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Association of the maternal experience and changes in adiposity measured by BMI, waist:hip ratio and percentage body fat in urban Brazilian women

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The aim of the present study was to determine the association between the maternal experience and changes in adiposity measured by BMI, percentage body fat (PBF) and waist:hip ratio (WHR). In a cross-sectional study, 203 women were recruited at health care and educational facilities in Brasilia, Brazil. These women were divided into three groups: fifty-three nulliparous (no full-term pregnancy); sixty-three primiparous (one full-term pregnancy); eighty-seven multiparous (two or more full-term pregnancies). Socio-economic, behavioural, reproductive and dietary data were collected. All the women were measured for weight, height, skinfold thicknesses and waist and hip circumferences. Analysis of covariance was used to measure the differences among the three groups in relation to BMI, PBF and WHR, controlling for the following covariates: age; socio-economic status; use of oral contraceptives; smoking; energy intake level; cooking oil intake; physical activity level; lactation score; parity. The three groups of women differed significantly for BMI ($P = 0{\cdot}04$), PBF ($P = 0{\cdot}0008$) and WHR ($P = 0{\cdot}0001$). Multiparous women presented higher BMI ($P = 0{\cdot}01$) and PBF ($P = 0{\cdot}03$) compared with primi- and nulliparous groups. PBF was also associated with age and high socio-economic status. Primi- and multiparous women showed a higher WHR than nulliparous women ($P < 0{\cdot}0001$). Age and smoking habit were also factors associated with higher WHR.

Pregnancy: Adiposity: BMI: Waist:hip ratio

Maternal obesity is not a new condition (Sheldon, 1949) and medical literature has recorded that women often refer to pregnancy as the main cause of their obesity (Mullins, 1960; Bradley, 1985; Lean *et al.* 1989; Öhlin & Rössner, 1990). However, a cause-and-effect relationship between the maternal experience and weight gain has proved difficult to establish due to a large number of possible confounding factors. During the present decade more attention has been paid to this period of physiological fat accretion (Öhlin & Rössner, 1990, 1994, 1996; Smith *et al.* 1994; Ness, 1995; Rössner & Öhlin, 1995; Sohlström & Forsum, 1995; Björkelund *et al.* 1996; Harris *et al.* 1997*a*,*b*; Wolfe *et al.* 1997), and some evidence indicates that the maternal experience may be a critical period for the establishment of weight gain and obesity in young women (Harris & Ellison, 1997).

Weight gain and central distribution of adiposity are related to increased health risks of dislipidaemia, non-insulin-dependent diabetes mellitus, hypertension and CHD (Lapidus *et al.* 1984; Manson *et al.* 1990, 1993; Huang *et al.* 1998; Martins *et al.* 1998). Identification of groups of individuals susceptible to weight gain is important for public health intervention, since this group is more prone to obesity and associated comorbidities (Garrow, 1981).

Brazil has been through a nutrition transition, with profound modifications of lifestyle and dietary habits associated with urbanisation (Monteiro *et al.* 1995). Since 1989 there has been a dramatic shift towards weight gain especially among poor Brazilian women (Monteiro *et al.* 1995). Results from the Brazilian III Demographic and Health Survey conducted in 1996 showed that obesity in women is now an important issue, as 25·2 % of women of reproductive age (15–49 years) are overweight (BMI $\geq 25\ kg/m^2$) and 9·3 % are obese (BMI $\geq 30\ kg/m^2$; Coitinho, 1998). There is still very limited information available concerning the factors contributing to the high prevalence of obesity in women in Brazil. Our objective was to determine the association between the maternal

Abbreviations: EI, energy intake; PBF, percentage body fat; TEE, total energy expenditure; WHR, waist : hip ratio.
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experience (gestation and lactation) and changes in adiposity measured by BMI, percentage body fat (PBF) and waist : hip ratio (WHR) in a sample of urban Brazilian women, controlling behavioural and demographic factors. Part of this work has already been briefly reported (Da Costa & Rodrigues, 2000).

Material and methods

Subjects

Women included in the present study were healthy non-pregnant, between 18 and 43 years of age and reported no clinical or behavioural conditions such as diabetes mellitus, hypertension, cancer, twin births, in treatment for obesity or broad fluctuations in food intake. Participation of human subjects in the present study was approved by the Ethical Committee of the Faculty of Health Sciences, University of Brasilia. After presentation of the study objectives and formal consent from the volunteers, the protocol was followed, or another close date was organised for the interview and anthropometric measurements. All women who had completed a pregnancy were examined at 12–15 months post-partum. The women (*n* 203) were recruited and divided according to parity into three groups: eighty-seven multiparous women with two or more complete pregnancies (38–42 weeks gestation); sixty-three primiparous women with one complete pregnancy; fifty-three nulliparous women with no history of complete pregnancy.

Recruitment sites

The study was conducted in Brasilia, a modern and planned city, where residents have higher incomes. The city is surrounded by small satellite cities. The population in the satellite cities are predominantly of low income and work in Brasilia, using its education and health services. Brasilia has only one public university and one university hospital, both of which receive a large proportion of the population from the surrounding area in search of quality health and education services. Primi- and multiparous women were recruited at the outpatient paediatric clinic during the follow-up consultation for their child at the university hospital, and of a nearby public health centre of the local health authority. Nulliparous women were recruited at two public education centres and at the University of Brasilia. These recruitment sites were chosen because they were close to the University of Brasilia. Recruitment also included personnel who work or study at the University of Brasilia or the university hospital and live in the city of Brasilia, in order to have a more representative sample of the population of Brasilia. Volunteers were accepted for participation in the study according to their order of arrival at these sites. The sample was not biased, as we followed the order of arrival and the weekdays on which data were collected were randomised throughout the period of collection. Care was taken to finalise the three groups with women of the same age range and socio-economic status. Recruitment extended from April 1996 to April 1998. A 6-month pilot study was carried out in October 1995.

Study design and methods

A cross-sectional study design was adopted to investigate the association between reproductive history and changes in adiposity. Standardised questionnaires were developed to obtain detailed socio-demographic, behavioural, reproductive and dietary information.

Demographic data. The first part of the questionnaire asked for information on the date of birth, address, race, marital status, education, profession and occupation of the woman, and for women who had completed a pregnancy, the profession, present occupation and years of education of the father of the child. Each woman was asked to indicate the range of family income, which was divided into five levels, based on the national minimal wage (R$ 151·00 or US$ 83·80). Information on the number of children, with respective ages, and the number of adults living in the household was also obtained. Classification of women into either low or high socio-economic level was based on the information obtained about the family income (with a cut-off point at five times the national minimum wage), in association with a careful analysis of all other demographic information and the presence of commodity goods in the household such as refrigerator and/or freezer.

In a partial report of the present study (Da Costa & Rodrigues, 2000), marital status was considered in the analysis of covariance (see later, p. 112), but as it did not reach statistical significance, it was removed from the final analysis.

Health and reproductive history. The second part of the questionnaire requested information about the woman's health and reproductive history. Women were asked about any known pathologies, use of drugs or medical prescriptions, use of oral contraceptive, vitamin supplements and smoking. Physical activity was classified into four levels according to programmed physical exercise and occupational activities: (1) sedentary; (2) regular physical exercise <4 h/week; (3) regular physical exercise >4 h/week; (4) heavy physical activity or competitive sport (Heitmann *et al.* 1995). Questions about reproductive history included the number of full pregnancies and/or abortions, date of birth, gender and duration of lactation (months) for each child. From the data on duration of lactation, a simple scoring system was established (adapted from the work of Öhlin & Rössner, 1990), assigning the following number of points per month for each month of breast-feeding: <1 month, 0 1–5 months 2, 6 months 3, 7–8 months 4, 9–11 months 5, ≥ 12 months 6. A range of 0–72 points could therefore be obtained by each mother per child. The mean lactation score was then calculated by taking the total number of points obtained divided by the number of children. The mean lactation score was used in the analysis as a rough estimate of the total energy expenditure for milk production.

Dietary information. The third part of the questionnaire consisted of dietary information. Two sets of questionnaires were developed to record food intake by 24 h recall and by food frequency. The food-frequency questionnaire was adapted from that used for the study reported by Sichieri & Everhart (1998) for the Brazilian population. Food items included in the list represented major contributors to energy

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intake as carbohydrates, fats and beverages. Frequency of consumption was recorded by d, week or month as well as 'never' and 'almost never'. Data on food intake were obtained by the authors or by trained undergraduate students of nutrition who participated in the project. All 24 h recall and food-frequency questionnaires were closely supervised by one of the authors (mainly M.L.C.F.R.). A combination of dietary assessment methods has been shown to assure better accuracy of dietary information for young women (Sawaya *et al.* 1996).

At the end of the 24 h recall questionnaire we included a question designed to indicate whether the data represented habitual intake or whether it represented an atypical intake (i.e. a weekend or party day). To estimate the amount of cooking oil used during the preparation of meals we obtained information on the amount of oil consumed per month and the number of members of the family or household eating the meals. Children ≤ 10 years of age were considered to have half the intake of an adult. The individual daily oil intake was expressed as ml/person per d.

Energy intake (EI) was calculated by computer using the Sistema de Apoio à Nutriçâo program version 2.5 (Centro de Informàtica de Saude, Sao Paulo, Brazil). Additional energy values for foods not represented were obtained from the manufacture's food labels or from recipes. We obtained the weight (g) of total carbohydrate, protein and fat in the diet and calculated the energy value by multiplying by 16·7 kJ (4 kcal)/g, 16·7 kJ (4 kcal)/g and 37·7 kJ (9 kcal)/g respectively. Total energy was calculated as the sum of the three values.

We divided the EI into categories from the estimation of total energy expenditure (TEE). The equations of the Food and Agriculture Organization/World Health Organization/ United Nations University (1985) based on gender, age and body weight were used to estimate BMR. To correct for the presence of under- or overweight individuals in the sample, we considered the ideal body weight of each women as height $(m)^2 \times 22$ (Keys *et al.* 1972). TEE was calculated by multiplying BMR by the average daily physical activity level (1·56, 1·64 and 1·82 for sedentary, moderate or heavy physical activity respectively). A further 2·1 MJ (500 kcal)/d Food and Agriculture Organization/World Health Organization/United Nations University (1985) was added to the TEE for all women who were breast-feeding. Mean TEE was 9·40 (SD 1·1) MJ (2246 (SD 257) kcal)/d for the whole sample. The cut-off values were calculated as mean and 1 SD. The levels of EI (MJ) were then established as: 1, $\leq$8·2, 2, 8·3–9·3, 3, 9·4–10·4, 4, $\geq$10·5. Women were first classified into one of the four levels of EI according to the value for EI calculated from the 24 h recall, and then classified according to the frequency of intake of the energy-rich food items. The two sets of information were combined and the level of EI adjusted to give a final level of EI for each woman. The dietary data analysis and the adjustment of the EI level were performed blindly for parity, and revised independently by the two authors. This procedure allowed us to use a one-parameter statistical model which took into consideration the quantitative (24 h recall) and qualitative (food frequency) dietary information.

Anthropometry

Anthropometric measurements were performed in all women wearing light clothing and without shoes. For weight and height the procedure described by Jelliffe (1966) was followed. The weight measurements were performed on the same set of digital scales. All scales were periodically checked for precision (Soehnle 7306; Soehnle, Germany and Filizola, São Paulo, Brazil). Weight was measured to the nearest 0·1 kg. Height was obtained using a Microtoise tape (Stanley, London, UK) to the nearest 0·1 cm. BMI was calculated as weight divided by height^2 (kg/m^2). For the purpose of the present study we adopted the World Health Organization (1998) classification of body weight in adults according to BMI (kg/m^2): normal weight 18·5–24·9; overweight 25·0–29·9; obese $\geq$30·0.

We chose not to obtain pre-pregnant weight through recall as it would have been more difficult to rely on the information, especially for multiparous women for whom the period of recall would be greater. It was impossible to obtain medical records of weight before pregnancy for the sample studied.

Skinfold measurements were performed on the right side of the body at the following sites: triceps; subscapular; suprailiac, thigh. Thus, two measurements were obtained for both the upper and lower body. Measurements were taken to the nearest 0·2 mm with a Harpender calliper (CMS Weighing Equipment, London, UK) and the average of the two readings recorded. A third reading was taken if a difference of more than 1 mm was obtained and the two closest readings were averaged. The equations of Durnin & Womersley (1974) were used to estimate body density and the equation of Siri (1961) was used to calculate PBF.

Waist circumference was measured midway between the lowest rib margin and the iliac crest, where the smallest measurement was obtained using a tape measure. Hip circumference was measured at the widest point between the iliac crest and buttock. All circumferences and skinfold thicknesses were measured with the subject standing. WHR was calculated as waist circumference divided by hip circumference.

All anthropometric measurements were performed independently by the authors. Measurements were shared evenly between the two anthropometrists among the parity groups, and data collection was performed according to a pre-established schedule. Intra- and inter-observer evaluation was conducted in a subset of subjects (n 21). In this sample measurements were randomized by the observers. High inter-observer correlation was found in relation to skinfold ($r > 0·95$, $P < 0·0001$) and circumference ($r = 0·99$, $P < 0·0001$) measurements. There were no statistical differences with respect to intra-observer measurements.

Statistics

Analysis of covariance was used to evaluate mean differences in adiposity measured by BMI, PBF and WHR among the three groups. Maternal age, socio-economic status, oral contraceptive use, smoking, lactation score, physical activity level, EI level, cooking oil intake and parity were included as covariates in the model.

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Table 1. Demographic, behavioural, dietary and anthropometric characteristics of nulli-, primi- and multiparous urban Brazilian women*
(Mean values with their standard errors; other values represent the no. of subjects in each category)

Variables	Nulliparous (*n* 53) Mean	SE	Primiparous (*n* 63) Mean	SE	Multiparous (*n* 87) Mean	SE
Demographic						
Age (years)	25·4	4·8	25·4	5·0	28·3	5·5
Socio-economic status: High	21		15		17	
Low	32		48		70	
Behavioural						
Physical activity level: L	38		59		84	
M	6		3		2	
I	9		1		1	
Lactation score (points)	0		43·6	3·8	45·4	2·2
Oral contraceptive use: Yes	12		35		30	
No	41		28		57	
Smoking: Yes	2		7		19	
No	51		56		68	
Dietary						
Energy intake level†: 1	24		20		27	
2	21		22		34	
3	5		8		14	
4	3		13		12	
Cooking oil intake (ml)	17·4	9·3	24·9	14·2	26·0	14·0
Energy intake (MJ)	6·6	2·2	8·2	2·8	7·4	2·9
Protein (% total energy)	15	3·4	14	4·0	14	4·8
Fat (% total energy)	38	8·1	36	9·3	36	8·1
Carbohydrate (% total energy)	47	9·3	51	11·2	50	10·6
Anthropometric						
Body weight (kg)	54·7	8·3	54·8	8·9	57·8	9·8
Height (m)	1·58	0·07	1·57	0·06	1·57	0·06
BMI (kg/m^2)	21·8	2·9	22·1	3·7	23·6	3·6
Total body fat (%)	27·2	4·6	26·0	5·6	28·2	5·5
Waist circumference (cm)	69·0	6·4	73·7	8·1	76·6	8·1
Hip circumference (cm)	93·0	14·0	92·7	7·1	95·5	7·7
WHR	0·73	0·05	0·79	0·05	0·80	0·05

L, light; M, moderate; I, intense; WHR, waist : hip ratio.
* For details of procedures, see p. 108.
† Energy intake level (MJ): 1 ≤8·2, 2 8·3–9·3, 3 9·4–10·4, 4 ≥10·5; for details of classification, see p. 109.

Statistical analysis was performed using Statistical Analysis Systems software package version 6.04 (SAS Institute Inc., Cary, NS, USA). $P < 0{\cdot}05$ was considered to be significant.

Results

Demographic, behavioural, dietary and anthropometric characteristics of the three groups are presented in Table 1. Women enrolled in the present study were mostly young, with 66 % of the sample being between 19 and 28 years of age. They were mainly low socio-economic status (>60 %), were non-smoking (>75 %) and had a sedentary physical activity level (>70 %). Very few women in the primi- and multiparous groups reported a moderate or intense physical activity level. Some nulliparous women reported being more active with 11·3 % and 17 % of the nulliparous sample reporting moderate or intense physical activity respectively. Use of oral contraceptive pills was more frequent among primiparous women (55 %), while the majority of nulli- (77 %) and multi- (66 %) parous women did not use this method of contraception.

On average women had a BMI within the normal range (Table 1) but with a tendency to a higher BMI with increasing parity. PBF was ≤28·2 % in all groups. Primi- and multiparous women showed a larger waist circumference and consequently a greater WHR. EI levels 1 (≤8·2 MJ) and 2 (8·3–9·3 MJ) were predominate in all groups (%): nulliparous 85; primiparous 67; multiparous 70. Intake of cooking oil was about 70 % higher for primi- and multiparous women than for the nulliparous group. Nulliparous women had the lowest average EI and the percentage of dietary energy from the different macronutrients were typical of a Western diet; higher in fat (>35 % total EI) and proportionally lower in carbohydrates (<55 % total EI). The majority of the women examined were from a lower-income urban population.

Analysis of covariance controlling for the covariates presented in Table 2 shows that the three groups of women differed significantly for BMI ($P = 0{\cdot}04$), PBF ($P = 0{\cdot}0008$) and WHR ($P = 0{\cdot}0001$; full model). There were significant increases in BMI ($P = 0{\cdot}01$) and PBF ($P = 0{\cdot}03$) with multiparity (Table 3) and an inverse association between BMI and PBF and EI level ($P = 0{\cdot}02$). PBF was significantly higher for women with a higher socio-economic status ($P = 0{\cdot}02$; Table 3) and was significantly associated with age ($P = 0{\cdot}007$; Table 2).

Primi- and multiparous had significantly higher WHR ($P = 0{\cdot}0001$), which was associated in the model with age ($P = 0{\cdot}03$) and smoking ($P = 0{\cdot}01$). There was a borderline statistical significant ($P = 0{\cdot}06$) association with socio-economic status (Table 2). Primi- and multiparous

Table 2. Analysis of covariance for body mass index (BMI), percentage body fat (PBF) and waist : hip ratio (WHR) in urban Brazilian women

	BMI		PBF		WHR	
Model	F	*P*	F	*P*	F	*P*
Full model	1·85	0·04*	2·90	0·0008*	8·86	0·0001*
Age	0·13	0·71	7·27	0·007*	5·03	0·03*
Socio-economic status	0·91	0·34	5·23	0·02*	3·65	0·06
Oral contraceptive agent	0·10	0·76	0·03	0·87	1·47	0·23
Smoking	1·59	0·21	1·51	0·22	6·35	0·01*
Energy intake level	2·86	0·04*	2·72	0·04*	0·87	0·46
Cooking oil intake	0·05	0·83	0·07	0·79	0·33	0·56
Physical activity level	0·12	0·88	1·42	0·24	1·03	0·36
Lactation score	0·97	0·33	1·49	0·22	0·26	0·61
Parity	6·34	0·002*	3·55	0·03*	16·09	0·0001*
R^2	0·11		0·17		0·38	

* *P* values which reached significance.

women had significantly higher WHR than nulliparous women ($P = 0{\cdot}0001$; Table 3). Smoking was associated with a higher WHR (0·80) compared with non-smoking women (0·77, $P = 0{\cdot}01$; Table 3).

Discussion

The present work has shown a significant association between changes in body mass and body fat distribution in a sample of urban Brazilian women after the maternal experience. The present study shows for the first time, in Brazilian women, that an increase in parity is related to central fat distribution after adjustment of the covariates known to influence an increase and distribution of body fat.

There are some methodological limitations in a study with a cross-sectional design. These include systematic biases associated with recall of dietary intake, environmental and behavioural data. There might also be intrinsic differences that are difficult to control for between women who have been through the maternal experience compared with nulliparous women. There is also the lack of information on pre-pregnant body weight, as there were no systematic records of weight and height that could be referred to. The comparison of the adiposity changes in women of reproductive age was performed in a sample recruited from a population who use the medical and educational services of the University of Brasilia and facilities of the nearby region. Hence, the data reported in the present study cannot be said to be a true representation of the mean change in adiposity in women of reproductive age living in the Brasilia area. In this case, the interpretation of the results can be used only to identify possible associations between weight change and the maternal experience, and should be extrapolated with caution. The present work is important in the context of Brazilian women, for whom there is very limited information regarding the maternal experience and adiposity changes, and it is only recently it has started to be investigated.

The results obtained appear to indicate that the first pregnancy is an important factor in determining changes in the distribution of adiposity. Other studies have also shown a change in body fat distribution measured by WHR (Tankelaar *et al.* 1990; Smith *et al.* 1994) or triceps:subscapular skinfold thickness (Ness, 1995) in different racial groups, including black and white Americans (Smith *et al.* 1994), Hispanic women living in the USA (Ness, 1995), Dutch women (Tankelaar *et al.* 1990) and Swedish women (Björkelund *et al.* 1996). The majority of the Brazilian population has a mixed racial background, which makes classification of race difficult. For the sample studied, race was classified as predominantly black or white, although for fifteen women race predominance could not be exactly defined (nine multiparous and six primiparous). In a previous analysis (results not shown) race was considered as one of the covariates, but was not significant for any of the variables studied (BMI $P = 0{\cdot}13$, PBF $P = 0{\cdot}15$, WHR $P = 0{\cdot}36$), and was therefore removed from the analysis. WHR was also associated with age and smoking, with higher WHR among smoking women. The increase in central fat distribution associated with smoking has been described previously in male subjects (Seidell *et al.* 1991).

Table 3. Comparison by least square means of body mass index (BMI), percentage body fat (PBF) and waist : hip ratio (WHR) according to parity, socio-economic status, smoking status, and energy intake level in urban Brazilian women*

	BMI	PBF	WHR
Covariates	Mean	Mean	Mean
Parity			
Nulliparous	20·5[a]	26·3[e]	0·74[g]
Primiparous	22·0[a]	27·2[e]	0·81[h]
Multiparous	23·4[b]	29·1[f]	0·81[h]
Socio-economic status			
Low	21·7	26·6[c]	0·79
High	22·2	28·5[d]	0·78
Smoking			
No	22·4	28·2	0·77[a]
Yes	21·5	27·0	0·80[b]
Energy intake level (MJ)			
1 (≤8·2)	23·0[c]	29·0[c]	0·79
2 (8·3–9·3)	22·6[c]	28·6[c]	0·79
3 (9·4–10·4)	20·7[d]	26·0[d]	0·78
4 (≥10·5)	21·5[d]	26·7[d]	0·77

[a,b,c,d,e,f,g,h] Mean values within a column and covariate category with unlike superscript letters were significantly different: [a,b]$P = 0{\cdot}01$, [c,d]$P = 0{\cdot}02$, [e,f]$P = 0{\cdot}03$, [g,h]$P = 0{\cdot}0001$.

* For details of procedures, see p. 108.

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The results obtained in the present study show that BMI was significantly higher ($P = 0.01$) in multiparous women. It has recently been shown that there is a mean weight gain of 0·9 kg/year after the first pregnancy in Brazilian women (Coitinho, 1998). In the extensive review published by Harris & Ellison (1997) on the causes of weight gain in women who have completed at least one pregnancy, they show an average gain of 0·9–3·3 kg following pregnancy when compared with non-pregnant controls, and this gain persists after control for a number of socio-behavioural confounders. Certainly, it is difficult to isolate parity from other behavioural factors associated with maternity in women. Populational studies on weight trends that have controlled for parity have shown a positive association between weight gain and parity (Smith *et al.* 1994; Wolfe *et al.* 1997).

Data on the estimation of PBF from skinfold thickness values in primi- and multiparous women are scarce in the literature. Sohlström & Forsum (1997) have measured a small (2·5 %) decrease in PBF after 12 months post-partum in a sample of eleven women followed from before pregnancy. Brewer *et al.* (1989) have measured large decreases in total fat content in mothers of lower parity only during the first 3 months post-partum. In our sample, nulli- and primiparous women did not significantly differ in PBF, but multiparous women presented a significant increase in PBF after age, socio-economic status and EI level were controlled for. The observed association between PBF and WHR with age in the statistical model stresses the need to control for this variable, as PBF and WHR are known to increase with age (Forbes, 1994). Hence, the measured increases in PBF and WHR with increased parity were significant (Table 2) after age was controlled for in the analysis of covariance.

The macronutrient intakes of women enrolled in the present study (Table 1), with fat >35 % total energy and carbohydrate ≤50 % total energy, depict what has been termed a nutrition transition (Popkin, 1994; Drewnowski & Popkin, 1997), with decreasing intakes of complex carbohydrate and fibre and increasing intakes of total fat, saturated fat and sugar. The increase in fat in the diet has been associated with an increase in obesity worldwide (Weststrate, 1995; Golay & Bobbioni, 1997; Bray & Popkin, 1998). We have measured the intake of cooking oil, which may contribute to the increase in the energy density of diets. The increase in energy density has been claimed as an important factor affecting weight control and obesity (Poppitt, 1995; Poppitt & Prentice, 1996; Bell *et al.* 1998; Drewnowski, 1998). In the regression analysis the higher cooking oil intake for primi- and multiparous women did not reach statistical significance, presenting a smaller impact in the model comparison. However, the contribution of the increase in vegetable oils in the diet, although not significant in a cross-sectional type of study, might have adverse effects if it is a long-lasting and persistent dietary behaviour. We are not aware of any other work which has estimated cooking oil consumption among primi- and multiparous women.

Estimation of total energy through recall procedures has been shown to be a source of bias towards underestimation of dietary intake, especially for overweight women (Lichtman *et al.* 1992). The problems faced in the assessment of dietary intake are important and considered to be one of the fundamental obstacles preventing the collection of accurate habitual dietary intake data (Macdiarmid & Blundell, 1998). We have observed underestimation of EI among women of higher BMI and PBF. This finding might reflect a tendency for overweight women to record less than the actual food intake, the frequent presence of cycling behaviour of lower food consumption in an attempt to reduce being overweight, and other socially-related pressures which favour under-reporting of food intake (Macdiarmid & Blundell, 1998). A similar behavioural pattern, i.e. lower measured EI for overweight women, was reported in a longitudinal study conducted to analyse determinants of weight gain and overweight in adult Finns (Rissanen *et al.* 1991). The tendency to under-report in the present study was independent of the parity group, since the mean EI:BMR$_{estimated}$ was 1·22 (SE 0·42), 1·38 (SE 0·53) and 1·50 (SE 0·53) for nulli-, primi- and multiparous women respectively. A value of 1·55 × BMR is used as the energy requirement for a sedentary lifestyle and 1·35 × BMR is the lowest value given for habitual energy intake of an individual compatible with a normal (not bed-bound) lifestyle (Black *et al.* 1991).

Physical activity levels were not associated with adiposity change in the statistical analysis. Sedentary behaviour was predominant in all groups, a pattern associated with urbanisation and modern society (Prentice & Jebb, 1995). For primi- and multiparous women there are additional changes in lifestyle due to maternity commitments which have been shown to favour inactivity and weight retention (Rössner, 1992; Harris & Ellison, 1997).

For the group studied, lactation did not protect primi- and multiparous women from adiposity change. The mean lactation score was similar and high for primi- and multiparous women, showing that women lactated for an average of 7·5 months. In fact a number of other studies have also recognised that lactation may not protect urban women from weight gain and may even promote weight increase (Rookus *et al.* 1987; Dugdale & Eaton-Evans, 1989; Dorea, 1997; AbuSabha & Greene, 1998) and abdominal cell size increase (Björkelund *et al.* 1996), a result consistent with the measured increase in WHR. Physiologically, lactation is a period of increased nutritional requirement for milk synthesis and secretion (Food and Agriculture Organization/World Health Organization/United Nations University, 1985). In general, it is considered that exclusive and persistent lactation may promote fat mobilisation and weight loss if it extends for a period of more than 3 months (Brewer *et al.* 1989; Öhlin & Rössner, 1990; Dewey *et al.* 1993). However, the fat-mobilising effect of lactation may be overcome by an increase in energy intake or energy density and the reduced level of physical activity observed in urban women. This possibility requires further investigation.

In conclusion, our results appear to indicate that the maternal experience is associated with an increase in total body weight, body fat and central accumulation of body fat in this sample of urban Brazilian women. Although these increases were below the health-risk cut-off points, the results show that primi- and multiparous women are at increased risk of becoming obese. Women undergoing the

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maternal experience (gestation and lactation) should receive advice from health professionals in order to prevent initiation of obesity. We suggest that close attention be paid to the lactation period, when appropriate nutritional and physical activity counselling should be given which favours return to the prepregnancy weight.

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