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Contribution of fish to intakes of micronutrients important for fetal development: a dietary survey of pregnant women in the Republic of Seychelles

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Abstract

Objectives—To characterise the diets of pregnant women in the Republic of Seychelles and to determine the contribution of fish to intakes of nutrients important for fetal and neonatal development.

Design—Observational, prospective study.

Setting—Seychelles Child Development Centre, Mahé, Republic of Seychelles.

Subjects and methods—Pregnant women (*n* 300) were recruited at their first visit to an antenatal clinic. At 28 weeks' gestation subjects completed a 4 d diet diary (*n* 273) and intakes were analysed using dietary analysis software.

Results—Mean (SD) energy intake was 9·0 (2·5) MJ/d and fat intakes were higher than UK recommendations for almost two-thirds of the cohort. Fish consumption was lower than in previous surveys, suggesting a move towards a more Westernised diet. Low intakes of a number of nutrients important during pregnancy for fetal development (Fe, Zn, Se and iodine) were observed. However, women who met the current recommendations for these nutrients consumed significantly more fish than those who did not (97 *v.* 73 g/d).

Conclusions—The present study highlights the importance of fish in the diet of pregnant Seychellois women for ensuring adequate intakes of micronutrients important in fetal development. Dietary patterns in Seychelles, however, are in a state of transition, with a move towards a Western-style diet as evidenced by higher fat and lower fish intakes. If these dietary trends continue and fish consumption declines further, micronutrient status may be compromised.

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There are no conflicts of interest.

These findings suggest caution in establishing public health policies that promote limitation of fish intake during pregnancy.

Keywords

Pregnancy; Fish; Micronutrients; Diet

The nutritional status of women during pregnancy influences physiological outcomes in the child, including birth size[1,2], later risk of CVD and diabetes[3,4] and cognitive function[5]. Despite some concerns about exposure to methylmercury[6], fish consumption during pregnancy provides an excellent source of dietary protein[7] as well as a number of micronutrients essential for fetal development[8,9] such as Fe, iodine, Zn, Se, choline and long-chain PUFA.

Iodine and Fe deficiencies are two of the most common nutritional deficiencies in the world. An estimated 30% of the world's population inhabits areas of iodine deficiency [10] while Fe deficiency anaemia affects up to 50% of pregnant women in developing[11] countries and up to 25% of children under the age of 3 years, with higher rates observed in developing countries[10]. Correction of iodine deficiency in pregnancy can be achieved with supplementation and is associated with improved psychomotor test scores in infants[12]. Fe supplementation in children can improve mental and motor scores in standardised developmental assessments[13]. Maternal Zn status has been linked with infants' early behaviour[14], with Zn supplementation during pregnancy associated with increased motor activity in the offspring[15]. Se is also a vital component of the maternal diet with essential roles in fetal development[16]. Se might influence fetal development directly by interacting with iodine in regulating thyroid function[17] and might also have a protective role in the prevention of methylmercury toxicity[18].

Long-chain PUFA play an important structural role in neural tissue, especially the brain and retina[19]. Fetal accretion is at its greatest in the third trimester of pregnancy [20] and supplementation with long-chain PUFA in pregnancy has been shown to improve cognitive function [21]. Choline, a nutrient that can be synthesised *de novo* in the body, appears to be a conditionally essential dietary nutrient for optimal brain development both pre- and postnatally[22]. Supplementation with choline in animal models has indicated a life-long enhancement in spatial memory[23] and cognitive function[24].

The Republic of Seychelles is a small tropical archipelagic state in the Indian Ocean with one of the highest per capita rates of fish consumption in the world[25]. The population consumes a traditional diet based around high fish consumption in conjunction with a high intake of fruit and vegetables. Such a diet would be expected to provide optimal nutrient intake with respect to those micronutrients of importance in infant development. Evidence has indicated that fish consumption has decreased by up to one-third over the last two decades as the Seychellois population adopts a more Western-style diet and life-style [26]. This has led to increased concern that if these trends continue, micronutrient status may be compromised. However, no study to date has examined in detail dietary patterns during pregnancy in this population. The aims of the current project, therefore, were to characterise the diets of pregnant Seychellois women and to determine the role that fish play in promoting adequate intakes of nutrients important for fetal and neonatal development.

Materials and methods

Subjects

A total of 300 pregnant women were recruited in 2001 from all (*n* 9) antenatal clinics on Mahé in the Republic of Seychelles. All eligible women attending the antenatal clinics for their first antenatal visit within a 3-month period, who met the inclusion criteria, were invited to participate on the study. Inclusion criteria were aged over 16 years, resident on Mahé (main island of the Seychelles archipelago and where 90% of the total population lives) and native-born Seychellois. The cohort of 300 represents one-fifth of total annual deliveries in Seychelles and 75% of all women booking at antenatal clinics during the enrolment period, and was therefore considered to be a representative sample of the population. Women were excluded if they were vegetarian, or if they reported a serious medical illness such as insulin-dependent diabetes, toxaemia with seizures or a haematological disorder such as thalassaemia or sickle cell anaemia. The study was reviewed and approved by the Research Subjects Review Board in Seychelles and the appropriate Research Subjects Review Boards of the collaborating partners.

Dietary assessment

Detailed information on the issues involved in establishing the dietary survey methodology in Seychelles is documented elsewhere[27]. Briefly, at 28 weeks' gestation detailed dietary information was collected from each subject by means of a prospective 4 d semi-quantitative food diary (two consecutive weekdays and two weekend days). The diet diaries were available in both English and Kreol language, and detailed instructions on completion of the diet diary were given to each subject by trained investigators.

Nurses, trained by nutritionists from the University of Ulster, reviewed the diaries within one week of completion, and errors and omissions were clarified with subjects. Data in the diet diaries were then converted to gram weights for input into a dietary analysis package (WISP version 2·0; Tinuviel Software, Warrington, UK). Package weights of imported food, much of which was from the UK at that time, were obtained from UK standard food portion sizes[28].

The dietary analysis package, WISP, was supplemented with food composition and recipe data for additional foods consumed in Seychelles. These data were obtained from a variety of food composition tables from around the world including *The Composition of South African Foods*[29] and *The Concise New Zealand Food Composition Tables*[30]. In addition, the energy and nutrient composition of ten of the most commonly consumed fish were chemically analysed (CCFRA Technology Ltd, Chipping Campden, UK) and nutrient values entered into the database. The WISP program was further augmented with data for the choline content of foods obtained from the US Department of Agriculture food composition database[31]. Data were mapped to the most appropriate food codes in the UK database by a registered nutritionist. This process involved both matching for food name and nutrient profile.

Anthropometry

Maternal height and weight were measured according to standardised procedures by trained nurses at enrolment into the study and BMI was calculated as [weight (kg)]/[height (m)]^2. Measuring equipment in each of the participating antenatal clinics was calibrated prior to initiation of the study, and regularly throughout the project, by the Seychelles Bureau of Standards.

Estimated BMR

BMR (MJ/d) was estimated for all subjects at enrolment into the study using the Schofield equations[32]. Depending on the age of the subject at enrolment the following equations were used:

$$\text{BMR}=0\cdot 057\times \text{weight}+1\cdot 184\times \text{height}+0.411 \text{ for subjects aged } 18-30 \text{ years}$$

and

$$\text{BMR}=0\cdot 034\times \text{weight}+0\cdot 006\times \text{height}+3\cdot 530 \text{ for subjects aged} >30 \text{ years},$$

where weight is in kilograms and height is in metres.

Under-reporting

The level of under-reporting (MJ/d) of energy intake (EI) was determined as follows. Cut-off limits for EI:BMR were calculated as described by Goldberg *et al.*[33] using the following equation[34]:

$$\text{EI}_{\text{rep}}\text{:BMR}>\text{PAL}\times \exp\left[\text{SD}_{\text{min(or max)}}\times \frac{S/100}{\sqrt{n}}\right],$$

where PAL (physical activity level) was assumed to be 1·4 × BMR as recommended by Prentice *et al.*[35] for the third trimester pregnancy; S is a factor that accounts for variation in BMR, EI and PAL; n is the number of subjects; and $\text{SD}_{\text{min(or max)}}$ is −2 or +2SD for the 95% upper confidence limit.

Socio-economic status

Socio-economic status (SES) was assigned to each participant using the Hollingshead four-factor score based on education, occupation, sex and marital status. Occupational scores were based on a list of Seychellois employment codes, as previously reported[36].

Statistical analysis

All data were analysed using the SPSS 12·0 for Windows statistical software package (SPSS Inc., Chicago, IL, USA). Data for all variables were tested for normality and adjusted where necessary. To reduce the inaccuracies associated with estimating the extent of nutritional inadequacy in this population based on short-term dietary data collection, statistical methods were used to estimate the usual distribution of intakes based on the observed intakes. Adjustment of observed intakes was carried out as follows. Dietary data were normalised, and within- and between-person variances were calculated. The mean intake of each subject was then adjusted as follows:

$$[(\text{subject's mean intake}-\text{group mean intake})\times(\text{SD}_{\text{between}}/\text{SD}_{\text{observed}})]+\text{group mean intake}.$$

The resulting adjusted distributions were then used to compare reported nutrient intakes with dietary recommendations, using the cut-point method[37,38]. In the Republic of Seychelles, nutritional guidelines are based on the UK Dietary Reference Values (DRV)[39].

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To assess the potential impact of dietary misreporting on the extent of potential nutrient inadequacy, dietary intakes reported by the whole group were compared with those reported by subjects not classified as under-reporters using one-way ANOVA. Independent *t* tests were used to examine for differences between fish consumption in subjects meeting nutrient requirements compared with those who did not. A significance level of $P<0·05$ was used to evaluate all statistical outcomes.

Results

Subject characteristics

Of the 300 women recruited to the study at their first visit to an antenatal clinic (mean gestational age 12·5 weeks) dietary data were available for 273 women. Dropouts were for a combination of reasons including miscarriage/abortion (*n* 12), not pregnant (*n* 4), illness (*n* 1), relocation (*n* 2) and non-compliance (*n* 8). On average, women who participated in the study had a mean (SD) age of 27·0 (6·1) years, were 1·60 (6·7)m tall, weighed 66·7 (16·6) kg and had a BMI of 25·9 (6·3) kg/m^2 at enrolment. SES was assessed by the Hollingshead score (*n* 260). This score is divided into four groups: unskilled (13·5 %), semi-skilled (25·8 %), skilled (25·4%) and business/professional (35·4 %). The highest percentage of pregnant women were in the business/professional category. SES had no influence on nutrient densities (nutrient intake/MJ energy intake; data not shown).

Estimated BMR was calculated at enrolment to the study. For the group as a whole, mean (SD) BMR was 5·98 (0·83) MJ/d. Mean EI_{rep}:BMR was 1·33. Calculation of cut-off values was based on a PAL of 1·4 × BMR[35]. The daily variance in energy intake was 22·07% and the estimated BMR and physical activity levels were 8·5% and 15% respectively[34], giving a cut-off for under-reporting of 1·37 × BMR. A total of 109 women (39·6%) were classified as under-reporters.

Energy and macronutrient intakes

Table 1 presents mean (SD) and median (5th, 95th percentiles) dietary intakes of pregnant women in Seychelles for the group as a whole and after excluding under-reporters. For the whole group, median (5th, 95th percentiles) daily energy intake was 8·9 (5·0, 13·4) MJ and comprised 48·6 (37·8, 56·8) % carbohydrate, 36·3 (28·8, 44·0) % fat and 15·4 (12·0, 19·4) % protein. Comparisons between nutrient intakes of the whole group (*n* 273) and those who were classified as non under-reporters (*n* 164) indicated a significantly higher intake of all nutrients except vitamin A in those subjects who were not deemed to be under-reporters. Macronutrient intake expressed in relative terms (percentage of energy) was not significantly different between the group as a whole and after excluding under-reporting, suggesting that under-reporting was not macronutrient-specific.

Nutritional adequacy

The Estimated Average Requirement (EAR)[39] is advocated by the Institute of Medicine[40] as the most appropriate yardstick for assessing nutritional adequacy. Preferably, these comparisons should be made on data that have been statistically adjusted to estimate the distribution of usual intakes from the observed intakes[37]. Table 2 presents a comparison of adjusted mean dietary intakes with the UK EAR for the group as a whole and after excluding under-reporters. Where nutrient recommendations for pregnancy are available (applicable to Reference Nutrient Intakes (RNI) only), comparisons have been made using the adjusted dietary intakes with the appropriate RNI (specifically protein, vitamins A, B_1, B_2, folate and vitamin C) and also for nutrients where only RNI are stated (Cu, iodine and Se). As there are recommendations for a number of nutrients during pregnancy, comparison with RNI was more frequent than with EAR.

When fat and carbohydrate intakes (expressed as a percentage of energy) were compared with UK DRV, saturated fat intakes for >90% of the study group were in excess of recommendations. Non-milk extrinsic sugar intakes, however, were below the recommended DRV of ≤10% energy intake for 97% of the population.

Vitamins B_6 and B_{12} were the only nutrients that met recommended requirements (RNI) in the population as a whole. Intakes of protein and vitamin C when compared with the RNI were deemed to be adequate for >90% of the population. When under-reporters were excluded, the percentage of the group attaining the appropriate DRV was higher for all nutrients except vitamin A (comparison with RNI). Intakes of nutrients specifically important in pregnancy such as Fe and Zn (comparison with EAR), folate and Se (comparison with RNI) were evaluated and low levels were observed in 80·6%, 8·4%, 91·2% and 20·2% of the population as a whole, respectively. The exclusion of under-reporters reduced these values to 69·5%, 0 %, 84·8% and 9·1%, respectively.

Contribution of food groups to nutrient intakes

Average fish intake was 76 g/d and consumed by 98% of all subjects. The most commonly consumed fish were karang (32 %), mackerel (12 %), spinefoot shoemaker (12 %), fresh tuna (6 %), tinned tuna (6 %) and barracuda (5 %). Meat and fish made similar contributions to protein intake and together accounted for 40% of overall protein intake. Vegetables (excluding potatoes) were consumed by all subjects and fruit/fruit juice was consumed by 95·2% of the subjects (data not shown).

Table 3 presents the contribution of the various food groups to the dietary intake of the nutrients of specific interest in pregnancy, i.e. Fe, Zn, Se, iodine and choline. The main food groups contributing to Fe intakes were vegetables, meat and bread and rolls. Egg consumption provided over one-third of choline intakes, with the second largest contribution coming from the fish and fish products food group. Although not the most nutrient-dense food in terms of Se content, bread and rolls were consumed in amounts that made this food group the most important source of dietary Se, followed by fish. Red meat was the best source of dietary Zn. In terms of overall dietary contribution of the aforementioned nutrients which have an important role in pregnancy, fish was the second most widespread source of iodine, Se and choline, and contributed to both Zn and Fe intakes.

Separation of the subjects into those who met the appropriate recommendations for Fe, Zn, iodine and Se (*n* 35) and those who met recommendations for three or fewer of these nutrients indicated a significantly greater mean (SD) fish consumption of 98·6 (65·8) g/d compared with 73·2 (42·1) g/d (P<0·05).

Discussion

The present paper reports dietary habits of pregnant women in the Republic of Seychelles, a small island developing state and the location for a number of long-term observational epidemiological studies examining the effect of fish consumption on infant neurodevelopment [36,41]. Mean (SD) weekly fish consumption was high at approximately 527 (327) g[42] and therefore would be expected to contribute considerably to dietary intakes of micronutrients such as iodine, Se and Zn. Indeed, women meeting dietary recommendations for all of the aforementioned micronutrients had a significantly higher fish intake. In the group as a whole, however, comparison of micronutrient intakes (adjusted means) with UK EAR or RNI where appropriate indicated noticeable shortfalls. Dietary Fe requirements, for example, were not met by 80·6% of the population (based on UK EAR). The Institute of Medicine have concluded that Fe is the only nutrient in pregnancy for which diet alone cannot meet requirements[43]. Supplements are routinely supplied during

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pregnancy in Seychelles but uptake appears sporadic at best[44]. Although some dietary intakes observed in our study were low, the findings are comparable to those in populations in the UK, Mexico and South Africa[45–47].

Initial analysis of the current cohort suggested that iodine intakes did not meet recommendations in 62·9% of the study group (based on UK RNI). Low intakes of dietary iodine have also been observed in women of childbearing age in Europe and are approximately 50% of recommendations[48]. This apparent shortfall in iodine intake is of concern as low iodine status in pregnancy has adverse implications for fetal neurodevelopment[49]. However, intakes are likely to have been underestimated as the iodine content of some fish species consumed in Seychelles is unknown and therefore was unaccounted for in the dietary analysis. Subsequent analysis, using an assumed average iodine concentration per 100 g fish, suggested that 36·3% did not meet requirements. Dietary intakes of Se were adequate in 79·8% of the whole group (based on UK RNI). Although not the richest source of Se, bread had high habitual consumption that ensured this food group was the highest contributor to dietary Se, followed by fish. Adequate Se status might be important in high fish-eating populations given its possible role in counteracting the toxicity of methylmercury, which is also present in fish. Although Zn deficiency has been estimated to be as high as 25% in the world's population[50], in our study group inadequate Zn intakes (based on UK EAR) were seen in only 8·4% of the population. However, after excluding under-reporters, the levels of apparent nutritional inadequacy decreased by 13·8%, 19·6% and 55·0% for Fe, iodine and Se, respectively, and the dietary recommendation for Zn intake of 5·5 mg/d was met by all subjects.

Since recommendations for choline intake were published, several studies have reported that choline intakes often do not meet recommendations in both pregnant[51] and non-pregnant individuals[52]. Currently no RNI or EAR has been defined for choline; however, in the USA an Adequate Intake (AI) for pregnant women of 450mg/d has been established. In our study group choline intake was 198mg/d. This intake is considerably lower than the AI, despite habitual consumption of eggs that in the current study supplied 33·4% of the choline intake. However, as with the assessment of dietary iodine intake, dietary choline intakes are likely to have been underestimated owing to the incompleteness of the dietary database.

When interpreting the results of the present survey, the biases associated with conducting dietary surveys must be acknowledged; most notably, under-reporting and the use of standard portion sizes to estimate weights of food consumed. In our study the lack of data on pre-pregnancy weight, combined with the use of an estimated PAL[53], will have influenced the determination of BMR and, subsequently, the calculated cut-off for under-reporting. Therefore, we might have underestimated under-reporting and it is not possible to state conclusively that subjects above the cut-off level determined for under-reporting were actually achieving their energy and/or nutrient requirements. It is also conceivable their levels of under-reporting could have been underestimated owing to reluctance among subjects to report foods accepted as inappropriate during pregnancy, such as alcohol. It is also impossible to state if some foods regarded as being 'healthy' were over-reported. Nevertheless, the levels of under-reporting observed are plausible based on one other study in pregnant women[54] and within the range observed in other studies which used more objective measures to assess energy requirements [55,56]. Consequently, we believe the findings are likely to be an accurate reflection of misreporting in this group.

In the absence of biochemical indices of micronutrient status, adequacy of micronutrient intakes was judged against UK dietary recommendations. To reduce the inaccuracies associated with estimating nutritional inadequacy, statistical methods were used to estimate the usual distribution of intakes based on the observed intakes. The variety of foods generally available for consumption in the Seychelles is limited compared with Western societies. This lack of variability may have reduced reporting errors and improved accuracy in assessment of nutrient intake. In addition, piloting and feasibility studies were undertaken in Seychelles prior to initiation of the current dietary survey[27] and adjustments were made to reflect usual dietary intakes. However, while every effort was made to collect accurate records of food intake, the value of the intake data is currently constrained by the lack of comprehensive food composition data.

In conclusion, despite reports of a decline in fish consumption, the Seychellois population had a weekly average (SD) fish intake of 527 (327) g. This intake is almost four times greater than those observed in the UK[57]. Fat intakes were higher than previously reported [26] and in most subjects exceeded the UK DRV for fat as a percentage of energy intake for both total (<35 %) and saturated (<10 %) fat. Indeed, macronutrient intakes in pregnant women in Seychelles were similar to intakes reported among pregnant women in the UK[45]. These findings are reflective of a move towards a more Western-type diet and the emergence of an increased prevalence or risk factors for CHD in the Seychelles[26]. Our observation that fish consumption was significantly higher in the subset of subjects who met nutrient recommendations for Fe, Zn, iodine and Se is an important finding and highlights the critical role of fish in ensuring optimal dietary intakes of key micronutrients during pregnancy. Furthermore, as a source of protein in the Seychellois diet, fish was equivalent to meat but without the associated higher energy and fat content. These findings are of vital public health importance to the Seychellois and emphasise the necessity in maintaining current levels of fish consumption in this population. However, the overall trend towards a lower consumption of fish could become problematic in the future. These findings suggest caution in establishing public health policies that promote limiting fish intake during pregnancy to reduce exposure to methyl-mercury. Such policies may result in concomitant decreases in important micronutrient intakes and increased energy and fat intakes. Emphasis on the benefits of fish consumption should, therefore, be prioritised.

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Table 1

Observed nutrient intakes in pregnant Seychellois women including (*n* 273) and excluding under-reporters (*n* 164)

	Estimated dietary intake (*n* 273)				Estimated dietary intake (subjects above cut-off for under-reporting*; *n* 164)				
	Mean	**SD**	**Median**	**P5, P95**	**Mean**	**SD**	**Median**	**P5, P95**	***P* value†**
Energy (MJ/d)	9·0	2·5	8·9	5·0, 13·4	10·4	2·0	10·2	7·8, 14·6	0·000
Energy (kcal/d)	2149	597	2120	1206, 3197	2474	486	2417	1858, 3470	0·000
Fat (g/d)	87·2	27·7	84·1	47·6, 137·2	101·1	24·8	96·7	68·0, 146·8	0·000
Fat (%)	36·5	4·8	36·3	28·8, 44·0	36·6	4·8	36·3	29·1, 45·1	0·607
Saturated fat (g/d)	34·8	12·3	33·5	16·3, 57·5	40·3	11·6	37·7	24·2, 63·4	0·000
Saturated fat (%)	14·5	2·8	14·5	10·2, 19·2	14·6	2·8	14·6	10·2, 19·4	0·709
CHO (g/d)	277	83	268	153, 405	319	71	310	230, 475	0·000
CHO (%)	48·1	5·7	48·6	37·8, 56·8	48·1	5·4	48·6	37·8, 56·3	0·987
NMES (g/d)	54·9	29·2	52·0	15·7, 107·4	64·30	30·2	60·7	23·7, 120·5	0·001
NMES (%)	9·6	4·7	9·0	3·5, 18·1	9·8	4·1	9·1	3·6, 18·1	0·744
Protein (g/d)	82·2	24·0	81·3	46·0, 128·4	93·6	21·0	92·7	62·0, 132·1	0·000
Protein (%)	15·4	2·2	15·4	12·0, 19·4	15·2	2·0	15·1	12·0, 19·1	0·288
Fibre (g/d)	10·5	4·0	10·8	4·1, 20·0	12·2	3·6	11·7	7·0, 17·9	0·000
Vitamin A (μg/d)	588	713	376	150, 2011	675	776	437	200, 2354	0·241
Vitamin C (mg/d)	144	77	133	45, 265	169	78	161	58, 290	0·001
Vitamin B_1 (mg/d)	1·3	0·4	1·2	0·6, 2·0	1·4	0·4	1·3	0·9, 2·1	0·000
Vitamin B_2 (mg/d)	1·6	0·7	1·52	0·7, 2·8	1·9	0·7	1·8	1·0, 2·9	0·000
Niacin (mg/d)	16·5	5·8	16·2	8·1, 26·8	18·6	5·4	18·0	11·4, 28·7	0·000
Vitamin B_6 (mg/d)	1·8	0·6	1·8	0·9, 2·8	2·1	0·5	2·0	1·5, 2·9	0·000
Vitamin B_{12} (μg/d)	5·5	3·0	4·7	2·4, 11·2	6·3	3·1	5·5	2·9, 12·1	0·009
Folate (μg/d)	230	91	218	42, 113	259	86	237	156, 475	0·001
Choline (mg/d)	208	81	204	93, 370	229	79	221	111, 387	0·009
Ca (mg/d)	948	389	916	388, 1671	1104	376	1061	548, 1764	0·000
Mg (mg/d)	234	74	232	119, 360	272	63	264	183, 386	0·000
Fe (mg/d)	9·5	3·1	9·1	5·0, 15·5	10·9	2·7	10·6	7·2, 15·9	0·000
Cu (mg/d)	1·2	0·4	1·2	0·6, 1·9	1·4	0·4	1·3	0·9, 2·1	0·000
Zn (mg/d)	8·6	2·6	8·4	4·6, 13·1	9·9	2·2	9·7	6·4, 13·9	0·000

	Estimated dietary intake (*n* 273)				Estimated dietary intake (subjects above cut-off for under-reporting*; *n* 164)				
	Mean	**SD**	**Median**	**P5, P95**	**Mean**	**SD**	**Median**	**P5, P95**	***P* value†**
Iodine (μg/d)	134	57	123	56, 237	151	53	141	76, 249	0·002
Se (μg/d)	79·3	26·4	77·4	39·9, 129·4	89·3	25·0	85·6	48·3, 135·7	0·000

P5, 5th percentile; P95, 95th percentile; CHO, carbohydrate; NMES, non-milk extrinsic sugars.

*Cut-off points for under-reporting were calculated as described by Goldberg *et al.*(33).

†$P < 0{\cdot}05$ indicates a significant difference in dietary intakes between all subjects (*n* 273) and those who did not under-report (*n* 164).

Table 2

Comparison of adjusted mean intakes of energy and nutrients with UK DRV for the whole group (*n* 273) and after excluding under-reporters (*n* 164) in pregnant Seychellois women

	Adjusted intake (*n* 273)				% below EAR		% below RNI	
	Mean	**SD**	**UK RNI**	**UK EAR**	**Whole group (*n* 273)**	**Above cut-off for under-reporting (*n* 164)**	**Whole group (*n* 273)**	**Above cut-off for under-reporting (*n* 164)**
Energy (MJ/d)	8·9	2·2		8·9*†	50·2	24·4		
Energy (kcal/d)	2071	21						
Fat (g/d)	85·9	23·0						
Fat (%)	36·3	4·1		35 (DRV)	38·1	39·6		
Saturated fat (g/d)	32·7	5·5						
Saturated fat (%)	15·0	0·7		10 (DRV)	8·4	14·0		
CHO (g/d)	274	74						
CHO (%)	48·2	5·0		50 (DRV)	60·8	59·8		
NMES (g/d)	47·0	3·6						
NMES (%)	8·51	0·62		10 (DRV)	97·1	97·6		
Protein (g/d)	81·2	20·5	51				9·9	0·6
Protein (%)	15·4	2·0						
Vitamin A (μg/d)	506	413	700*				86·8	84·8
Vitamin B_1 (mg/d)	1·2	0·5	0·9*				16·9	26·2
Vitamin B_2 (mg/d)	1·6	0·6	1·4*				41·0	25·6
Vitamin B_6 (mg/d)	1·8	0·5		13 (μg/g protein)	0·0	0·0		
Vitamin B_{12} (μg/d)	5·2	1·9		1·25	0·0	0·0		
Vitamin C (mg/d)	138	59	50*	25			2·4	0·0
Folate (μg/d)	224	70	300*	150			91·2	84·8
Choline (mg/d)	198	49	450†		100	100		
Ca (mg/d)	931	340		525	11·0	1·2		
Mg (mg/d)	232	66		200	31·1	9·8		
Fe (mg/d)	9·4	2·6		11·4	80·6	69·5		
Cu (mg/d)	1·2	0·3	1·2				53·6	31·7
Zn (mg/d)	8·5	2·2	7·0	5·5	8·4	0·0		

	Adjusted intake (*n* 273)				% below EAR		% below RNI	
	Mean	SD	UK RNI	UK EAR	Whole group (*n* 273)	Above cut-off for under-reporting (*n* 164)	Whole group (*n* 273)	Above cut-off for under-reporting (*n* 164)
Iodine (μg/d)	130	47	140				62·9	50·6
Se (μg/d)	77·6	20·2	60				20·2	9·1

DRV, Dietary Reference Value (a term used to cover all intakes, including RNI and EAR); RNI, Reference Nutrient Intake (appropriate for 97 % of the population); EAR, Estimated Average Requirement (appropriate for 50 % of the population); CHO, carbohydrate; NMES, non-milk extrinsic sugars.

*Available recommendations for pregnancy have been used; otherwise recommendations for women are for the age group specified.

†US Adequate Intake for pregnancy.

‡Last trimester only.

Table 3

Contribution of food groups to nutrients important in cognitive development in pregnant Seychellois women

	Consumers		Fe intake		Iodine intake		Se intake		Choline intake		Zn intake	
Food group	***n***	**% of population**	**% contribution**	**mg/d**	**% contribution**	**µg/d**	**% contribution**	**µg/d**	**% contribution**	**mg/d**	**% contribution**	**mg/d**
Bread and rolls	267	97·8	14·3	1·4	3·8	5·2	28·2	22·9	5·8	12·3	6·1	0·5
Breakfast cereals	136	49·8	5·6	1·1	2·1	5·7	0·5	0·8	0·8	3·4	2·6	0·4
Meats	269	98·5	11·7	1·1	4·7	6·4	12·1	0·7	16·6	35·1	22·3	1·9
Fish and fish products	268	98·2	8·1	0·8	13·8	18·7	26·0	21·1	22·8	48·4	5·1	0·4
Crustaceans and molluscs	39	14·3	0·3	0·2	0·5	4·4	1·9	10·4	0·1	1·0	0·6	0·4
Potatoes and potato products	198	72·5	1·5	0·2	0·6	1·0	0·3	0·3	9·7	2·0	1·1	0·1
Vegetables excluding potatoes	273	100·0	22·7	2·2	2·7	3·6	2·2	1·8	5·1	10·6	8·4	0·7
Biscuits, cakes and puddings	220	80·6	5·3	0·6	3·1	5·1	0·7	0·7	1·8	4·5	2·3	0·3
Sweets, snacks and added sugar	262	96·0	1·7	0·2	0·9	1·2	0·3	0·2	1·0	2·1	0·9	0·1
Fruit and fruit juices	260	95·2	7·2	0·7	2·7	3·8	0·9	0·8	3·4	7·4	2·9	0·3
Eggs and egg dishes	240	87·9	6·2	0·7	12·2	18·6	4·3	3·9	36·7	87·0	4·7	0·5
Milk, cream, yoghurt and ice cream	268	98·2	2·1	0·2	36·4	49·8	4·2	3·4	1·3	2·9	15·7	1·4
Cheese	231	84·6	0·5	0·1	4·8	7·6	2·4	2·3	1·2	3·0	4·5	0·5
Spreading fat, lard and oils	270	98·9	0·7	0·1	0·6	0·8	0·1	0·1	0·2	0·4	0·3	0·0
Alcoholic drinks	38	13·9	0·2	0·2	0·0	0·0	0·0	0·2	0·2	3·7	0·2	0·1
Non-alcoholic drinks (excluding water)	271	99·3	2·7	0·3	1·6	2·2	0·2	0·1	0·3	0·7	0·9	0·1
Rice	271	99·3	4·8	0·5	8·5	11·5	14·3	11·5	0·0	0·01	18·7	1·6
Other cereals and pasta	124	45·4	2·0	0·4	0·1	0·3	1·2	2·0	1·3	6·0	1·7	0·3
Other foods (including nuts, herbs and sauces)	272	99·6	2·1	0·2	1·0	1·3	0·2	0·2	0·6	1·2	1·2	0·1