HIGHER INTAKE OF FRUITS AND VEGETABLES IN PREGNANCY IS ASSOCIATED WITH BIRTH SIZE

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Abstract. Maternal nutrition has a programming effect on fetal growth. This cross-sectional study investigated the association between maternal micronutrient, fruit and vegetable intake with birth size. Nutrient and food intake were examined using a validated semi-quantitative food frequency questionnaire. One hundred twenty-one pregnant women at 28 to 38 weeks gestation aged 19-40 years, were recruited from the Universiti Sains Malaysia Hospital, Malaysia. Birth weight, length and head circumference were obtained from the medical records. Data were analyzed using multiple linear regression. Results indicate no significant association between any of the measured micronutrients and birth size. However, 2 of the 6 vegetable subgroups and those consumed fruit during pregnancy had children whose birth size was significantly associated with consumption. An increase of 10 g of leafy vegetables per day was associated with a 1.78 cm increase in head circumference (p=0.04), and tuber vegetable intake was associated with birth length (β=0.21, p=0.03) and head circumference (β=0.21, p=0.01). Fruit intake was associated with birth weight (β=0.19, p=0.04), birth length (β=0.20, p=0.04) and head circumference (β=0.19, p=0.03). The lack of association between maternal nutrient intake and fetal growth and the significant association between fruit and vegetable intake and birth size suggests the existence of other micronutrients and phytochemicals present in foods that play an important role in birth size. The types of nutrients and their roles in birth size warrant further investigation.

Keywords: maternal dietary intake, vegetables, fruits, pregnancy, birth size

INTRODUCTION

The "fetal origins" hypothesis proposes alterations in fetal nutrition or an adverse environment in utero can lead to a permanent physiological change in the fetus, predisposing to chronic disease in later life (Barker, 1994, 1995). This hypothesis has led to the renewed interest in nutrition during pregnancy and the assumption that improving maternal nutrition could improve fetal growth and subsequent health (Yajnik, 2006). Birth weight, birth length, head circumference, ponderal index and placental weight have been used as indicators of fetal growth to predict adult diseases (Godfrey and Barker, 2000, 2001; Barker, 2001, 2003).

Many studies have reported the effect of maternal nutrition on birth outcomes by focusing on single macro- or micronutrients, but with contradictory results

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(Langley-Evans and Langley-Evans, 2003; Lagiou *et al*, 2004; Moore *et al*, 2004; Andreasyan *et al*, 2007; Nagata *et al*, 2007; Abu-Saad and Fraser, 2010). Specific nutrient, intake of whole food components during pregnancy in relation to birth outcomes has been examined (Olsen *et al*, 1991; Petridou *et al*, 1998; Olsen *et al*, 2002; Mannion *et al*, 2006). To our knowledge, there have been only three studies which focused on maternal fruit and vegetable consumption and birth size (Rao *et al*, 2001; Mikkelsen *et al*, 2006; Ramon *et al*, 2009). Positive associations were found between vegetable intake and birth size in all three studies; the effect of fruit intake on birth size has only been reported in two studies which showed a positive association (Rao *et al*, 2001; Mikkelsen *et al*, 2006).

Birth size varies by ethnic group. According to Yadav (1983), Malaysian Chinese babies had the highest birth weight, followed by Malay babies and Indian babies. We focused on examining the birth size of Malay babies, since Malays are the major population in Malaysia especially in Kelantan state. To our knowledge, no study has been carried out in Malaysia to examine the association between maternal dietary intake in pregnancy and birth size. We investigated the effect of maternal diet on birth size among Malays. We focused on fruit and vegetable consumption and hypothesized micronutrients, vegetables and fruit intake during pregnancy would exert an impact on birth size.

MATERIALS AND METHODS

Study subjects

The pregnant women in their third trimester were identified through the antenatal clinic at the Universiti Sains Malaysia Hospital (HUSM), Kelantan, Malaysia. The Kelantan State is located in northeastern Peninsular Malaysia, where ethnic Malays comprise 95% of the population. Inclusion criteria were: 1) Malaysian citizenship and Malay ethnicity; 2) aged 19 - 40 years; 3) pregnant with an estimated gestational age of 28 to 38 weeks based on the last normal menstrual period or an early ultrasound scan; 4) and having the ability to give informed consent. One hundred seventy-seven women were recruited from November 2009 to March 2010. The study was approved by the Research Ethics Committee (Human) HUSM and written informed consent was obtained from each participant.

Data collection

Information regarding sociodemographic, medical and pregnancy history were obtained using a standardized questionnaire. Height was measured using a stadiometer (SECA, Germany) and weight was measured using a digital weighing scale (SECA, Germany). Pre-pregnancy weight was based on the mothers' recall. A high correlation (r=0.98) between actual and recalled pre-pregnancy weight had been reported previously (Steven-Simon *et al*, 1986).

Birth weight, length, head circumference and gestational age at delivery were obtained from the medical records. Women who had multiple pregnancies, women with preexisting chronic diseases, such as diabetes mellitus, hypertension and heart disease, and those who did not give birth at HUSM were excluded from the analysis, leaving a total of 121 women. No women were excluded due to misreporting of energy intake, since the energy adjustment approach based on the Willet residual method (Willet, 1998) is more appropriate to handle misreporting and to assess diet-disease relationships (Poslusna *et al*, 2009).

Table 1
Semi-quantitative food frequency questionnaire validity and reproducibility test.

Food group	Validity test: Correlation coefficient		Validity test: Cross classification into quartile (%)		Reproducibility test
	Energy-unadjusted	Energy-adjusted	Correctly classified[a]	Grossly Misclassified[b]	Intraclass correlation coefficient[c]
Leafy vegetables	0.32[d]	0.25[d]	76	7	0.90
Cruciferous vegetables	0.38[d]	0.38[d]	72	8	0.90
Legume vegetables	0.36[d]	0.29[d]	80	2	0.82
Tuber vegetables	0.37[d]	0.26[d]	81	3	0.87
Raw vegetables "ulam"	0.38[d]	0.25[d]	77	3	0.90
Other vegetables	0.25[d]	0.23[d]	72	10	0.88
Fruits	0.39[d]	0.23[d]	77	5	0.88

[a] Correctly classified if classified into same or adjacent (+/ - 1) quartiles
[b] Grossly misclassifies if classified into opposing quartiles
[c] Based on log-transformed values
[d] $p<0.01$

Dietary assessment

A dietary assessment was carried out in face-to-face interviews by dieticians using a validated semi-quantitative food frequency questionnaire (FFQ). The FFQ has been validated against two 24-hour dietary recalls among pregnant mothers. The Spearman correlation coefficient and cross classification analysis were used to estimate validity. A reproducibility test was repeated 20-28 days apart. It was assessed using intraclass correlation (Table 1). The FFQ contained 82 food categories with an assigned standard portion size for each food category. Mothers were asked to recall their food intake during the preceding six months of pregnancy, followed by estimating the frequency of intake either daily, weekly or monthly, and the respective portion size. An Atlas of Food Exchanged & Portion sizes (Suzana *et al*, 2009) containing color pictures of common household measures was used to aid in identifying portion size. The energy and nutrient values for each food category were obtained from the Malaysian Nutrient Composition of Foods and USDA nutrient database using Nutritionist Pro™ software (Axxya Systems LLC, Stanfford, TX).

Statistical analysis

The nutrient and food intake distributions were described in median and interquartile ranges since all of them were positively skewed. Associations between maternal nutrient and food intake and birth outcomes were examined using multiple linear regression analyses. Maternal variables were included in the analyses if they were significantly associated with birth outcomes on univariate analysis or reported in previous studies (Moore *et al*, 2004; Andreasyan *et al*, 2007). These included social class based on maternal employment, monthly household income,

Table 2
Characteristics of Malay pregnant women and their infants (n=121).

Characteristics	Descriptive statistics	
	Mean	SD
Age (year)	30.03	5.16
Weight at recruitment (kg)	70.84	12.61
Pre-pregnancy weight (kg)	59.60	12.48
Height (cm)	155.05	6.04
Pre-pregnancy body mass index (kgm^{-2})	24.78	5.25
Birth weight (g)	3,164.55	459.27
Birth length (cm)	51.79	2.45
Head circumference (cm)	33.39	1.62
Gestational age at delivery (week)	38.62	1.07
	Median	IQR
Parity	1	0, 2
Monthly household income (RM)	2,500.00	1,200.00, 4,000.00
	n	%
Employment status		
Employed	68	56.20
Unemployed	53	43.80
Infant sex: male	61	50.41

SD, standard deviation; IQR, inter-quartile range; RM, Ringgit Malaysia

maternal height, weight at recruitment, pre-pregnancy weight, body mass index, gestational age at delivery, parity and infant sex. Nutrient and food intake were log-transformed to reduce the leverage of outliers and adjusted for total energy using the residual method described by Willet (1998). All statistical evaluations were computed using the Statistical Package for the Social Sciences (SPSS) version 18.0 (SPSS, Chicago, IL).

RESULTS

Table 2 shows the maternal and birth characteristics among 121 pairs of mothers and infants. Fifty-six mothers (32%) were dropped from the study due to multiple pregnancies or not giving birth at the HUSM. Pre-pregnancy body mass index showed 5.6% of women were underweight, 54.6% of women were normal weight, 9% of women were overweight and 13.9% of women were obese. Twenty-nine point eight percent of women were primiparous. None of the women smoked during pregnancy. The mean birth weight was normal and the majority (98%) delivered at full-term. Only 5% of babies had a low birth weight (<2,500 g). In general, boys had higher birth weights, birth lengths and head circumferences than girls, although the corresponding differences were not statistically significant.

Table 3 shows the estimated median daily intake of energy and nutrients in pregnancy. The main energy sources were carbohydrates (60%), followed by fat (24%) and protein (16%). On average, maternal energy and protein intake were

Table 3
Energy and nutrient intakes among pregnant Malay women.

Nutrient intake	Median	Lower quartile	Upper quartile
Energy (kJ/d)	8,543.8	6,808.5	11,002.5
Protein (g/d)	83.9	64.3	108.7
Carbohydrate (g/d)	306.4	255.4	394.1
Fat (g/d)	54.6	42.8	72.6
Sodium (mg/d)	2,736.5	1,930.4	3,616.6
Potassium (mg/d)	1,648.1	1,224.1	2,218.6
Calcium (mg/d)	820.5	540.0	1,293.4
Iron (mg/d)	20.1	14.5	28.3
Phosphorus (mg/d)	997.5	757.8	1,334.4
Vitamin A, RE[a] (µg/d)	959.0	608.5	1,642.4
Vitamin C (mg/d)	121.2	75.0	180.4
Thiamin (mg/d)	1.6	1.1	2.4
Riboflavin (mg/d)	2.0	1.4	2.8
Niacin (mg/d)	15.9	11.5	21.4
Dietary fiber (g/d)	7.0	4.2	9.9

[a] RE, retinol equivalents

9,071.6 (2,929) kJ/d and 90.4 (41.1) g/d, respectively. These values are comparable to the Recommended Nutrient Intake (RNI) for Malaysian pregnant women (NCCFN, 2005). Vitamins A and C, micronutrients rich in vegetables and fruits had the mean values of 1,453.6 (1,354.4) µg and 145.1 (105.2) mg, respectively. Intake was higher than recommended according to the RNI (NCCFN, 2005). Regression analysis indicated no significant association between any of the measured macronutrients and birth size.

Table 4 shows the median daily intake of the vegetable subgroups and fruits consumed during pregnancy. Leafy vegetables were eaten more frequently than other vegetable subgroups. Overall, total fruit and vegetable intake was inadequate using the Malaysian Food Pyramid recommendations (NCCFN, 2010). A multiple regression model showed leafy vegetables, tuber vegetables and fruits were significantly associated with birth size (Table 5). An increase of 10 g of leafy vegetables was associated with a 1.78 cm increase in head circumference at birth (p=0.04). Tuber vegetable intake was positively associated with birth length (β=0.21, p=0.03) and head circumference (β=0.21, p=0.01). Fruit intake was positively associated with birth weight (β=0.19, p=0.04), birth length (β=0.20, p=0.04) and head circumference (β=0.19, p=0.03).

DISCUSSION

The majority of pregnant women were normal or overweight before conception, indicating undernutrition is not common in this population. It also manifests the growing problem of overweight and obesity in the Malaysian adult population, especially among women (Institute of Public Health, 2008).

In this study, energy, macronutrients

Table 4
Intake of fruits and vegetables among pregnant Malay women.

Food intake (g/d)	Median	Lower quartile	Upper quartile
Leafy vegetables[a]	18.4	9.2	29.7
Cruciferous vegetables[b]	7.1	3.6	14.3
Legume vegetables[c]	2.3	0	6.0
Tuber vegetables[d]	4.0	0	12.6
Salad "ulam"[e]	1.7	0	5.6
Other vegetables[f]	14.7	3.7	29.4
Fruits[g]	147.0	88.0	272.2

[a]Included mustard leaves, swamp cabbage, kale, spinach, sweet potato shoots, fern shoots
[b]Included common cabbage and cauliflower
[c]Included string beans and four-angled beans
[d]Included potatoes, carrots and sweet potatoes
[e]Included Indian Pennywort and "Ulam raja"
[f]Included cucumbers, gourds and tomatoes
[g]Included oranges, apples, bananas, pears, papayas, watermelons, honeydew melons, pineapples, mangos, guavas, water apples, grapes, duku, rambutans, durians, mangosteens and jackfruits.

Table 5
Intake of fruits and vegetables with birth outcomes among pregnant Malay women[a].

Food intake (g)	Birth weight		Birth length		Head circumference	
	β	p	β	p	β	p
Leafy vegetables	0.12	0.20	0.18	0.08	0.18	0.04[b]
Cruciferous vegetables	-0.12	0.22	0.06	0.58	-0.03	0.78
Legumes	0.12	0.22	-0.04	0.72	0.13	0.14
Tuber vegetables	0.06	0.53	0.21	0.03[b]	0.21	0.01[b]
Raw vegetables "ulam"	0.002	0.98	-0.08	0.45	-0.05	0.59
Other vegetables	0.03	0.74	-0.05	0.52	0.13	0.11
Fruits	0.19	0.04[b]	0.20	0.04[b]	0.19	0.03[b]

[a] Adjusted for social class based on maternal employment, monthly household income, maternal height, weight at recruitment, pre-pregnancy weight, body mass index, gestational age at delivery, parity and infant sex. Food intake adjusted for total energy.
[b] Significant at 95% confidence interval $p<0.05$

and micronutrients were not significantly associated with birth parameters. Similar findings were seen in studies among pregnant women in southern England (Mathews *et al*, 1999) and the United States (Lagiou *et al*, 2004). According to Yajnik (2006), maternal macronutrient intake was not a strong factor in determining birth size. Both vitamins A and C are common in fruits and vegetables, but were not associated with birth size. Other studies indicated maternal energy (Susser, 1991), protein (Andreasyan *et al,* 2007), carbohydrate (Moore *et al,* 2004), fat (Kanade *et al,* 2008) and micronutrient intake (Osrin *et al,* 2005; Watson and McDonald, 2010) were associated with birth size in poor countries where nutrient deficiencies are common (Christian, 2003; Abu-Saad and Fraser, 2010). It has been argued the impact of maternal nutrients upon birth outcomes is greater in less affluent countries (Doyle *et al,* 1992). An association will only emerge when a large deviation from normal nutrient intake is found in a population. This explains the limited impact of maternal nutrients on birth size seen in the present study in Malaysia, a prosperous thriving middle-income nation. A non-significant association may also be partly due to the dilution effect of other non-nutritional variables not included in the analysis.

Six vegetable subgroups were examined in the present study. These were leafy vegetables, cruciferous vegetables, legume vegetables, tuber vegetables, salad "ulam" and other vegetables. "Ulam" is a traditional salad recognised as a popular main dish in traditional Malay villages. The positive association between vegetable intake and birth size was in line with some studies (Rao *et al,* 2001; Mikkelsen *et al,* 2006; Ramon *et al,* 2009), but not with one earlier study by Petridou *et al* (1998). A small increase in birth weight in our study was only seen by the consumption of tuber vegetables, but not green leafy vegetables, as found in other studies (Rao *et al,* 2001; Mikkelsen *et al,* 2006; Ramon *et al,* 2009). A possible explanation is the small amount of green leafy vegetables consumed did not play a significant role in birth size. When analysing the relationship between consumption of all vegetable subgroups with birth size, no significant associations were found (data not shown). This indicates the important role of specific types of vegetables.

Increasing consumption of fruits was associated with an increase in all birth size parameters. Our findings agree with previous studies that fruit intake increased birth weight by 10.7 g per quintile in a Danish study (Mikkelsen *et al,* 2006) and 4.3 g per category of consumption in an Indian study (Rao *et al,* 2001). Studies in Greece (Petridou *et al,* 1998) and Spain (Ramon *et al,* 2009) found no association between fruit intake and birth size. It is inappropriate to compare the findings of studies assessing fruits intake with birth size, especially among Asians. Fruits consumed by western populations contribute different types of nutrients and have different effects on birth size. Differences in study design and statistical analysis may also lead to differences in findings.

Fruits and vegetables are a rich source of antioxidants and phytochemicals. The differences between fruits and vegetable of growth reflect different micronutrients and phytochemicals in relation to fetal growth. The lack of association between examined micronutrients and birth size, but the significant associations between fruit and vegetable intake and birth size, suggest other unmeasured nutrients in fruits and vegetables contribute to these differences. Several studies have investigated antioxidant intake on birth size, with inconsistent results (Boer *et al,* 2009). The weak association between intake of fruits and vegetables and birth size may be partly due to better nutritional status in the studied population. However, we believe a stronger association will be observed for the same food groups and birth size when studying undernourished populations as was found in a previous study (Kanade *et al,* 2008).

Strengths and limitations are present

in the present study. The major strength of this study was the inclusion of different vegetable subgroups in the analysis. It provides a clearer picture of the beneficial roles of specific types of vegetables in promoting fetal growth. Food-based analysis provides a clearer message in relation to dietary recommendations, which facilitates later intervention programs. Supplements, such as vitamins, minerals (Alwan *et al,* 2010) and herbal medicines (Azriani *et al,* 2009) that are commonly taken during pregnancy, were not analysed in this study since our main purpose was to investigate the effect of natural food intake on birth size. The high drop out rate of mothers led to a small sample size in our study. However, this did not bias the results, since there were no significant differences in dietary intake between the included and excluded women (data not shown). The small sample size causes difficulty in generalizing our results. However, the significant associations between fruit and vegetable consumption and birth size highlight the importance of those foods for improving birth size. This serves as a reference to further studies of the effect of maternal dietary patterns on birth size, as shown by a study in Denmark (Knudsen *et al,* 2008). Participation bias may attenuate findings, where those who took part in the study were more likely to have a healthier lifestyle and better nutritional status, which could impact the reported dietary intake and birth size. However, dietary that obtained prospectively before knowing the birth weight helps to reduce information bias. Misreporting may occur among mothers who deliver low birth weight or high birth weight infants when dietary data are obtained after pregnancy.

Increasing consumption of fruits and vegetables is associated with better birth size. The present findings suggest consumption of fruits and vegetables plays a beneficial role in improving birth size and subsequent health outcomes. However, the contribution of unmeasured micronutrients and phytochemicals present in fruits and vegetables and their roles in determining birth size warrant further investigation.

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REFERENCES

Abu-Saad K, Fraser D. Maternal nutrition and birth outcomes. *Epidemiol Rev* 2010; 32: 5-25.

Alwan N, Greenwood D, Simson N, McArdle H, Cade J. The relationship between dietary supplement use in late pregnancy and birth outcomes: a cohort study in British women. *BJOG* 2010; 117: 821-9.

Andreasyan K, Ponsonby AL, Dwyer T, *et al.* Higher maternal dietary protein intake in late pregnancy is associated with a lower infant ponderal index at birth. *Eur J Clin Nutr* 2007; 61: 498-508.

Azriani AR, Siti Amrah S, Zulkifli A, Halim S, Wan Nudri WD, Abdul Manaf H. Women's attitude and sociodemographic characteristics influencing usage of herbal medicines during pregnancy in Tumpat District, Kelantan. *Southeast Asian J Trop Med Public Health* 2009; 40: 330-7.

Barker DJP. Mothers, babies, and disease in later life. London: BMJ Publishing Group, 1994.

Barker DJP. Fetal origins of coronary heart disease. *BMJ* 1995; 311: 171-4.

Barker DJP. Fetal and infant origins of adult disease. *Monatsschr Kinderheilkd* 2001; 149 (suppl 1): S2-6.

Barker DJ. The developmental origins of adult disease. *Eur J Epidemiol* 2003; 18: 733-6.

Boer JMA, Bakel AM, Hoogervorst EM, Luijten M, Vries A. Effects of maternal diet during pregnancy on birth weight of the infant. Netherlands: RIVM Report 350020009. National Institute for Public Health and the Environment, 2009.

Christian P. Micronutrients and reproductive health issues: an international perspective. *J Nutr* 2003; 133: S1969-73.

Doyle W, Wynn AHA, Fibiol MAC, Wynn SW. Nutritional counselling and supplementation in the second and third trimester of pregnancy, a study in a London population. *J Nutr Environ Med* 1992; 3: 249-56.

Godfrey KM, Barker DJ. Fetal nutrition and adult disease. *Am J Clin Nutr* 2000; 71: S1344S-52.

Godfrey KM, Barker DJ. Fetal programming and adult health. *Public Health Nutr* 2001; 4: 611-24.

Institute of Public Health. The Third National Health and Morbidity Survey 2006 (NHMS III). Nutrition status. Kuala Lumpur: Institute for Public Health, Ministry of Health Malaysia, 2008: 50-1.

Kanade AN, Rao S, Kelkar RS, Gupte S. Maternal nutrition and birth size among urban affluent and rural women in India. *J Am Coll Nutr* 2008; 27: 137-45.

Knudsen VK, Orozova-Bekkevold IM, Mikkelsen TB, Wolff S, Olsen SF. Major dietary patterns in pregnancy and fetal growth. *Eur J Clin Nutr* 2008; 62: 463-70.

Lagiou P, Tamimi RM, Mucci LA, Adami HO, Hsieh CC, Trichopoulos D. Diet during pregnancy in relation to maternal weight gain and birth size. *Eur J Clin Nutr* 2004; 58: 231-7.

Langley-Evans AJ, Langley-Evans SC. Relationship between maternal nutrient intakes in early and late pregnancy and infants weight and proportions at birth: prospective cohort study. *J R Soc Promot Health* 2003; 123: 210-6.

Mannion CA, Gray-Donald K, Koski KG. Association of low intake of milk and vitamin D during pregnancy with decreased birth weight. *CMAJ* 2006; 174: 1273-7.

Mathews F, Yudkin P, Neil A. Influence of maternal nutrition on outcome of pregnancy: prospective cohort study. *BMJ* 1999; 319: 339-43.

Mikkelsen TB, Osler M, Orozova-Bekkevold I, Knudsen VK, Olsen SF. Association between fruit and vegetable consumption and birth weight: a prospective study among 43,585 Danish women. *Scand J Public Health* 2006; 34: 616-22.

Moore VM, Davies MJ, Willson KJ, Worsley A, Robinson JS. Dietary composition of pregnant women is related to size of the baby at birth. *J Nutr* 2004; 134: 1820-6.

Nagata C, Iwasa S, Shiraki M, Sahashi Y, Shimizu H. Association of maternal fat and alcohol intake with maternal and umbilical hormone levels and birth weight. *Cancer Sci* 2007; 98: 869-73.

National Coordinating Committee on Food and Nutrition (NCCFN), Ministry of Health Malaysia. Recommended nutrient intakes for Malaysia. A report of the Technical Working Group on Nutritional Guidelines. Kuala Lumpur: NCCFN, 2005.

National Coordinating Committee on Food and Nutrition (NCCFN), Ministry of Health Malaysia. Malaysian dietary guidelines. Kuala Lumpur: NCCFN, 2010.

Olsen J, Overvad K, Frische G. Coffee consumption, birth weight, and reproductive failures. *Epidemiology* 1991; 2: 370-4.

Olsen SF, Secher NJ. Low consumption of seafood in early pregnancy as a risk factor for preterm delivery: prospective cohort study. *BMJ* 2002; 324: 447.

Osrin D, Vaidya A, Shrestha Y *et al.* Effects of antenatal multiple micronutrient supplementation on birth weight and gestational duration in Nepal: double-blind, randomised controlled trial. *Lancet* 2005; 365: 955-62.

Petridou E, Stoikidou M, Diamantopoulou M, Mera E, Dessypris N, Trichopoulos D. Diet during pregnancy in relation to birth weight in healthy singletons. *Child Care Health Dev* 1998; 24: 229-42.

Poslusna K, Ruprich J, de Vries JH, Jakubikova M, van't Veer P. Misreporting of energy and micronutrient intake estimated by food records and 24 hour recalls, control and adjustment methods in practice. *Br J Nutr* 2009; 101 (suppl 2): S73-85.

Ramon R, Ballester F, Iniguez C, *et al.* Vegetable but not fruit intake during pregnancy is associated with newborn anthropometric measures. *J Nutr* 2009; 139: 561-7.

Rao S, Yajnik CS, Kanade A, *et al*. Intake of micronutrient-rich foods in rural Indian mothers is associated with the size of their babies at birth: Pune Maternal Nutrition Study. *J Nutr* 2001; 131: 1217-24.

Stevens-Simon C, McAnarney ER, Coulter MP. How accurately do pregnant adolescents estimate their weight prior to pregnancy? *J Adolesc Health Care* 1986; 7: 250-4.

Susser M. Maternal weight gain, infant birth weight, and diet: causal sequences. *Am J Clin Nutr* 1991; 53: 1384-96.

Shahar S, Mohd Yusoff NA, Shanita Safii N, Ghazali R, Ahmad R. Atlas of food exchanges & portion sizes. 2nd ed. Kuala Lumpur: MDC Publishers (91168-A), 2009.

Watson PE, McDonald BW. The association of maternal diet and dietary supplement intake in pregnant New Zealand women with infant birth weight. *Eur J Clin Nutr* 2010; 64: 184-93.

Willett W. Nutritional epidemiology. 2nd ed. New York: Oxford University Press, 1998: 288-91.

Yadav H. Birth weight distribution, mean birth weights, and low birth weights among various ethnic groups in Malaysian newborns. *Singapore Med J* 1983; 24: 145-9.

Yajnik C. Nutritional control of fetal growth. *Nutr Rev* 2006; 64: S50-S51.