binary logistic regression analysis. Most of the predictors showed significant associations with the risk of occurrence of LBW, except for residence. Mothers engaged in manual work or household activities have significantly higher odds of giving birth to LBW babies compared to those in service/professional category. The risk of delivering LBW infant was significantly high among the mothers of 'low education' compared to higher, 'poor wealth index' category compared to rich, 'Hindu or Muslim religions' compared to 'Others', 'non-tribal' in contrast to tribal group.

Regional variation in infant BW was also diverse in India. The regression model showed that the risk of LBW was significantly high among the babies of different zones compared to the North-East Zone. The only exception was found in the South Zone where no difference was observed. The mother's age should be a part in the risk to give birth of LBW infants. In this analysis, no such pattern was found, though teen-age mothers showed a significant risk at 10% level, which was not our consideration in the present study. Underweight and short

Table 1. Relationship between BW and mother's socioeconomic and other variables

Socio-economic and demographic variables	*N*	*LBW (%)*	*Mean BW (kg)*	*SD*
Residence				
Urban	8565	17.8	2.87	0.641
Rural	6565	21.2	2.83	0.695
Occupation				
Domestic work	11053	19.4	2.84	0.946
Prof/clerical/sales	1616	13.9	2.95	0.656
Agro-related	1511	22.2	2.83	0.768
Labour	950	23.2	2.82	0.712
Education				
Primary	4084	25.0	2.79	0.763
Secondary	8381	18.4	2.85	0.634
Higher	2665	13.6	2.94	0.584
Wealth index				
Poor	2025	24.5	2.79	0.778
Middle	2530	22.5	2.82	0.700
Rich	10575	17.6	2.87	0.631
Religion				
Hindu	11042	20.2	2.82	0.664
Muslim	1883	20.6	2.86	0.672
Others	2205	13.6	3.01	0.641
Tribe/Non-tribe				
Tribe	1562	12.7	3.06	0.668
Non-tribe	13568	20.1	2.83	0.661
Zone				
North	2075	27.2	2.72	0.689
Northeast	2646	13.0	3.05	0.657
East	1970	20.4	2.81	0.679
Central	1638	22.7	2.78	0.748
West	2827	21.7	2.80	0.669
South	3974	15.7	2.87	0.577
Mother's age at birth				
<=19 years	1570	26.4	2.75	0.709
20-35	13104	18.5	2.86	0.656
36 and above	456	19.1	2.94	0.722
Sex of the baby				
Male	8296	18.1	2.89	0.676
Female	6834	20.8	2.80	0.648
INDIA (overall)	15130	19.3	2.85	0.665

statured mothers were more prone to give birth to LBW infants compared to others. Female children were significantly more susceptible to the risk of LBW compared to male children.

The association between maternal autonomy and infant BW is shown in Table 4. It was found that economic independence or involvement was associated with less likelihood of infant LBW. The analysis confirmed that the women who play prominence role in large household purchase had significantly lower risk of LBW infants compared to others. Women with no bank account or have no money of their own exhibited higher risk of LBW babies compared to the reference group. Independent mobility also played an important role in the risk of LBW. Table 4 showed that the women with independent mobility to visit health facility alone, were at significantly lower risk of LBW infants compared to the other category (having no access).

Table 2. Relationship between infant BW and mother's decision making autonomy

Mother's Autonomy	*N*	*LBW (%)*	*Mean BW (kg)*	*SD*
Mother's household say on				
Own health care				
Respondent alone or with others[1]	10287	18.4	2.87	0.656
Other	4843	21.4	2.81	0.682
Large purchase				
Respondent alone or with others	8612	17.2	2.89	0.652
Others	6518	22.2	2.80	0.679
Daily needs				
Respondent alone or with others	9538	18.1	2.88	0.657
Others	5592	21.4	2.80	0.676
Visit to relatives				
Respondent alone or with others	10184	18.0	2.88	0.650
Others	4946	22.0	2.80	0.692
Independence of mobility				
Go to health facility				
Allowed alone	8841	17.4	2.89	0.655
Allowed with others	5782	21.8	2.81	0.675
Not allowed	507	24.7	2.79	0.688
Go to market				
Allowed alone	9565	17.7	2.88	0.653
Allowed with others	4153	22.3	2.80	0.685
Not allowed	1412	21.7	2.83	0.679
Financial autonomy				
Have bank account				
No	11749	20.4	2.83	0.674
Yes	3381	15.6	2.92	0.627
Have money for own use				
No	8515	20.7	2.83	0.669
Yes	6615	17.6	2.88	0.659
Overall autonomy				
High	8082	16.6	2.90	0.645
Average	4497	21.3	2.82	0.672
Low	2551	24.4	2.76	0.702
Antenatal visit				
No/incomplete	3714	23.6	2.81	0.752
Complete	11416	17.9	2.87	0.634
Mother's BMI				
Underweight	3694	24.9	2.73	0.683
Normal	8756	18.2	2.87	0.654
Overweight/obese	2680	15.3	2.96	0.653
Mother's height				
Short (<145cm)	1359	26.5	2.69	0.665
Not-short (>=145cm)	13771	18.6	2.87	0.663
India	15130	19.3	2.85	0.665

[1] i.e., accompanied with other members.

Consequently, the results also predicted that mothers with no antenatal visits (at least four visits during pregnancy regardless of the specified routine) were more inclined to give birth to LBW infants compared to those who had at least four antenatal visits. Mother's nutritional status, measured through BMI, showed a direct association with infant BW. It was found that the odd ratios of giving

Table 3. Logistic regression showing the association of risk factors of BW with respect to different socio-demographic factors†

Socio-demographic variable	*Odds ratio*	*p-value*	*95% CI*	
			Lower limit	*Upper limit*
Residence				
Rural	1.086	0.086	0.983	1.193
Urban	1.000			
Mother's occupation				
Domestic work	1.188	0.030	1.017	1.387
Agro-related	1.090	0.408	0.889	1.337
Labour	1.360	0.005	1.097	1.687
Prof/clerical/sales	1.000			
Mother's education				
≤Primary	1.844	0.000	1.585	2.146
Secondary	1.381	0.000	1.210	1.575
Higher	1.000			
Wealth index				
Poor	1.225	0.000	1.098	1.367
Non-poor	1.000			
Religion				
Hindu	1.236	0.006	1.064	1.436
Muslim	1.254	0.017	1.041	1.511
Others	1.000			
Tribe/non-tribe				
Non-tribe	1.379	0.001	1.145	1.660
Tribe	1.000			
Zone				
North	2.337	0.000	1.984	2.752
South	1.007	0.927	0.861	1.179
East	1.307	0.002	1.101	1.550
Central	1.703	0.000	1.428	2.030
West	1.643	0.000	1.404	1.924
North east	1.000			
Mother's age at birth				
≤19 years	1.224	0.139	0.937	1.600
20-35	0.858	0.222	0.671	1.097
36 and above	1.000			
Sex of child				
Female	1.220	0.000	1.124	1.325
Male	1.000			

†Dependent variable: LBW=1, other=0 (reference category)

birth to low BW infants among short height and underweight mothers were significantly high compared to the reference category.

DISCUSSION

LBW is a major public health problem due to its association with high morbidity and mortality of infants (Lawn, 2005). The results of the present study have shown that the prevalence of LBW is 19.3% in the study population. Along with other variation, regional variation was prominent where it varies from 13% to 27% in India. Most important reason for regional differences on prevalence

Table 4. Logistic regression showing the association of risk factors of BW with respect to maternal autonomy and other factors†

Autonomy related variables	*Odds ratio*	*p-value*	*95% CI*	
			Lower limit	*Upper limit*
Own health care				
Respondent alone or with others	0.994	0.899	0.899	1.098
Other	1.000			
Large purchase				
Respondent alone or with others	.792	0.000	0.708	0.885
Others	1.000			
Daily needs				
Respondent alone or with others	1.066	0.261	0.953	1.192
Others	1.000			
Visit to relatives				
Respondent alone or with others	.939	0.266	0.840	1.049
Others	1.000			
Allowed to mobility				
Go to health facility				
Allowed alone	.700	0.008	0.537	0.913
Allowed with others	.816	0.109	0.636	1.047
Not allowed	1.000			
Go to market				
Allowed alone	1.047	0.627	0.870	1.259
Allowed with others	1.108	0.244	0.933	1.316
Not allowed	1.00			
Financial autonomy				
Have bank account				
No	1.161	0.008	1.039	1.296
Yes	1.000			
Have money for own use				
No	1.097	0.038	1.005	1.197
Yes	1.000			
Mother's BMI				
Underweight	1.479	0.000	1.352	1.618
Normal or other	1.000			
Mother's height				
Short (<145 cm)	1.509	0.000	1.327	1.717
Not-short (>=145 cm)	1.000			
Antenatal visit				
No/incomplete	1.297	0.000	1.184	1.422
Complete	1.000			
Overall autonomy				
Low	1.356	0.000	1.238	1.485
Medium	1.317	0.000	1.171	1.481
High	1.000			

†Dependent variable: LBW=1, other=0 (reference category)

of LBW is that India's different regions are endowed with different natural and human resources like education. The regional disparities inherited from colonial rule, which have increased in the post-independence period because of faulty unified and centralised planning, political structure, and social norms and traditions. Proportion of LBW infants was found to be more frequent in rural areas (21.2%) compared to urban areas (17.8%). This was not only because

of the economic conditions of the households but also may be due to their poor access to medical and educational facilities. Among different socioeconomic and other factors, women's education, type of occupational activities, wealth index (which is a proxy of household economic status), ethnicity (SC, ST) and mother's age at birth were found to be the important predictors of infant LBW.

Earlier studies showed that women with no or primary education were more susceptible to LBW infants (Som *et al.*, 2004; Khatun & Rahman, 2008). Our results corroborate that women of primary or no education were at higher risk (OR=1.844) of delivering LBW infants. The frequency of LBW was significantly high among mothers belonging to Hindu and Muslim communities compared to other religious groups. Relating to caste hierarchy, non-tribal women had significantly higher odds (OR=1.379) compared to tribal women. The fact may be that religion or ethnicity are linked to various cultural practices, which in turn may affect infant BW.

Early age at marriage and teenage pregnancy are quite common in India (NFHS 3, 2007). The effect of mother's age on BW has been a matter of debate, with some studies reporting that teenage mothers are more likely to give birth to preterm infants and of LBW, and others suggest that incidence of LBW in younger adults can be explained in part by biological factors such as not attaining physical maturity and in part by socioeconomic differences which may confound results and weaken any conclusions regarding the effect of age (Joshi *et al.*, 2005; Negi, Khandpal & Kukreti, 2006). Our result confirms that teenage mothers were significantly more affected in delivering LBW babies compared to reference category. Mothers of 20-35 age groups, though not significant, showed that they were at lower risk of delivering LBW babies compared to mothers of 36 and above age group. It was presumed that household economic status played an important role in the determination of LBW in India (Som *et al.*, 2004). The present study also found that the maximum number of mothers giving birth to LBW infants belong to the poor socioeconomic category. The impact of socioeconomic status on LBW may be due to intrauterine growth retardation (IUGR) (Mavalankar, Gray & Trivedi, 1992; Fikree & Berenes, 1994). In such conditions, the infant's LBW stems primarily from mother's poor nutrition and health over a long period. Our result showed similarity with this study. It was observed that mothers with low BMI (underweight) or short stature are more vulnerable to LBW.

It is likely that women with primary or no education have low knowledge or awareness relating to health care practices which consequently may influence fetal growth. Complete or a good number of antenatal care visits may provide routine check-up of mothers with fetal problems (Dubey *et al.*, 2015; Paliwal *et al.*, 2013; Idris *et al.*, 2000). The present findings were similar. Our study also observed that maximum number LBW infants are coming from the mothers who were working as manual labour (30% more) compared to service group.

Similar observations were documented in earlier studies (Shahnawaz *et al.*, 2014). Results from this study have shown that women's poor nutritional status, reflected through low BMI (<18.5 kg/m2) had 48% higher odds of having LBW infants. These findings are in agreement with previous studies (Frederick *et al.*, 2008; Han *et al.*, 2011; Agarwal & Singh, 2012). Several studies examining the relationship between maternal height and LBW showed that shorter maternal height was associated with reduced fetal growth and LBW (Jananthan, Wijesinghe

& Sivananthewerl, 2009; Kramer, 2003; Ozaltin, Hill & Subramanian, 2010; Wills *et al.*, 2010) and concluded that the primary reason for this association was undernutrition/malnutrition.

In this study,the risk of delivering LBW infant was significantly high with odds of 51% or more among the short height women (<145 cm). Understanding the role of women's decision making autonomy in relation to BW is complex because of its multidimensionality and difficulty in formulating an appropriate measure. The results confirmed that women autonomy seemed to be a prime factor towards infant BW though different dimensions of autonomy might have different influences on BW.

Women's independent mobility orfinancial autonomy (money for own use) have much impact on her own health care. Periodic health check-up during pregnancy (antenatal visits) is important for maternal and child health. A study done by Bloom, Wypij & Das Gupta (2001) in North India showed that women's autonomy was the major determinant of maternal health care utilisation. Women with greater freedom inmovement were more likely to receive better antenatal care. Our results showed that women's independent mobility, having money for her own use and four or more antenatal visits had a lower chance of giving birth to LBW infants than their counterparts.

CONCLUSION

The present study found that along with different socioeconomic and related factors, women's autonomy showed a substantial influence on infant BW. In India, women's social position varied widely across regions affecting differences in BW. Therefore, along with the improvement of socioeconomic conditions of mothers, attention should be given to empower women the form of which may vary from region to region.

Authors' contributions

Shome S, performed data analysis, prepared the draft of the manuscript, reviewed the manuscript, reviewed and approved the final manuscript; Pal M, conceptualized and designed the study, adviced on the data analysis and interpretation, reviewed the manuscript, reviewed and approved the final manuscript; Bharati P, assisted in drafting of the manuscript, made critical revision of the manuscript, reviewed and approved the final manuscript.

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Maternal postpartum weight loss and associated factors in Beji subdistrict Depok City, Indonesia

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ABSTRACT

Introduction: Weight retention during postpartum period is generally not preferred by mothers. Mothers are known to reduce energy intake during lactation in order to lose weight. Additional energy is required during lactation to provide for breast milk production. This study aimed at investigating factors that influence postpartum weight loss. **Methods:** Data from a prospective cohort quasi experiment study conducted in Beji subdistrict, Depok City were used. This study had recruited lactating mothers from community health centres and they were followed up from delivery to six months postpartum. A total of 201 breastfeeding mothers determined by cohort sample size formula were included. The dependent variable was six months' postpartum weight loss, while the independent variables included age, energy intake, education, working status, parity and exclusive breastfeeding practice. Bivariate analysis using independent *t*-test and multiple linear regression was used for statistical analysis. **Results:** Mean age of the mothers was 30.3 years (95% CI: 29.8-31.1 years). Majority of the mothers had senior high school education, were not working, multiparous and practising exclusive breastfeeding. Mean intake of energy was 1946 kcal/day (1897-1994 kcal/day). They experienced a mean weight loss of 3.79 kg during the study period (3.27-4.31 kg). Postpartum weight loss was associated with exclusive breastfeeding (p=0.004), and education status of the mothers (p=0.029). **Conclusion**: Exclusive breastfeeding for six months is the dominant factor associated with postpartum weight loss of the mother. Breastfeeding mothers should be supported on their intention to exclusively breastfeed and not be unduly concerned with gaining weight.

Keywords: Exclusive breastfeeding, postpartum, retention, weight loss

INTRODUCTION

The average weight gain during pregnancy ranges from 7-12 kg depending on the mothers' weight before pregnancy (IOM, 2007). Underweight mothers usually gain about 12.5 kg to 18.0 kg compared to mothers with normal weight (11.5 kg-16.0 kg), and obese mothers (7.0 kg-11.5 kg) (IOM, 2007).

After delivery, with the release of infant, placenta, amniotic fluid and blood, the mother's weight will decrease but the decrease is only about 5-6 kg. Most postpartum mothers gain weight, compared to body weight before pregnancy, within one year postpartum (Endres *et al.,* 2015). This leads to women who are initially in the normal weight

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category to become overweight or obese, and triggering the occurrence of long-term obesity (Rooney, 2002). According to the World Health Organization (2008) about 1.5 billion adults older than 20 years are overweight and one-fifth of which are obese women. A total of 2.8 million adults die each year are associated with overweight and obesity (WHO, 2008). In Indonesia, the prevalence of obesity in women is increasing from 13.9% in 2007 to 32.9% in 2013 (National Basic Health Research, MOH-RI, 2013a).

In Indonesia, postpartum mothers are attracted to diets for reduction of energy intake in order to lose weight during breastfeeding. Study by Fikawati *et al.* (2013) in Jakarta and Depok showed that maternal energy intake during breastfeeding was significantly lower (1960 kcal/day) than during pregnancy (2241 kcal/day). This is in contrast to the Indonesian Dietary Recommendations which recommended a higher energy intake per day during lactation (2530-2600 kcal/day) than for pregnancy (2380-2500 kcal/day) (MOH-RI, Indonesia, 2013b).

Various studies have reported an association of energy intake during breastfeeding with success in exclusive breastfeeding for six months (Fikawati, Syafiq & Mardatillah, 2017; Syafiq, Fikawati & Widiastuti, 2015). Additional intake of energy is needed by breastfeeding mothers for breast milk production. The additional energy cost of lactation is estimated at 500 kcal/day, which is fulfilled by increasing energy consumption, reducing energy output and using fat stores (Lovelady, 2011). Normally, shortfalls of energy intake during breastfeeding is derived from the mother's energy reserve built up during pregnancy.

Postpartum mothers' weight gain is also influenced by various factors including age (Endres *et al.,* 2015; Olson, 2010), maternal education (Althuizen *et al.,* 2011; Krummel, 2007), physical activity (Oken *et al.,* 2007), parity (Gunderson *et al.,* 2004), and energy intake (Fikawati *et al.*, 2017; Kristiyanti *et al.,* 2013; Mahan *et al.,* 2012; Padmawati, 2011). This study investigated the factors that influence postpartum weight loss among six-month postpartum mothers using secondary data from a study undertaken in Beji subdistrict Depok City, Indonesia.

MATERIALS AND METHODS

This study analysed data from a quasi-experimental study using a prospective cohort approach undertaken in Beji Sub-district, Depok City (Fikawati *et al.*, 2017). The primary study respondents were mother-infant couples who met the inclusion criteria related to infants: sufficient gestational age, normal birth weight, no malformation, single birth, and criteria related to the mother namely, had no chronic illness, intended to give six months EBF, and willing to participate. A total of 201 mothers were recruited and followed-up for six months. The study was approved by the Commission of Research Expert and Research Ethics of Faculty of Public Health University of Indonesia (Letter of Approval No.180/H2.F10/PPM.00.02/ 2015 dated 20 April 2015).

In this secondary data analysis, all the 201 mothers were included. Variables included in this analysis were weight loss of six-month postpartum, age, energy intake, education, working status, parity, and exclusive breastfeeding for six months. Weight loss was measured by subtracting weight at the beginning from the weight at the end of the study. Age and education by year of schooling of mothers were recorded. Working status was categorised as working or not working based on mother's report. Parity was classified as primiparous and multiparous.

Energy intake was estimated using 24-hour recall conducted monthly. Any supplementation provided during six-month study period was taken into consideration. Exclusive breastfeeding was defined in accordance to WHO definition and checked monthly. Bivariate analysis was conducted using independent t-test to identify significant by differences of weight loss among subjects grouped by variables category. Significance was determined by $p<0.05$. Multivariate analysis used multiple linear regression was conducted to identify dominant factor associated with weight loss as dependent variable after controlling of covariates.

RESULTS

The mean age of the postpartum mothers was 30.3 years, with 95% CI of 29.8-31.1 years and a range of 19-44 years (Table 1). Most respondents (74.10%) have at least a senior high school education.

The average energy intake of the mothers was 1946 kcal/day with a range of 891-2957 kcal/day (95% CI: 1897-1994 kcal/day). The average weight loss experienced by mothers during the six months was 3.79±3.74 kg. Most mothers (83%) lost weight while the rest gained weight. The highest weight loss was 16.0 kg and the highest weight gain was 9.0 kg, with an average weight loss of between 3.27-4.31 kg.

Table 2 presents weight loss based on socioeconomic characteristics (education and working status), maternal parity and exclusive breastfeeding. The group of low education mothers (less than senior high school education) had slightly lower weight loss (-2.89±3.33 kg) compared to high education mothers (-4.11±3.83 kg). The independent *t*-test showed significant difference ($p<0.05$) in mean weight change between the high and low education groups. Most mothers (90.50%) were not employed outside the home. Weight loss of working mothers, on the average, was 4.05±5.39 kg, which was higher than that of non-working mothers of 3.76±3.54 kg, but this difference was not significant.

Most mothers (75.10%) were multiparous. The mean mother's postpartum weight loss in primiparous mothers was higher than that for multiparous mothers, -4.32±3.49 kg and -3.62±3.81 kg respectively, however, this difference was not significant.

Most mothers (92.50%) exclusively breastfed their infants for six months. The average weight loss of mothers who exclusively breastfed for six months was -3.92±3.83 kg, more than mothers who did not, (-2.26±1.72 kg). This result showed statistically significant difference.

In multivariate analysis, six variables were included in modelling namely age, energy intake, education, occupation, parity and exclusive breastfeeding (Table 3). The analysis result showed that standardized coefficient beta value of exclusive breastfeeding variable was

Table 1. Description of respondents' weight loss, age and energy intake

Variable	*Mean*	*SD*	*Min - Max*	*95% CI*
Weight loss (kg)	-3.79	3.74	-16.00 – 9.00	3.27 – 4.31
Maternal age (years)	30.26	5.65	19.00 – 44.00	29.84 – 31.05
Energy intake (kcal)	1945	350	891 - 2957	1897 – 1994

[1] Note: (-) weight loss
[2] Results are expressed as Mean±SD

Table 2. Difference of weight loss based on characteristics of respondents

Variable	*n*	*%*	*Average weight loss (kg)*	*SD*	*p-value*
Maternal education					
Low education (< Senior High School)	52	25.90	-2.89	3.33	0.04
High education (≥ Senior High School)	149	74.10	-4.11	3.83	
Working status					
Working	19	9.50	-4.05	5.39	0.83
Not working	182	90.50	-3.76	3.54	
Parity					
Primiparous	50	24.90	-4.32	3.49	0.25
Multiparous	151	75.10	-3.62	3.81	
Exclusive breastfeeding					
Not giving exclusive breastfeeding	15	7.50	-2.26	1.72	0.004
Giving exclusive breastfeeding	186	92.50	-3.92	3.83	

[1] Results are expressed as Mean±SD

the largest, which means exclusive breastfeeding was the dominant factor of mother's postpartum weight loss after controlling for age, education and energy intake.

Table 3. Multivariate analysis results in maternal postpartum weight loss

Variable	*Non-standardised coefficients, b*	*Standardised coefficients, B*	*p-value*
Age	0.052	0.078	0.265
Education	-1.326	-0.126	0.029
Energy intake	0.001	0.103	0.159
Exclusive breastfeeding	-1.792	-0.156	0.044

DISCUSSION

In this study, six months after delivery, most mothers lost weight, with an average weight loss range of 3.7-4.3 kg. This quantum of postpartum weight loss was not as much as the weight gain during pregnancy of 7.5-11.6 kg reported in another study of Indonesian mothers (Fikawati *et al.*, 2012).

Mothers who breastfed exclusively for six months lost weight (3.92 kg) more than mothers who did not (2.26 kg). This study is in line with study by Kristiyanti & Kusumastuti (2013) stating that weight loss in mothers who give exclusive breastfeeding is 1.54 times more than mothers who do not give exclusive breastfeeding (Oken *et al.,* 2007). The high prevalence of six-month exclusive breastfeeding may be due to effect of intervention in the form of education on exclusive breastfeeding and supplementation provision that becomes an encouraging factor and positive reward for mothers to maintain breastfeeding exclusiveness. This is in line with views of Green and Kreuter (1991) on reinforcement factors (Green *et al.,* 1991) and social behaviour theory from Bandura (1977) on positive rewards.

Breastfeeding mothers who reduce energy intake are at risk of insufficient milk production (Fikawati *et al.*, 2017; Syafiq *et al.*, 2015). Shortened exclusive breastfeeding duration and associated decrease in maternal energy expenditure

may lead to maternal desire to lose weight.

Exclusive breastfeeding was the dominant factor of mother's postpartum weight loss after controlling for age, education and energy intake variables. Many studies showed that exclusive breastfeeding is the significant factor affecting postpartum weight loss. This is because to produce 100 cc of breast milk, mothers can burn 80-90 kcal calories (Oken *et al.*, 2007). The result of this study also is supported by previous studies which showed that exclusive breastfeeding is associated with maternal postpartum weight loss. Furthermore, Baker *et al.* (2008) mentions that exclusive breastfeeding for six months helped mother to lose the remaining weight due to accumulation of postpartum fat after delivery. Epidemiological evidence showed that obese and overweight mothers are less likely to breastfeed their infants than mothers with normal body weight (Amir & Donath, 2007).

The results of this study also showed a significant difference in postpartum weight loss of mothers with low and high education. These results are in line with another study which suggested that postpartum mothers who have low education experience a high weight gain at least 9.07 kg (Endres *et al.*, 2015). The level of education significantly affects the ability to receive nutritional information. The level of education affects the ease with which a person accepts knowledge. The higher the mother's education, the easier is the access to nutrition information (Montgomery *et al.*, 2013). The level of education and nutrition knowledge affected exclusive breastfeeding practice among Indonesian mothers (Fikawati *et al.*, 2014).

This study was subjected to several limitations. The number of subjects might be too small to yield sufficient power to the variables studied, especially for exclusive breastfeeding where almost all mothers were exclusively breastfeeding. Energy intake measurement might be underestimated due to the flat slope syndrome found in this study.

CONCLUSION

Exclusive breastfeeding for six months is the dominant factor associated with postpartum weight loss of the mother. Breastfeeding mothers should be supported on their intention to exclusively breastfeed the infants for six months, and not be unduly concerned with gaining weight.

Conflict of interest

The authors declare that they have no conflict of interest.

Authors' contributions

Fikawati S, principal investigator, concepted and design the study, led the data collection, prepared the draft of manuscript, reviewed the manuscript and revised the manuscript as MJN's reviewer suggestion; Sari VGP, conducted data analysis and interpretation, and added new related references for manuscript.

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Profile of complementary food consumption during the first year of life based on Indonesia Individual Food Consumption Survey 2014

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ABSTRACT

Background: In Indonesia, though the recommendation to start complementary foods (CF) is at six months, mothers do not comply with this recommendation. **Methods:** Data from Indonesia Individual Food Consumption Survey (IFCS) 2014 of 1,514 infants aged 0-11 months was used for this study. The profiles of CF consumption during the first year of life, including frequency of consumption, types of CF, timely introduction and nutritional contents of CF were determined. Mothers were interviewed at home to determine infant intake using 24-hour dietary recall. The IFCS classified CF as home-made or manufactured. Nutrient contents were calculated using several sources. Nutrient intakes from CF for 6-11 months were compared with WHO (2001) and Dewey (2001) recommendations. **Results:** There were 19.2% early and 3.2% late introduction of CF. Homemade complementary foods were widely consumed. Frequency of consumption of CF among 82.7% of infants aged 6-8 month was 2-3 times per day. Intake of fat, iron, zinc and calcium from CF were inadequate in 75.5%, 86.6%, 72.9% and 60.3% respectively among infants aged 6-8 months. Inadequate intake of fat, protein, iron, zinc and calcium were also found among infants aged 9-11 months. Inadequate intake of vitamin D was also found in 89.5% and 88.7% of infants in each age group. Excessive sodium intake was found in 37.2% and 49.3% of infants in each age groups. **Conclusion:** While untimely complementary feeding introduction was found, greater concern was for inadequate intake of several key nutrients and excess intake of sodium among Indoensian infants. Complementary feeding education is recommended.

Keywords: Complementary food, infants, Indonesia Individual Food Consumption Survey (IFCS) 2014

INTRODUCTION

The period from birth to two years of age is a critical window for promotion of infants' optimal growth, health and behavioral development. They should get adequate nutrient intake for optimal growth and development, because inadequate or excessive nutrient intake will have an irreversible impact on the quality of their life. The recommendations for infant and young child feeding have been clearly provided by the World Health Organization (WHO): exclusive breastfeeding for the first six months, thereafter infants should receive complementary foods (CF) due to insufficient nutrient intake from breast milk and continued

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breastfeeding for up to 2 years of age or beyond (WHO, 2001; WHO, 2003. Similarly, the government of Indonesia has also provided recommendations, which are in accordance with WHO recommendations.

Indonesia is facing a nutritional problem in infants and children. According to the Indonesia Basic Health Research 2013, 37% of children under 5 years of age in Indonesia were stunted, 12% were wasted and 19.6% were underweight (Ministry of Health, 2013a). Poor breastfeeding and complementary feeding practices, coupled with high rates of infectious diseases, are the principal proximate causes of malnutrition during the first two years of life. Complementary food is defined as nutritious food that is given to infants aged six months and above in addition to breast milk in order to achieve nutritional need of infants (WHO, 2001).

WHO recommends that complementary foods should have or provide adequate nutrients, be introduced timely and can be consumed 2-3 times per day at the age of 6-8 months and 3-4 times per day at the age of 9-11 months (WHO, 2001; WHO, 2003). Introduction of CF prior to six months of age may displace breast milk and have a negative impact on nutrient intake (Friel *et al.,* 2010). Also, early introduction to complementary feeding does not have any potential benefits in regards to improved growth velocities or food acceptance of infants. On the other hand, delayed introduction to complementary feeding is associated with negative consequences to the infants' health. As breast milk is no longer able to fulfil the nutritional requirements of an infant after six months of age, continuing to feed only breast milk beyond this period leads to nutritional deficiencies and as a consequence malnutrition, the child is susceptible to infections thus increasing morbidity (Basnet *et al.,* 2015).

The purpose of this study is to determine the consumption profile of CF during the first year of life, including frequency of consumption, types of complementary food, and to compare nutritional intake of CF against the nutritional needs of Indonesian infants aged 6-11 months based on the data collected through the IFCS 2014. This study also assessed timely introduction for age group 0-5 months old and 6-11 months old.

MATERIALS AND METHODS

Study population

This study was carried out using the data resulted in the Individual Food Consumption Survey (IFCS) 2014 on 1,514 individuals from the age group of 0-11 months who were part of the National IFCS 2014. The National IFCS survey involved 145,360 individuals aged 0->55 years from all provinces in Indonesia. The surveyed individuals for the age group of 0-11 month were divided into the following age groups: 0–5, 6-8 and 9-11 months.

IFCS 2014 is a cross-sectional survey, which was conducted by the Ministry of Health of the Republic of Indonesia. Food consumption was collected by interviewing the mothers/ householder using a questionnaire. The questionnaire was designed to obtain information on age of infants as well as the type and quantity (weight) of food consumed by infants using 24-hour dietary recall method. The 24-hour dietary recall method was conducted by asking the householder to recall all the food consumed in the past 24 hours (one day) by means of probing using the 5-Step Multiple-Pass Method.

Identification and categorisation of complementary foods

Complementary foods were categorised into two groups, namely homemade complementary food and manufactured complementary food. Homemade

complementary food includes cereals (wheat, rice, barley, oats, rye, maize, millet, sorghum and buckwheat), tubers (cassava, sweet potato, potato, arrowroot, starchy materials (sago, palm), pulses (mung bean, red bean), oil seed (soybean, ground nut, sesame), milk, fish, meat, poultry meat, fruit and vegetables; whereas manufactured complementary food is classified based on it's category and brand.

Assessment of profile of complementary food consumption

a) Identifying the timely introduction of CF is to know the early introduction for infants under the age group of 0-5 months and the late introduction for 6-11 months age group. It is called early complementary food feeding if infants aged 0-5 months have been provided with CF, while those aged 6-11 months but have not yet been given CF fall under the category of late introduction to the complementary food. The proportion of early and late introduction of CF is presented as the number and percentage of sample populations.
b) Identifying the frequency of consumption of CF among infants under the age group of 6-8 months and the 9-11 months age group.
c) Determination of the nutrient content of CF includes energy, protein, fat, vitamins (vitamin B1, vitamin B2, vitamin B3, vitamin B6 dan vitamin D) and minerals (iron, zinc, calcium, phospor, sodium, potassium, iodine, and magnesium). The nutrient content of homemade complementary food was calculated using the Nutrisurvey 2007 software, whereas for foods that are not available in the Nutrisurvey 2007 software the calculation of nutrient content was based on TKPI-2009 or ACFD-2014. Nutrient content of manufactured complementary food was calculated using nutrition information label.

Data analysis

Nutrient intakes of CF to nutritional adequacy was analysed based on WHO (2001) and Dewey (2001) recommendation on percentage amount of nutrient needed from complementary food. Analysis was conducted through the following steps:

a) Calculating the nutrient needed from CF by multiplying the recommendation as percentage amount of nutrient needed from complementary food with Indonesia Recommended Dietary Allowance (Ministry of Health, 2013).
b) Nutrient intake from CF was calculated by counting consumption amount of complementary food per day per individual.
c) Nutrient intake from food is categorised as sufficient when fulfilling 80-120% of nutritional need (McCrory & Campbell, 2011). Referring to those recommendations, nutrient intake analysis was categorised into three groups, namely <80% (less), 80-120% (sufficient) and >120% (excessive).

RESULTS

Out of 1,514 individuals surveyed, 863 (57%) were aged 0-5 months, 288 (19.0%) were 6-8 months old and 363 (23.9%) were 9-11 months of age. The proportions in the age groups of 0-5, 6-8 and 9-11 months who consumed CF were 19.2%, 96.2% and 97.3% respectively. The characteristics of individuals by age and sex are described in Table 1.

Homemade complementary foods were prepared from 342 raw materials which were divided into 15 food groups, whereas manufactured CF consisted of nine variances. Homemade CF was the

Table 1. Individual profile of 0-11 months age group

Age group (months)	*Consuming complementary food*			*Not consuming complementary food*			*Total (persons)*
	Boy (persons)	*Girl (persons)*	*Total (persons)*	*Boy (persons)*	*Girl (persons)*	*Total (persons)*	
0-5	82	84	166	367	330	697	863
6-8	137	140	277	7	4	11	288
9-11	170	183	353	4	6	10	363
Total	389	407	796	378	340	718	1514

most widely consumed among the age groups. Consumption of CF category by age group is described in Figure 1.

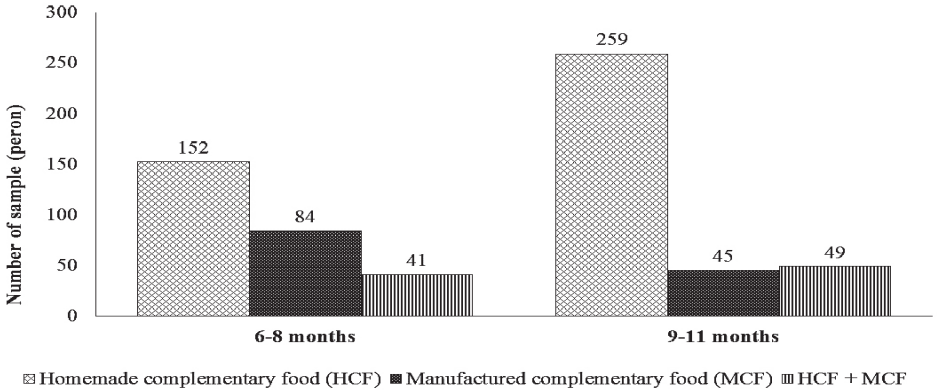

Figure 1. Complementary food consumption by category

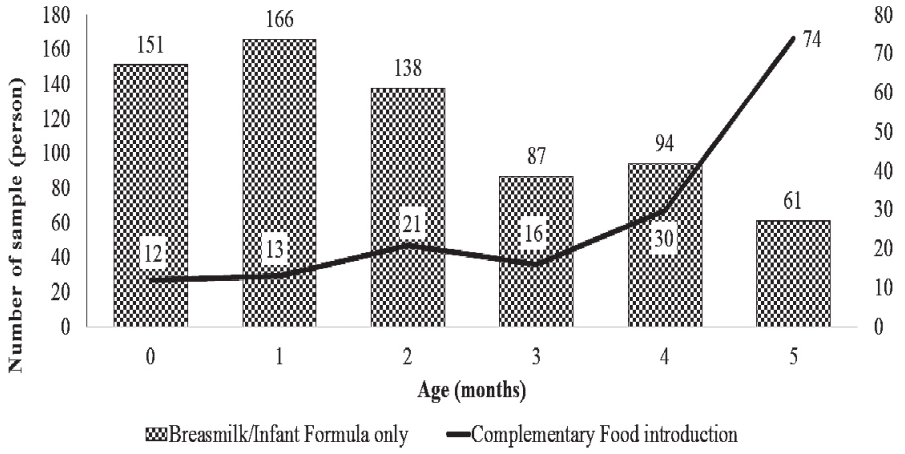

Figure 2. Early introduction profile of complementary food

Timely introduction of complementary food

Out of 863 infants aged 0-5 months, 19.2% were introduced early CF (Figure 2). Manufactured CF, cereal-based homemade CF and fruit-based CF were the most widely consumed by infants aged 0-5 months. In contrast, 3.2% of 651 infants aged 6-11 months had not been introduced with complementary food at the time of the survey.

As for frequency of CF consumption, 82.7% of 6-8 months consumed 2-3 times per day, and 59.5% aged 9-11 months 3-4 times per day.

Nutrient intake of complementary food

Nutrient intake of CF for infants of the 6-8 months age group is described in Figure 3a, Figure 3b and Figure 3c.

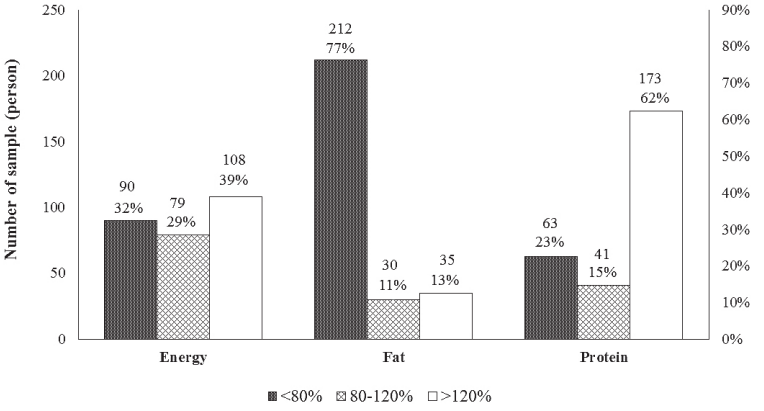

Figure 3a. Macronutrients intake of complementary food for 6-8 months age group

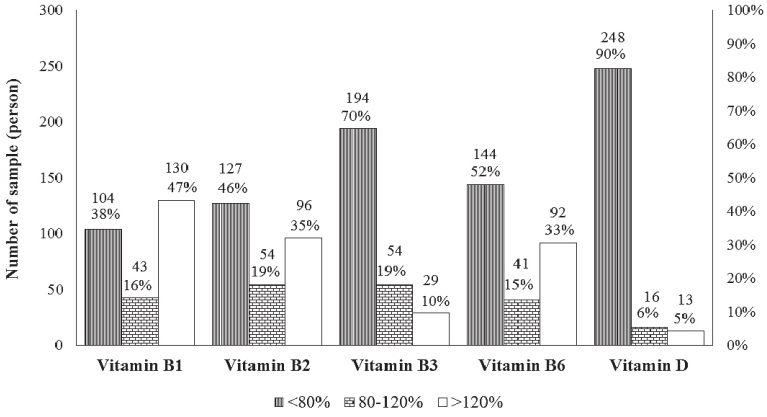

Figure 3b. Vitamins intake of complementary food for 6-8 months age group

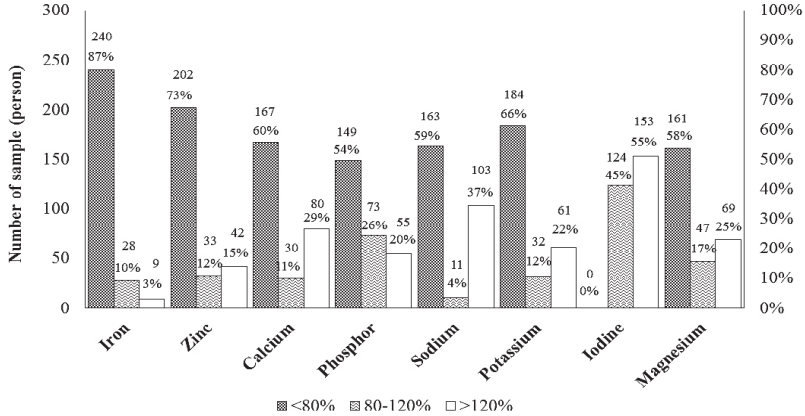

Figure 3c. Minerals intake of complementary food for 6-8 months age group

There were 76.5% who had less intake of fat and 62.5% excessive protein intake. Almost all vitamin intakes were less than recommendations with vitamin D being the worse-off with 89.5% not meeting requirements. As for mineral intake, iron, zinc, potassium, calcium and sodium intake showed 86.6%, 72.9%, 66.4%, 60.3% and 58.8% not meeting respective requirements. In contrast, intake of sodium and iodine exceeded recommendations was found in 55.2% and 37.2% respectively of the infants. The main source of iodine was manufactured CF.

Intake of energy, fat and protein were below recommendations among aged 9-11 months involving 69.1%, 90.4% dan 47.0% individuals respectively (Figure 4a). Almost all vitamin and mineral intakes were below requirements with vitamin D as the lowest involving 88.7% of the infants (Figure 4b and Figure 4c). Also for this age group, sodium and iodine intake exceeded recommendations in 49.3% and 11.0% respectively of the infants.

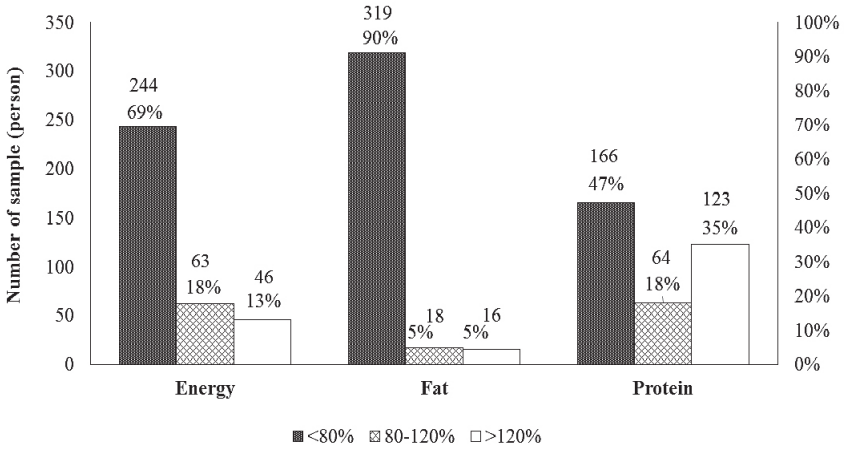

Figure 4a. Macronutrients intake of complementary food for 9-11 months age group

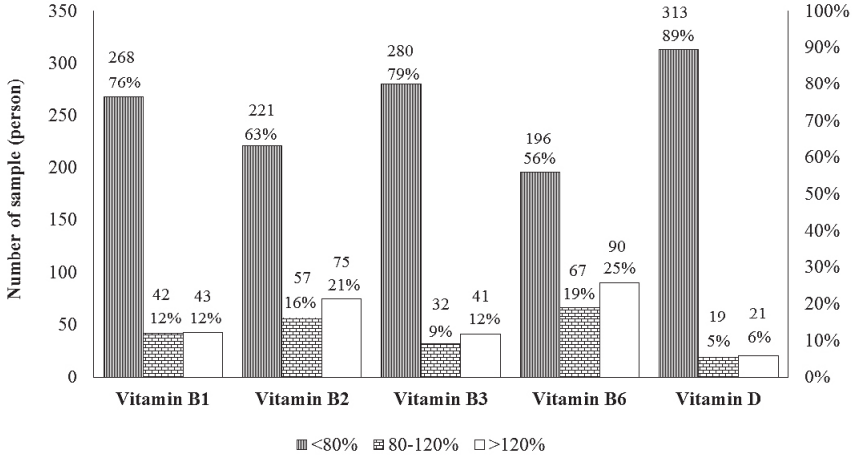

Figure 4b. Vitamins intake of complementary food for 9-11 months age group

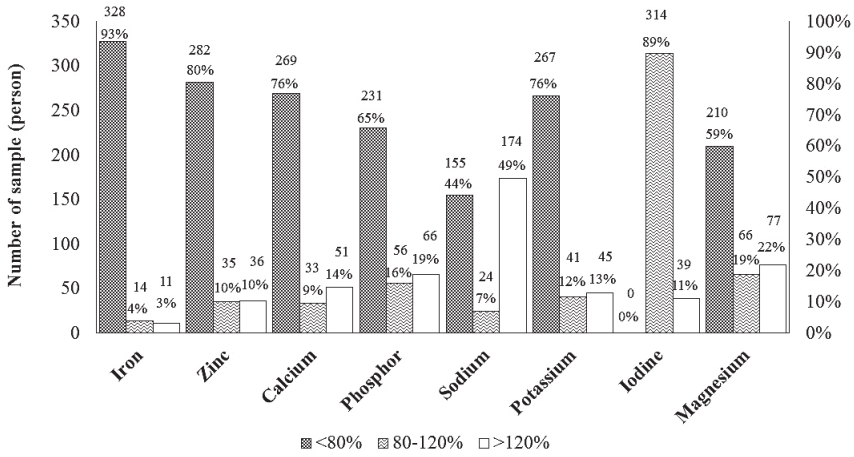

Figure 4c. Minerals intake of complementary food for 9-11 months age group

DISCUSSION

In many developing countries, manufactured CF is difficult to obtain due to very limited availability. As a result, homemade complementary foods are frequently used for child feeding (Abeshu, Lelisa & Geleta, 2016). As a developing country, in Indonesia, homemade CF is also the most widely consumed among infants aged 6-11 months. According to WHO recommendations, the purpose of feeding practice is to get used to eating family food (Indonesian Pediatrician Association, 2015). The cases of early and late introduction of CF were found in Indonesia, however, the late introduction case is less than the early introduction. It is important to educate the members of the community about the impact of early introduction. An argument by Saleem *et al.* (2014) suggests that mother's education have a positive impact on the timely and appropriate complementary food feeding. The untimely introduction was also found in other countries. A study of 562 mothers with children aged 6-23 months in Ethiopia, showed that 59.6% of them were introduced CF before the age of six months (Agedew *et al.,* 2014). A study in northeast Italy involving 400 infants reported that 7.0% were given CF at three months, 32.0% at four months, and 47.0% at five months (Carletti *et al.,* 2017). Basnet *et al.* (2015) and Mrosková, Schlosserová, & Magurová (2016) reported various reasons given by the mothers for early introduction of CF, including insufficient breast milk, infants were old enough to be given CF, needed to return to work, infants were able to take CF, and infants were often hungry on breast milk only.

Frequency of CF consumption among the Indonesian infants was in line with WHO recommendations for breastfed infants. This study however, did not analyse the difference of consumption frequency between breastfed and non-breastfed infants or combination of both. WHO has provided different recommendations for the breastfed and non-breastfed infants.

Infants belonging to the 6-8 month age group received excessive protein, compared to those aged 9-11 months. Breastmilk is deemed adequate as the main source of protein, and only 21% of the recommended dietary allowance for protein is needed from CF for infants 6-8 months (WHO, 2001; Dewey, 2001). As for ages 9-11 months, 42% of their required protein has to be from CF, owing to decreasing protein from breastmilk.

Fish, cereal, and poultry and game meat are the major sources of protein.

Vitamin intake in the CF was low by the majority of the infants. Inadequate intake of vitamins could lead to metabolic disorders, which in turn will have a negative impact on growth. Intake of zinc, calcium, iron was also below recommendations. Campos *et al.* (2010) reported nutrient intake from CF of 64 infants aged 6-12 months in Guatemala were near recommendation levels except for calcium, iron and zinc, identified as "problem nutrients". Fortifing CF with iron was reported effective in reducing iron deficiency (Qasim & Friel, 2015); Wang *et al.,* 2009). According to Dewey (2001), the content of these three minerals in breast milk decrease significantly and should be supplied by CF. Iron, zinc and calcium intake of Indonesian infants were mainly from manufactured CF, but the amount of manufactured CF consumption was very small compared to homemade CF that are largely vegetable based.

This study found iodine intake to be generally sufficient. Iodine's content in breast milk is sufficient for infants and not necessary to be supplied by CF (Dewey, 2001). It is recommended to reduce salt in CF as this analysis found excessive sodium intake in the CF consumed. WHO (2003) recommended reduced sodium intake as there is a correlation between high sodium intake with the risk of hypertension.

CONCLUSION

There are cases of early and late introductions of complementary feeding to Indonesian infants. Frequency of complementary food consumption for 6-8 months age group was 2-3 times per day and 3-4 times per day for the 9-11 months age group. Intake of fat, iron, zinc and calcium was found to be insufficient. There was excessive iodine and sodium intake in some individuals. Almost all vitamin intakes were inadequate with vitamin D being the lowest. To improve this, government policies on complementary feeding education and homemade complementary food supplementations are thus required.

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Authors' contributions

Yusra E contributed to study concept and design, data acquisition, analysis, and interpretation, and manuscript writing; Nurheni SP and Endang P contributed to study concept and design, analysis, and critical revision of the manuscript and approved the final draft.

Conflict of interest

The authors declare that they have no competing financial interests and that their freedom to design, conduct, interpret, and publish research is not compromised by any controlling sponsor.

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Food choices among Malaysian adults: Findings from Malaysian Adults Nutrition Survey (MANS) 2003 and MANS 2014

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ABSTRACT

Introduction: Changes in dietary habits are known to be associated with changes in health outcomes. This study determined food choices among Malaysian adults using secondary data of the Malaysian Adults Nutrition Survey (MANS) in 2003 and MANS in 2014. **Methods:** A total of 6,742 and 3,000 adults aged 18 to 59 years participated in MANS 2003 and MANS 2014, respectively. Both studies used a semi-quantitative food frequency questionnaire (FFQ) to assess habitual food intake. **Results**: Overall, the prevalence of adults consuming rice twice daily were 97.3% and 86.9% in 2003 and 2014, respectively. While the percentage of urban dwellers who consumed rice daily differed significantly between 2003 (96.7%) and 2014 (86.9%), the percentage remained quite similar among rural adults in 2003 (97.8%) and 2014 (96.3%). Other top ten food items consumed daily were sugar (2003, 58.5% vs 2014, 55.9%), marine fish (40.8% vs 29.4%), green leafy vegetables (39.9% vs 43.2%) and sweetened condensed milk (35.2% vs 29.3%). In both surveys, a higher percentage of men consumed rice, sugar and sweetened condensed milk on a daily basis compared to women, a higher proportion of whom daily consumed green leafy vegetables and marine fish. Majority of the adults reported drinking plain water daily. Other beverages taken daily were tea, coffee and chocolate-malt drinks. **Conclusion:** Rice, sugar and sweetened condensed milk were among the top food items consumed daily in 2003 and 2014. Educational efforts to improve dietary intake of Malaysian adults is recommended.

Keywords: Dietary, food consumption, Malaysian Adults Nutrition Survey (MANS)

INTRODUCTION

Malaysia is known for its multi-cultural people and foods. With the emerging multimedia technologies in food marketing, it influences the food choice decisions among Malaysian consumers especially adults. Eating habits play a very important role in determining one's health status and level of morbidity of diseases occurring in a population because whatever food that we consume, it will impact our well-being (Francesco, Jessica & Emile, 2011).

Food choices are known to be associated with general health and the

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rapid socio-economic growth in Malaysia has influenced the lifestyle of Malaysian people. It was closely linked to the awareness of people towards healthy food intake as one of the best methods to improve health and well-being of the body in spite of reduced risk of specific diseases. Anyway, the number of consumers who believed that food can contribute directly to their health and well-being has increased all over the world (Golnaz *et al.*, 2012). Similarly, to Malaysians, they also felt the same due to a rapid change in consumer's preference towards changes in food choices, consumer's lifestyle and food consumption patterns (Golnaz *et al.*, 2012).

Agricultural practises have changed over the past 50 years and have seen increases in productivity, greater diversity of foods and less seasonal dependence. Food availability also increased as a consequence of raising the income levels of the consumers (Kearny, 2010). Similar to food choices, changes in dietary habits are known to be associated with changes in health status and may increase the prevalence of chronic diseases. Therefore, it is advisable to take a balanced diet every day and practice physical exercise despite having access to sources of adequate, nutritious, safe and good quality foods. The National Plan of Action for Nutrition Malaysia (NPANM) 2006-2015 was developed to provide nutrition knowledge and guidance on choosing the right and healthy food among the Malaysian population.

This paper examines the food choices among Malaysian adults from 2003 to 2014 using secondary data from Malaysian Adults Nutrition Survey 2003 (MANS 2003) (Institute for Public Health, 2003) and Malaysian Adults Nutrition Survey 2014 (MANS 2014) (Institute for Public Health, 2014).

MATERIALS AND METHODS

This is a retrospective study using secondary data from MANS 2003 and 2014. Both studies were nationwide cross-sectional studies which were carried out by the Institute for Public Health (IPH), Ministry of Health Malaysia. Geographically, both surveys covered the whole of Malaysia, both urban and rural areas. It covered only households living in private Living Quarters (LQs) which was divided into several Enumeration Blocks (EBs). An EB is a geographical continuous area with identified boundaries which contained between 80 to 120 LQs with an average population of 500 to 600 people.

The sampling frame was provided by the Department of Statistics (DOS), Malaysia. Multi-stage stratified cluster sampling was adopted as sampling method. A stratified random sampling with proportional allocation was used for both surveys which covered six zones in Malaysia such as Southern, Central, East Coast and Northern zones of Peninsular Malaysia, Sabah and Sarawak. A total of 6,742 and 3,000 adults aged 18 to 59 years were recruited in MANS 2003 and MANS 2014 respectively (IPH, 2003; IPH 2014). The first stage units of sample selection were the EBs while the second stage units were the LQs within the selected EBs. Random probability sampling was used to select LQs from each selected EBs and twelve LQS were selected from each selected EBs. The selection of LQs was also done by DOS, Malaysia.

Both studies used a semi-quantitative food frequency questionnaire (FFQ) to assess dietary behaviour among adults in Malaysia. The FFQs were developed and pre-tested in bi-lingual (Bahasa Malaysia and English). The FFQs consisted of more than 100 food items which were listed according to food groups and were administered

by interviewers through face-to-face interview, where respondents were asked to recall the frequency of intake of each listed food item by day, week or month. There were four main columns in the FFQ. The first column contained list of food items, second column described the frequency of intake by day, week or month, third column described the serving size of each food item such as cup, slices, pieces, spoon and so on, and the fourth column described the number of servings consumed each time the food item was eaten.

The only difference in the two surveys was that MANS 2003 used FFQ that comprised 13 food groups with 126 food items whereas MANS 2014 used the same FFQ but upgraded to 14 food groups with 165 food items (IPH, 2003; IPH 2014). The additional food group in MANS 2014 was fast food which consists of 8 food items such as burger, pizza, potatoes, sausage and so on. In MANS 2003, all the fast foods were in the group of meat and meat product. Besides, MANS 2014 added some food items in each groups such as brown rice and wholemeal bread in cereal product group, quail and internal organs in meat product group, snails, dried squid and its crackers in fish and seafood group, soy bean pudding in legumes product group, commercial milk in milk product group, tomatoes, brinjals and other vegetables, pickled fruits and many others in fruits group, pre-mixed drinks, herbals and botanic drink, chocolate bar, cream crackers and so on in confectionaries group, chocolate and garlic spread, and some additional in flavours group.

Respondents were also requested to report the number of serving(s) they consumed each time they eat the food. A food photo album describing the portion sizes of common Malaysian foods was specially developed and used in both surveys (MOH, 2004). It contains photographs of several locally available foods, either cooked or raw. Its purpose was to help the respondents to identify the types of food and the amount they eat during the interview session. These foods were shown in various serving sizes as mentioned above.

Both surveys were based on a complex, multistage sample design. Data analysis for these surveys took into account the complex survey design and the sample weights as well. Other than descriptive analysis, zeta test was used to produce the *z*-score to indicate significant changes among the top ten prevalence of food most consumed. The data was analysed using SPSS version 20 (SPSS IBM, New York, U.S.A) and STATA.

This survey (NMRR-12-815-13100) was reviewed and approved by the Medical Research and Ethics Committee, Ministry of Health Malaysia. All respondents were provided with information sheet and a copy of signed consent form. In the case of illiterate respondents, the information sheet and consent form were read to them and their thumb print was taken to replace written signature.

RESULTS

The prevalence and mean frequency of the top ten food items consumed daily by Malaysian adults in MANS 2003 and MANS 2014 are shown in Table 1. A high prevalence (97.2%) of Malaysian adults consumed white rice twice a day with an average of two plates (95% CI: 2.1, 2.2) per day in 2003. In 2014, white rice was consumed twice a day at a significantly lower prevalence of 89.8%, with an average of 2.5 plates (95% CI: 2.4, 2.6) daily. MANS 2003 showed that 58.5% of Malaysian adults consumed sugar with an average of four teaspoons per day, followed by marine fish (40.8%) and green leafy vegetables (39.9%). In 2014,

Table 1. Prevalence and mean frequency of the top ten food items consumed daily (MANS 2003 and MANS 2014)

MANS 2003				*MANS 2014*			
Food Items	*Prevalence (%)*	*Servings consumed per day (95% CI)*	*Intake per day (g)*	*Food Items*	*Prevalence (%)*	*Servings consumed per day (95% CI)*	*Intake per day (g)*
White rice	97.2	2.1 (2.1, 2.2) plates	210.0	White rice	89.8	2.5(2.4, 2.6) plates	250.0
Sugar	58.5	4.1 (3.9, 4.3) teaspoons	20.5	Sugar (white, brown, palm sugar)	55.9	3.7(3.4, 3.9) teaspoons	18.5
Marine fish	40.8	1.9 (1.8, 2.0) whole medium	201.4	Green leafy vegetables	43.2	5.9(5.6, 6.3) tablespoons	88.5
Green leafy vegetables	39.9	4.8 (4.7, 5.0) tablespoons	72.0	Marine fish	29.4	1.6(1.5, 1.7) whole medium	169.6
Sweetened condensed milk	35.3	2.8(2.7, 2.9) teaspoons	25.2	Chilies	24.2	1.8(1.6, 2.1) tablespoons	12.6
Powdered milk	17.1	3.1(3.0, 3.2) tablespoons	22.5	Condensed milk/creamer	23.5	2.7 (2.3, 3.0) tablespoons	24.3
Bread	17.1	3.3(3.1, 3.5) slices	94.1	Soy sauce	20.3	2.1(1.9, 2.3) teaspoons	17.8
Biscuit	16.3	4.8 (4.6, 5.0) pieces	36.8	Biscuit	13.8	4.8(4.3, 5.4) pieces	43.2
Traditional delicacies	14.5	2.3(2.2, 2.4) pieces	69.0	Condiment	14.6	2.4(2.1, 2.7) teaspoons	19.2
Hen eggs	12.1	1.7(1.2, 2.1) whole medium	91.8	Hen eggs	14.2	1.6(1.4, 1.8) pieces	86.4

Table 2. Prevalence and mean frequency of the top ten food items consumed daily according to sex (MANS 2003 and MANS 2014)

MANS 2003						*MANS 2014*					
Men			*Women*			*Men*			*Women*		
Food Items	*(%)*	*Mean Servings per day (95% CI)*	*Food Items*	*(%)*	*Mean Servings per day (95% CI)*	*Food Item*	*%*	*Mean Servings per day (95% CI)*	*Food Items*	*%*	*Mean Servings per day (95% CI)*
White rice	97.9	2.3 (2.2, 2.3) plates	White rice	96.4	2.0 (1.9, 2.0) plates	White rice	92.6	2.9 (2.7, 3.0) plates	White rice	86.8	2.0 (1.9, 2.1) plates
Sugar	59.9	4.4 (4.2, 4.6) teaspoons	Sugar	57.1	3.8 (3.6, 4.0) teaspoons	Sugar	58.2	4.0 (3.7, 4.4) teaspoons	Sugar	53.3	3.2 (2.8, 3.6) teaspoons
Sweetened condensed milk	42.6	3.1 (2.9, 3.2) teaspoons	Marine fish	41.8	1.8 (1.7, 1.9) whole medium	Green leafy vegetables	39.8	6.1 (5.6, 6.7) tablespoons	Green leafy vegetables	46.8	5.7 (5.3, 6.1) tablespoons
Marine fish	39.8	2.0 (1.9, 2.1) whole medium	Green leafy vegetables	41.6	4.8 (4.6, 5.0) tablespoons	Marine fish	28.3	1.7 (1.5, 1.8) whole medium	Marine fish	30.5	1.5 (1.4, 1.7) whole medium
Green leafy vegetables	38.2	5.0 (4.7, 5.3) tablespoons	Sweetened condensed milk	28.3	2.5 (2.3, 2.6) teaspoons	Sweetened condensed milk	26.2	3.0 (2.5, 3.5) teaspoons	Chilies	25.4	1.9 (1.5, 2.2) teaspoons
Bread	15.4	3.7 (3.3, 4.0) slices	Powdered milk	22.6	3.2 (3.0, 3.4) tablespoons	Chilies	23.1	1.8 (1.5, 2.1) teaspoons	Sweetened condensed milk	20.6	2.2 (2.0, 2.4) teaspoons
Traditional delicacies	15.4	2.4 (2.2, 2.6) pieces	Bread	18.8	3.0 (2.7, 3.3) slices	Soy sauce	21.0	2.2 (4.1, 6.5) teaspoons	Soy sauce	19.5	2.0 (4.1, 4.9) teaspoons
Hen eggs	14.7	1.9 (1.2, 2.6) whole medium	Traditional delicacies	13.6	2.2 (2.0, 2.4) pieces	Hen eggs	18.1	1.7 (1.4, 2.1) whole medium	Biscuits	17.9	4.5 (4.1, 4.9) pieces
Biscuits	12.5	5.4 (5.0, 5.8) pieces	Biscuits	13.6	4.4 (4.1, 4.6) pieces	Chicken meat	15.5	1.8 (1.5, 2.1) pieces	Condiment	14.4	2.4 (2.0, 2.8) teaspoons
Chicken meat	12.4	1.8 (1.6, 2.0) pieces	Anchovies	12.8	1.7 (1.6, 1.9) tablespoons	Condiment	14.8	2.4 (2.1, 2.8) teaspoons	Anchovies	13.0	1.5 (1.3, 1.6) tablespoons

Table 3. Prevalence and mean frequency of the top ten food items consumed daily by strata (MANS 2003 and MANS 2014)

MANS 2003						*MANS 2014*					
Urban			*Rural*			*Urban*			*Rural*		
Food Items	*(%)*	*Mean Servings per day (95% CI)*	*Food Items*	*(%)*	*Mean Servings per day (95% CI)*	*Food Item*	*%*	*Mean Servings per day (95% CI)*	*Food Items*	*%*	*Mean Servings per day (95% CI)*
White rice	96.7	2.0 (1.9, 2.1) plates	White rice	97.8	2.3(2.2, 2.4) plates	White rice	86.9	2.3 (2.2, 2.4) plates	White rice	96.3	2.9 (2.7, 3.0) plates
Sugar	51.4	3.5(3.4,3.7) teaspoons	Sugar	69.1	4.7 (4.5, 5.0) teaspoons	Sugar	50.5	3.4 (3.1, 3.8) teaspoons	Sugar	68.1	4.0 (3.5, 4.5) teaspoons
Green leafy vegetables	42.2	4.6 (4.4, 4.8) tablespoons	Marine fish	51.3	2.2(2.0, 2.3) whole medium	Green leafy vegetables	44.6	5.8 (5.3, 6.2) tablespoons	Marine fish	43.5	1.7 (1.6, 1.8) whole medium
Sweetened condensed milk	34.9	2.7 (2.5, 2.9) teaspoons	Green leafy vegetables	36.5	5.3(5.0, 5.7) tablespoons	Marine fish	23.6	1.5 (1.4, 1.7) teaspoons	Green leafy vegetables	39.9	6.3 (5.6, 7.1) tablespoons
Marine fish	33.6	1.7 (1.6, 1.8) whole medium	Sweetened condensed milk	36.5	3.0(2.9, 3.2) teaspoons	Chilies	23.5	1.9 (1.5, 2.2) teaspoons	Sweetened condensed milk	27.4	2.6 (2.4, 2.8) teaspoons
Bread	19.6	3.2 (2.9, 3.4) pieces	Traditional delicacies	19.7	2.3(2.1, 2.5) pieces	Sweetened condensed milk	21.8	2.7 (2.2, 3.2) teaspoons	Chilies	26.8	1.8 (1.4, 2.1) teaspoons
Powdered milk	18.5	3.2 (3.0, 3.4) tablespoons	Biscuits	18.6	5.0(4.8, 5.4) pieces	Soy sauce	20.2	2.0 (1.7, 2.2) teaspoons	Soy sauce	20.6	2.4 (1.9, 2.8) teaspoons
Biscuits	14.7	4.5 (4.2, 4.8) pieces	Anchovies	16.1	1.8 (1.7, 1.9) teaspoons	Chicken meat	14.3	1.8 (1.5, 2.0) pieces	Traditional delicacies	17.5	2.7 (2.4, 2.9) pieces
Chicken meat	12.0	1.7 (1.6, 1.9) pieces	Powdered milk	15.1	2.9 (2.7, 3.1) tablespoons	Hen eggs	14.1	1.5 (1.3, 1.7) whole medium	Condiment	16.8	2.7 (2.1, 3.3) teaspoons
Hen eggs	11.8	1.4 (1.3, 1.5) whole medium	Bread	13.4	3.6 (3.2, 4.0) pieces	Condiment	13.7	2.3 (1.9, 2.6) teaspoons	Anchovies	16.3	1.8 (1.6, 2.0) tablespoons

Table 4. Comparison of prevalence of food intake between MANS 2003 and MANS 2014

Food Items	*MANS 2003*		*MANS 2014*		*z-score*
	Prevalence (%)	*Standard error*	*Prevalence (%)*	*Standard error*	
White rice	97.20%	0.0028	89.80%	0.0090	-7.85***
Sugar	58.50%	0.0071	55.90%	0.0149	-1.58
Marine fish	40.80%	0.0069	29.40%	0.0146	-7.06***
Green leafy vegetables	39.90%	0.0070	43.20%	0.0148	2.02*
Sweetened condensed milk	35.30%	0.0070	23.50%	0.0114	-8.82***
Powdered milk	17.10%	0.0055	10.10%	0.0080	-7.21***
Bread	17.10%	0.0056	11.90%	0.0083	-5.19***
Biscuits	16.30%	0.0053	13.80%	0.0086	-2.47*
Traditional delicacies	14.50%	0.0048	12.10%	0.0089	-2.37*
Hen eggs	12.10%	0.0050	14.20%	0.0088	2.07*

Significant level for zeta test with *z*-score 1.96 **(p<0.05), **p<0.01 (2.576), ***p<0.001 (3.29)*

the prevalence of sugar consumption remained high (55.9%) among the Malaysian population, and a higher percentage of people consumed green leafy vegetables (43.2%) compared to marine fish (29.4%).

Other food items being consumed daily in 2003 by a smaller proportion of Malaysian adult population were sweetened condensed milk (35.3%), powdered milk (17.1%), bread (17.1%), biscuits (16.3%), traditional delicacies (14.5%), and hen eggs (12.1%). In 2014, 24.2% of Malaysian adults consumed chilies daily, followed by sweetened condensed milk (23.5%), soy sauce (20.3%), biscuits (13.8%), condiment (14.6%), and hen eggs (14.2%). All these food items were consumed at least once a day (Table 1).

Table 2 shows the prevalence and mean frequency of the top ten food items consumed daily by gender from MANS 2003 and MANS 2014. In 2003, the prevalence of white rice consumption was 97.9% among men and 96.4% among women, while 92.6% and 86.8% among men and women respectively in 2014. From 2003 to 2014, Malaysian adults consumed an average of two to three plates of white rice twice daily. More than half of the Malaysian population consumed sugar daily in MANS 2003, with a prevalence of 59.9% among men and 57.1% among women. In MANS 2014, the prevalence of sugar consumption was 58.2% and 53.3% among men and women respectively. A higher percentage of women consumed marine fish (41.8% vs 39.8%) and green leafy vegetables (41.6% vs 38.2%) daily compared to men in MANS 2003, while a higher percentage of men consumed sweetened condensed milk (42.6% vs 28.3%) daily compared to women in 2003. Similarly, in 2014, a higher percentage of women

consumed green leafy vegetables (46.8% vs 39.8%) and marine fish (30.5% vs 28.3%) daily compared to men. A higher percentage of men consumed sweetened condensed milk (26.2% vs 20.6%) daily compared to women in 2014. Other food items that are being consumed daily by both genders in 2014 were presented in Table 2.

The prevalence and the mean frequency of the top ten food items consumed daily by strata from MANS 2003 and MANS 2014 are shown in Table 3. Results showed that 96.7% of urban dwellers consumed white rice daily in MANS 2003 and the prevalence was 86.9% in 2014 (average 2-3 plates per day). The prevalence of white rice consumption among rural dwellers in 2003 and 2014 were 97.8% and 96.3% respectively. In both surveys, the prevalence of daily sugar consumption was higher among adults residing in rural areas (69.1% in MANS 2003 and 68.1% in MANS 2014) compared to those residing in urban areas (51.4% in MANS 2003 and 50.5% in MANS 2014). In 2003, 42.2% of adults from urban areas consumed green leafy vegetables daily, followed by sweetened condensed milk (34.9%), marine fish (33.6%) and so on. After 10 years in 2014, 44.6% of urban dwellers consumed green leafy vegetables daily, followed by marine fish (23.6%), chilies (23.5) and so on. From 2003 to 2014, approximately half of the Malaysian adult population who residing in rural areas consumed marine fish daily, with the prevalence of 51.3% in 2003 and 43.5% in 2014. Other food items that are being consumed daily by adults from rural areas in 2014 were presented in Table 3.

White rice, marine fish, sweetened condensed milk, powdered milk and bread showed significantly decreased among the top ten food items consumed. Malaysian adults demonstrated a good habit of drinking plain water daily, 99.0% in 2003 and 98.2% in 2014 (Table 4).

DISCUSSION

Both surveys portray that rice is the most important food crop and the primary source of food among Malaysians. Food is the basic human need of calories, which provides energy, nutrients and other requirements that are essential for growth and health (Wardle *et al.*, 2004). Both surveys found that Malaysian adults prefer sugar as the second choice of food intake in daily living to replace sweetened condensed milk. However, with awareness of less sugar intake, a significantly lower percentage of Malaysian people consumed sugar and sweetened condensed milk daily in MANS 2014. Both sugar and sweetened condensed milk are carbohydrates that provide high sugar level, which might increase the risk of overweight and may contribute to chronic diseases, including diabetes, hypertension and heart problems (Mohamad Asif, 2014). The increasing intake of foods with high sugar content is often seen as major factors contribute to the raising of obesity (Amarra, Khor & Chan, 2016). MANS 2014 reported that prevalence of overweight in Malaysia was 32.4% (95% CI: 29.9-35.1) which is increasing every year. In view of the perspective of nutrition, eating habits and food choices play a very important role to determine the health status and level of morbidity. It is clearly stated that whatever food we eat will have a direct impact on our health and existence of particular diseases (Mohamad Asif, 2014).

Majority of Malaysian adults consumed white rice twice a day with an average intake of 2.5 plates per day. Results showed that rice was the main food for Malaysians and normally rice was consumed during lunch and dinner. The lunch and dinner food patterns

in Malaysia consisted of rice and vegetables, plus either chicken or fish as a protein intake (Nur Indrawaty, Khor & Imelda, 2012). Previous study reported that *nasi lemak* was the first choice in terms of breakfast food for most of their participants both from the urban and rural areas in Malaysia (Nur Indrawaty *et al.*, 2012). Rice also becomes the primary ingredient in daily meals and source for traditional foods menu planning in Malaysia (Nur Hafizah *et al.*, 2013). Sometimes fried rice is also one of the dishes for breakfast among Malaysians and this indicates that rice is the main and first choice food in Malaysia. Rice is the staple food for all ASEAN countries.

From 1970 to 2009, the domestic utilisation of rice rose to more than 100% in all South-East Asia countries between the four decades. Thus, rice production needs to be scaled up to support the increasing needs of the growing population (Soon & Tee, 2014). In 2014, rice consumption significantly decreased, similarly with other food items such as marine fish, powdered milk and bread. However, Malaysian people still believed that energy intake derived much more from rice. Same as in Japan, although rice consumption has decreased over the past several years in Japan but 30% of energy intake of Japanese is still derived from rice (Nanri *et al.*, 2010). Besides white rice, results from both surveys showed that other food items such as sugar, green leafy vegetables and marine fish were commonly consumed either daily or weekly by Malaysian adults.

Food choices are important because they are basic necessity for human beings. The selection of food is closely linked to the awareness of people towards healthy food intake for improving well-being and reducing the risk of specific diseases. Furthermore, the absence of food and nutrition security may have significant effects such as malnutrition, obesity, diseases and poverty (Hammond & Dube, 2012). It should be noted that the occurrence of diseases or negative health outcomes is closely related to dietary habits among Malaysian adults where some of them practiced a balanced diet but some were not. People who have less nutrition knowledge may have unhealthy food choices in their daily life and will generate unhealthy life (Shridhar *et al.*, 2015). This global problem of consuming a large scale of unhealthy diet and its impact on human health needs to be emphasised. People should be educated to increase health awareness, limit consumption of unhealthy foods and practise healthy eating habits for a better living (Shridhar *et al.*, 2015).

Findings from MANS 2003 and MANS 2014 showed that mean frequencies for daily intake of white rice, sugar and sweetened condensed milk were significantly higher among men compared to women. Results showed that men consumed higher carbohydrates than women and this probably due to their height, weight, activity level, workload and their preference to eat. On the other hand, women consumed significantly higher servings of marine fish and green leafy vegetables compared to men. As a concern, women are more dissatisfied with their bodies and always concerned about their appearance as an influence on their feelings of well-being. It is noted that women desire to control their body weight and much more concern about health, thus they tend to choose healthier diet compared to men (Gaston & Adriana, 2007). In general, men usually prefer to have fewer high fibre foods, and fewer fruits and vegetables compared to women (Wardle *et al.*, 2004). However, both MANS 2003 and 2014 revealed that consumption of fruits is still low among Malaysian adults and it is not included in the top ten daily consumed foods. Similarly, in southern, central, eastern

European countries and Australia, fruits and vegetables consumption still remains below the recommended levels (Kearny, 2010).

The Malaysian Dietary Guidelines (2010) recommend a daily minimum intake of five servings of fruits and vegetables (approximately 400g) which are two servings for fruits and three servings for vegetables per day. Early this year, the Ministry of Health Malaysia advised all Malaysians to take more fruits and vegetables through the *'suku-suku separuh'* (Quarter Quarter Half, Malaysian Healthy Plate) campaign which divided the portions of a plate to a quarter for meat and fish, a quarter for grains and nuts and half for fruits and vegetables. Sufficient intake of fruits and vegetables has been related with reducing risk of chronic disease and body weight management (Pem & Jeewon, 2015).

Both surveys showed that a small proportion of men consumed chicken and eggs daily. This could be due to chicken and eggs being more affordable and easier to obtain from markets or stores as compared with other food items. In addition, men from urban areas indicated a higher consumption of cooked food and fast food than men from rural areas. These local fast foods are widely consumed in huge servings, many times a week and many of the office workers have their limited access to healthier choices around their work place (Soon & Tee, 2014). Nowadays, eating fast food is not only prevalent among adult population, but also commonly practiced among children. This indicates that children will have a high tendency to take unhealthy foods and drinks, which are known to have a high content of sugar, fats and salt (Totu, Oswald & Halik, 2013). In Malaysia, local fast foods are on sale literally everywhere throughout the day whether it is at the roadside hawker stalls to posh restaurants as well.

Findings from MANS 2003 and MANS 2014 showed that a small proportion of women consumed breads and biscuits daily. We postulated that the convenient, light packaging of crackers and their relatively longer shelf life compared with that of breads might be the reasons why women nowadays tend to choose biscuits for convenience and its longer storage time. It is also possible that they felt that by choosing the right types of biscuit, they would maintain their body weight by reducing their calorie and fat intake. Women were always found to have a better dietary intake compared to men especially in daily breakfast and meal frequency (Kremmyda *et al.*, 2008). Furthermore, women were found to choose eating more fruits, vegetables, cereals and breads to maintain their healthy food choices (Mikolajczyk, Ansari & Maxwell, 2009).

With regard to plain water intake, both surveys in 2003 and 2014 indicated that Malaysian adults habitually consumed six glasses of plain water daily and were considered meeting the recommended intake of plain water in terms of amount and frequency. It is well-known that water plays an extremely important role in our body. Our body is composed of about 60.0% of water which is functional as digestion, absorption, transportation of nutrient intake, and maintenance of body temperature. Drinking plain water is an effective way to provide adequate hydration without calories (Amstrong, 2010). Instead of caloric beverages, it also helps to reduce dietary energy density and may contribute to management of body weight. Water from beverages and foods is the key determinant of the energy density of the diet (Tate *et al.*, 2012). Results showed a good habit of water consumption among Malaysian adults over the 10-year period and this should be maintained for the overall good health and wellbeing of Malaysian population.

Other types of beverages such as tea, coffee and chocolate/malted drinks were also commonly consumed by Malaysian adults in 2003 and the percentages increased approximately 1.5 to 2 times higher in 2014. This may be due to socio-economic changes and expanding of beverage marketing practices which could influence the beverage preference of consumers.

Nutrition education is important to improve nutritional knowledge of the community especially in a developing country such as Malaysia to avoid lack of alert about the dietary requirements and nutritive value of different foods, which are crucial to prevent malnutrition among children, pregnant women and other vulnerable groups in the community. According to Kushi, Byers & Doylce (2006), lifestyle choices with respect to diet are very important in both primary and secondary prevention of chronic disease. In Malaysia, good socio-economic progress and rapid urbanisation has changed the lifestyle of the Malaysian population. These changes include eating habits and food choices which ultimately have an impact on health and disease patterns among the Malaysians. A balanced diet with optimal levels of physical activity is the foundation of health. Therefore, people must be given easy access to healthy foods, and being exposed to knowledge about healthy food choices which influenced them to choose the right and healthy diet (National Plan of Action for Nutrition of Malaysia, 2006-2015). Furthermore, establishing healthy and balanced dietary practices in younger population among children and adolescents is an important public health strategy to promote optimal nutritional status and to reduce the risk of non-communicable diseases (Abdullah, Teo & Foo, 2016).

CONCLUSION

MANS 2003 and MANS 2014 showed that a wide variety of food items were consumed daily and weekly by Malaysian adults. Majority of them consumed rice twice a day with an average intake of 2.5 plates per day. Malaysian adults showed a preference for sugar as the second most common choice of food consumed on a daily basis.

There are existing government guidelines and intervention programmes to promote healthy eating and healthy lifestyle among Malaysian adults. In light of the findings in this study, more efforts should be undertaken to instil more healthy food choices and dietary practices.

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Authors' contributions

Noraida MK was responsible for the preparation and drafted the manuscript, study conception, design, conduct, acquisition of subjects, data interpretation, drafting, critical revision and final approval of the manuscript; Mohamad Hasnan A and Balkish MN were responsible for the data entry, data analysis, data interpretation, critical revision and final approval of the manuscript; Azli BS was responsible for the study design, data interpretation critical revision and final approval of the manuscript; Chan YY and Tahir A were responsible for the data interpretation, critical revision, language and grammar and final approval of the manuscript. All authors approved the final manuscript.

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Knowledge, attitude and practice regarding dietary fibre intake among Malaysian rural and urban adolescents

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ABSTRACT

Introduction: Awareness of the importance of dietary fibre (DF) in health among adolescents is seldom reported in Malaysia. This study aimed to compare the knowledge, attitude and practice (KAP) of DF intake between Malaysian rural and urban school-going adolescents. Pulau Pangkor in Perak and Damansara in Selangor were randomly selected as rural and urban schools, respectively. **Methods:** A total of 305 school adolescents with a mean age of 13.5±0.6 years were randomly selected from rural (72 Malay, 85 Chinese) and urban (86 Malay, 62 Chinese) schools completed socio-demographic, validated KAP on DF intake questionnaire, as well as a 24-hour dietary recall. **Results:** Adolescents from both areas have moderate knowledge (54.4±11.3%), positive attitude (78.7±13.1%) and good practice (65.8±19.9%) scores towards DF intake. Although rural adolescents had significantly (p=0.022) higher DF intake (7.8±3.5 g) compared to urban adolescents (6.9±3.5 g), their DF intake was still lower than the Malaysian recommendation of 20-30 g/day. The attitude of DF intake of rural (r=0.390) and urban (r=0.370) adolescents showed significant positive correlations with practice score of DF intake. While a significant correlation was found between the practice score and DF intake (r=0.191, p=0.017), no significant correlation was found between knowledge and attitude scores with DF intake. **Conclusion:** Public health authorities and schools should raise awareness on health benefit of consuming DF to promote an increase in DF consumption among school adolescents.

Keywords: Dietary fibre intake, KAP, rural, urban, school adolescents

INTRODUCTION

Overweight and obesity among children and adolescents have become worse in recent times. Globally, WHO (2016) stated that over 340 million children and adolescents aged 5-19 years were overweight or obese. The prevalence has increased from 4% in 1975 to 18% in 2016 (WHO, 2016). A national survey conducted in the United States revealed that the prevalence of overweight and obesity among American adolescents aged 12 to 19 years old were 34.5% and 20.5% respectively (Ogden *et al.,* 2014). In Malaysia, the prevalence of overweight and obesity among adolescents aged between 7-13 years old has increased from 5.4% and 6.1% in 2006 to 15.4% and 8.5% respectively in 2014 (Majid *et al.,* 2014). The rise in overweight and obesity rates among adolescents will subsequently increase the risk of serious health problems including diabetes, high blood pressure, heart diseases,

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and breathing difficulties (WHO, 2016). Thus, overweight and obesity prevention during adolescence are crucial to reduce present and future health risks.

Intake of fibre-rich diet has been suggested to reduce the prevalence of obesity. Fibres have the ability to displace the energy from other nutrients by adding bulk and weight to the meal (Dhingra *et al.*, 2012). Likewise, low energy density and glycaemic load in fibre-rich diet appear to affect satiety and satiation that may help in body weight reduction (Papathanasopoulos & Camilleri, 2010). Dietary fibres (DF) often known as non-starch polysaccharides can be found in all plant-derived foods such as vegetables, fruits, whole grains and legumes. Miketinas *et al.* (2017) reported that addition of 10 g of DF into a diet could reduce about 2.2 kg of body weight. Lower body mass index, waist circumference and percentage of overweight or obese were reported among adults (19-50 years) who consumed whole grains more than three servings per day compared to those with lower intake of whole grains (<0.6 servings/day, O'Neil *et al.*, 2010). Fruits and vegetables also have low energy density and glycaemic index, which potentially controls body weight by increasing satiety as well as reducing the energy intake (Berleere & Dauchet, 2017). Epuru, Eideh & Alshammari (2014) stated that risk of obesity was two times lower for subjects with higher intake of vegetable compared to subjects with lower vegetable intake.

However, data on the intake of DF among Malaysian adolescents were scarcely reported. Low intake of DF (2.7±7.6 g/day) was reported among 170 Malay adolescents in Kelantan, Malaysia (Nurul-Fadhilah, Teo & Foo, 2012). A recent study by Ng *et al.* (2016) also revealed that the mean daily intake of DF among Malaysian adolescents (aged 14.8±1.5 years) were still lower than the recommended DF daily intake (20-30 g/day) (NCCFN, 2017) with a mean of 12.4±5.3 g/day DF. Rapid urbanisation with variety of food sources has changed adolescents current food intake as the adolescents were likely to have poor eating habits by consuming high fat foods, processed food or fast foods, high calorie snacks, excessive intake of calorie, having irregular mealtime, skipping breakfast and eating an unbalanced diet (Nemnunhoi & Sonika, 2016). In addition, the geographical differences are likely to affect the exposure to different food intake among adolescents. In Bangladesh, people from urban areas frequently consumed expensive food items such as meat, fish, egg and milk regularly whereas rural society consumed more calorie-rich foods like rice, potato and vegetables (Sadika, Mohd Isa & Wan Abdul Manan, 2013). Zhang et *al.* (2017) also found that Chinese children (4-17 years) in the urban areas with higher-income families have a significantly higher (p<0.05) total energy intake compared to rural children. To date, there is no comparative study being carried out on DF intake between rural and urban areas in Malaysia. Therefore, this study was conducted to determine the knowledge, attitude and practice (KAP) and the DF intake among Malaysian rural and urban school adolescents. The correlations between these factors were also investigated.

MATERIALS AND METHODS

Subjects and study location

This cross-sectional study was conducted among school adolescents who gave their informed consent to participate. The schools were selected based on the urban and rural definition from the Department of Statistics in Malaysia. Sekolah Menengah Kebangsaan Damansara Damai 1 (Damansara, Selangor) was purposively

selected to represent the urban area, while Sekolah Menengah Kebangsaan Pangkor (Pulau Pangkor, Perak) was chosen to represent the rural area. The adolescents were eligible for the study if they were apparently healthy. Adolescents who were under medical treatment and extreme diet plan were excluded from this study. Prior to the start of the study, a written approval was obtained from the Ministry of Education Malaysia, State Education Departments and schools administrators.

The sample size of 305 was calculated according to Godden (2004), $S = Z^2p (1-p)/ C^2$ where S is the desired sample, Z represents confidence level, p indicates the percentage of population picking a choice (50%) and C is confidence interval (5%). Assuming 95% of confidence level, the sample size for this study is calculated as $S = (1.96^2) (0.5) (1-0.5)/ (0.05^2)$. According to this formula, the actual needed sample size was 384 adolescents. However, only 305 students successfully participated in this study. This was because the school authorities only allowed students from Forms 1, 2 and 4 to participate in this study, thus limiting the number of adolescents involved in this study.

KAP questionnaire

The KAP of adolescents on the importance of DF was assessed using a validated questionnaire. This was performed by pre-testing a set of questionnaire on 30 students of Universiti Kebangsaan Malaysia in Bangi, Selangor. The reliability of the questionnaire was then analysed using Cronbach's Alpha analysis. The results showed that the reliability for the KAP scores were good (Cronbach's $\alpha > 0.07$), in which the Cronbach's α for KAP were 0.733, 0.814 and 0.736, respectively. Then, this questionnaire was used to evaluate the KAP of school adolescents towards the importance of DF intake. The knowledge and practice domains comprised of seven and 12 multiple choice questions respectively, which consisted of 'yes' and 'no' options. The correct answer was scored as one point and the wrong answer as zero point. A total of 13 questions on attitude towards DF intake were assessed based on a five-point Likert scale consisted of 'strongly disagree', 'disagree', 'neutral', 'agree' and 'strongly agree'. The score for each question was categorised from lowest to the highest score (0 point for negative scale, 1 point for neutral and 2 point for positive scale). The total KAP scores were presented as percentages. Adolescents who scored <40% for the KAP domains were placed in the low category, while for those scoring between 40-80% were categorised as medium, and high category was classified as scores higher than 80%.

DF intake assessment using 24-hour dietary recall

The 24-hour dietary recall was used to investigate daily average DF intake. This method was considered as one of the best self-reported dietary assessment methods available for children and adolescents because of its simplicity in recording food intake compared to food record method for multiple days. During the assessment, a comprehensive list of food model photos and common household measurements (plates, bowls and spoons of different serving size) were used to help adolescents to quantify food items with the assistance of trained interviewers. Each subject was asked to report detailed descriptions as well as amount of serving size for all foods and beverages consumed in the assigned day. DF intake was reported as the mean intake.

Statistical analysis

All statistical analysis was performed using Statistical Package for the Social

Sciences (SPSS) version 20.0 for Windows (SPSS Inc, Chicago, IL, USA). The DF intake was analysed using Dietplan6 (Forestfield Software Ltd, West Sussex, United Kingdom). Data were presented as mean±SD. Independent *t*-test was used to examine the differences of the mean score of KAP towards the importance of DF intake and total DF intake between rural and urban adolescents. Relationship between KAP domains and the DF intake were determined using Pearson correlation. The significance level for all analysis was set at $p<0.05$.

RESULTS

General characteristic of study population

The age range of the subjects was between 13-15 years, with a mean age of 13.5±0.6 years. (Table 1). A total of 148 (73 male, 75 female) were from urban and 157 (62 male, 95 female) were from rural area. Most of the parents of urban adolescents (75.6%) earned between RM1,000-RM3,000 per month. In contrast, the adolescents in rural area came from low-income parents (<RM1,000) who work as fishermen, hotel workers and a few of them owned small businesses.

Knowledge on DF intake

Overall, the knowledge on the importance of DF intake of school adolescents from both areas was at moderate level, with a mean value of 54.4±11.3% (Table 2). Rural adolescents had significantly ($p=0.011$) higher knowledge level (56.0±11.8%) of DF intake compared to urban adolescents (52.7±10.5%). Based on Table 3, adolescents have good knowledge about food source of DF in which 86.6% of rural and 77.7% of urban adolescents answered correctly that fruits, vegetables and bean products are the source of DF in our diet. More than half of the adolescents knew the role of DF on health in which they have answered 'correct' for DF to act as laxative, reduce cholesterol level, prevent colon cancer and obesity. However, only 45.9% of rural and 27.1% of urban adolescents knew that the recommended intake of DF is 20-30 g/day. The majority of the adolescents (70.7% rural and 61.5%

Table 1. Distribution of socio-demographics characteristics of adolescents ($n=305$)

Characteristics	*Total (n=305)*		*Urban (n=148)*		*Rural (n=157)*	
	n	*%*	*n*	*%*	*n*	*%*
Gender						
Male	135	51.5	73	54.1	62	44.1
Female	170	48.5	75	45.9	95	55.9
Ethnic group						
Malay	158	51.8	86	58.1	72	45.9
Chinese	147	48.2	62	41.9	85	54.1
Household income(RM)[a]						
< RM 1000	131	42.9	13	8.8	118	84.2
RM 1000 – RM 3000	149	48.9	112	75.6	37	23.6
RM 3001 – RM 5000	21	6.9	20	13.5	1	0.6
> RM 5000	4	1.3	3	2.0	1	0.6

[a] Ringgit Malaysia, RM 1 = 0.25 USD

urban) also did not know that the recommended intake of fruits according to the food pyramid is two serving sizes. A total of 60.5% of rural adolescents answered correctly for three servings of vegetables consumption based on the food pyramid. However, majority of urban adolescents (72.3%) answered the question wrongly (Table 2).

Practices towards DF intake

Generally, the practice towards DF intake was classified as moderate for both areas as the adolescents scored 65.9±19.9%. No significant difference (p=0.152) was shown for DF practices from both areas (Table 2). The summary of DF practice of adolescents is presented in Table 3. Adolescents were relatively

Table 2. KAP score (%) towards the importance of DF intake among adolescents

Questionnaire	*Percentage scores (Mean±SD)*			
	Total (n=305)	*Urban (n=148)*	*Rural (n=157)*	*p value*
Dietary fibre knowledge	54.4±11.3	52.7±10.5	56.0±11.8	0.011*
Dietary fibre attitude	78.7±13.1	75.4±14.9	81.8±10.1	<0.01**
Dietary fibre practice	65.9±19.9	64.2±19.9	67.5±19.9	0.152

Indicates significant difference between urban and rural percentage KAP score, *p<0.05, **p<0.01. Significant difference between KAP score determined by independent samples t-test.

Attitudes towards DF intake

Table 2 shows that adolescents from both areas scored 78.7±13.1% for attitude towards importance of DF intake on health. Nevertheless, rural adolescents showed a significantly (p<0.01) higher positive attitude (81.8±10.1%) compared to urban adolescents (75.4±14.9%). A summary responses of self-reported attitudes related to DF intake is presented in Table 4. Majority of the adolescents from both areas (98.7% rural, 85.8% urban) strongly agreed that eating more fruits and vegetables would make them healthier. They also believed that an adequate DF intake can give a positive impact on health such as preventing constipation and having a healthier-looking skin. However, less than half of them (27.4% rural, 33.1% urban) believed that consumption of DF could prolong the feeling of satiety. In addition, only 36.3% of rural and 46.6% of urban school adolescents personally believed that they could influence people around them to consume fruits and vegetables.

good in consumption practices on DF intake as most of them (59.2% rural and 74.3% urban) consumed vegetables in every meal and high percentages of adolescents (86.6% rural and 69.6% urban) liked to eat salad. In addition, 58.6% of rural and 60.8% of urban adolescents claimed that they included fruits in their daily meals. At the same time, 90.4% of rural and 74.3% of urban adolescents were more likely to eat bean products rather than snacking on junk food. In contrast, more than half of the adolescents (70.7% rural and 61.5% urban) preferred carbonated drinks rather than fruit juices and most of them (61.1% rural and 60.8% urban) were likely to separate the vegetables from their food while having meal. Moreover, most of the adolescents (57.3% rural and 55.4% urban) had chosen nasi lemak or other foods compared to cereals when having breakfast in the morning. In addition to that, 50.3% of rural and 60.8% of urban adolescents preferred white bread compared to whole meal bread. Most of them (61.3% rural and

Table 3. Knowledge and practice towards DF intake adolescents (*n*=305)

Questions	*Urban (n=148)*		*Rural (n=157)*	
	Answer, n (%)			
	Correct	*False*	*Correct*	*False*
Knowledge				
Fruits, vegetables and bean products contain fibre	115 (77.7)	33 (22.3)	136 (86.6)	21 (13.4)
Recommended intake of fibre for adults is 20-30 gram per day	40 (27.0)	108 (73.0)	72 (45.9)	85 (54.1)
Consumption of fruits based on food pyramid is 2 servings	57 (38.5)	91 (61.5)	46 (29.3)	111 (70.7)
Consumption of vegetables based on food pyramid is 3 servings	41 (27.7)	107 (72.3)	95 (60.5)	62 (39.5)
What is the role of fibre to humans?				
Fibre acts as laxative	120 (81.1)	28 (18.9)	139 (88.5)	18 (11.5)
Fibre can reduce sinus disease	64 (43.2)	84 (56.8)	78 (49.7)	79 (50.3)
Fibre can increases body metabolism	45 (30.4)	103 (69.6)	23 (14.6)	134 (85.4)
Fibre can helps in weight reduction	111 (75.0)	37 (25.0)	90 (57.3)	67 (42.7)
Fibre can strengthens teeth and bones	41 (27.7)	107 (72.3)	60 (38.2)	97 (61.8)
Fibre can provides collagen	58 (39.2)	90 (60.8)	45 (28.7)	112 (71.3)
Fibre can increases red blood cells	48 (32.4)	100 (67.6)	53 (33.8)	104 (66.2)
Fibre can reduces cholesterol level	112 (75.7)	36 (24.3)	114 (72.6)	43 (27.4)
Fibre can increases white blood cells	72 (48.6)	76 (51.4)	105 (66.9)	52 (33.1)
Fibre can improves blood circulation	30 (20.3)	118 (79.7)	31 (19.7)	126 (80.3)
In your opinion, which of the following diseases can be prevented by consuming fibre?				
Colon cancer	94 (63.5)	54 (36.5)	120 (76.4)	37 (23.6)
Migraine	96 (64.9)	52 (35.1)	114 (72.6)	43 (27.4)
Obesity	108 (73.0)	40 (27.0)	121 (77.1)	36 (22.9)
Gout	88 (59.5)	80 (40.5)	109 (69.4)	48 (30.6)
Coronary heart disease	87 (58.8)	61 (41.2)	92 (58.6)	65 (41.4)
Diabetes	80 (54.1)	68 (45.9)	87 (55.4)	70 (44.6)
Jaundice	85 (57.4)	63 (42.6)	80 (51.0)	77 (49.0)
Asthma	96 (64.9)	52 (35.1)	109 (69.4)	48 (30.6)
Hypertension	97 (65.5)	51 (34.5)	109 (69.4)	48 (30.6)
Kidney failure	69 (46.6)	79 (53.4)	64 (40.8)	93 (59.2)
Practice				
I eat vegetables every meal.	110 (74.3)	38 (25.7)	93 (59.2)	64 (40.8)
I eat fruits every day.	90 (60.8)	58 (39.2)	92 (58.6)	65 (41.4)
I choose carbonated drinks rather than fruit juices.	91 (61.5)	57 (38.5)	111 (70.7)	46 (29.3)
I will choose snack junk food rather than fruits.	53 (35.8)	95 (64.2)	22 (14.0)	135 (86.0)
I like to eat salads.	103 (69.6)	45 (30.4)	136 (86.6)	21 (13.4)
I will separate the vegetables in my food.	90 (60.8)	58 (39.2)	96 (61.1)	61 (38.9)
I do not like to eat fruits.	48 (32.4)	100 (67.6)	51 (32.5)	106 (67.5)
I prefer to eat beans products rather than snack junk food.	110 (74.3)	38 (25.7)	142 (90.4)	15 (9.6)
I do not like to eat fibre-enriched food because the taste is not delicious.	95 (64.2)	53 (35.8)	99 (63.1)	58 (36.9)
I will eat fibre-enriched supplement every day.	66 (44.6)	82 (55.4)	52 (33.1)	105 (66.9)
I will choose wholemeal bread rather than white bread.	58 (39.2)	90 (60.8)	78 (49.7)	79 (50.3)
I do not like to eat side dishes.	93 (62.8)	55 (37.2)	103 (65.6)	54 (34.4)
I will eat cereals as breakfast rather than nasi lemak and others.	66 (44.6)	82 (55.4)	67 (42.7)	90 (57.3)

Table 4. Attitude towards dietary fibre intake among adolescents (*n*=305)

Questions	*Urban (n=148)*			*Rural (n=157)*		
	Answer choices, n (%)					
	Strongly agree	*Do not know*	*Strongly disagree*	*Strongly agree*	*Do not know*	*Strongly disagree*
Eating more fruit and vegetables will make me healthier.	127 (85.8)	14 (9.5)	7 (4.7)	155 (98.7)	2 (1.3)	0 (0.0)
Eating more fast foods and sweet snacks will make me have lighter weight.	14 (9.5)	27 (18.2)	107 (72.3)	12 (7.6)	19 (12.1)	126 (80.3)
Eating more fruits and vegetables will make me feel fresher.	107 (72.3)	28 (18.9)	13 (8.8)	140 (89.2)	15 (9.6)	2 (1.3)
Eating more fruits and vegetables will give me have a healthier skin.	102 (68.9)	33 (22.3)	13 (8.8)	137 (87.3)	16 (10.2)	4 (2.5)
Eating more fruits and vegetables will make me feel not full.	32 (21.6)	52 (35.1)	64 (43.2)	16 (10.2)	57 (36.3)	84 (53.4)
Eating more fruits and vegetables will prevent constipation.	95 (64.2)	46 (31.1)	7 (4.7)	129 (82.2)	21 (13.4)	7 (4.5)
Eating more fast foods, sweet and savoury snacks, and sweet drinks will make me at higher risk of some diseases such as heart disease, diabetes and high blood pressure.	107 (72.3)	29 (19.6)	12 (8.1)	139 (88.5)	9 (5.7)	9 (5.7)
I believe that adequate fibre intake can have a positive impact on health.	101 (68.2)	32 (21.6)	15 (10.1)	142 (90.4)	12 (7.6)	3 (1.9)
I believe that daily fibre intake can increase weight	15 (10.1)	68 (45.9)	65 (43.9)	22 (14.0)	61 (38.9)	74(47.1)
I feel that I can influence the people around me to eat fruits and vegetables.	69 (46.6)	53 (35.8)	26 (17.6)	57 (36.3)	70 (44.6)	30 (19.1)
I feel that daily fibre intake is not important.	9 (6.1)	44 (29.7)	95 (64.2)	13 (8.3)	18 (11.5)	126 (80.3)
I feel that fibre intake will prolong the feeling of satiety.	49 (33.1)	76 (51.4)	23 (15.5)	43 (27.4)	79 (50.3)	35 (22.3)

64.2% urban) reported that they do not like to eat fibre-enriched food because of the unpalatable taste (Table 3 & 4).

DF intake of rural and urban adolescents

Based on the recommended nutrient intake (RNI) for Malaysia (NCCFN, 2017) and Malaysian Dietary Guidelines (NCCFN, 2010), the recommended DF intake for adolescents is 20-30 g/day. However, the adolescents' intakes of DF reported in this study were lower than the recommendation even though DF

Table 5. Pearson correlation between KAP domains, KAP and DF intake among adolescents in rural and urban areas (n=305)

	Pearson Correlation of KAP					
	Total (n=305)		*Urban (n=148)*		*Rural (n=157)*	
	r-value	*p-value*	*r-value*	*p-value*	*r-value*	*p-value*
KAP Domains						
Knowledge, attitude	0.133	0.020*	0.127	0.125	0.077	0.339
Knowledge, practice	0.032	0.580	0.099	0.230	-0.046	0.566
Attitude, practice	0.382	<0.001**	0.390	<0.001**	0.370	<0.001**
KAP and DF intake						
Knowledge, DF intake	0.012	0.829	-0.107	0.197	0.076	0.345
Attitude, DF intake	0.025	0.667	-0.043	0.601	0.041	0.614
Practice, DF intake	0.096	0.095	-0.026	0.758	0.191	0.017*

Statistically significant at *p<0.05, **p<0.01

intake of rural adolescents (7.8±3.5 g/day) was significantly (p=0.022) higher compared to urban adolescents (6.9±3.5 g/day).

Correlation between knowledge, attitude and practice of DF intake

The correlation coefficient between KAP domains are presented in Table 5. Cohen (2013) stated that the strength of correlation between variables can be divided into three categories which are weak (r=0.10-0.29), moderate (r=0.30-0.49) and strong (r=0.50-1.00). With regards to the KAP towards DF, it was found that there was a moderate correlation between the attitude and practice of DF intake among adolescents from urban (r=0.390, p<0.001) and rural (r=0.370, p<0.001) areas. These positive correlations showed that adolescents who personally believed that DF intake can have a positive impact on health will consume high fibre food in their daily consumption. However, the knowledge about DF intake does not affect either the attitudes or practices of adolescents on importance of DF intake from both areas.

The relationship between KAP and DF intake

Rural adolescents have a significant weak correlation (r=0.191; p=0.017) between the practice score and the DF intake. However, no significant correlation (p>0.05) was found for other parameters (Table 5).

DISCUSSION

In this study, KAP toward the importance of DF intake between urban and rural adolescents was assessed. The results showed that in general, the rural and urban adolescents have moderate knowledge level (54.4±11.3%). Most of the adolescents were knowledgeable about the source and role of DF in human health including its role as a laxative and assists in the reduction of body weight and cholesterol level. However, they had less knowledge about the recommended intake of DF (20-30

g/day) (NCCFN, 2017) and the serving sizes of fruits and vegetables based on the food pyramid. Rural adolescents (56.0±11.8%) were significantly (p=0.011) more knowledgeable about DF compared to those from urban area (52.7±10.5%). In contrast, Ahmed et al. (2013) study among Bangladeshi adults (21-30 years) found that the urban respondents had higher knowledge about DF (96%) compared to rural respondents (74%). Adolescents possibly obtained nutritional information from several ways including their teachers, family members and textbooks. Moreover, nowadays the ability to access nutritional information is much easier using internet and 24-hour television regardless of whether people live in urban or rural area. Most of the teenagers spent their time more than three hours daily surfing social websites such as Facebook, Twitter and playing games (Wong *et al.*, 2011). Hence, there are many opportunities and resources for them to access in order to obtain nutritional information.

Nutritional knowledge potentially enables a person to practice healthy eating habits and ensure the welfare and health of the body. Spronk *et al.* (2014) revealed that respondents with higher knowledge of food and its nutrients were positively correlated with their food consumption. However, there were no significant correlations between knowledge of DF towards the attitude (r=0.093) as well as practice (r=-0.049) in this study. These findings coincide with Florida (2013) which showed that there was no significant correlation (r=0.177; p>0.05) between nutritional knowledge towards the dietary practices. In addition, Banwat *et al.* (2012) reported that nutritional knowledge alone could not ensure a good practice of healthy eating. The majority of the respondents (92.4%) in the study reported that they have moderate knowledge level on fruits and vegetables intake. However, only 69.2% of them actually consumed fruits and vegetables in their daily meal (Banwat *et al.*, 2012). Therefore, nutrition education promoting the importance of DF intake should be implemented among adolescents to increase their DF intake. Fruits, vegetables and legumes should be consumed daily as these foods contain high amount of DF. According to food pyramid, adolescents are encouraged to eat at least five servings of vegetables and fruits, which were three servings of vegetables and two servings of fruits per day (NCCFN, 2010).

The adolescents in this study also expressed the importance of DF intake with moderate score of attitude and practice (78.7±13.1% and 65.9±19.9% respectively). These results were expected because of their moderate score on their knowledge. Adolescents with positive attitudes towards DF intake presumably will have good practices in consuming high fibre diet. Both adolescents from urban and rural areas showed positive correlation (r=0.416 and r=0.363 respectively) between attitude and practice on DF intake. Zhang *et al.* (2013) reported that attitude towards healthy eating ultimately influence on diet practice of an individual. Shaziman *et al.* (2017) also reported that positive attitude significantly (p=0.006) influences the dietary practices of an individual. In recent years, the awareness on nutritional aspects and the effects of the food on health has increased among consumers, particularly in adults. The study revealed that DF intake may provide benefits on health among adults. In fact, high intake of DF from fruits, vegetables and cereal fibre or mixtures of whole grains has the potential in controlling body weight, lowering the risk of obesity, cardiovascular disease and type 2 diabetes (Cho *et al.*, 2013).

Geographic differences are likely to affect the exposure to different food intake among adolescents. Mean daily

DF intake of rural adolescents (7.8±3.5 g/day) reported was significantly (p=0.022) higher compared to urban adolescents (6.9±3.5 g/day). This might be due to the high availability of plant sources in rural areas (Downs *et al.*, 2012). In contrast, urban adolescents were more exposed to high availability of fast foods, which have less DF content but high in fat. However, this result contradicts with the findings of Downs *et al.* (2012), which demonstrated that urban adolescents in America have high DF intake compared with rural adolescents due to the lower quality of fresh food in rural area. Although DF intake among rural adolescents in this study was higher compared to urban adolescents, the intake was still low with regards to the Malaysian RNI (NCCFN, 2017) and Dietary Guidelines (NCCFN, 2010), which recommend 20-30 g DF per day. Lower practice score of DF intake for urban adolescents in this study may also be affected by the absence of parents at mealtimes as family meal frequency increase the quality of dietary intake among adolescents (Neumark-Sztainer *et al.*, 2010). In addition, adolescents are more likely to eat readily available and prepared food such as fast food and instant noodles. These foods usually contain less DF content and will lead to unhealthy diet. Majority of the adolescents from both areas (60.8% urban and rural 61.1%) in this study claimed that they tend to avoid taking vegetables in their meals. Refusal intake of leafy vegetables was common in childhood and adolescents. Lack of DF intake among adolescents may also be caused by a dislike of the taste of high fibre foods. Most vegetables have a bitter taste because of thiourea and certain compounds that make it unpalatable for children (Bell & Tepper, 2006). Besides, most high fibre foods are lacking in taste and less preferred in comparison to other snacks (Kamar, Evans & Hugh-Jones, 2016). Thus, the intake of vegetables and fruits should be encouraged from childhood, in order to nurture and create healthy food practices in the future.

There were few limitations identified in this study. This study was only carried out in one school from each urban and rural area due to time and logistic constraints. In addition, the application for authorities' approval to conduct this study has taken considerably longer than expected. The number of adolescents' participation were also limited as the school authorities only allowed subject recruitment within forms 1, 2 and 4 students as students in forms 3 and 5 were preparing for major examinations, the Lower Secondary Evaluation (PMR) and Malaysian Education Certificate (SPM). Hence, the findings cannot be generalised to represent a larger population of adolescents in Malaysia. However, it does provide a view on how the difference in geographical living areas contributes towards the KAP level and DF intake of adolescents.

CONCLUSION

Rural adolescents showed higher DF intake compared to urban adolescents. However, the DF intake of adolescents from both areas was still low compared to the Malaysian dietary recommendation. Therefore, both rural and urban adolescents should be exposed to the benefits and importance of consuming high fibre foods in achieving a good health status.

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Conflict of interest

There was no conflict of interest involved.

Authors' contributions

Norlida MD, principal investigor, conceptualized and designed the study, prepared the draft of the manuscript, reviewed the manuscript; Nor Izati F, conducted the study, data analysis and interpretation; Lam KY, conducted the study, data analysis and interpretation; Ika Aida AM, prepared the draft of the manuscript, data analysis and interpretation and reviewed the manuscript; Noor Fairuzi SY, assisted in drafting of the manuscript, reviewed the manuscript; Arnida Hani T, adviced on the data interpretation, reviewed the manuscript; Hafeedza AR, adviced on the data interpretation, reviewed the manuscript.

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Comparing the nutritional status of vegetarians and non-vegetarians from a Buddhist Organisation in Kuala Lumpur, Malaysia

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ABSTRACT

Introduction: A vegetarian diet is generally considered as healthy for preventing metabolic-related diseases. There is lack of studies in Malaysia comparing the nutritional status of vegetarians and non-vegetarians. This cross-sectional study aims to compare body weight status, dietary intake and blood pressure level between these two groups. **Methods:** A total of 131 vegetarians and 135 non-vegetarians were recruited using convenience sampling from a Buddhist organisation in Kuala Lumpur. Body weight, height, waist circumference, percentage of body fat, and blood pressure measurements were taken, while dietary intake was assessed using a 2-day 24-hour dietary recall. **Results:** More vegetarians were underweight than non-vegetarians (31.3% vs 15.6%), while prevalence of overweight and obesity was higher among the non-vegetarians (23.7% vs 9.9%). A higher proportion of non-vegetarians (34.1%) had an unhealthy range of body fat percentage and significantly higher risk of abdominal obesity (24.4%) than the vegetarians (19.1% body fat; 13.7% abdominal obesity). Mean intakes for protein and fat were significantly lower among the vegetarians, while no significant differences were observed in the mean intake for energy and carbohydrate. Vegetarians had significantly higher intakes of vitamins C, D and E, calcium, potassium and folate, while vitamin B_{12} intake was significantly higher in the non-vegetarians. More non-vegetarians presented with unhealthy blood pressure status. **Conclusion:** Vegetarians in this study generally showed healthier dietary intake and lower body fatness than the non-vegetarians. Studies are suggested to be undertaken on a bigger sample size of vegetarians to confirm these findings.

Keywords: Body weight status, dietary intake, obesity, blood pressure, vegetarian

INTRODUCTION

A vegetarian is an individual who does not consume any animal-based foods. A vegetarian diet can be classified into several groups, namely vegan, lacto-ovo vegetarian, lacto-vegetarian, and ovo-vegetarian (Agnoli *et al.*, 2017; Melina, Craig & Levin, 2016). A vegan does not consume any form of animal-derived foods, which include red meat, poultry, fish, seafood, eggs and dairy products in their diet, and may exclude honey. In

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addition to consuming vegetables, lacto-ovo vegetarians allow the consumption of milk, other dairy products and eggs. On the other hand, the lacto-vegetarian community only consumes dairy products and plant-based foods, whereas, ovo-vegetarian only consumes eggs and plant-based foods.

In Asia, vegetarianism has been practised mostly by Buddhists and Hindus for centuries. To date, the increased number of publication for both scientific and non-scientific articles on vegetarian nutrition and a growing number of vegetarians in the world population portray that vegetarian diet has significantly increased in popularity (Melina *et al.*, 2016). The prevalence of vegetarian was 0.8% in Shanghai, China (Mao *et al.*, 2015), 1.6% in Belgium (Mullee *et al.*, 2017), 2.4% in the United States (Jaacks *et al.*, 2016), 34.0% in Taiwan (Chiu *et al.*, 2014) and 33.0% in South Asia (Jaacks *et al.*, 2016). However, there is no published national data showing the percentage of vegetarians among Malaysians. In Malaysia, there is an increased trend of vegetarianism and a rising demand for vegetarian food products among practising Chinese and Indian vegetarian communities. This is evident in the expansion of vegetarian food market and vegetarian meals (Wong *et al.*, 2011). There is also an increased production of mock-meat products to cater to this demand (Joshi & Kumar, 2015).

In recent decades, several studies have reported the benefits of vegetarian diet towards one's health (Chiu *et al.*, 2014; Jaacks *et al.*, 2016; Melina *et al.*, 2016). A well-planned vegetarian diet is appropriate for all stages of life because it provides numerous health benefits (Melina *et al.*, 2016). Vegetarians avoid the intake of meat, include high amounts of plant-based foods and in most instances, adopt other healthy lifestyles (Mihrshahi *et al.*, 2017). Vegetarians reportedly have lower risks of chronic diseases such as coronary heart disease, hypertension, diabetes, obesity and cancer, as well as having a longer lifespan than the non-vegetarians (Jaacks *et al.*, 2016; Melina *et al.*, 2016; Mihrshahi *et al.*, 2017). Furthermore, a well-planned vegetarian diet also meets the current recommended dietary allowance (RDA), where it provides essential nutrients and has lower levels of cholesterol and saturated fat (Melina *et al.*, 2016).

Despite the health and nutritional benefits, it remains a concern that a particular nutrient inadequacy is prevalent among vegetarians. The lack of some nutrients seems to be more of a concern in vegetarian diets and these nutrients include protein, n-3 fatty acids, calcium, iron, zinc, vitamin D and vitamin B_{12} (Melina *et al.*, 2016). Awareness of possible differences in nutrient profiles between vegetarian and non-vegetarian dietary patterns is vital as nutritional differences can contribute to the development of diseases. Therefore, a cross-sectional study was carried out to determine the differences in nutritional status (body weight status, dietary intake and blood pressure level) between Chinese vegetarians and non-vegetarians in Kuala Lumpur, Malaysia.

MATERIALS AND METHODS

Study design

This was a cross-sectional study conducted at a Buddhist organisation in Kuala Lumpur. The target population of this study was a group of healthy Chinese adults taking vegetarian or non-vegetarian diet. Ethical approval from the Ethics Committee for Research Involving Human Subjects of Universiti Putra Malaysia (JKEUPM) was obtained. A permission letter was obtained from the Buddhist organisation prior to

conducting the study. A written consent letter was also obtained from every participant of this study.

Participants

A convenience sampling technique was used to recruit the study participants. Members of the Buddhist organisation consist of vegetarians and non-vegetarians. All members were invited to participate in this study. Those pregnant or lactating women and those with physical disability or chronic diseases were excluded from this study. The estimated sample size of this study was 127 per group using the formula for hypothesis testing for two-group comparison, taking into account 95% confidence level and 80% power.

Anthropometry and blood pressure assessments

Body weight and height of the participants were measured by using a TANITA Digital Weighing Scale HD 306 (TANITA Corporation, USA) to the nearest 0.1 kg and a SECA Body Meter 206 (SECA, Germany) to the nearest 0.1 cm, respectively. Each measurement was repeated twice to get an average value. Based on the measurements obtained, the body mass index (BMI) was calculated, and its classification was based on the World Health Organization's criteria (WHO, 2000). Waist circumference (WC) of the participants was measured to determine abdominal obesity by using a non-stretchable SECA measuring tape (SECA, Germany) to the nearest 0.1 cm. The recommended sex-specific cut-off points of WC was based on the WHO/IASO/IOTF (2000) criteria for Asians, in which ≥90 cm for men and ≥80 cm for women to be considered as an increased risk of abdominal obesity. The percentage of body fat of the participants was measured using an Omron Body Fat Analyser HBF-306 (Omron, Japan) to the nearest 0.1%. The cut-off values for the percentage of body fat as recommended by Lee and Nieman (2013) were used in this study. In addition, blood pressure of the participants was measured using an Omron automatic blood pressure monitor HEM-7121 (Omron, Japan) and its classification was based on the Clinical Practice Guidelines on the management of hypertension (MSH/MOH/AMM, 2013).

Dietary assessment

Dietary intake of the participants was measured using a 2-day 24-hour dietary recall, which comprised one weekday and one day on a weekend. Participants were asked to recall foods and drinks that were consumed during the previous day. Detailed descriptions of the foods and beverages, including cooking methods and brands of processed food were recorded. The portion size of the participants' food intake was estimated based on the standard household measurement tools. Energy, macronutrient and micronutrient intakes were analysed using the Nutritionist Pro software. For Malaysian adult population, it is recommended to have 50%–65% of the total daily energy intake derived from carbohydrates, 25%–30% from fat, and 10%–20% from protein (NCCFN, 2017). The mean values for energy and nutrient intakes for each participant were compared with the Recommended Nutrient Intakes (RNI) 2017 to determine nutrient intake adequacy. Adequacy was considered achieved if the individual's mean nutrient intake met or exceeded 100% of the RNI.

Statistical analyses

The statistical analyses were performed using IBM SPSS Statistics version 22. Continuous variables were presented as means and standard deviations, whereas categorical variables were presented as frequencies and percentages.

Independent-samples *t*-test was employed to determine the differences in the means of dietary intake, body weight status and blood pressure between vegetarian and non-vegetarian groups. Chi-square test of independence was used to determine the differences in categorical variables between vegetarian and non-vegetarian groups. The level of statistical significance was set at $p<0.05$.

RESULTS

Socio-demographic characteristics of the participants are shown in Table 1. A total of 266 participants were enrolled in this study. They consisted of 131 vegetarians (49.1%) and 135 non-vegetarians (50.8%). Out of 131 vegetarians, 36.6% were lacto-ovo-vegetarians, 27.5% were semi-vegetarians, 26.7% were vegans, 6.9% were ovo-vegetarians and 2.3% were lacto-vegetarians. The main reason for practicing a vegetarian diet was due to religion (71.0%). The other reasons revolved around animal welfare (67.2%), environmental benefits (58.8%), health (45.0%) and world hunger (15.3%). Most of the vegetarians (43.5%) and non-vegetarians (46.7%) were in the age group of 19-29 years, with a mean age of 33.8±10.4 years and 34.6±12.3 years, respectively. Vegetarians had a higher educational level compared to non-vegetarians ($\chi^2=13.34$, $p=0.001$), in which more vegetarians (68.7%) attained tertiary education compared to non-vegetarians (47.4%).

Vegetarians showed significantly lower mean values for BMI, percentage of body fat and systolic blood pressure

Table 1. Socio-demographic characteristics of the participants ($n=266$)

Socio-demographic characteristics	*Vegetarian (n=131)*	*Non-vegetarian (n=135)*	χ^2	*p*
Age (years old)			6.06	0.109
19-29	57 (43.5)	63 (46.7)		
30-39	36 (27.5)	27 (20.0)		
40-49	26 (19.8)	21 (15.6)		
≥ 50	12 (9.2)	24 (17.8)		
Mean±standard deviation	33.8±10.4	34.6±12.3		
Sex			2.89	0.089
Male	61 (46.6)	48 (35.6)		
Female	70 (53.4)	87 (64.4)		
Educational Level			13.37	0.001*
Primary education	4 (3.1)	12 (8.9)		
Secondary education	37 (28.2)	59 (43.7)		
Tertiary education	90 (68.7)	63 (47.4)		
Marital Status			2.35	0.125
Single/widow/divorced	83 (63.4)	72 (53.3)		
Married	48 (36.6)	63 (46.7)		
Employment Status			14.83	0.002*
Public	10 (7.6)	28 (20.7)		
Private	72 (55.0)	72 (53.3)		
Retired/unemployed/not working	37 (28.2)	19 (14.1)		
Self-employed	12 (9.2)	16 (11.9)		
Monthly Personal Income (RM)			7.23	0.065
≤1,000	3 (2.3)	7 (5.2)		
1,001-3,000	39 (29.8)	49 (36.3)		
3,001-5,000	45 (34.4)	28 (20.7)		
>5,000	7 (5.3)	10 (7.4)		

*significant at $p<0.05$

Table 2. Comparison of BMI, waist circumference, body fat percentage and blood pressure between vegetarian and non-vegetarian groups

Characteristics	*Vegetarian (n=131)*	*Non-vegetarian (n=135)*	*t*	*p*
Height (m)	1.67±0.08	1.63±0.08	4.76	<0.001*
Weight (kg)	58.52±10.95	59.91±12.03	-0.98	0.327
BMI (kg/m^2)[a]	20.80±3.16	22.62±4.17	-0.40	<0.001*
Underweight	41 (31.3)	21 (15.6)		
Normal	77 (58.8)	82 (60.7)		
Overweight/Obesity	13 (9.9)	32 (23.7)		
Waist circumference (cm)[b]	76.40±10.87	78.00±11.5	-1.17	0.245
Normal	113 (86.3)	102 (75.6)		
Abdominal obesity	18 (13.7)	33 (24.4)		
Body fat percentage (%)[c]	24.51±5.06	27.32±7.59	-3.56	<0.001*
Acceptable range (Lower end)	28 (21.4)	21 (15.6)		
Acceptable range (Upper end)	78 (59.5)	68 (50.4)		
Unhealthy (Too high)	25 (19.1)	46 (34.0)		
Systolic blood pressure (mmHg)[d]	113.95±8.28	118.69±12.34	-3.69	<0.001*
Normal	127 (96.9)	105 (77.8)		
Elevated	4 (3.1)	30 (22.2)		
Diastolic blood pressure (mmHg)[d]	73.67±6.47	72.59±8.96	1.14	0.257
Normal	128 (97.7)	122 (90.4)		
Elevated	3 (2.3)	13 (9.6)		
Hypertension classification[e]				
Optimal	90 (68.7)	71 (52.6)		
Normal	35 (26.7)	30 (22.2)		
High normal	5 (3.8)	26 (19.3)		
Stage 1 hypertension	1 (0.8)	8 (5.9)		

[a]BMI classification: Underweight <18.5 kg/m^2, Normal 18.5-24.9 kg/m^2, Overweight 25-29.9 kg/m^2, Obesity ≥30 kg/m^2 (WHO, 2000)

[b]WC classification: ≥90 cm for men and ≥80 cm for women as abdominal obesity (WHO/IASO/IOTF, 2000)

[c]Body fat percentage classification: lower end (male 6–15%, female 9–23%), upper end (male 16–24%, female 24–31%), too high (male ≥25%, female ≥32%) (Lee & Nieman, 2013)

[d]Elevated blood pressure: Systolic ≥130 mmHg, Diastolic ≥85 mmHg

[e]Hypertension classification: optimal (systolic <120 mmHg, diastolic <80 mmHg), normal (systolic 120-129 mmHg, diastolic 80-84 mmHg), high normal (systolic 130-139 mmHg, diastolic 85-89 mmHg), Stage 1 hypertension (systolic 140-159 mmHg, diastolic 90-99 mmHg) (MSH/MOH/AMM, 2013)

*significant at $p<0.05$

Table 3. Energy and macronutrient intakes of vegetarians and non-vegetarians

Nutrients	*Mean*±SD		*t*	*p*	*n (%)*		χ^2	*p*
	Vegetarian (n=131)	*Non-vegetarian (n=135)*			*Vegetarian (n=131)*	*Non-vegetarian (n=135)*		
Total energy intake (kcal)	1905±466	2005±360	-1.96	0.051				
Carbohydrate (g)	293±87.2	280±5.4	1.32	0.189				
Percentage of energy from carbohydrate (%)	61.02±7.97	55.89±7.64	5.36	<0.001*			33.62	<0.001*
<50%					11 (8.4)	33 (24.4)		
50 – 65%					78 (59.5)	93 (68.9)		
>65%					42 (32.1)	9 (6.7)		
Protein (g)	57.9±15.6	75.8±20.3	-8.07	<0.001*				
Percentage of energy from protein (%)	12.25±2.21	15.13±2.88	-9.18	<0.001*				<0.001*
<10%					15 (11.5)	0		
10 – 20%					116 (88.5)	126 (93.3)		
>20%					0	9 (6.7)		
Total fat (g)	53.5±19.0	64.4±20.6	-4.47	<0.001*				
Percentage of energy from total fat (%)	25.44±6.72	28.87±7.55	-3.91	<0.001*			9.25	0.010*
<25%					68 (51.9)	46 (34.1)		
25 – 30%					31 (23.7)	38 (28.1)		
>30%					32 (24.4)	51 (37.8)		

*significant at $p<0.05$

Table 4. Micronutrient intakes of vegetarians and non-vegetarians

Nutrients	*Mean±SD*		*t*	*p*
	Vegetarian (n=131)	*Non-vegetarian (n=135)*		
Vitamin A (μg)	797±363	760±468	0.72	0.471
Vitamin B_1 (mg)	1.0±0.3	1.0±0.4	1.73	0.084
Vitamin B_2 (mg)	1.4±0.5	1.5±0.8	-0.62	0.535
Vitamin B_3 (mg)	9±3	10±5	-1.95	0.052
Vitamin B_{12} (μg)	2.5±1.1	4.4±3.2	-6.47	<0.001*
Vitamin C (mg)	148±79	54±25	13.02	<0.001*
Vitamin D (μg)	0.6±0.5	0.5±0.4	2.07	0.040*
Vitamin E (mg)	6.8±3.7	3.8±2.6	7.59	<0.001*
Calcium (mg)	548±216	494±222	2.02	0.045*
Phosphorus (mg)	774±228	805±277	-1.02	0.309
Potassium (g)	1.5±0.5	1.3±0.5	3.24	0.001*
Iron (mg)	16±6	15±7	1.26	0.209
Folate (μg)	194±87	114±70	8.26	<0.001*
Sodium (mg)	4157±1346	3872±1294	1.76	0.080
Zinc (mg)	13.4±6.0	13.9±9.8	-0.55	0.582

*significant at $p<0.05$

level than non-vegetarians (Table 2). More non-vegetarians (23.7%) were overweight and obese than vegetarians (9.9%), whereas a higher percentage of vegetarians (31.3%) were underweight. In relation to abdominal obesity, nearly twice as many non-vegetarians (24.4%) tend to have abdominal obesity compared to vegetarians (13.7%). More non-vegetarians (34.0%) had a high body fat percentage (male ≥25%; female ≥32%) than vegetarians (19.1%). In term of blood pressure level, more non-vegetarians had elevated systolic and diastolic blood pressure.

No significant difference was observed in the mean energy intake between vegetarians (1905±466 kcal) and non-vegetarians (2005±360 kcal; t=-1.96, p=0.051) (Table 3). Non-vegetarians were more likely to have a higher percentage of energy intakes from protein and fat while vegetarians tended to have a higher proportion of energy intake from carbohydrate. In terms of micronutrient intake, vegetarians showed significantly higher intakes for vitamins C, D and E, calcium, potassium and folate, while vitamin B_{12} intake was significantly higher in non-vegetarians. The results revealed no significant differences in intakes of vitamins A, B_1, B_2, B_3, phosphorus, iron, zinc and sodium intakes between the two groups (Table 4). The prevalence of inadequacy in each micronutrient among vegetarians and non-vegetarians is summarised in Figure 1. More vegetarians met the RNI levels for most of the nutrient intakes compared to that of non-vegetarians.

DISCUSSION

The main findings of this study indicate that vegetarians had a better nutrient intake and blood pressure level and were

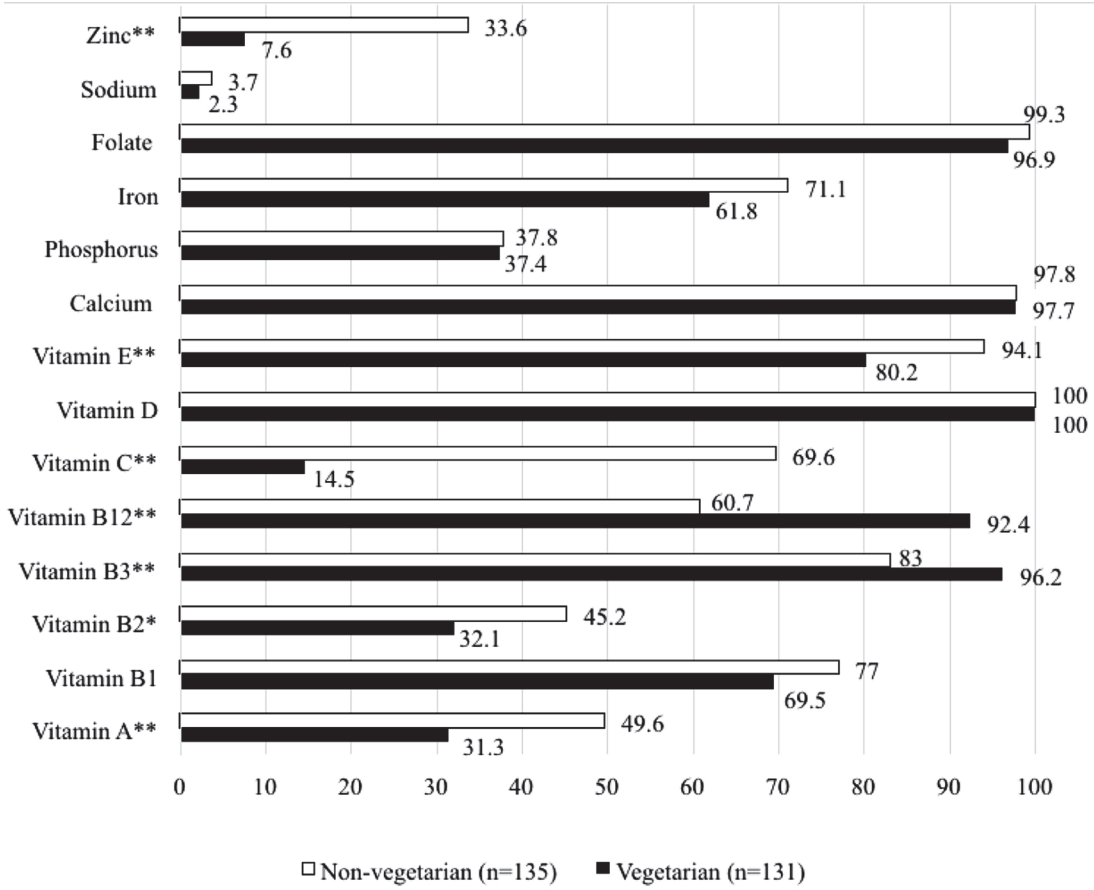

Figure 1. Prevalence of micronutrient inadequacy in vegetarians and non-vegetarians

**Chi-square test with p<0.05*
***Chi-square test with p<0.01*

more likely to be underweight and had a lower risk of both unhealthy body fat percentage and abdominal obesity than non-vegetarians. The result reaffirms findings of other studies (Jaacks *et al.*, 2016; Mihrshahi *et al.*, 2017; Rizzo *et al.*, 2013; Sabaté & Wien, 2010). The wider the spectrum of animal-based products consumed, the higher the BMI value of an individual (Rizzo *et al.*, 2013). A meta-analysis that was conducted over 60 studies showed a significantly lower weight and BMI in vegetarians than non-vegetarians (Sabaté & Wien, 2010). A cross-sectional study of 71,751 healthy adults from the Adventist Health Study 2 showed that mean BMI was significantly lower among vegetarians than non-vegetarians (Rizzo *et al.*, 2013). Rizzo *et al.* (2013) explained that high protein intake from meat based was strongly associated with increasing BMI among non-vegetarians, whereby similar findings were observed in the present study revealed that non-vegetarians had higher protein intake than vegetarians. However, Wong *et al.* (2013) reported that the mean BMI among non-vegetarians (22.0±4.66 kg/m^2), lacto-ovo vegetarians (22.5±4.96 kg/m^2) and strict vegetarians

(20.5±3.10 kg/m^2) in Selangor, Malaysia was not significantly different. The authors postulated individual's lifestyle, daily habit and varied dietary patterns in different countries could result in lack of difference observed in the mean BMI of vegetarians and non-vegetarians.

Non-vegetarians in the current study showed a slightly higher mean WC (78.0±1.52 cm) than vegetarians (76.4±10.9 cm). Similarly, Huang *et al.* (2014) reported that WC of non-vegetarians (72.8±9.5 cm) was slightly higher than vegans (72.2±11.0 cm) and lacto-ovo vegetarians (72.7±8.7 cm). Chiu *et al.* (2014) in Taiwan also found that WC of non-vegetarians was significantly higher than vegetarians. Sedentary lifestyle and overconsumption of fatty and processed foods may increase abdominal fat accumulation among non-vegetarians (Nande, 2014).

A significantly higher body fat percentage was evident among non-vegetarians when compared with vegetarians in the present study. The latter had a significantly lower total fat intake and this may result in having lesser fat accumulation in the body. However, another study in Malaysia reported that body fat percentages were higher, albeit not significantly, among lacto-ovo vegetarians (25.2±10.3%) than among non-vegetarians (21.2±7.5%) (Wong *et al.*, 2013).

Vegetarians especially vegans have a significantly lower prevalence of hypertension compared with non-vegetarians (Garbett, Garbett & Wendorf, 2016; Melina *et al.*, 2016). A meta-analysis comparing blood pressure from more than 21,000 people around the world found that vegetarians had significantly lower mean value of systolic and diastolic blood pressure than non-vegetarians (Yokoyama *et al.*, 2014). Low blood pressure in vegetarians may be attributed to high consumption of vegetables and less salt and total fat together with high intake of antioxidants such as vitamin C and folate (Shridhar *et al.*, 2014), which were also shown in this study.

No significant difference was observed in the mean energy intake between vegetarians and non-vegetarians. Clarys *et al.* (2013) which highlighted a similar finding in that the mean total energy intake was comparable among matched-paired vegetarians (2070±570 kcal) and non-vegetarians (2120±585 kcal) for age, sex, health and lifestyle characteristics. Deriemaeker *et al.* (2010) also showed no significant difference in total energy intake between vegetarians (2110±460 kcal) and non-vegetarians (2215±678 kcal). Conversely, a study conducted by Clarys *et al.* (2014) that involved a large sample size (n=1,475) revealed that non-vegetarians had a significantly higher total energy intake (2985±1029 kcal) than vegetarians (2722±875 kcal).

The mean carbohydrate intake among the vegetarians was almost similar to that of non-vegetarians in this study and finding was consistent with previous study (Clarys *et al.*, 2014). Vegetarians showed a significantly higher percentage of energy derived from carbohydrate than non-vegetarians in the present study. The finding can be attributed to higher consumption of starchy vegetables such as potatoes, corn and peas among vegetarians compared to non-vegetarians. Non-vegetarians consumed a significantly higher mean protein intake than vegetarians, which is consistent with findings of previous study (Clarys *et al.*, 2013). Furthermore, non-vegetarians had a higher total fat intake in their diet compared to vegetarians in this study. Individuals who are more educated and well-informed would tend to be more conscious about health-related issues when choosing various types of food to consume (Cramer *et al.*, 2017). The vegetarian participants in this study were

found to be more educated compared to non-vegetarians. This could explain the low-fat intake among vegetarians in the present study.

Non-vegetarians in the present study had a significantly higher mean intake of vitamin B_{12} than vegetarians, in which the finding is consistent with another local study (Wong *et al.*, 2013). A long-term lacto-ovo-vegetarian diet may cause vitamin B_{12} status to be low among vegetarians, especially pregnant women, where the risk of experiencing neural tube defect in the newborn is substantially increased (Koebnick *et al.*, 2005). Vegetarians who had an increased risk of experiencing vitamin B_{12} deficiency could attribute to this circumstance to the lack of consumption of animal-based food products. The mean vitamin B_{12} intake among non-vegetarians was approximately 3 to 4 times higher than strict vegetarians and lacto-ovo vegetarians (Wong *et al.*, 2013). Therefore, vegetarians should consume more plant-based foods that are high in vitamin B_{12} such as dried purple laver (nori), fermented soybean-based food, and mushroom to maintain an adequate intake of this particular vitamin (Watanabe *et al.*, 2014).

As for the consumption of minerals, the vegetarian participants consumed higher amounts of folate, calcium and potassium than their non-vegetarian counterparts. A local study conducted by Wong *et al.* (2013) found that strict and lacto-ovo vegetarians had a significantly higher folate and calcium intakes than non-vegetarians. Folate is abundantly found in legumes and green leafy vegetables. A plausible explanation for the higher folate intake among vegetarians than non-vegetarians is the frequent consumption of legumes and green leafy vegetables in their daily diet as shown in the present study. On the other hand, nearly half of the vegetarian participants were lacto-ovo vegetarians (48%) where their diet consist of dairy products and eggs that are the main sources of calcium. Additionally, vegetarians consumed higher amounts of dark-green vegetables, legumes and soy based food (such as *tempeh*, pickled tofu, *tau-kua*, *fucok* and tofu) than the non-vegetarians in this study. These plant-based foods are the alternative sources of calcium. However, calcium status among vegetarians needs to be given due consideration because, for example, soy bean contains a high level of oxalic acid. This form of acid may affect calcium bioavailability in the body.

In relation to the intake of iron, no significant difference was found between vegetarians and non-vegetarians in this study, which is consistent with a local study done by Wong *et al.* (2013). Similarly, another study done by Hawk, Englehardt & Small (2012) showed that mean iron intake did not differ significantly (p=0.480) between vegetarians (16.8±6.36 mg) and non-vegetarians (14.8±7.10 mg). This could be due to an increased consumption of iron-fortified food among vegetarians. The intake of iron can easily be achieved in a vegetarian diet as iron can be obtained from grains, cereals, nuts, legumes and vegetables. However, non-heme iron in the vegetarian diet is less bio-available than heme iron of non-vegetarians. Therefore, the status of iron is of great concern among vegetarians. Moreover, phytate in whole grains, legumes, lentils and nuts; polyphenols in tea, coffee, red wines and certain vegetables; protein from soy and eggs as well as calcium and phosphate, can inhibit the absorption of iron. Hence, vegetarians should increase the recommended daily iron intake by 1.8 times more than non-vegetarians (IOM, 2006) due to the low bioavailability of non-heme iron in the vegetarian diet, which can potentially cause iron deficiency.

There are several limitations in the present study. First, this study was a cross-sectional study in which causal relationship between variables cannot be determined. Second, convenience sampling was used in this study which may cause selection bias and the sample population was not representative to the general population. Furthermore, this study did not match-pair the vegetarians with the non-vegetarians in terms of age and sex due to small sample size. Future studies should match the vegetarian and non-vegetarian groups in order to increase the accuracy of the results. Additionally, 24-hour dietary recall which is characterised as a retrospective method of dietary assessment was largely relies on the honesty and memory of the participants. Different types of food group intake were not assessed in this study. Lastly, the current findings may not be generalised to Indian vegetarians as this study did not include Indian vegetarians. Also, the dietary patterns between Chinese and Indian-styled vegetarianism are different. Nevertheless, this study is able to provide baseline data for future research on comparison of nutritional status between vegetarians and non-vegetarians. The findings of this study can also help in the development of vegetarian dietary guidelines.

CONCLUSION

This study provides some insights into body weight status, dietary intake and blood pressure level among Malaysian Chinese vegetarians and non-vegetarians. Although more vegetarian participants achieved nutrient adequacy than their non-vegetarian counterparts, they should be aware of the likelihood of deficiencies of vitamin B_{12}, folate, calcium and niacin. Nutrition education programmes and interventions should be held more frequently for the benefit of vegetarians in general. Future studies should assess blood micronutrient concentrations to provide a better understanding of the nutritional status of vegetarians.

Authors' contributions

Gan WY, principal investigor, conceptualized and designed the study, prepared the draft of the manuscript and reviewed the manuscript; Boo S, data collection and reviewed the manuscript; Seik MY, data collection and reviewed the manuscript; Khoo HE, data analysis and interpretation, assisted in drafting of the manuscript and reviewed the manuscript.

Conflict of interest

The authors have no conflict of interest.

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Effects of sports nutrition education intervention on sports nutrition knowledge, attitude and practice, and dietary intake of Malaysian team sports athletes

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ABSTRACT

Introduction: The purpose of this study was to determine the effects of sports nutrition education intervention on improvements in sports nutrition knowledge, attitude and practice (KAP), and dietary intake among Malaysian team sports athletes. **Methods**: A total of 105 male participants representing four team sports under the elite sports programme were recruited based on a name list provided by National Sports Council of Malaysia. Teams were assigned by stratified random sampling to either the experimental group (EG) (n=52) or the comparison group (CG) (n=53). The EG received seven weeks of education intervention programme based on a validated booklet covering basic sports nutrition for team sports. A self-administered sports nutrition KAP questionnaire and dietary intake assessment of total energy, carbohydrates, proteins and fats based on three-day food records was conducted before and after the intervention. **Results:** There were significant increments (p<0.001) in the EG's post-intervention mean scores for knowledge (6.21±2.95), attitude (9.04±6.65) and practice (4.39±4.27) compared to decrements in the respective mean scores of the CG (-2.15±1.45; -1.72±5.06; -0.74±2.32). Significant improvements were found in the EG's total energy intake, total carbohydrate and total protein intake compared to those of the CG. **Conclusion:** The sports nutrition education intervention was useful in improving the sports nutrition KAP scores, total carbohydrate and total protein intake of team sports athletes.

Keywords: Athletes, intervention study, dietary intake, sports nutrition, knowledge

INTRODUCTION

Sports nutrition can be defined as the application of nutrition knowledge to practical daily diet plan in order to provide energy for physical activity, repairing process in the body, optimising sports performance in competitions and to ensure health and well-being (Contento, 2007). Researchers have reported that physical activity, athletic performance and recovery from exercise were enhanced by optimal nutrition

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(American Collage of Sport Medicine, American Dietetic Association & Dietitians of Canada, 2009).

Delivering optimum nutrition practice is important for all sports, regardless of individual sports or team sports since sports and nutrition are directly related to each other (Supriya & Ramaswami, 2013). In individual sports, the dynamics that govern success is the athlete himself. Individual athletes achieve success through high self-reliance, high discipline in training, with other application of sports science including sports nutrition. Meanwhile, in team sports, two or more athletes work together on a common playing area to defeat an opposing group of competitors (Fink & Mikesky, 2015). Team sports are based on intermittent high-intensity activity patterns, but experience marks the variability of the game characteristics among sports, playing positions and playing styles. Such differences create a diversity of physiological challenges and nutritional needs of team sports athletes (Mujika & Burke, 2010). Position-specific tasks and physique requirements, playing level, gender and age issues further affect nutrient requirements (Holway & Spriet, 2011). In team sports, athletes rely on teammates to achieve team success, it is most important for every team members in team sports to have basic nutritional knowledge and disseminate the correct sports nutrition practice.

Sports nutrition knowledge is important in assessing the knowledge of those athletes who practice sports nutrition and spread information about it. This evaluation is intended to avoid myths and misinformation, as well as to ensure that accurate information is obtained and optimal sports nutrition is practiced by athletes (Zinn, Schofield & Wall, 2005). However, the level of general and sports-specific nutrition knowledge of athletes has been a popular question for researchers. Athletes lack knowledge in nutrition, healthy food choices and the components of a well-balanced diet (Davar, 2012), and these factors have implications on athletes' performance. Hornstorm *et al.* (2011) found a significant inverse relationship between female softball players' nutrition knowledge scores and the quality of their food selections, indicating that the players with less nutrition knowledge had poorer eating habits.

Athletes have special nutritional needs compared to the general population. Burke *et al.* (2001) reported that athletes' diets were often nutritionally inadequate when compared with sports nutrition and general population recommendations. Only 15% of male athletes and 26% of female athletes had adequate carbohydrate and protein intake, respectively (Hinton *et al.*, 2004). One of the strategies to help athletes consume an adequate diet is nutrition education (Spendlove *et al.*, 2012), and the transition from theory to practice usually requires an educational programme (Trabucco *et al.*, 2013). Therefore, the objective of this study is to determine the effects of sports nutrition education intervention on KAP regarding sports-related nutrition and dietary intake among Malaysian elite team sports athletes.

MATERIALS AND METHODS

Study design

In this quasi-experimental intervention study, two groups of participants were recruited, consisting of one experimental group (EG) and one control group (CG) for comparison purposes. The EG attended a seven-week intervention programme on sports nutrition education, while no programme was provided to the CG. The data was collected; at week 0 (i.e.,

the baseline or pre-intervention), and at week eight (post-intervention) after the seven-week intervention.

Participants

Representatives of four elite team sports out of seven listed by the National Sports Council of Malaysia were selected for this study. The participants were grouped into either the EG or the CG, using stratified random sampling. Stratified random sampling was used because of the small number of certain groups that might cause representatives from those groups not to be selected if a simple random sampling was used (McKenzie *et al.*, 2005). Two team sports that stays and train at National Sports Complex Bukit Jalil were grouped into the EG while the other two team sports that stay and train away from Bukit Jalil were grouped into CG, this was done to avoid respondent contamination during the intervention. In total, 110 participants from four team sports were recruited in the study and 105 respondents completed the study. The players representing two team sports (field hockey and football) were assigned to the EG (n=52), and the representatives of the other two (cricket and rugby) were assigned to the CG (n=53) (Figure 1). The inclusion criteria were as follows: (i) male, (ii) engaged in intermittent team sports, (iii) an elite athlete in a training squad, (iv) between 18 and 35 years old (young adult), (v) never received any formal sports nutrition education before this study and (vi) not at a competition phase. The exclusion criteria were as follows: (i) not an elite athlete and (ii) an athlete with an injury. The sample size calculation was based on Chan (2003) formula for calculating the intervention group size, as follows:

Size per group,

$$M = c \times \frac{\pi 1 (1 - \pi 1) + \pi 2 (1 - \pi 2)}{(\pi 1 - \pi 2)^2},$$

where c is constant $[z(1-\alpha/2) + z(1-ß)]^2$ = 7.9, $z(1-\alpha/2)$ = standardised value for 95% confidence interval = 1.96 and $z(1-ß)$ = 80% power = 0.842. Proportion estimates were derived from the effect size of 1.2 (Sharifirad *et al.*, 2009). Based on interpretation by Cohen (1988), an effect size of 1.2 equals to 88% of the treatment group will be above mean of the control group (62%) of having successful outcome. Proportion estimates $\pi 1$ = 0.88 (88% of the EG would be above the mean of the CG that had a successful outcome), and $\pi 2$ = 0.62 (62% of the CG would have a favourable outcome). Therefore, the calculated sample size per group comprised of 50 participants (after considering an 80% response rate), and totals 100 participants in both groups.

Procedure for the intervention

The intervention activities consisted of distribution of the educational booklets, lecture sessions, group discussions and group activities. The intervention programme was conducted in small group sessions, with each group consisting of five to six participants. The EG attended one to two hours of educational sessions on a weekly basis. Each session comprised a one-hour lecture based on one of the sports nutrition topics from the educational material (booklet), followed by a half-hour discussion, including a question-and-answer segment. Some topics in the booklet required the respondents to perform some calculation activities for about half an hour. Table 1 presents the intervention activities. The principal researcher, who had a sports nutrition background, delivered the lecture sessions. Before the educational sessions began, the EG was given a one-hour explanation regarding the booklet and the activities that would be conducted during the intervention. No intervention programme was provided to the CG as it served the purpose of comparison only.

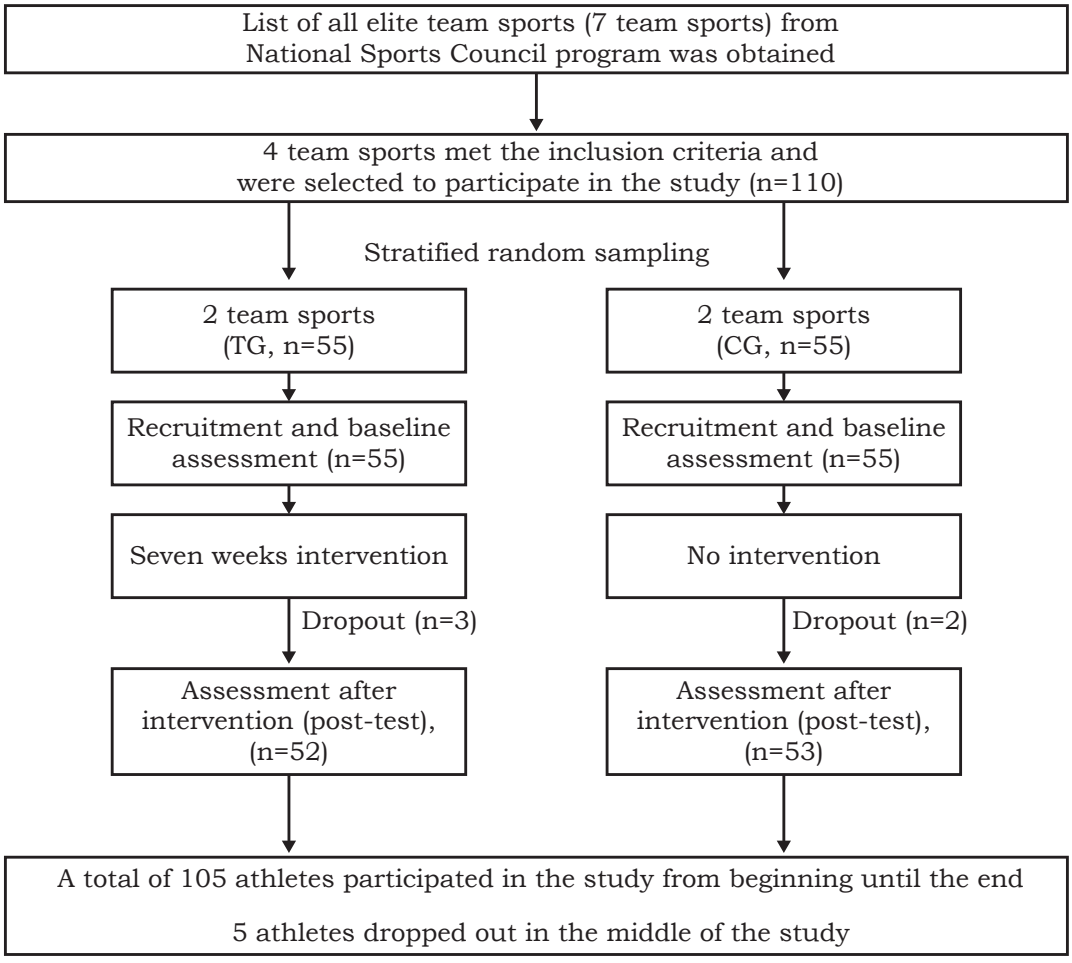

Figure 1. Flow of recruitment, data collection and intervention conducted

There were seven education sessions, and attendance for EG participants was compulsory. Participants who attended the session signed the attendance list. Participants were considered to have dropped out if they did not complete or attend the education session more than two times and did not complete the baseline and post-intervention assessment. Participants who withdrew from the study due to unwillingness to participate were also considered to have dropped out.

Measurement outcomes

The baseline data and the post-test results were collected from the participants in both groups. The data were collected from sports nutrition KAP questionnaires and three-day food records. The socio-demographic section of the questionnaire was used only at the baseline, while similar methods and instruments were applied again at the post-test phase (after the intervention) to collect the data.

Socio-demographic information
In the self-administered questionnaire, each participant was asked about his age, date of birth, ethnicity, educational level, sports category and number of years as an athlete.

Sports nutrition questionnaire
The athletes' sports nutrition KAP levels were determined using a validated questionnaire developed by Hornstrom *et al.* (2011). The sports nutrition questionnaire was first translated using the forward translation method (from English to Bahasa Malaysia) and was translated again using the backward translation method (from Bahasa Malaysia to English) to ensure the accuracy and the clarity of the questionnaire's language, meaning and content. The questionnaire consisted of the following three sections:

(i) Knowledge on basic sports nutrition included 25 questions. Each answer was coded as "correct" and given one mark or "incorrect" and given a zero. The total score was calculated by summing up the marks obtained for all items. A higher score indicates a higher level of knowledge on sports nutrition.

(ii) The second section comprised nutrition choices and nutrition practice, consisting of seven questions on usual food choices and proper nutrition. The respondents were required to choose one out of four answer options. The positive statements about nutrition choices were assigned numbers in a reverse way for scoring purposes. The items were reversed from 1 = every day, 2 = most days, 3 = occasionally and 4 = rarely to 1 = rarely, 2 = occasionally, 3 = most days and 4 = every day. The nutrition practice subsection included five questions about the respondents' nutrition practice based on the Malaysian food pyramid. The participants were required to choose one out of four answer options (1 = four times or more per day, 2 = two or three times per day, 3 = once per day and 4 = less than once per day). The total score was calculated by adding the mark obtained for each of the 12 items in the nutrition choices and the nutrition practice subsections. A higher score indicates healthier nutrition practice.

(iii) Questionnaire on attitude towards nutrition and sports-enhancing diet consisted of 20 questions. The participants were required to choose one out of four options (1 = strongly agree, 2 = agree, 3 = disagree and 4 = strongly disagree). The positive statements in this section were assigned numbers in a reverse way. The total score was calculated by summing the marks obtained from items 1 to 20. A high score indicates higher or more positive attitude towards sports-enhancing diets.

Three-day food records
The three-day food records were self-administered by the participants. To ensure the accuracy of the contents, the researcher interviewed the participants after they handed their completed forms. These dietary records were used to obtain the respondents' dietary and energy intake information. The participants were required to record their entire food and beverage intake, including supplements, during two weekdays on training days and one weekend on rest days. The respondents can choose any two weekdays and any weekend for their dietary intake records. Their total energy and macronutrient intake was examined. The participants' dietary intake was analysed using the Nutritionist Pro software.

Development of educational material
A booklet on basic sports nutrition for team sports was developed, based on information gathered from various learning materials, including scientific

journals, books, websites, fact sheets and pamphlets from local and international publications. After the information was collected, an expert panel of two senior lecturers from the Department of Nutrition and Dietetics and three sports nutritionists from the Sports Nutrition Department, National Sports Institute of Malaysia revised the contents of the booklet. Simple questionnaires about the booklet were distributed to the expert panel and the sports nutritionists to assess the content validity of the instrument. Comments and suggestions from the expert panel and the sports nutritionists were used to improve the booklet's content, images, font types and appearance so that it would be precise and attractive to use as the intervention instrument.

The booklet entitled *Asas Pemakanan Sukan untuk Sukan Berpasukan* (ISBN 978-983-2408-27-7) was written in Bahasa Malaysia as the teaching material to be used during the intervention programme. The booklet consisted of seven topics on basic sports nutrition, as follows: (i) food and healthy nutrition; (ii) macronutrients; (iii) micronutrients; (iv) fluid and hydration; (v) nutritional intake before, during and after training or competition; (vi) energy balance and body weight management, and (vii) dietary supplements.

Data collection

The study was carried out for a total of nine weeks, including one week for the pre-intervention data collection (baseline), seven weeks for the intervention programme and another week for the post-intervention data collection. The participants received an information sheet prior to the data collection to enhance their understanding of this study's objectives. Each respondent signed and returned a consent form, indicating his agreement to participate in the study.

Ethics approval

The Ethics Committee for Research Involving Human Subjects, under the Research Management Centre of Universiti Putra Malaysia, approved this study (Approval No. UPM/TNCPI/RMC/1.4.18.1(JKEUPM)/F2 dated 17 April 2015). Permission to involve the Malaysian elite team sports athletes was obtained from the National Sports Council of Malaysia, related sports associations and team sports managers and coaches.

Data analysis

Descriptive statistical analysis was used to determine the mean, standard deviation, frequency and percentage. Chi-square test was performed to determine associations between categorical variables, while paired *t*-test was used to determine the differences in the means of continuous data within each group before and after the intervention. Independent *t*-test was conducted to determine the significant differences in the means of continuous data between the EG and the CG at the baseline. A general linear model, repeated-measure ANOVA for the two groups at the baseline and the post-test phases was used to determine if any significant differences existed between the groups at each time point. If a significant difference between the groups was found at the baseline, ANCOVA was performed, using the baseline data as covariates. The analysis was based on the intention to treat the EG, and the statistical significance was assigned at $p<0.05$. The data was analysed with the SPSS 22.0.

RESULTS

Initially, 110 eligible respondents were included in the study. At the end of the seven-week intervention, five respondents dropped out, and 105 continued to the post-intervention

Table 2. Socio-demographic characteristics of experimental and comparison groups

Characteristics	*Experimental group (n=52) n (%)*	*Comparison group (n=53) n (%)*	*Overall n (%)*	*Chi-square** (p-value)*
Ethnicity				0.851 (0.356)
Malay	48 (92.3)	46 (86.8)	94 (89.5)	
Indian	0 (0.0)	6 (11.3)	6 (5.7)	
Chinese	2 (3.8)	0 (0.0)	2 (1.9)	
Others	2 (3.8)	1 (1.9)	3 (2.8)	
Type of Sports				6.191 (0.013)*
Cricket	0 (0.0)	14 (26.4)	14 (13.3)	
Football	26 (50.0)	0 (0.0)	26 (24.8)	
Hockey	26 (50.0)	0 (0.0)	26 (24.8)	
Rugby	0 (0.0)	39 (73.6)	39 (37.1)	
Years Being Athletes				0.826 (0.363)
< 5 years	0 (0.0)	4 (7.5)	4 (3.8)	
5 - 10 years	43 (82.7)	36 (67.9)	79 (75.2)	
> 11 years	9 (17.3)	13 (24.5)	22 (21.0)	
Education Level				28.806 (<0.001)*
Secondary	39 (75.0)	12 (22.6)	51 (48.6)	
Pre University	7 (13.5)	6 (11.3)	13 (12.4)	
University	6 (11.0)	35 (66.0)	41 (39.0)	

*significant difference between groups
**Chi-square based on 2x2 contingency table

phase. Of the 105 participants, 52 were from the EG, and 53 were from CG. The programme continuation rates for the EG and the CG were 94.5% and 96.4%, respectively. After the intervention, the final sample's programme completion rate averaged 95.5%. Age of participants was between 18-32 years old and mean age for EG was 18.69 (*SD*=0.88) while mean age for the CG was 23.26 (*SD*=3.81). There was significant difference between mean age for EG and CG, $t(58)=-8.513$, $p<0.001$. The EG and the CG were similar in terms of ethnicity and number of years as an athlete. However, the two groups differed significantly ($p<0.05$) in the type of sports and educational level. The participants in the EG were football (24.8%) and hockey (24.8%) players, while the participants in the CG engaged in cricket (13.3%) and rugby (37.1%) sports ($\chi^2=6.191$, $p<0.05$). For educational level, 75.0% of the respondents in the EG and 22.6% of the respondents in the CG had completed secondary education. Meanwhile, 66.0% of respondents in CG and 11.0% respondents in EG completed their tertiary education ($\chi^2=28.806$, $p<0.001$) (Table 2).

Table 3 presents the pre-test and the post-test mean scores for the sports nutrition KAP of the EG and the CG. At the baseline, the CG's mean score for knowledge was significantly higher than that of the EG, but there was no significant difference in the mean scores for attitude and practice between the two groups. There were significant increments in the EG's KAP mean scores after the intervention, as indicated by the mean changes in the knowledge ($\Delta M=6.21$, $p<0.001$), attitude ($\Delta M=9.04$,

Table 1. Outline of sports education intervention activities

Week	*Activities*	*Content*	*Period*
1	Lecture session	Topic 1: Food and healthy nutrition	1 hour
	Group discussion		½ hour
2	Lecture session	Topic 2: Macronutrient	1 hour
	Group discussion		½ hour
3	Lecture session	Topic 3: Micronutrient	1 hour
	Group discussion		½ hour
4	Lecture session	Topic 4: Fluid and hydration	1 hour
	Activity	Calculation of percent body weight loss during training and volume of fluid to be replaced	½ hour
	Group discussion		½ hour
5	Lecture session	Topic 5: Nutrition before, during and after training or competition	1 hour
	Group discussion		½ hour
6	Lecture session	Topic 6: Energy balance and weight management	1 hour
	Activity	Calculation of BMI and estimation of energy requirement	½ hour
	Group discussion		½ hour
7	Lecture session	Topic 7: Dietary supplement	1 hour
	Group discussion		½ hour

$p<0.001$) and practice ($\Delta M=4.39$, $p<0.001$) scores between the baseline and the post-test phases. The increments in the post-test KAP mean scores contributed to the significant difference ($p<0.001$) in the KAP mean scores between the EG and the CG. Meanwhile, there was a significant decrease in the CG's KAP scores after the intervention.

Table 4 presents the pre-test and the post-test mean total energy and macronutrient intake of the EG and the CG. At the baseline, there was a significant difference in the total energy intake between the two groups. For the macronutrient intake at the baseline, the two groups showed significant differences in carbohydrate intake, in g/kg of body weight, percentage of total carbohydrate intake, total protein intake, percentage of total protein intake, total fat intake and percentage of total fat intake ($p<0.001$). No significant difference was found in total carbohydrate intake and protein intake (in g/kg of body weight). After the intervention, the mean total energy intake was significantly higher in the EG than in the CG, as indicated by the mean change between the groups ($\Delta M=401$ versus -104, $p<0.001$). Meanwhile, there were significant increments in certain macronutrient variables in the EG, as indicated by the mean changes in their total carbohydrate intake ($\Delta M=38.13$ g, $p<0.001$), carbohydrate intake (in g/kg of body weight; $\Delta M=0.57$, $p<0.001$), total protein intake ($\Delta M=30.45$, $p<0.001$) and total fat intake ($\Delta M=18.36$, $p<0.001$).

Table 4. Mean differences of total energy and macronutrient intake between the experimental and comparison groups

Variable	*Experimental group (n=52) Mean±SD*	*Comparison group (n=53) Mean±SD*	*F-value*	*p-value*
Total energy (kcal)				
Pre	2478±364	2801±541		
Post	2879±385 [c]	2697±600 [c]	24.517[a a]	<0.001[*]
Difference	401±486	-104±338		
Total carbohydrate (g)				
Pre	342.15±59.96	332.24±52.96		
Post	380.28±62.72 [c]	319.39±59.80 [c]	13.025[b]	<0.001[*]
Difference	38.13±74.54	-12.85±45.49		
Carbohydrate g/kg body weight				
Pre	5.25±1.05	4.37±0.88		
Post	5.82±1.24 [c]	4.12±0.57 [c]	49.990[a]	<0.001[*]
Difference	0.57±1.15	-0.25±0.66		
Carbohydrate percentage (%)				
Pre	55.13±4.84	48.05±4.53		
Post	52.79±5.54 [c]	48.11±4.89	0.905[a]	0.344
Difference	-2.33±5.46	0.06±4.91		
Total protein (g)				
Pre	108.68±23.32	142.62±38.54		
Post	139.14±22.22 [c]	141.34± 41.40	15.822[a]	<0.001*
Difference	30.45±29.33	-1.28±22.93		
Protein g/kg body weight				
Pre	1.68±0.43	1.83±0.39		
Post	2.13±0.47 [c]	1.79±0.39	1.748[b]	0.189
Difference	0.46±0.47	-0.04±0.31		
Protein percentage (%)				
Pre	17.63±2.97	20.11±2.71		
Post	19.41±2.46 [c]	20.63±2.46	0.349[a]	0.556
Difference	1.77±3.14	0.51±2.49		
Total fat (g)				
Pre	75.94±16.22	101.68±26.42		
Post	94.30±19.80 [c]	96.21±26.76	9.973[a]	0.003[*]
Difference	18.36±23.01	-5.58±20.01		
Fat percentage (%)				
Pre	27.58±4.03	32.29±3.36		
Post	29.50±4.27 [c]	31.68±3.44	1.502[a]	0.233
Difference	1.92±5.40	-0.62±3.96		

[*] significant difference between groups, $p<0.05$

[a] result from ANCOVA with baseline data as covariates

[b] result from GLM repeated measures ANOVA

[c] significant difference within-group between baseline and post-intervention as determined by paired sample *t*-test

The significant increments in the post-test results for these variables contributed to the significant difference (p<0.001) between the EG and the CG. After the intervention, no significant difference was found in the percentage of carbohydrate intake, percentage of protein intake, protein intake (in g/kg of body weight) and percentage of protein intake between the two groups.

DISCUSSION

This study was conducted to examine the effects of sports nutrition education intervention on Malaysian team sports athletes. After the intervention, the time and the group effects on the KAP scores showed significant interactions between the two groups of respondents over the two periods. The main effect of time on the KAP scores showed significant increments in the EG's KAP test scores and decreases in the CG's KAP test scores at the post-test phase. The EG (with intervention programme) and the CG (no intervention programme) showed statistically significant results, indicating differences in the KAP scores of both groups, with the EG demonstrating better outcomes after the intervention compared to the CG. These findings are consistent with those of Abood, Black & Birnbaum (2004), Valliant *et al.* (2012) and Rossi *et al.* (2017), which showed significant improvements in the athletes' nutrition knowledge and dietary practice after an education intervention programme. Another study found a positive relationship between nutrition knowledge and attitude; higher knowledge and attitude scores were associated with athletes that had more nutrition education (Hornstrom *et al.*, 2011).

The mean KAP scores for EG shows increment after the intervention, while the CG decreased in their mean KAP scores after the intervention. Within-group comparison revealed that there was statistically significant effect of time for pre- and post-KAP scores for both groups, with EG showing increment in their post-test KAP scores, while the CG decreased their test score at post-test. The effect comparing the two types of intervention between EG which received seven weeks of sports nutrition education and CG who do not receive any education programme was significant suggesting there was differences in KAP scores for both groups with the EG showing better result of sports nutrition knowledge, attitude and practice compared to the CG. The differences in the scores between the EG and the CG is assumed to be due to the input given to the EG which comprise comprehensive approach on basic sports nutrition during the intervention program while no information given to the CG on the importance of sports nutrition knowledge, attitude and practice of sports nutrition.

At baseline, the significant differences in the type of sports were due to the differences in the training regime, training volume, training environment, rest time, daily life activity and sports culture of the different team sports involved in this study. Moreover, the players' body physique depended on the type of sports that they were playing.

Athletes' energy requirements depend on the scheduled training and the competition cycle and vary from day to day throughout the yearly training plan relative to changes in volume and intensity (ACSM, 2016). This study found a significant improvement in the EG's mean energy intake at the post-test phase. This result indicated good practice because the total calorie intake showed an improvement, with more energy intake to balance the athletes' energy requirements. Additionally, the EG's energy intake (2879 kcal) after the intervention exceeded the value of the

energy intake (2784 kcal) reported in Ismail and colleagues' (1995) local study among selected sportsmen.

The recommended nutrient (e.g., carbohydrates and proteins) and energy intake should be expressed by using guidelines per kilogram of body weight to allow scaling to a large range of the body sizes of athletes (ACSM, 2016). The mean intake of total carbohydrate and carbohydrate (in g/kg of body weight) were significantly increased in the EG after the intervention. The EG's carbohydrate intake (in g/kg of body weight) showed improvement over the two periods, but the value (5.6 g/kg of body weight) did not reach the recommended range for actively training athletes (6-10 g/kg of body weight). Although the EG's total carbohydrate intake increased (from 342.15 g to 380.28 g) at the post-test phase, converting this amount from gram to percentage showed a decrease with 53% of the total carbohydrate intake, and this value did not meet the recommended total energy requirement from carbohydrate intake. The EG's failure to meet the adequate percentage of carbohydrate intake indicated that the improvement in their total energy intake was due to their consumption of high-protein and high-fat foods instead of carbohydrate-rich foods. These findings are similar to those of Villiant *et al.* (2012), who reported an improvement in the participants' dietary intake and an increased percentage of their fat intake after the intervention programme. In the present study, the respondents would need to reduce their fat intake and increase their carbohydrate intake to meet the dietary intake recommendations for athletes. According to Loucks (2004), the limiting factor for performance is energy intake, especially carbohydrate intake, below the recommended total energy requirement. In contrast, Villiant *et al.* (2012) study showed an increase in the participants' carbohydrate intake from 48% to 66% before and after the intervention, respectively.

The EG had significant increases in their total protein intake, protein intake (in g/kg of body weight) and percentage of total protein intake after the intervention. Their protein intake was within the recommended range for athletes (1.2–1.7 g/kg of body weight) (Jeukendrup & Cronin, 2011) at the pre-test phase and exceeded the recommended protein intake for athletes (2.13 g/kg of body weight) at the post-test phase. Their percentage of total protein intake slightly increased from 18% at the pre-test phase to 19% at the post-test phase, remaining within the recommended range for the total energy intake. The EG's total fat intake and percentage of total fat intake increased significantly at the post-test phase. Although their percentage of total fat intake increased, the value was just acceptable and less than 30% of the recommended range for the total energy requirement from fat intake.

One of the functions of nutrition education is to facilitate voluntary adoption of eating and other nutrition related behaviour conductive to health and well-being (Contento, Randell & Basch, 2002). Nutrition education programmes are designed to improve nutrition knowledge, with the aim of supporting sound dietary practice within the community or specific target population (Worsely, 2002). In this research, results of increased KAP scores in the EG after the intervention programme shows that nutrition education given to EG was useful to facilitate the participants in EG to apply a good dietary practice and this shows from their positive dietary intake increments after the intervention. Meanwhile, in CG the dietary intake data shows either significant decreased or no significant difference within group after the intervention since no education programme given to this comparison

group to guide them on practicing good nutrition habits.

Limitations

Several limitations could have affected this study's findings. The study involved players from only four team sports. Hence, the results might not be representative of all the other team sports athletes in Malaysia. The study was conducted among team sports athletes only, which might not be generalised to other sports athlete populations. The nutrition education programme used was only limited to the team sports in the experimental group only, while athletes in the comparison group did not receive the nutrition education program. No comparison could be made to female athletes since this study only involved male athletes. The participants' types of sports might have biased this study's results because the respondents in the EG and the CG played different sports. This variety reflected the differences in both groups' sports culture, body physique, training regime, training time, training volume and intensity, and all of these factors could have affected the study's results.

During the data collection, self-bias might have occurred because each participant's diet was unobserved. The dietary intake information used in this study was based on the subjects' self-reports, and the collected data depended on their honesty in documenting their three-day food records. Under- or over-reporting on the three-day food records might have led to an underestimation or an overestimation of the participants' total caloric intake in this study. Furthermore, the questionnaire used in this study was self-administered. Hence, the reliance on the self-reported data depended on the participants' honesty and ability to understand the questionnaire.

CONCLUSION

The sports nutrition education intervention increased the sports nutrition KAP scores, improved athletes' intake of total energy and macronutrients. This study's findings support the need for programmes to improve the dietary intake of team sports athletes for optimal performance.

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Authors' contributions

Siti Soraya ME, principal investigator, conceptualized and designed the study, led the data collection, prepared the draft of the manuscript and reviewed the manuscript; Hazizi AS, conceptualized and designed the study, led the data collection, advice on the data analysis and interpretation, assisted in drafting of the manuscript and reviewed the manuscript; Mohd Nasir MT, conceptualized and designed the study and reviewed the manuscript; Zubaidah J, conceptualized and designed the study and reviewed the manuscript.

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Self-perception of body image among Saudi females at Princess Nourah University, Riyadh, Kingdom of Saudi Arabia

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ABSTRACT

Background: Women are influenced by many socio-cultural factors on how they perceive their body image. **Methodology**: This cross-sectional study assessed self-perception of body image, body mass index (BMI), and compared the agreement between actual and perceived BMI among Saudi female adults at Princess Nourah University (PNU) in Riyadh. A total of 336 participants aged 18-50 years were recruited, by randomly selecting one of the three colleges in PNU and from among the workers in the selected college. A structured self-administered questionnaire was used to obtain socio-demographic information, weight perceptions, body satisfaction and media influence on body image. Participants had to "give best description of your perceived weight and height". **Results**: Majority of the participants were aged 18-29 years and unmarried. Mean BMI was 26.1±9.41 kg/m^2, and more than half of the participants (55.7%) belonging to 55-80 kg weight range were overweight. Their mean BMI by actual measurement was 24.2±8.26 kg/m^2 while their self-estimated BMI also fell in the normal BMI category. Cohen's Kappa K value of 0.635 indicated a good agreement between the actual and perceived BMI categories. Positive body image perception was given by 68.6% of the participants; 83.9% felt appearance was very important in the context of body image perception; 47.1% agreed that changing their abdominal part was what they wanted to change most, while 52.8% opted to lose weight in improving their appearance. **Conclusion**: Overall, an underestimation of body weight in terms of BMI was found among the participants. Such misconceptions should be addressed in view of the high obesity prevalence in Saudi Arabia.

Keywords: Self-perception, body image, misperception, BMI, Saudi female

INTRODUCTION

Body image is defined "as a person's mental representation of his/her own body, encompassing perceptual, affective, cognitive, and behavioural body aspects" (Lee, 2013). The perception of individuals of their own weight status and body image often incorporates visualisation of their own body formed in their mind. It is also a multidimensional concept incorporating sociocultural, neurological and psychological elements (Shagar *et al.*, 2014). Preference for a particular body weight and attitude

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towards body image may be mediated by cultural, physical, interpersonal, and emotional factors that increase body image dissatisfaction leading to eating disorders (Makara-Studzińska, 2013; Calado, 2011).

Students reportedly perceived themselves as too thin or too fat (El Ansari *et al.*, 2010). Body image discrepancies were reported among Saudi students, in that 44.1% were "thinner" and 19.7% were "heavier" than their perceived body image (Khalaf *et al.*, 2015). Another study among Saudi female university students showed one-third misclassified themselves when compared with their actual weight (Epuru *et al.*, 2013). Underestimating one's own weight is associated with prevalence of gaining weight, and associated with depression, low self-esteem, feelings of shame and anxiety, and social isolation. Studies in adults have also shown a decline in recognition of overweight in recent decades (Salcedo *et al.,* 2010). Weight perception is an important determinant of nutritional habits and weight measurement, regardless of whether a person is underweight, normal or overweight. Prevalence of obesity has been increasing progressively globally, and Saudi Arabia is no exception. Inaccurate recognition of weight status can pose a threat to healthy weight control.

Since significant weight misperception has been reported in Saudi Arabia, the present study is aimed at assessing self-perception of body image in terms of body mass index among Saudi females at Princess Nourah University (PNU) in Riyadh.

MATERIALS AND METHODS

A cross-sectional study was conducted at PNU located in Riyadh, Saudi Arabia. The PNU was chosen because of its accessibility and presence of Saudi females from different socioeconomic backgrounds and ages.

Sample size was selected from open EPI website based on confidence interval of 95%, with 499 representing target population. A simple random sampling was used to select the participants. There are three colleges in PNU and the College of Sciences was randomly chosen, from which, participants were randomly selected.

A structured self-administrated questionnaire with close-ended questions was used to collect data. Some of the questions were derived from previous studies and modified to be in line with Saudi culture. It included socio-demographic and lifestyle information, assessment of self-perception, weight perception, body satisfaction and media influence. Perceived measurements were posed as "give the best description of your perceived weight and height". The participants completed it while the researchers conducted measurements of weight, height and waist circumference. Body mass index (kg/m^2) was calculated and categorized as (underweight: BMI <18.5; normal weight: BMI 18.5-24.9; overweight: BMI 25.0- 29.9; obesity: BMI 30.0-34.9) (WHO, 2016).

Body image perception aligned with Saudi culture was assessed on a 10-point Likert scale from thinness to fatness. Regarding perception of ideal body image, a scale of 10 was used whereby scores of 1-4 were considered "thin", 5-6 "moderate body weight", and 7-10 "overweight/fat".

The data was edited for inconsistencies, and descriptive and analytical results were obtained. Data were tested for normality using the Kolmogorov-Smirnov test, skewedness and Kurtosis. Descriptive statistics such as mean and standard deviation were calculated for the continuous variables (height, weight and waist circumference) and frequencies for categorical data.

Chi square test was used for the bivariate analysis to determine the association between BMI classification and misperception of own weight status using significant *p*-values for categorical variables. Agreement between actual BMI and perceived BMI categories was checked using Cohen's Kappa. The confidence interval was based on 95% and the level of significance was *p*-value ≤0.05. Analysis was done through SAS/JMP statistical analysis program (Version 13).

RESULTS

This study included 336 respondents, majority of whom were aged 18-29 years and unmarried. According to actual measurements, the mean BMI was 24.2±8.26 kg/m^2 while, based on self-estimated weight and height, their BMI was estimated as 23.3±9.17 kg/m^2 (Table 1).

Table 1. Social background, actual and self-estimated body weight and height of subjects (*N*=336)

Variables	*N (%)*	*Mean±SD*
Age (years)		
18-29	301 (90)	
30-42	35 (10)	
Marital status		
Married	48 (14.3)	
Not married	288 (85.7)	
Measurements (actual)		
Height (cm)		156.62±7.59
Weight (kg)		58.73±12.64
BMI (kg/m^2)		24.2±8.26
Measurements (self-estimation)		
Height (cm)		159±6.0
Weight (kg)		58±12.0
BMI (kg/m^2)		23.3±9.17

More than half (55.7%) with actual weight range of 55-80 kg showed a mean BMI of 26.1±9.41 kg/m^2, which falls in the overweight category. In comparison, more than half (58.0%) self-perceived their weight in the range 33-58 kg, with a mean estimated BMI 21.0±10.9 kg/m^2, which is in the normal weight category. Such a discrepancy of BMI was found high (90%) among aged 18-29 years (Table 2). The result from Cohen's Kappa was 0.635, indicating a good agreement between the actual and perceived BMI categories, and it is statistically significant at $p<0.001$. Agreement between actual and perceived BMI was highest (51.4%) in the normal weight category, followed by overweight (13.3%), underweight (8.5%) and obese (5.7%) categories (Table 3).

Out of the total participants, 68.6% showed positive body image perception. The difference between positive and negative body image perceptions was statistically significant at $\chi^2(3)=53.53$, $p<0.001$ (Table 4). Majority of the participants (83.9%) felt that their appearance was very important in the context of body image perception. Nearly half of them (47.1%) agreed that changing their abdominal part was what they wanted to change most, while 52.8% opted to lose weight in improving their appearance (Table 5).

Table 2. Weight range and BMI classifications on females at Princess Nourah University (*N*=331)

Weight categories	*N*	*%*	*BMI Mean±SD*
Weight categories (kg) based on actual measurements			
29-54	131	39.2	20.0±2.10
55-80	186	55.7	26.1±9.41
81-105	15	5.0	35.0±3.65
106-131	2	0.1	44.0±3.19
Weight categories (kg) based on self-estimations			
33-58	196	58.3	21.0±10.90
59-84	130	38.7	25.8±3.27
85-110	9	2.7	34.9±4.14
111-136	1	0.3	43.4†

†has no *SD* because it's only one participant

Table 3. Assessing agreement between actual and self-estimated BMI categories (*N*=331)

Self-estimated BMI categories	*Actual BMI categories*								*K*	*p*
	Underweight		*Normal weight*		*Overweight*		*Obese*			
	N	*%*	*N*	*%*	*N*	*%*	*N*	*%*		
									0.635	<0.001*
Underweight	28	8.5	18	5.4	0	0.0	0	0.0		
Normal weight	1	0.3	170	51.4	29	8.8	3	0.9		
Overweight	0	0.0	6	1.8	44	13.3	8	2.4		
Obese	0	0.0	1	0.3	4	1.2	19	5.7		
Total	29	8.8	195	58.9	77	23.3	30	9.1		

*Significance difference $p<0.05$.

Table 4. Distribution of positive and negative body image perception according to BMI classification among females

BMI classification (based on actual measurements)	*Body image perception*				χ^2	*p*
	Positive		*Negative*			
	N	*%*	*N*	*%*		
Underweight	18	5.4	11	3.3	53.53	<0.001*
Normal weight	162	48.9	33	10.0		
Overweight	38	11.5	39	11.8		
Obese	9	2.7	21	6.3		
Overall	227	68.6	104	31.4		

*Significant difference $p<0.05$

About half (52.7%) reported that social media sometimes affects their body image perception, but 44% reported no such media influence. Approximately more than one third (38.6%) stated that sometimes they compared their body shape with others. Lowered self-esteem was the highest (47.9%) consequence of having a negative body image perception, followed by feelings of being insecure around people, general unhappiness and embarrassment. On the other hand,

Table 5. Assessment of body image perception

Assessment of body image perception	*n*	*%*
Assessment of body appearance		
I. Importance of appearance (*n*=335)		
Very important	281	83.9
Moderately important	48	14.3
Slightly important	5	1.5
Not important	1	0.3
II. Body part wants to change (*n*=333)		
Upper part	46	13.8
Abdominal part	157	47.1
Lower part	85	25.5
Nothing	45	13.5
III. Prefer to (*n*=335)		
Do nothing	23	6.9
Lose weight	177	52.8
Gain weight	44	13.1
Maintain as it is	91	27.2
Social media effect on body image perception		
I. Media affect (*n*=334)		
Always	106	31.7
Sometimes	176	52.7
Never	52	15.6
II. Social pressure (*n*=334)		
Always	58	17.4
Sometimes	129	38.6
Never	147	44.0
Psychological considerations of body image		
I. Comparing body shape with others (*n*=334)		
Always	36	10.8
Sometimes	208	62.3
Never	90	26.9
II. Consequences relate to negative perception of BI (*n*=334)		
Being insecure around people	112	33.6
Embarrassment	46	13.8
General unhappiness	68	20.4
Lowered self-esteem	159	47.9
Undesirable to the opposite sex	15	4.5
Gaining motivation to exercise, eat healthier.	118	35.4
III. How often do you think a negative thought about your body (*n*=333)		
Always	31	9.3
Sometimes	200	60.1
Never	102	30.6

positive feelings of motivation to exercise and to eat healthier were also reported as outcomes of having a negative body image perception. The feeling of being undesirable to the opposite sex was reported by lowest percentage of the participants arising from having a negative perception of body image (Table 5).

The majority in the overweight BMI (71%) perceived themselves as having moderate body size to the Likert scale.

Also, 60% among the obese ranked themselves as being moderate. This underestimation of perception towards body image may lead to obesity complications in the long term.

DISCUSSION

In the present study, self-estimated body mass index was significantly lower than that actually measured. Over-estimation of body weight among normal-weight adolescents is reportedly uncommon (Jackson *et al.*, 2015; Yang *et al.*, 2014; Hayward *et al.*, 2014; Edwards *et al.*, 2010). A study in Spain showed that the prevalence of underestimation of actual weight was more prevalent among middle-aged adults than younger ages (Bibiloni *et al.*, 2017). Body image misconceptions are more common among overweight and obese people, leading to depressive symptoms and psychological distress (Gavin *et al.*, 2010).

Nonetheless, this study found a significantly higher prevalence of positive body image perception than feelings of negative perception. This finding may be due to the majority of the participants being young, educated and unmarried adults, who tend to be more open-minded.

Females tend to overestimate their body weight than what they actually are (Hancock *et al.*, 2012). Physical appearance is more important in females than males, regardless of higher prevalence of excessive weight among males and females (Yaemsiri *et al.*, 2011). The majority of the female respondents in this study agreed that body appearance is highly important.

In the present study respondents agreed that media sometimes has an effect on body image perceptions. In many cultures, thinness is desired as ideal body image. The effect of mass media images favouring models resulted on both genders suffering with anorexia (Ro & Hyun, 2012; Ratanasiripong & Burkey, 2011; Brennan *et al.*, 2010). On the other hand, based on Bahraini findings, Arab women consider the midrange of fatness to be the most socially acceptable, while very thin or obese body sizes were least accepted (Khalaf *et al.*, 2015).

CONCLUSION

Discrepancy between actual and self-perceived perceptions of body weight found among the Saudi females may potentially contribute to an increased risk of overweight in the population. The prevalence of overweight and obesity in the Kingdom of Saudi Arabia (KSA) has increased in recent decades, with females having a higher prevalence rate (75-88%) than males (70–85%) (Ng *et al.*, 2011). Obesity is strongly associated with chronic diseases in Saudi Arabia. With the increase in life expectancy, obesity is causing more years of disability (Kelsey *et al.*, 2014). Hence, the increased cost of obesity and its sequelae will put a strain on the resources of governments and individuals (Withrow *et al.*, 2011).

Authors' contributions

Layam A, principal investigator, conceptualized and designed the study, prepared the draft of the manuscript and reviewed the manuscript; conducted the study, data analysis and interpretation, assisted in drafting of the manuscript, reviewed the manuscript; Hind Q, statistical expert, conceptualized and designed the study; Asma AA, led the data collection, data processing, assisted in drafting of the manuscript and reviewed the manuscript; Hessah IS, led the data collection, data processing, assisted in drafting of the manuscript and reviewed the manuscript; Hessa FA, led the data collection, data processing, assisted in drafting of the manuscript and reviewed the manuscript; Rehab AA, led the data collection, data processing, assisted in drafting of the manuscript and reviewed the manuscript; Shima AA, led the data collection, data processing, assisted in drafting of the manuscript and reviewed the manuscript.

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Do probiotics and fibre in milk powder have an effect on functional constipation and general wellbeing of Filipino mothers?

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ABSTRACT

Introduction: This study aimed to evaluate the effect of probiotics and fibre in milk powder on functional constipation and general well-being of a sample of Filipino mothers. **Methods:** The study employed a single group, controlled, before-after intervention design. Out of 115 females recruited from 7 military camps in Metro Manila aged 21-31 years, 85 mothers met the inclusion criteria namely, defecation frequency of <3 days/week or constipated for about 2-8 weeks, experienced bloating, flatulence, gurgling, feeling heavy after eating, and abdominal pain, willing to stop vitamin supplementation a week before the start of the study. Milk powder (40 g) in 200 ml of water was consumed twice a day for 28 days under supervision at the workplace. Digestive health, health and wellness, bowel habit and Bristol stool chart questionnaires, which were modified and pre-tested, were administered every 3-4 day visits. Constipation was defined as <3 days/week defecation frequency (Rome II). Appropriate statistical tests were employed in data analysis. **Results:** A total of 72 participants completed the study. At 4 weeks, a significant improvement in defecation frequency was reported. There was an increasing percentage of participants who were highly satisfied with their defecation frequency, stool characteristics, comfort during defecation and defecation duration as the number of intervention days increased. **Conclusion:** The consumption of a probiotic and fibre fortified milk powder might have contributed in alleviating functional constipation and the improvement in general health and wellbeing of the participants. Further studies should be conducted to confirm these results.

Keywords: Powder milk, probiotic, fibre, digestive health, constipation

INTRODUCTION

Functional constipation (FC) is a common functional bowel disorder in clinical practice, manifesting as straining during defecation, lumpy or hard stools and infrequent bowel movements, in the absence of evident organic or structural diseases (Xin *et al.,* 2014). Persistent constipation adversely affects the patients' mental state and their quality of life (Friedenberg, Dadabhai & Sankineni, 2012). Probiotics are live microorganisms that when administered in adequate amounts confer a health benefit on the host (Hill C *et al.*, 2014). Probiotics such as *Lactobacillus* and *Bifidobacterium* are producers of organic acids like lactic acid and acetic acid that can lower the pH of the colon, enhancing peristalsis and reducing colonic transit time

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(Walker *et al.*, 2011). Furthermore, lactic acid bacteria, including *Lactobacillus* species, which have been used for preservation of food by fermentation for thousands of years, serve a dual function by acting as agents for food fermentation in addition to imparting potential health benefits. Apart from these, some species of *Saccharomyces cerevisiae, E. coli* and *Bacillus* are also used as probiotics. The probiotic properties of genera, species, and strains may vary according to the indication (Agency for Healthcare Research and Quality, 2011).

Probiotics are intended to assist the body's naturally occurring gut microbiota. Some probiotic preparations have been used to prevent diarrhoea caused by antibiotics, or as part of the treatment for antibiotic-related dysbiosis. Studies have documented probiotic effects on a variety of gastrointestinal and extra-intestinal disorders, including inflammatory bowel disease (IBD), irritable bowel syndrome (IBS), and immune enhancement (Amara & Shibl, 2015; Kruis, 2004). In general, the strongest clinical evidence for probiotics is related to their use in improving gut health and stimulating immune function (Guarner *et al.*, 2008). Intake of probiotics majorly focuses on normalising the gastrointestinal flora and assisting normal digestive function. A systematic review and meta-analysis of 14 previous studies showed that probiotics indicated that overall, probiotics positively affected shortened regional gut transit time (GTT), increase stool frequency, and improve stool consistency. Several other cardinal symptoms of constipation also significantly improved, e.g. bloating, sensation of incomplete evacuation, occurrence of hard stools, ease of stool expulsion (Dimidi *et al.,* 2014).

Constipation is one of the most commonly experienced gastrointestinal symptoms and is not a disease (Ehrenpreis, 2006). It is defined as having bowel movement fewer than three times per week. Stools are usually hard, dry, small in size, and difficult to eliminate. People who experience constipation find it painful to have a bowel movement and often experience straining, bloating, and the sensation of a full bowel. Common causes of constipation are inadequate fibre in the diet, lack of physical activity, medications, irritable bowel syndrome (IBS), changes in life or routine, ignoring the urge to have a bowel movement, dehydration, specific diseases or conditions (such as stroke) and problems with the colon, rectum and intestinal function (Rome II Criteria). Prolonged constipation can lead to complications like haemorrhoids, anal fissures and rectal bleeding. Though chronic constipation is non-life threatening, it has significant impact on the quality of life and hence its management is important (Belsey *et al.,* 2010).

Constipation often affects adults, especially women; pregnant women suffer more from constipation and it is a common problem following childbirth or surgery (National Institute of Diabetes and Digestive and Kidney Disease, 2012). However, due to the sensitivity of the condition of pregnant women, the study opted to target women with children less than three years old.

The objective of this study was to evaluate the effect of probiotics (DR10™ Bifidus Lactis) and inulin fibre-fortified milk powder on functional constipation and general well-being of sample Filipino mothers.

MATERIALS AND METHODS

The study employed a single group, controlled, before-after intervention study design. About 115 mothers aged 21-35 years with a child aged 3 years old or above from seven military camps in Metro Manila were invited for screening.

Screening questionnaire, which indicated the screening criteria were administered face-to-face by trained research assistants. Inclusion criteria were mothers who had a defecation frequency of less than 3 days per week or constipated for about 2-8 weeks, experienced non-specific symptoms including bloating, flatulence, gurgling, feeling heavy after eating, and abdominal pain (Rome II criteria), willing to stop taking vitamin supplements a week before the start of the study. A total of 85 had passed the screening criteria and were recruited as participants in the study after having sought the signed informed consent. This study was approved by the FNRI Institutional Ethics Review Committee (FIERC) and was registered at ClinicalTrials.Gov (#NCT01862341).

Subjects took the probiotic – fibre-fortified milk powder twice a day for 28 days under supervised regimen. Table 1 indicates the nutrient profile of the investigational product. Each serving (40 g) of the product contains 3.2 x 10^7 cfu of DR10 Bifidus Lactis, fortified with 5 g of inulin fibre, and provides ~150kcal of energy. The product was packed in a single serving foil pack labelled with an expiry date and batch number.

Table 1. Nutrient profile of investigational product

Nutrient	*Per serve (40g)*
Energy (kcal)	~150
Protein (g)	10
Fat (g)	2.2g
Carbohydrate (g)	18
Fibre[1] (g)	5
DR10 Bifidus Lactis (cfu)	3.2 x 10^7
Calcium (mg)	500
Iron (mg)	5.4
Folate (ug)	120
Vitamin A (ugRE)	195
Vitamin C (mg)	22.5
Vitamin D (ug)	3.75
Vitamin E (mg)	4.5

[1] *Fiber used is Inulin*

One pack of the probiotic – fibre-fortified milk powder was directly administered by the research assistants (RA) in the morning (1000h) and one in the afternoon (1500h). Each milk pack was added to 200 ml of safe drinking water. Each RA has specific sites to cover. Compliance in this study which was recorded in the case report form (CRF) was indicated by the number of days the participants had consumed two packs of milk powder. Reported adverse events, which included complaints, related to the milk drinking like diarrhoea, bloating or flatulence after thorough investigation by a Physician were recorded daily in the Adverse Event Form.

All questionnaires used in this study were pre-tested, and modified prior to its use. These were administered face-to-face by trained RA. General profile, socio-economic and demographic data were collected at baseline. General Lifestyle Evaluation Form, Digestive Health Questionnaire (Bukovina, 2013) and Bristol Stool chart (Lewis & Heaton, 1997) were administered every 3-4 day visit while the Bowel Habit Questionnaire was administered only during the first and last day of the intervention.

General Lifestyle Evaluation Form

The General Lifestyle Evaluation Form included 12 items that assessed changes in the participants' attitude to health and well-being. Each item was rated on a 5-point Likert scale ranging from 0 (never) to 4 (all the time).

Digestive Health Questionnaire

Participants also answered questions regarding intestinal health which include defecation frequency, difficulty of bowel motion, defecation duration and self-assessed bowel habits. For the first part of the Digestive Health Questionnaire, four questions relating to the participants' satisfaction with their bowel habit were asked. Each

item was rated on a 4-point Likert scale ranging from 0 (highly satisfied) to 3 (not satisfied). An 11-item self-assessment of whether the participants perceived improvements in their digestive system was also included in the questionnaire. Each item was rated on a 4-point Likert scale ranging from 0 (never) to 3 (always).

Bristol Stool Chart

Stool consistency was assessed by a 6-point scale using the Bristol Stool chart: Type 1 (separate hard lumps, like nuts), Type 2 (sausage-shaped but lumpy), Type 3 (like a sausage but with cracks on its surface), Type 4 (like a sausage or snake, smooth and soft), Type 5 (soft blobs with clear-cut edges), Type 6 (fluffy pieces with ragged edges, a mushy stool), Type 7 (watery, no solid pieces, entirely liquid) .The responses of the participants for the Bristol Stool Chart were also re-categorised into the following 1) constipation, 2) normal stool, 3) diarrhoea and urgency (Lewis & Heaton, 1997).

Anthropometry

Weight and height were measured to compute for body mass index (BMI) at baseline. Subjects were weighed using a calibrated Detecto weighing scale (Webb City, Mo. U.S.A.) while height was taken using a calibrated Microtoise (Depose, France). Participants were weighed in official uniform without shoes, belts and other accessories. Weight was recorded to the nearest 0.1 kg while height was recorded to the nearest 0.1 cm. Two readings for weight and height were recorded per measurement; based on the means of the two readings BMI was calculated.

Statistical analysis

A per-protocol analysis of the effects of milk powder with probiotics and fibre on the digestive habits and general well-being of selected Filipino mothers with less than three times per week defecation was done. Frequencies and descriptive statistical measures were calculated for baseline characteristics using statistical software SPSS (Statistical Package for the Social Sciences) version 12. For the Bowel Habit Evaluation Form, the non-parametric Wilcoxon Signed Rank test was used to compare the change in Intestinal Health of mothers at baseline and week 4 (28 days). For changes in eating habit, the McNemar Change and the Wilcoxon Signed Rank test was used whenever applicable. A p-value of <0.05 was considered statistically significant. To illustrate the differences of responses in each item in the Digestive Health Questionnaire, all items were subdivided in a component bar graph in every visit. To calculate the statistically significant difference on each item throughout the study period, the Friedman Test was used.

RESULTS

A total of 85 military female participants were enrolled in the study, however, only 72 had completed the study. Thirteen (13) participants were dropped from the study because they were transferred to another office outside Metro Manila (Figure 1). Analysis of all baseline characteristics of drop-outs like mean age, weight, height, education, and income showed no significant difference between that of the remaining subjects.

The mean age of the participants was 29.8 (*SD*=3.7) years, 87.5% were college graduates, and 45.8% were professionals. The mean monthly income was PhP 33,222.22 (*SD*=16,999.77) (US$664.44±340.00) with an average food expenditure of PhP 405.8 (*SD*=203.5) (US$ 8.12±4.07) per day. The participants mostly belonged to a nuclear family (54.2%) and 25.0% had an average household size of three (Table 2).

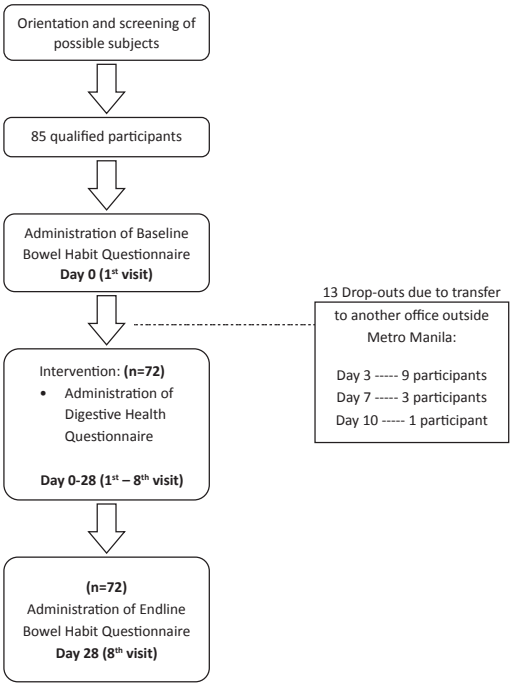

Figure 1. Operational flow of the study

Intestinal Health at Baseline and at Week 4

All participants who were enrolled in the study were categorized as constipated at baseline. At endline, a significant improvement in the frequency of defaecation wherein 71 (98.6%) participants had defecated more than 5 times a week and 1 (1.4) had it for 3-5 times a week.

During baseline, about 33.3% had spent about ¼ of their time having a difficulty in bowel motion, 37.5% had 1/3 and 29.2% had spent about ½ of their time. Majority had spent more than 5-10 minutes (83.3%) while 13.9 had spent 15-30 minutes defecating. At end line, 100% did not experience any difficulty in defecation and the defecation duration was ≤5 minutes. Self-assessment of their bowel habit showed that before the start of the study, 40.3% had some pushing down and discomfort, 56.9% had strong pushing down and discomfort with small/hard defecation, and 2.8% often have constipated feeling and painful bowel motion. After the intervention, 71 (98.6%) had assessed themselves as having normal bowel habit.

At week 4, about 98.6% of the participants were able to defecate more

Table 2. Demographic and anthropometric data of participants at baseline

Anthropometric Measurement	*Mean*	*SD*	*Min, Max*
Age	29.83	3.68	23,35
Height (cm)	156.8	7.4	151.2, 169.9
Weight (kg)	61.7	9.6	43.0, 87.8
Hip (cm)	95.3	7.5	69.4, 113.2
Waist (cm)	83.8	8.3	69.7, 108.0
BMI (kg/)	25.0	3.6	18, 34
Monthly Income (PhP)	33,222.22	16,999.77	4,000.00, 100,000.00
Average Food Expenditure per day (PhP)	405.8	203.5	120, 1000

The anthropometric data obtained at baseline showed that the mean height was 156.8 (*SD*=7.4) cm and the mean weight was 61.7 (*SD*=9.6) kg. Mean hip and waist measurement was 95.3 (*SD*=7.5) cm and 83.8 (*SD*=8.3) cm, respectively. The mean calculated BMI of the participants was 25.0 (*SD*=3.6) kg/m^2.

Table 3. Distribution of participants by defecation frequency, difficulty of bowel motion, defecation duration and self-assessed bowel habit at baseline and week 4

Item	*Baseline (n=72)*		*Week 4 (n=72)*		*Wilcoxon Signed Rank test*	
	Frequency	*Percentage (%)*	*Frequency*	*Percentage (%)*	*z*	*p*
Defecation Frequency						
More than 5 times (0)	-	-	71	98.6	-7.997	<0.0001*
3-5 times (1)			1	1.4		
1-<3 times (2)	72	100.0	-	-		
Total	72	100.0	72	100.0		
Difficulty of Bowel Motion						
No difficulty (0)	-	-	72	100.0	-7.479	<0.0001*
Difficulty 1/4 of the time (1)	24	33.3	-	-		
Difficulty 1/3 of the time (2)	27	37.5	-	-		
Difficulty more than 1/2 of the time (3)	21	29.2	-	-		
Total	72	100.0	72	100.0		
Defecation Duration						
≤5 min (0)	1	1.4	71	98.6	-7.874	<0.0001*
>5-10 min (1)	60	83.3	1	1.4		
>10-30 min (2)	10	13.9	-	-		
More than 30 min (3)	1	1.4	-	-		
Total	72	100.0	72	100.0		
Self-assessed bowel habit						
Normal (0)	-	-	71	98.6	-7.561	<0.0001*
Some pushing down and discomfort only (1)	29	40.3	1	1.4		
Strong pushing down and discomfort, difficult or small/hard defecation (2)	41	56.9	-	-		
Often have constipated feeling and painful bowel motion (3)	2	2.8	-	-		
Total	72	100.0	72	100.0		

**Significant difference*

than five times in a week, took less than 5 minutes to defecate and described their bowel habits as normal (Table 3). Only one participant (1.4%) had the defecation frequency of 3-5 times, defecated for 5-10 minutes and said that her bowel habit was "Some pushing down and discomfort only".

Using the Wilcoxon Signed Rank test, it was found that all 72 participants had defecated more frequently at week 4 than at baseline and none of the participants had difficulty in bowel motion at week 4. It further showed that a 4-week,

twice daily intake of fortified milk powder elicited a statistically significant improvement in defecation frequency of the participants constipation (z=-7.997, p<0.0001) and in defecation of all participants (z=-7.479, p<0.0001).

The defecation duration of the 70 participants was decreased at week 4 though only two participants had unchanged bowel movement duration. Furthermore, it was found that 71 participants had assessed their defecation to be better at week 4 than at baseline and only one participant said there was no change. The 4-week, twice daily intake of fortified milk powder elicited a statistically significant change in defecation duration of the participants with mild to moderate constipation (z=-7.874, p<0.0001) and participants' self-assessed bowel habits (z=-7.561, p<0.0001) (Table 3).

Eating Habits at baseline and at week 4

At baseline, about 93.1% of participants preferred white bread and rice followed by fish (91.7%), fried food (86.1%) and chicken and beef (86.1%). Only 16.7% of the participants preferred eating brown rice and entire-wheat bread. On the contrary, majority (81.9%) of the participants preferred water to other types of beverages at baseline. At week 4, the participants were again asked about the food they prefer and showed that 70 participants (97.2%) preferred white rice or white bread, followed by fish (95.8%), fruit and vegetables (91.7%), and chicken

Table 4. Distribution of participants by food and drink preferences at baseline and week 4[a]

Preferences	*Baseline (n=41)*		*Week 4 (n=41)*		*p-value*
	Frequency	*Percentage (%)*	*Frequency*	*Percentage (%)*	
Food preference					
Fruit and vegetable	59	81.9	66	91.7	0.118
Fish	66	91.7	69	95.8	0.453
Chicken and beef	62	86.1	66	91.7	0.344
White rice or white bread	67	93.1	70	97.2	0.375
Brown rice/Entire-wheat bread	12	16.7	9	12.5	0.581
Fried food	62	86.1	60	83.3	0.727
Dairy products	26	36.1	34	47.2	0.200
Bean products	22	30.6	32	44.4	0.087
Potato chips/snack	35	48.6	33	45.8	0.845
Dessert	35	48.6	33	45.8	0.845
Drink preference					
Tea	21	29.2	13	18.1	0.152
Water	59	81.9	70	97.2	0.001
Coffee	45	62.5	47	65.3	0.824
Carbonated drinks	40	55.6	35	48.6	0.332
Milk (fresh liquid or UHT)	23	31.9	18	25.0	0.458
Milk (as milk powder)	20	27.8	57	79.2	<0.0001
Fruit juice	40	55.6	34	47.2	0.307
Others	7	9. 8	2	2.8	NA

[a] multiple responses

and beef (91.7%). Using the McNemar Change test, it was found that the food preference of the participants at baseline is not statistically and significantly different from week 4 (Table 4).

Results also showed that by the end of week 4, 97.2% of the participants drank water, followed by milk as milk powder (79.2%) and coffee (65.3%). The number of participants drinking water increased from 59 (81.9%) at baseline to 70 (97.2%) at week 4. This change is found to be statistically significant (p=0.001). In addition, the number of participants who drink powdered milk also increased from 20 (27.8%) to 57 (79.2%) from baseline to end line, respectively and this is statistically significant (p<0.001).

Digestive Health Questionnaire

The improvement of the participants' digestive system was assessed using the Digestive Health Questionnaire. The 72 participants were visited eight times during the 4-week duration of the study.

A. Bowel Habit

An increasing percentage of participants stated they were highly satisfied with their defecation frequency, stool characteristic, comfort during defecation and defecation duration as the number of days increased. There was a significant change over time in satisfaction with defecation frequency (χ^2=314.06, p<0.0001), stool characteristic (χ^2=329.26, p<0.0001), comfort during defecation (χ^2=307.30, p<0.0001) and defecation duration (χ^2=302.25, p<0.0001), on every visit. It was interesting to note that by day 10 of the intervention program, the percentage of participants who were jointly satisfied and highly satisfied with their defecation frequency, stool characteristics and defecation duration rose to 87%, 75% and 80%, respectively. There was a statistically significant improvement in satisfaction with bowel function; nearly 80% of women reported a noticeable improvement.

B. Improvement of Digestive System

Over the study course, a steady decline on the prevalence of abdominal bloating or distention (χ^2=143.31, p<0.0001), abdominal pain (χ^2=149.54, p<0.0001), heaviness in mid-abdomen (χ^2=143.25, p<0.0001), weighing down around the abdominal area (χ^2=147.30, p<0.0001) (Figure 3A), constipation (χ^2=219.86, p<0.0001), presence of gas or wind (χ^2=110.39, p<0.0001), pain or discomfort felt during a bowel motion (χ^2=180.74, p<0.0001), straining when passing a bowel motion (χ^2=197.53, p<0.0001), intestinal gurgling (xχ^2=138.17, p<0.0001), presence of poor appetite (χ^2=57.12, p<0.0001), and mid-abdominal discomfort (χ^2=153.42, p<0.0001) was observed. There was a statistically significant reduction with feeling constipated; over 50% felt less constipated within seven days of taking fortified milk powder. Moreover, by day 10, over 45% never felt strained when passing a bowel motion and over 40% never felt pain or discomfort during the bowel motion.

General Lifestyle Evaluation Form

During the whole study period, a significant improvement in the following items from the general lifestyle evaluation form were observed: feeling good in shape (χ^2=120.10, p<0.0001), feeling positive in physical wellbeing (χ^2=104.42, p<0.0001), feeling positive in emotional wellbeing (χ^2=93.19, p<0.0001), feeling positive about one's self (χ^2=70.52, p<0.0001), feeling in control of one's life (χ^2=79.69, p<0.0001), feeling confident in day to day activities (χ^2=70.65, p<0.0001), feeling that life as a mother is enjoyable (χ^2=19.08, p=0.008), feeling happy as a mother (χ^2=21.69, p=0.003),

feeling energized (χ^2=62.34, p<0.0001), feeling in shape to be the best mother one can be (χ^2=53.04, p<0.0001) and reduction in worrying about one's looks (χ^2=107.16, p<0.0001) and feelings of tiredness (χ^2=177.09, p<0.0001). There was a statistically significant change in self-rated feelings of good health and of feeling positive about themselves and their mental wellbeing, and about being in control of their lives. Around 40% of participants felt more positive about their health than at baseline (four separate measures all agreed). Nearly half of subjects were less worried about how they looked after only seven days and this was statistically significant and over a third of women felt less tired after seven days (statistically significant). By day 7 of taking the fortified milk powder, about 28% of the participants felt positive about their physical well-being all the time, and about 30% each felt positive about their emotional wellbeing and felt positive about themselves.

Two items on the General Lifestyle Evaluation Form specifically asked whether the participants felt trimmer and slimmer (a) or whether they felt lighter (b) around the middle of their abdomen since the study start. There was a statistically significant increase over time whether the participants felt trimmer and slimmer (χ^2=325.49, p<0.0001) and whether they felt lighter (χ^2=328.87, p<0.0001).

Bristol Stool Chart

Most of the participants started from a Type 2 (sausage-like but lumpy) Bristol stool category, and then at Day 3, the stool category became a Type 5 (soft blobs with clear-cut edges). It can also be noticed in the figure below that starting Day 3, participants with a Type 4 (like a sausage or snake, smooth and soft) stool increase gradually until Day 28. There was a statistically significantly different median assessment of the stool of the participants on every visit (χ^2=182.39, p<0.0001).

The responses of the participants for the Bristol Stool Chart was re-categorised into 1 (constipation), 2 (normal stool) and 3 (diarrhoea and urgency). At Day 0, although most of the participants are constipated, there are still some with stool categorized as normal. In Day 3, a high proportion of the participants had diarrhoea which slowly decreased until Day 24. At the end of the study, all the participants had normal bowel movement.

DISCUSSION

Constipation targets the population regardless of age group and gender. It is related to increasing age, female gender, lower socioeconomic status, low consumption of fibre and the western lifestyle (Mugie *et al.,* 2011). It is also associated with physical activity, limited education, a history of sexual abuse and symptoms of depression (Lembo *et al.*, 2003).

Several studies have shown that some probiotics are effective therapeutic agents in many different gastrointestinal disorders. Though the exact mechanism of how a probiotic helps in constipation is not clearly known, several hypotheses have been proposed. Firstly, a dysbiosis in the gut flora in constipated patients has been suggested to improve after the administration of probiotic bacteria (Picard *et al.*, 2005; Szajewska *et al.*, 2006). Furthermore, probiotics can lower the pH of the colon by producing lactic, acetic and other short chain fatty acids. A lower pH enhances colonic peristalsis and subsequently decreases colonic transit time (Picard *et al.*, 2005; Szajewska *et al.*, 2006).

In this study, at baseline majority of the participants (83.3%) constipation, and had difficulty in passing bowel motions wherein 83.3% took 5-10

minutes with strong pushing down and discomfort, difficult or small/hard defecation (56.9%). These symptoms affect the general health of the participants and can lead to intestinal obstruction, stercoral ulceration, mental disturbances, urinary retention, overflow diarrhoea and can result in megacolon leading to sigmoid volvulus, ischemic colitis, cecal perforation, rectal prolapse and even haemorrhoids (Toney *et al.*, 2008). This condition might have been aggravated by sedentary lifestyle (70.8%), and low consumption of high fibre foods as evidenced by the results of the food preferences of participants: white rice, fried foods, fish and meat, coffee and carbonated drinks. Coffee and carbonated drinks mostly have caffeine and contribute to constipation due to the diuretic effects of caffeine. Diuretics cause excretion of fluid through the kidneys, and can lead to dehydration, which may produce hard stools that are difficult to pass leading to constipation (Ignatavicius & Workman, 2013).

The administration of the probiotic – fibre-fortified milk powder reflected several positive effects that have been reported by the participants. There was a statistically significant improvement in satisfaction with bowel function; nearly 80% of women recorded a noticeable improvement. Moreover, at day 10, the percentage of participants who were satisfied to highly satisfied in terms of their defecation frequency, stool characteristics and defecation duration were 87%, 75% and 80%, respectively. Furthermore, based on the analysis of the digestive system questionnaire, there was a statistically significant reduction with feeling constipated with over 50% of the participants feeling less constipated within seven days of taking the fortified milk powder. Additionally, by day 10, over 45% never felt strained when passing a bowel motion and over 40% never felt pain or discomfort during the bowel motion. This is consistent with the results of a systematic review and meta-analysis of 14 studies with 1182 patients. It was revealed that overall, probiotics significantly reduced whole gut transit time by 12.4 h (95% CI: 222.3, 22.5 h) and increased stool frequency by 1.3 bowel movements/week (95% CI: 0.7, 1.9 bowel movements/week), Probiotics improved stool consistency (SMD: +0.55; 95% CI: 0.27, 0.82) (Dimidi, 2014). The addition of fibre in the milk might also have contributed to the significant improvement in gut health. Dietary fibre is commonly used in the treatment of patients with IBS. The proposed mechanism of action of fibre, in the treatment of IBS and constipation, is the acceleration of oroanal transit and a decrease in the intra-colon pressures (Camilleri *et al.*, 2002). The inulin fibre added in the milk is a natural fibre from plant. Inulin resist digestion in the upper gastrointestinal tract but are fermented in the colon. By increasing faecal biomass and water content of the stools, they improve bowel habits. (Roberfroid, 1993). Amongst others, one of the most promising effects is modulation of the activity of the colon which is more and more recognized to play an essential role in maintaining health and well-being as well as reducing the risk of diseases (Gibson & Roberfroid, 1995; Cummings, 1997).

Furthermore, there was a statistically significant change in self-rated feelings of good health and of feeling positive about themselves, mental, emotional wellbeing, and about being in control of their lives at endpoint: e.g. felt more positive about their health (40%) than at baseline; less worried about how they looked and felt less tired after seven days. Based on the analysis of the general lifestyle evaluation forms, women felt lighter, trimmer and slimmer most of the time just 10 days after taking the fortified milk powder. These results is in congruent with the

study in Canada where a combination of *Lactobacillus rhamnosus* CGMCC1.3724 (LPR), inulin and oligofructose helped to further reduce weight (2.7 kg) and total body fat mass (1.8%) during a weight-loss and weight maintenance period in women (Sanchez *et al.,* 2014). This improved well-being might have been due to the improvement in the function of the colon and significant reduction in experiencing the symptoms of functional constipation. It has been postulated that disturbances of the colon's functions may lead to dysfunction not only in the gut but also in the whole body. The colon has a major role in digestion (as achieved by the microbial fermentation) through the salvage of energy, and possibly nitrogen, from carbohydrate and protein not digested in the upper gut. But it also plays important roles in (Rowland, 1988; Berg, 1996; Cummings, 1997; Cummings & Macfarlane, 1997) the absorption of minerals and vitamins; the protection of the body against translocation of bacteria; the protection of the body against the *in situ* proliferation of pathogens; the regulation of intestinal epithelial cell growth and proliferation; the immune function (Roberfroid, 2005).

Based on the Bristol Stool Chart Analysis, a normalised bowel movement was reported at the end (28th day) of the study. Also, participants with ideal stools (Type 4, like a sausage or snake, smooth and soft) according to the Bristol Stool Chart increased gradually from baseline to the end of the study. This is in conformity with the previous findings from Sakai *et al.* (2011), who reported that three weeks treatment of fermented milk reduces incidence of hard lumpy stools among healthy subjects. Furthermore, it has been reported that probiotics soften the stools by increasing the secretion of water and electrolytes (Tabbers *et al.*, 2011). The fermentation process by probiotics in the intestine produces short-chain fatty acids that promote osmotic stimulation (Ribeiro *et al.,* 2012). Moreover, studies on healthy adults have also shown an increase in short-chain fatty acids and improvement in defecation conditions after the probiotic intake (Sanmugapriya *et al.,* 2013; Riezzo G *et al.,* 2012). So, softer stools along with improved intestinal peristalsis will probably relieve the symptoms of constipation. Again, the addition of fibre in the milk might have acted with the improvement in the defecation conditions.

CONCLUSION

The consumption of a probiotic and fibre-fortified milk powder might have contributed in alleviating functional constipation and the improvement in general health and wellbeing of the participants. Further studies should be conducted to confirm these results with better design by employing a randomised double blind trial.

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Physical properties of microencapsulated anthocyanin obtained by spray drying of Red *Amaranthus* extract with maltodextrin

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ABSTRACT

Introduction: Anthocyanins are water-soluble plant pigments responsible for bright red, purple and blue colours in fruits and vegetables. Extraction of anthocyanins from plant cells becomes an important task closely related to the need of preservation of their bioactivity. Therefore, encapsulation by spray drying is a technique used to retain maximum anthocyanin and colour. **Methods:** The study was designed to investigate the physical properties of spray drying of Red *Amaranthus* extract with maltodextrin. The extract was prepared by soaking washed and finely chopped red spinach (Red *Amaranthus*) leaves in water for 72 h at 4°C of with potable water (solvent), followed by storage at refrigerated condition at 4°C for 72 h. The extract was mixed with maltodextrin solution in three different ratios: 1:1, 1:2 and 1:3. Powder properties were studied for the three different extract and maltodextrin ratios that were fed in the spray dryer. All analyses were conducted in triplicates. **Results**: The 1:1 ratio retains maximum anthocyanin 93.03 mg/100g of spray dried powder compared to the other ratios; the moisture content of the 1:1 ratio was 0.44% (dry basis). The color chroma value of a* of 1:1 ratio was 26.24 and density was 0.55 g/cm^3 whereas the water activity of the sample was 0.62±0.01. By comparing the three ratios, the 1:1 ratio of extract and maltodextrin was the optimum combination for encapsulation of anthocyanin using spray-drying technique. **Conclusion:** Encapsulation with maltodextrin at 1:1 ratio had a significant impact on retention of anthocyanin and colour in the final product.

Keywords: Red *Amaranthus*, maltodextrin, spray drying, anthocyanin, colour

INTRODUCTION

Microencapsulation is a process in which tiny particles or droplets are surrounded by a coating or embedded in a homogeneous or heterogeneous matrix to give small capsules with several beneficial properties. Spray drying method is used widely as a microencapsulation technology, employed to produce commercially engineered powders from liquid feed in a single step (Bazaria & Kumar, 2016). It offers short contact times at relatively low temperatures, allowing the properties of foods such as colour, flavour, and nutrients to be retained in considerable percentages. The powders obtained by spray-drying are amorphous materials, susceptible to glass-transition related changes including stickiness,

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caking, and collapse as well as colour changes leading to low product yield and operational problems. Surface modification of droplets with protein is a novel way to minimise stickiness in sprays dried powder. The elementary operational conditions of spray drying namely temperature of drying air and feed flow rate of feed are crucial in explaining the quality characteristics of product. The most conventional carrier agents used in spray drying is maltodextrin mainly due to its high solubility and low viscosity (Mahdavi *et al.*, 2016). This carrier agent has a high molecular weight and is also useful for increasing the product's glass transition temperature, aiming at avoiding spray drying operational problems such as sticking to the chamber wall, as well as structural transformations during food processing and storage (Tonon *et al.*, 2008).

Fruit juice powders have various benefits and economic potentials over their liquid counterparts such as reduced weight, reduced packaging, easier handling and transportation, and extended shelf life. Their physical state provides a stable and natural ingredient which generally finds usage in many foods products such as flavouring and colouring agents (Shrestha *et al.*, 2007). Freeze drying is the best way to dry sensitive plant pigments. However, spray drying, if feasible, would be a more applied and cost-effective method of producing powdered sensitive colorants as the processing cost is 30-50 times less than for freeze drying (Cai & Corke, 2000).

Research studies have shown that anthocyanins are unstable and are easily oxidized under various conditions such as pH, temperature, enzymes resulting in colour change and degradation (Santos & Williamson, 2003). Extracted plant pigment (anthocyanin) is good for health since they have numerous beneficial effects associated with their anti-mutagenic and antioxidant properties (Edenharder *et al.*, 2002). Many studies showed that red colour juices such as those of pomegranates, grapes, and different berries have beneficial effects on human health due to their high anthocyanin content and antioxidant activity (Lin & Tang, 2007).

There is a swelling interest to minimise the use of synthetic colours used in the food industries on a large scale and to replace it with natural pigments obtained from fruits and vegetables (Cai *et al.*, 2000).

Red spinach is one of the common leafy vegetables cultivated around the world and it comes under the *Amaranthaceae* family. It grows well in warm climates and well aerated sandy soil. It has red leaves and bright red stem. Red spinach is rich in vitamin A, C, iron, calcium, phosphorous, sodium, potassium and other essential amino acids. It helps in digestion and is a rich source of fibre. The role of anthocyanin as a food-colouring agent is established in the food industry. However, stability is an important aspect to consider for the use of these pigments as a colourant in food products. Based on the above reasons, this study is undertaken to investigate the feasibility of spray drying of Red *Amaranthus* extract and to evaluate the physical properties of the powder produced, including the content of anthocyanin, moisture, water activity, colour and density analysis.

MATERIALS AND METHODS

Processing of sample

Fresh bunches of Red *Amaranthus* (red spinach) were collected from the local market in Chennai. The samples were cleaned thoroughly to remove excess soil and debris. The non-edible part was separated and the leaves were used for further experimental analysis.

Preparation of extract

Potable water was used as a solvent to carry out different extraction methods to obtain maximum extract from the sample. The extraction was done using mortar and pestle (Sivasankar *et al.*, 2011), magnetic stirrer (Tomsone *et al.*, 2012) and soaking the samples in water refrigerated at 4°C (Dayang Norulfairuz *et al.*, 2014). 10 g of fresh leaves were treated with varying volumes of potable water in the ratio of 1:1, 1:2, 1:3 and a contact time of 5, 10, 15 minutes. The mixture was macerated using a mortar and pestle and was centrifuged at 10,000 rpm for 10 min. For extraction using magnetic stirrer, 10 g of fresh leaves were added to varying volumes of potable water in the ratio of 1:1, 1:2, 1:3 and extraction was done at 700 rpm for 30, 60 and 90 minutes at room temperature.

Preparation of feed suspension for spray drying

The extract was prepared by soaking the washed and finely chopped red spinach leaves in water for 72 h at 4°C. The extract was collected using a muslin cloth and filtered before mixing with maltodextrin. For each run, three different ratios (1:1, 1:2 and 1:3) of the extract and wall material (maltodextrin) were used. The extract was fed into the spray drier with an inlet temperature of 110°C and outlet temperature varying between 65-75°C.

Experimental design

The extract was prepared by soaking the washed and finely chopped red spinach (Red *Amaranthus)* leaves in water for 72 h at 4°C of with potable water (solvent) and stored at refrigerated condition at 4°C for 72 h. The extract obtained from Red *Amaranthus* was mixed with the solution of maltodextrin in three different ratios: 1:1, 1:2 and 1:3 was carried out. The extract was fed into the spray drier with an inlet temperature maintained at 110°C and outlet temperature varying between 65°C-75°C. The physical properties of the obtained powder were determined and all the analysis were done in triplicates and reported as mean±standard deviation.

Analysis of the spray-dried powder

The spray-dried powders were analysed for their total anthocyanin content (TAC), moisture content, water activity, colour and density parameters.

Total Anthocyanin Content (TAC)

TAC was quantified in accordance to the method described by Sutharut *et al.*, (2012). 1 ml extracted solution was transferred into 10 ml volumetric flask for preparing two dilutions of the sample, one volume adjusted with potassium chloride buffer pH 1.0 and the other with sodium acetate buffer pH 4.5. These dilutions were equilibrated for 15 min. The absorbance of each dilution was measured at 510 nm and 700 nm against a blank cell filled with distilled water.

Moisture content

The moisture content was determined based on Association of Analytical Communities (AOAC) method. Triplicate samples of red spinach powder (1 g each) were weighed and then dried in a hot air oven at 105°C. The drying was continued until a constant weight was obtained and moisture loss was expressed in terms of percent dry basis (d.b).

Water activity

Water activity was measured using the water activity meter. The average of the triplicate values was recorded (Lab Touch, Novasina).

Colour determination

The colorimeter is used to obtain the values of the spray dried Red *Amaranthus*

powder. The results were obtained as L*, a*, b* values which determine the different colour range and brightness, darkness of the sample. The L* value determines the brightness (white at 100) to darkness (black at 0), while a* measures green when negative and red when positive. Similarly, b* measures yellow when positive and blue when negative. Calibration was done using the white tile prior to the sample analysis. Colour analysis was performed using Hunter Colorimeter (ColorQuest XE) in triplicates.

Density analysis

The parameters were determined as per Chang *et al.* (2012). Bulk density: 2 g of sample was added to a pre-weighed volumetric cylinder and the volume was read as V1. Tapped density: 2 g of sample was placed into a measuring cylinder and tapped until a consistent volume (V2) is reached which corresponds to the maximum packing density of the material. By measuring bulk and tapped volume, the following parameters were determined.

Statistical analysis

Data were expressed as mean±standard deviation of three replications and statistical analysis (ANOVA) was done using Minitab 17. The values were considered to be significant with $p<0.05$.

RESULTS AND DISCUSSION

Total Anthocyanin Content

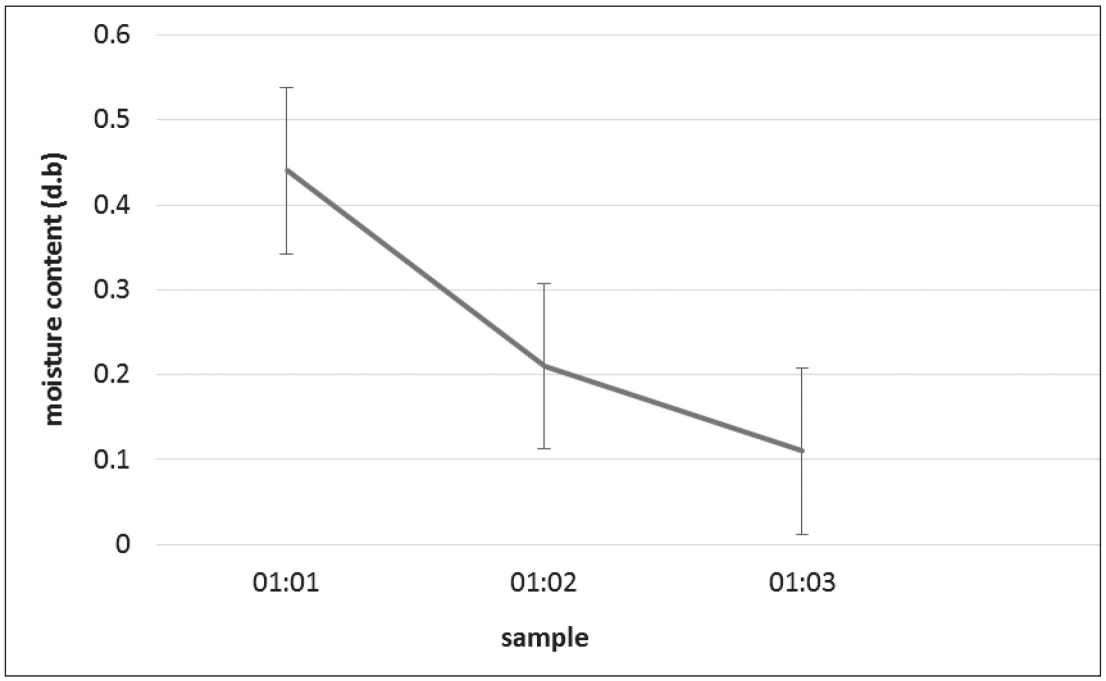
Anthocyanins are very sensitive compounds and unstable during processing and storage. The internal properties such as pH, chemical structure, and anthocyanin concentration of the product, available enzymes and processing conditions also play a role in their stability. The initial total anthocyanin content of fresh leaves is 169.22 mg/100 g fresh weight and whereas the total anthocyanin content in the final product ranged from 43.11-98.03 mg/100 g sample weight. From Figure 1 it was observed that raising maltodextrin levels reduced anthocyanin rate of the product (extract: maltodextrin). Khazaeia *et al.* (2014) reported this decrease too, stating that in these cases, the juice was not really encapsulated and the carrier agent acted merely as an aid for facilitating the drying process, which is probably a reason for the lower anthocyanin content when this agent was used. The same phenomenon was reported by Tonon *et al.* (2008) who used different carrier agents including maltodextrin for spray drying of acai juice.

Moisture content

Moisture in powder plays a significant role in determining its flowability, stickiness and storage stability due to its effect on glass transition and crystallisation behaviour. The moisture content of spray dried red spinach extract was done with triplicate samples and ranged from 0.11% to 0.44% (on dry basis). The results (Figure 2) show that as the amount of maltodextrin increases, there is a decrease in the moisture content. In a spray drying system, the water content of the feed influences the final moisture content of the powder produced. The results show similarity to the study conducted by Quek *et al.*, (2007), where addition of maltodextrin to the feed prior to spray drying increased the total solid content and also increases the amount of water for evaporation. Hence, decreased the moisture contents of the powder produced. Powders with lower moisture content could be obtained by increasing the amount of maltodextrin in the feed.

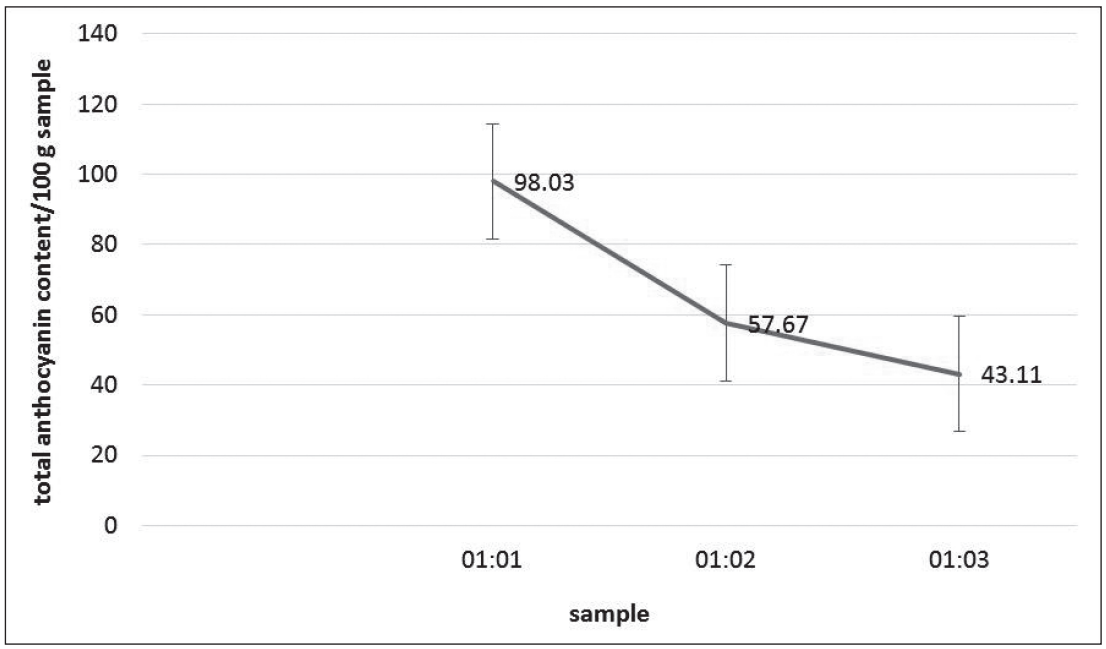
Water activity

Water activity (a_w) is an important parameter for spray-dried powder because it can significantly affect the



Data represent the mean±standard deviation of triplicate readings.

Figure 1. Total anthocyanin content of the spray dried powder with varying volume of maltodextrin (extract: maltodextrin)



Data represent the mean±standard deviation of triplicate readings.

Figure 2. Moisture content of spray dried *Red amaranthus* extract with maltodextrin

Table 1. Water activity of spray dried powder obtained from different ratios of extract and maltodextrin

Extract : maltodextrin	*Water activity, a_w*	*Temperature*
1:1	0.629±0.01	31.3°C
1:2	0.605±0.01	31.4°C
1:3	0.586±0.01	32.1°C

Data represent the mean±standard deviation of triplicate readings.

shelf life of the powder produced. Water activity is different from moisture content as it measures the availability of free water in a food system that is accountable for biochemical reactions, whereas the moisture content represents the water composition in a food system. High water activity indicates more free water available for biochemical reactions and results in a shorter shelf life. Generally, food with a_w<0.6 is considered as microbiologically stable and if there is any spoilage it is attributed to chemical reactions rather than by micro-organism.

From Table 1, the water activities of the obtained powders were in the range of 0.5–0.6. This shows that the spray-dried powders produced were relatively stable microbiologically. However, the storage conditions also played an important role in this matter. As the spray-dried powder contains maltodextrin, they are highly hygroscopic and should be stored properly in air-tight containers and kept in a cool dry place.

Table 2. Colour analysis of the spray dried samples

Extract : maltodextrin	*L**	*a**
1:1	53.75	26.24
1:2	72.65	22.38
1:3	81.17	14.88

Triplicate samples were analysed and the mean was recorded.

Colour intensity

The results of the colour measurement for the spray dried powder are shown in Table 2. The L* value measures the lightness of the sample and +*a** measures the red colour. The a* value ranged from 14-26 and the maximum value was observed in 1:1 spray dried sample as increased quantities of maltodextrin reduced the colour intensity of *a** that correlates with the total anthocyanin present in the final product. The positive correlation with the a* value and anthocyanin pigment in the present study is in correlation with the experiments carried out using beet juice by Bazaria *et al.* (2016).

Density analysis

Bulk density is a measure of the heaviness of powder and an important parameter that determines the suitability of powder for the ease of packaging and transportation. The bulk density of the spray dried powder of different ratios was found to be in the range of 0.3-0.5 g/cm^3. Higher maltodextrin reduced density of the final product, probably due to a decrease in its moisture content or the higher air trapped in the particles as maltodextrin is a skin forming material (Fazaeli *et al.*, 2012). This indicates that maltodextrin as a coating agent

Table 3. Density analysis of three different ratios of the extract with maltodextrin

Extract: maltodextrin	*Bulk density (g/cm³)*	*Tapped density (g/cm³)*	*Hausner ratio*	*Carr's index %*
1:1	0.553±0.03	0.680±0.03	1.22±0.03	18.67±0.04
1:2	0.353±0.02	0.421±0.03	1.19±0.03	16.15±0.02
1:3	0.294±0.04	0.368±0.04	1.25±0.03	20.10±0.05

Data represent the mean±standard deviation of triplicate readings.

could reduce the hygroscopicity of the anthocyanin. Comparable results were observed by Goula and Adamopoulos (2005) and Abadio *et al.* (2004) when tomato and pineapple pulp were dried using maltodextrin as the carrier in a spray dryer.

The flowability of the dried powder is determined by the Hausner ratio and Carr index. Carr index shows the flowability index of the dried food product as given in the Table 3, 5-15% corresponds to excellent flowability index and poor flowability, if the value is less than 25%. From the result, it can be concluded that the powder has poor flowability property.

CONCLUSION

Different ratios of extract and maltodextrin were used to study the quality parameters of Red *Amaranthus* powder. The models for powder physical and functional properties were statistically significant (p<0.05) where total anthocyanin content and a* values were considered as important parameters for incorporation into functional foods as a red colorant replacing the use of synthetic food colour used commercially. From this study, it can be concluded that the optimised combination includes equal parts of the wall material, in this case, maltodextrin and extract. The 1:1 ratio retains maximum anthocyanin 93.03 mg/100 g fresh weight, a* value of 26.24 and density of 0.55 g/cm$^{3.}$ Increased quantities of maltodextrin reduced the total anthocyanin and the moisture content present in the final product. The results of density analysis show that all ratios of the spray dried powder can be considered as a medium flowing powder in accordance to the Hausner ratio. This study demonstrated the feasibility of production of spray-dried Red *Amaranthus* extracts as a food grade colorant.

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Authors' contributions

Meenakshi N, carried out the research as a main author, all the experiments are carried out by this author; Sasikala Shanmugam, guided the experiment work carried out in this work; Pavithra MS, assisted in analytical works carried out in this work.

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CASE REPORT

Is enhanced recovery after surgery safe and beneficial for the elderly?

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ABSTRACT

Introduction: Enhanced recovery after surgery (ERAS) protocols are multidisciplinary perioperative care aimed to achieve early recovery after surgery by maintaining pre-operative organ function and reducing the surgical induced stress response. **Case presentation:** A 79-year-old female patient with Transverse Colon Adenocarcinoma, elective admitted for colon resection. Patient was cachexia with weight 33 kg; loss of 7 kg within 1 month; PGSGA score 14 (severe malnourished); Albumin 30 g/L. She experienced very poor oral intake for past 1 month with intake of 450 kcal/day and 15 g/day protein. Carbohydrate loading with 100 g carbohydrate as evening drink and 50 g carbohydrate 3 hours pre-operation. Clear fluid (carbohydrate plus whey protein drink) was allowed on the first day of operation (POD). Regular diet was started on the POD3 since patient tolerated 500 ml of clear fluid. Patient tolerated well with solid food on POD4 and allowed discharged on POD5. As summary, length of hospital stay 5 days 2 hours, ambulation length 20 hours, length of clear fluid toleration 18 hours, length of solid food toleration 4 days and length of gastrointestinal function (flatus & bowel open) 4.5 days. **Discussion:** Advanced age is a proven risk factor of post-operative complications. Shorter hospital stay was found associated with a lower risk of post-operative complications. Length of hospitalization after colorectal surgery does not significantly differ between younger and older age groups of the patients. **Conclusion:** ERAS showed good overall outcome even elderly. Good quality of care at home is required and crucial as well after quicker discharged.

Keywords: Enhanced recovery after surgery, clear fluid, elderly, length of hospital stay

INTRODUCTION

Enhanced recovery after surgery (ERAS) protocols are multidisciplinary perioperative care aimed to achieve early recovery after surgical procedures by maintaining pre-operative organ function and reducing the stress response following surgery and improve clinical practice by incorporating evidence-based medicine into patient management. Optimal pain control, prevention of fluid overload, and aggressive post-operative rehabilitation, including the early recovery of oral feeding and mobilisation should improve short-term outcome after surgery (Veenhof *et al.,* 2012). ERAS is shown beneficial young surgical patient but how about elderly?

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Case presentation

A 79-year-old female patient was diagnosed with Transverse Colon Adenocarcinoma, elective admitted for colon resection operation on the next day of admission. During admission, patient was cachexia with weight 33 kg where weight loss of 7 kg within 1 month. Patient's height was 1.5 m and BMI was 14.7 kg/m^2; her PGSGA score was 14 (moderate malnourished) and albumin level was 30 g/L. Patient reported reduced appetite significantly and poor oral intake for past 1 month. From diet recall, patient tolerated half bowl of plain porridge and some sugary drink. Estimated oral intake was 450 kcal and 15 g/day protein. After discussed with surgical team, ERAS protocol (carbohydrate loading) was started on this patient. Specific drink with carbohydrate plus whey protein was served as carbohydrate loading drink. Patient was loaded with 100 g carbohydrate and 18 g of whey protein as evening drink, and 50 g carbohydrate and 9 g whey protein 3 h pre-operation. Her operation took 95 min. Patient was allowed and served with specific drink on the first day of operation. On the second day of operation, patient able to ambulate and sit on chair; tolerated 300 ml of specific drink. Patient was allowed a regular diet on the third day in view of being able to tolerate >500 ml of drink. Patient tolerated solid food well on 4th day of post operation and was allowed to be discharged on 5th day of post operation. In summary, length of hospital stay was 5 d 2 h, with ambulating time of 20 h, length of clear fluid toleration was 18 h, length of solid food toleration was 4 d and length of gastrointestinal function (flatus & bowel open) was 4.5 d.

DISCUSSION

Cancers are one of the leading causes of morbidity and mortality in worldwide. There are frequent development of malnutrition and metabolic derangement among cancer patients due to increase nutrients requirement and reduced oral intake. Treatment of cancers includes surgeries, radiotherapies and pharmacological therapies. Surgery, like any injury, leads to inflammation and metabolic stress response. Surgical stress and trauma will induce further catabolism of nutrient storage in body (glycogen, fat and protein) among cancer patients (Arends *et al.,* 2017).

Elective surgery has been shown that reduce in surgery stress, minimise catabolism and support anabolism throughout surgical treatment and promote speedy recovery process. Traditionally, patient was kept nil-by-mouth prior to surgery. Nasogastric tube was used to clear stomach content and withheld oral feeding until resolution of the post-operative ileus because patient was believed that unable to tolerate early feeding. Once bowel function returned with bowel sound, patient was allowed for clear fluid as standard post-surgery drink and step up feeding/diet accordingly (Kehlet *et al.*, 1997). However, researches have proven that early recovery after surgery (ERAS) whereby patient was allowed for solid food 6 h and clear fluid 2 h before surgery as well as early oral feeding on first day of post-surgery length of hospital stay, length of bowel function and length of solid food toleration significantly (Kehlet *et al.*, 1997; Fearon *et al.*, 2005; Ljungqvist, 2014; Bakker *et al.*, 2015; Lassen *et al.*, 2009).

Advanced age is shown as the risk factor of post-operative complications. Studies showed that elderly patients' post-operative morbidity rate and mortality rate were significantly higher if compared with younger patients (Ljungqvist, 2014). The elderly probably take a longer time to recover from

anaesthesia and their ileus rate after surgery is higher if compared with younger patients (Bakker *et al.*, 2015). Traditional perioperative care patient's length of stay after elective colorectal surgery was reported around 10-15 d and was associated with delayed return of bowel motility (Gustafsson *et al.*, 2013; Bardrum *et al.*, 2000; Marusch *et al.*, 2002; Kehlet *et al.*, 2006). However, studies showed that the length of hospitalisation after colorectal surgery does not significantly differ between younger and older age groups of patients, averaging about 5 d in both groups (Bardram *et al.*, 2000; Scharfenberg *et al.*, 2007).

Good compliance with the ERAS protocol also resulted in faster peristalsis return and earlier bowel movement, which was 2.5 d post-operatively on average regardless of the age of patients. Patients stayed in the ward for 10-15 d and with delayed bowel motility post-operatively under traditional care (Murasch *et al.*, 2002; Staib *et al.*, 2002; Kehlet *et al.*, 2006). Studies also proved that ERAS significantly shorten the length of hospital stay and reduced the number of post-operative complications (Gustafsson *et al.*, 2013; Bardram *et al.*, 2000). Post-surgery complication rate, length of hospital stay and length of solid food toleration indicate successfulness of ERAS protocol implementation. There are no significant differences in length of stay post colorectal operation between younger and older age groups of patients; mean of hospital stay was 5 d (Scharfenberg *et al.*, 2007; Bardram *et al.*, 2000). Both younger and older groups of patients reported that able to tolerate early post-operative oral fluid and food intake.

This case report is supported by previous studies result whereby elderly patient benefited via ERAS protocol post-operatively. ERAS protocol did not show to be harmful in elderly surgical patients; instead, it has comparable positive outcomes as younger surgical patients (Verheijen *et al.*, 2012; Keller *et al.*, 2013). In summary, ERAS protocol showed good recovery and overall outcome in morbidity and mortality even in elderly patients.

CONCLUSION

Implementation of the ERAS protocol is possible for all age groups of elective colorectal patients. ERAS protocol do help in shorten length of hospitalisation, length of bowel motility and length of solid food toleration but not cause a higher risk of post-operative complications or readmissions. Implementation of ERAS among elderly patients requires good quality of care at home, especially after quicker discharge from the surgical ward.

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Conflict of interest

The authors declare no conflict of interest arising from the findings for the reported case and its management.

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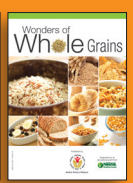

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