Public Health Nutrition: 15(1), 116–125 doi:10.1017/S1368980011001182

The association between body shape silhouette and dietary pattern among Mexican women

Isabelle Romieu[1,2,*†], María C Escamilla-Núñez[2], Luisa M Sánchez-Zamorano[2], Ruy Lopez-Ridaura[2], Gabriela Torres-Mejía[2], Elsa M Yunes[2], Martin Lajous[2], Juan A Rivera-Dommarco[2] and Eduardo Lazcano-Ponce[2]

[1]International Agency for Research on Cancer, Lyon, France: [2]Instituto Nacional de Salud Pública, Av. Universidad # 655, Col. Santa María Ahuacatitlán, C. P. 62100, Cuernavaca, Morelos, Mexico

Submitted 5 October 2010: Accepted 14 April 2011: First published online 30 August 2011

Abstract

Objective: To investigate the relationship between dietary patterns and self-perceived body shape silhouette and BMI in a sample of Mexican women.
Design: A cross-sectional analysis of dietary habits from baseline data of a large cohort study (EsMaestra) conducted in 2006–2008.
Setting: The state of Veracruz, Mexico.
Subjects: Mexican teachers (*n* 20 330) provided information on body shape silhouette at baseline, changes in body shape silhouette and BMI, as well as information on sociodemographic variables and lifestyle.
Results: The median BMI was 26·8 kg/m^2; 43 % of women were overweight and 24 % were obese. The carbohydrates, sweet drinks and refined foods pattern was associated with a greater risk of having a large silhouette and a large BMI (BMI ≥ 30·0 kg/m^2 *v.* BMI < 25·0 kg/m^2; OR_{T1-3} = 1·86, 95 % CI 1·56, 2·22 and 1·47, 95 % CI 1·28, 1·69, respectively) with a significant trend when comparing the first and third tertiles of intake. The fruit and vegetable pattern was associated with a lower risk of having a large silhouette and a large BMI (OR_{T1-3} = 0·68, 95 % CI 0·57, 0·82 and OR_{T1-3} = 0·77, 95 % CI 0·67, 0·88, respectively) with a significant decreasing trend. Similar results were observed when change in silhouette (from 18 years of age to current silhouette) was considered.
Conclusions: High intakes of carbohydrates, sweet drinks and refined foods are related to larger silhouettes. Public health intervention improving access to healthy dietary guidelines, healthy food choice in the work place, promotion of physical activity and regulation of beverages with a high sugar content and of refined foods should be considered.

Keywords
Dietary pattern
Obesity
Body shape silhouette
Mexican women

Lifestyle and dietary habits in the Mexican population have changed dramatically in the past 20 years, reflected in an increased prevalence of overweight and obesity in both urban and rural adult populations – from 33·4 % in 1988 to 59·6 % in 2000 (Mexican National Health and Nutrition Survey[1]) and to 71·9 % in 2006[2]. This represents a 41 % and 160 % increase in prevalence of overweight and obesity, respectively, in just a decade[3]. Among adults, obesity is more prevalent among women than among men. In 2006, 36·9 % of women were obese (BMI ≥ 30·0 kg/m^2), whereas only 23·5 % of men belonged to the obese group[3]. A total of 35·1 % of Mexican adult women are estimated to be at risk for excessive carbohydrate intake and 12·6 % are deemed to be at risk for excessive fat intake[4]. In women over 60 years of age, overweight and obesity rates are even higher – approximately 40 % are overweight and 35·5 % are obese – and a high prevalence of hypertension and diabetes is observed[5]. Moreover, it appears that Mexicans have genetic susceptibility to insulin resistance and to altered carbohydrate and lipid metabolism[6]. It is therefore important to determine dietary factors that are most strongly associated with obesity in this population to provide public awareness and prevention strategies.

Assessment of dietary patterns is an approach that analyses intakes of specific foods in the context of the whole diet[7] and may be of particular interest to public health, providing a basis to make recommendations for eating practices that prevent disease. Several dietary patterns have been previously defined and associated with chronic diseases[8–13]; dietary patterns are culturally

† Dr Romieu's actual position belongs to International Agency for Research on Cancer.

*Corresponding author: Email iromieu@correo.insp.mx

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https://doi.org/10.1017/S1368980011001182 Published online by Cambridge University Press

defined, however, and differ between ethnically diverse populations. There exist very few data on dietary patterns associated with obesity in the Mexican population. Recently, Carrera *et al.*[14] evaluated data from the National Health and Nutrition Examination Survey (NHANES) on a small subsample of 659 Mexican-American adults without identifying a specific dietary pattern associated with obesity in this population.

Body shape silhouette is a promising tool to examine body size and image. Studies conducted in different countries have shown that the simple use of silhouette could adequately rank individuals according to body size[15–18]. In a study conducted in Mexico, a very good correlation (0·77) was observed between BMI and classification of body shape silhouette among adult women[19]. This approach has special value in large populations for which anthropometric measurements cannot be obtained.

As part of a large follow-up study of Mexican women to investigate the role of diet and lifestyle in the risk for chronic diseases, the association of self-perceived body shape silhouette and BMI with dietary patterns was evaluated. The dietary pattern most strongly associated with obesity and the usefulness of self-perceived body silhouette as proxy for body size in epidemiological studies were also assessed.

Methods

Study population

The source population for the present study consisted of a cohort of female teachers from the public education system who were aged ≥35 years and who were active members of the Federal and State level Ministry of Education's Economic Incentives Program called 'Magisterial Career' (MC). Using databases provided by the MC state programmes, we obtained the full name and place of work for active participants in the MC programme, identifying a total of 27 456 female teachers who met the age inclusion criterion (≥35 years old) in the state of Veracruz, a representative state of the Mexican population. These women work in 9699 different schools distributed across the entire geographical area, including urban and rural areas.

All 27 456 women were invited to participate in a cohort study to evaluate lifestyle and chronic disease incidence. In addition to being part of the MC programme and being ≥35 years of age, inclusion criteria included their consent to participate in the cohort study with planned long-term follow-up. The rationale for inviting MC programme participants was that MC members are highly motivated and trained individuals who are capable of responding to complex questionnaires in the setting of a developing country. Each potential participant received an invitation letter, a consent form, the baseline questionnaire, a promotional brochure and a fibreglass measuring tape in a personalized sealed envelope. Letters were sent through the state-level MC internal delivery network between 2006 and 2008. The questionnaire was self-administered, and women were asked to return the completed questionnaire to the National Institute of Public Heath in a return envelope provided, ensuring confidentiality. The protocol for the present study was approved by the Ethics Committee of the National Institute of Public Health, the Education Ministry, and the Health Ministry. A total of 20 258 questionnaires were returned, corresponding to a participation rate of 73·7 %. Respondents and non-respondents had a similar age distribution and were evenly distributed within the localities (with the exception of the city of Veracruz where respondents represented 15 % of the total sample and non-respondents represented 21 %). Among respondents, 18 875 questionnaires (93·2 %) had complete data on current silhouettes and anthropometric measures. The general characteristics of women did not differ between those who did and those who did not provide complete data on silhouette and anthropometric measures.

Baseline questionnaire

The questionnaire included general information on demographics, socio-economic status (SES; electrical appliance and car ownership, number of bedrooms and number of persons in the household), reproductive history and use of oral contraceptives, menopausal hormone therapy, clinical history, anthropometry, lifestyle (including an FFQ), physical activity (PA), smoking habits and early-life risk factors.

Anthropometry and silhouettes

Women were provided with a plastic measuring tape and a short set of instructions to measure their height, waist and hip circumference and weight. Waist-to-hip ratio (WHR) was determined from these measurements. BMI was calculated as weight in kilograms divided by the square of height in metres (kg/m^2).

In addition, women reported their weight at 18 years and the maximum weight attained at any age during their lifetime. Women were also asked to select a body silhouette from nine options (from very thin to very fat) at six different ages: 2 years after menarche, between 18 and 20 years of age, before their first pregnancy, between 25 and 35 years of age and at their current age. Responses to these pictograms have been validated in different settings and have proven to be reliable[20].

To validate the results reported on the questionnaire, 1000 women participating in the study were randomly selected and measured, weighed according to recommendations by Lohman *et al.*[21] and classified according to their body silhouette by a health professional during a clinical examination conducted in 2008. The reliability (concordance) of women reporting their silhouette when compared with that observed by a health professional

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was 0·70; the correlation between BMI based on weight and height reported on the questionnaire and that measured during the validation study was 0·90.

FFQ

Dietary intake was assessed using a semi-quantitative FFQ that included 116 food items with a standard portion size using the Mexican version of that developed by Willett[22]. This questionnaire has been validated and has been shown to perform well among women residing in Mexico City[23,24]. We added twenty-three food items to evaluate new food consumption patterns. The inclusion of these foods was based on the food reported in 24 h reports conducted as part of the Mexican National Health Survey[1]. For each food item, a commonly used unit or portion size was indicated (specified serving size: slice, glass or natural unit such as one apple) and participants were asked how often, on average over the previous year, they had consumed the specified amount of each food, choosing among ten frequencies of consumption: ≥6 times/d, 4–5 times/d, 2–3 times/d, 1 time/d, 5–6 times/week, 2–4 times/week, 1 time/week, 2–3 times/month, ≤1 time/month or never. Participants with an unreasonably high intake (>14 644 kJ (>3500 kcal)/d) or an unreasonably low intake (<2510 kJ (<600 kcal)/d) and those with more than seventy items left blank were excluded from the analysis (*n* 1752 or 9·3 %).

Physical activity

Women were asked to report a representative week in terms of the number of hours of mild, moderate and vigorous activity during work time, work at home or during recreational time on weekdays and weekends, as well as the number of hours of sleep. They were also asked to report the number of hours per week of watching television (TV). Specific definitions and examples were provided to the women on these different types of activities. Hours were summed to calculate the number of hours per week of mild, moderate and vigorous activity and to calculate MET-h/week (MET = metabolic equivalents), using the following coefficient to multiply the number of hours in each specific type of activity: mild (2·2), moderate (4·7) and vigorous (6·0).

Dietary pattern

Forty-eight food groups were defined (see Appendix) but only forty-six groups were included in the analysis because alcohol and atole (a Mexican drink) had an unsuitable distribution and a low consumption in our population. Food items were classified individually when their composition differed substantially from that of other foods or when they represented particular dietary habits, as mentioned by Hu[25].

Statistical analysis

Mean and SD were calculated for continuous variables, and frequencies were calculated for categorical variables. When the variable was not normally distributed, we used a transformation (in general, log transformation) to normalize the distribution. Categorical variables were compared using the χ^2 test, and continuous variables were calculated using the difference of mean tests. The SES index was calculated using factor analysis including the following variables: electrical appliance, car ownership, number of bedrooms and number of persons in the household. A single factor explained most of the variance. The SES factor was categorized into tertiles to define three levels of SES: low, medium and high.

Dietary pattern was defined using factor analysis as described earlier[25,26]. Factor analysis is a type of cluster analysis[27] that determines those features that are most important when classifying a group of items and that generates 'factor scores' representing values of the underlying constructs for use in other analyses[27]. In our context, this analysis allowed the grouping of individuals on the basis of food group intakes. Factors were rotated by orthogonal transformation (Varimax) to achieve simpler structures with greater interpretation. The number of factors retained was determined using a diagram for eigenvalues, the scree plot and the percentage of variance explained. Foods that loaded ≥0·30 were considered to contribute to the factor, although the value for meaningful loading is arbitrary and we included two foods in the second factor with a load of 0·28 (milk beverages) and 0·24 (milk). The factor score for each pattern was constructed summing observed intakes of the component food items weighted by factor loading. Three major dietary patterns were identified: (i) fruit and vegetables; (ii) meat and dairy; and (iii) carbohydrates, sweet drinks and refined foods. To reduce measurement errors and represent long-term dietary patterns, the cumulative average of pattern scores was calculated and then divided into tertiles.

Current silhouette was categorized into three groups by re-grouping the nine categories provided on the questionnaire: lean women silhouette, 1–3; medium, 4–6; and large, 7–9. For change in silhouette from 18–20 years to current age we also defined three groups: (i) women who did not change silhouette or who decreased silhouette; (ii) women who increased one or two silhouettes; and (iii) women who increased three or more silhouettes. For BMI we used cut-off points as follows: <25·0 kg/m^2, ≥25·0–<30·0 kg/m^2 (overweight) and ≥30·0 kg/m^2 (obese). For change in BMI from 18–20 years to current age, we categorized the difference into tertiles. Association of dietary pattern with current silhouette and change in silhouette and with current BMI and change in BMI was determined using logistic regression models, adjusting for potential confounders including age, socio-economic level, total energy intake, hours of watching TV and PA. Other potential confounders (marital status, smoking and parity) were not significant – they did not alter the results by >1 % – and were therefore not included in the final models. All analyses were conducted using the STATA statistical software package version 9·2 (StataCorp., College Station, TX, USA).

https://doi.org/10.1017/S1368980011001182 Published online by Cambridge University Press

Results

Population characteristics

Table 1 presents general and sociodemographic characteristics of the 18 875 women included in the analysis.

The mean age was 44 years in a range from 35 to 77 years. Most of the women lived with a partner. Approximately 12 % spoke a native language. Most of the women were non-smokers or former smokers and only 8·5 % reported being current smokers. The majority of women reported having one or two children with an age at first pregnancy between 16 and 39 years. Among teachers with children, 82·3 % reported breast-feeding. Women reported watching TV on average 5 h/week. PA was low; only 13·6 % reported some amount of vigorous PA (such as running or playing tennis). The mean moderate activity (such as playing volleyball, light bicycling, swimming, walking, dancing and home activities) was 6·7 (SD 3·2) h/week. In all, 74 % of women were premenopausal and 26 % reported natural menopause; 70 % of women reported living with a partner.

Table 1 Sociodemographic characteristics of women from Veracruz; EsMaestras Cohort Study, Mexico

Variable	*n**	%
Age category (years)		
35–40	5648	29·9
41–45	6816	36·1
46–50	3967	21·0
51–55	1623	8·6
56–60	595	3·2
>60	226	1·2
Socio-economic level		
Low	6218	34·6
Medium	5300	29·8
High	6275	35·3
Native language spoken		
No	16 489	88·5
Yes	2137	11·5
Smoking		
Never	12 324	67·5
Current	1557	8·5
Former	4372	23·6
Watching television (h/week)†	5·1	3·1
Physical activity (MET-h/week)†‡	24·9	13·6
Parity		
No pregnancy	1889	10·3
Number of live births (natural or Caesarean)		
1–2	9984	62·9
3–4	5457	34·4
≥5	436	2·8
Living with partner		
Yes	13 110	70·3
No	5544	29·7
Age at first pregnancy (years)†	24·8	4·8
<20	18	1·2
20–29	24·1	2·6
>29	33	2·9
Breast-feeding (months)§	10	6, 19
Menopausal status		
Premenopausal	13 447	73·8
Postmenopausal	4705	25·8

MET, metabolic equivalents.
*The total number for each variable shows some discrepancies because of different numbers of missing values.
†Data are presented as mean and SD.
‡On the basis of the number of hours of mild, moderate and vigorous activities during work time, work at home or during recreational time on weekdays and weekend days in a representative week, as well as the number of hours of sleep.
§Data are presented as median and 25th and 75th percentiles.

Table 2 presents anthropometric measurements. The median BMI was 26·8 kg/m^2 (25th percentile = 24·2, 75th percentile = 30·0); 67 % of women were either overweight (43 %) or obese (24 %). In addition, women who reported living with a partner were heavier than women who reported being single (69 % *v.* 31 % with BMI ≥ 30·0 kg/m^2; $P = 0{\cdot}000$).

Silhouette and change in silhouette

Overall, 34·3 % of women classified themselves as currently having a large body silhouette (7–9) and only 10·9 % as having a thin body silhouette (1–3). This contrasts with reports regarding body silhouette close to menarche, at which age 78·8 % of women reported a thin body silhouette and only 1·6 % reported a large body silhouette. A clear shift over time from a thinner to a larger silhouette was observed (Table 3, Fig. 1).

The majority of women increased silhouette from menarche to their current age, gaining up to three silhouettes over time. The change in silhouette from 18–20 years to current age was less, with the highest proportion of change corresponding to an increase of two silhouettes (25·7 %).

Dietary pattern and body silhouette

Foods most frequently consumed were tortilla and sweet breads, fruity and leafy vegetables (including tomato), rice and pasta, beans, fruit, milk, cereal, cream and butter. The fruit and vegetable pattern was composed mainly of fruit and vegetables, nuts and cereals. The meat and dairy pattern was composed mainly of meat, processed meat, fish, cream and butter, cheese and milk. The carbohydrates, sweet drinks and refined foods pattern was composed of tortilla and sweet bread, biscuits and pastry, rice and pasta, beans, jam and soft drinks. Table 4 displays factors for particular foods consumed in each of the three intake patterns.

Women with the highest (3rd tertile) intakes of carbohydrates, sweet drinks and refined foods were more likely to have a large body silhouette (7–9) when compared with women with the lowest intake (1st tertile; 1–3; $OR_{T1-3} = 1{\cdot}86$; 95 % CI 1·56, 2·22, test for trend $P = 0{\cdot}001$). In addition, women with the highest intakes of carbohydrates, sweet drinks and refined foods were more likely to have increased by ≥3 silhouettes from 18–20 years of age to current age ($OR_{T1-3} = 1.56$; 95 % CI 1·31, 1·85, test for trend $P = 0{\cdot}10$).

In contrast, women with the highest fruit and vegetable intakes were less likely to have a large silhouette ($OR_{T1-3} = 0{\cdot}68$; 95 % CI 0·57, 0·82) compared with women with the lowest intake, and to increase silhouette by ≥3 from 18–20 years of age to current age ($OR_{T1-3} = 0{\cdot}76$; 95 % CI 0·64, 0·90). Significant trends were observed for both outcomes.

https://doi.org/10.1017/S1368980011001182 Published online by Cambridge University Press

Table 2 Baseline anthropometric measurements of women from Veracruz; EsMaestras Cohort Study, Mexico

Anthropometrics	Median	5th percentile	95th percentile
Weight (kg)	65·0	50·0	89·0
Height (cm)	156·0	146·0	167·0
BMI (kg/m^2)	26·8	21·2	35·6
Overweight (25·0 ≥ BMI < 30·0 kg/m^2)*	27·2	25·2	29·7
Obesity (BMI ≥ 30·0 kg/m^2)*	32·8	30·1	40·4
Change of BMI: from 18 years to current	6·7	0·76	14·7
Change of silhouette: from 18–20 years to current	2·0	0·0	5·0

*Median and 5th and 95th percentiles are presented for women within this category of BMI.

Table 3 Self-perception of body image at baseline and at different ages for women from Veracruz; EsMaestras Cohort Study, Mexico

		Self-perception of body image (silhouette)		
		1–3	4–6	7–9
Lifetime	*n**	%	%	%
Two years after menarche	18 522	78·8	19·7	1·6
Between 18 and 20 years	18 530	66·7	31·1	2·2
Before first pregnancy†	16 260	56·6	40·3	3·1
Between 25 and 35 years	18 489	25·9	61·8	12·3
Current	18 875	10·9	54·8	34·3

*Some missing values.
†Only women with parity.

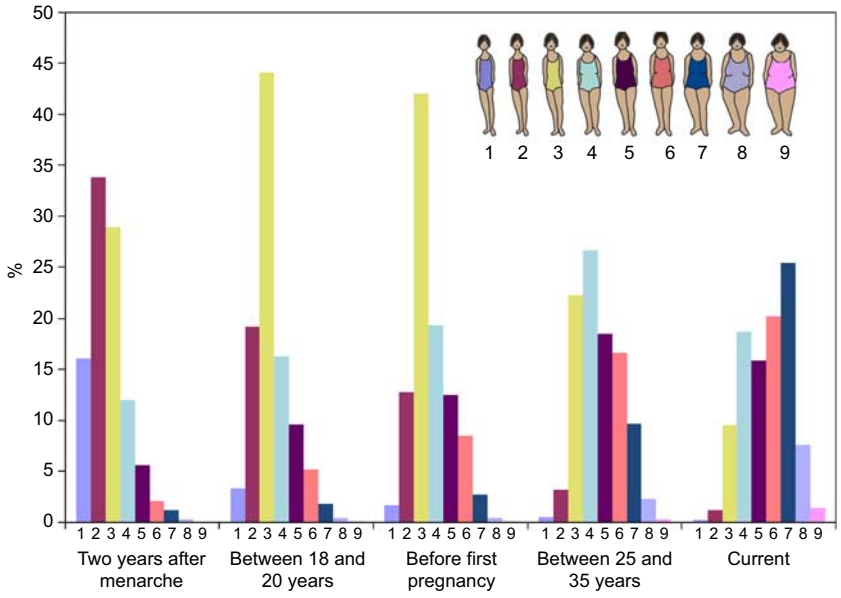

Fig. 1 (colour online) Frequency distribution of women from Veracruz by perceived silhouette at different ages; EsMaestras Cohort Study, Mexico

For the meat and dairy pattern, no significant relation was observed with current silhouette or change in silhouette (Table 5).

Dietary pattern and BMI

Women with the highest (3rd tertile) intakes of carbohydrates, sweet drinks and refined foods were also more likely to have a large BMI (≥30·0 kg/m^2 *v.* <25·0 kg/m^2) when compared with women with the lowest intake (1st tertile), with a significant increasing trend with increasing tertiles of intake (OR_{T1-3} = 1·47; 95 % CI 1·28, 1·69, test for trend P < 0·00). In addition, women with the highest intakes of carbohydrates, sweet drinks and refined foods were more likely to have a larger increase in BMI, with a significant increasing trend with increasing intake (OR_{T1-3} = 1·27; 95 % CI 1·11, 1·44, test for trend P = 001).

As observed for silhouette, women with the highest fruit and vegetable intakes were less likely to have a large

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Table 4 Factor-loading matrix for the major factors (dietary patterns) among women (*n* 19 705) from Veracruz; EsMaestras Cohort Study, Mexico

Foods or food groups	Factor 1	Factor 2	Factor 3
Fruity vegetables	0·81		
Carrots	0·76		
Other fruits	0·73		
Leafy vegetables (except cabbage)	0·64		
Fruits with β-carotene	0·61		
Potatoes	0·59		
Legumes	0·58		
Elote	0·58		
Cabbage	0·58		
Fruits with citric acid	0·58		
Orange juice	0·52		
Breakfast cereals	0·49		
Nuts	0·46		
Onion	0·43		
Waters	0·30		
Red meat		0·65	
Processed meat		0·61	
Fish		0·54	
Seafood		0·53	
Butter		0·51	
Cream		0·49	
Cheese		0·48	
Offal		0·48	
Fast food		0·47	
Ice cream		0·44	
Yoghurt		0·44	
Mexican food		0·43	
Semi-skimmed cheese		0·43	
Tuna and sardines		0·42	
Antojitos mexicanos		0·42	
Margarines		0·39	
Poultry		0·36	
Milk beverages		0·28	
Milk		0·24	
Cakes, pies, pastries			0·69
Junk food			0·59
Dry cakes, biscuits			0·53
Salty biscuits, aperitif biscuits			0·51
Bread			0·51
Pasta and rice			0·49
Chocolate			0·49
Tortilla			0·41
Gelatin			0·39
Coffee and tea			0·37
Chiles			0·37
Carbonated/soft/isotonic drinks			0·37

Factor 1, fruit and vegetables pattern; Factor 2, meat and dairy pattern; Factor 3, carbohydrates, sweet drinks and refined foods pattern.

BMI and to increase BMI between 18 years and current age, with a significant trend with increasing tertiles of intake ($OR_{T1-3} = 0{\cdot}77$; 95 % CI 0·67, 0·88 and $OR_{T1-3} = 0{\cdot}79$; 95 % CI 0·69, 0·90, respectively). No clear effect was observed for the meat and dairy pattern (Table 6).

Discussion

A dietary pattern characterized by high intakes of carbohydrates, sweet drinks and refined foods was significantly associated with current large body size and obesity. Significant trends were observed with increasing tertiles of intake. In contrast, a dietary pattern characterized by high intakes of fruit, vegetables, grains and nuts appears to protect against large body size and obesity. These patterns also appeared to be related to a change in silhouette over time.

The prevalence of obesity and overweight is increasing in the Mexican population[28] and this trend is made apparent by comparing national nutritional surveys conducted over the past 20 years. Overweight and obesity affect approximately 70 % of the Mexican population aged between 30 and 60 years for both sexes, with a greater percentage of obesity (approximately 32 %) among women (BMI ≥30·0 kg/m^2). In our study, women from the state of Veracruz were included for strategic reasons: Veracruz had been the first state to be included in our teachers' cohort. In all, 61 % of the teachers were either overweight (39 %) or obese (22 %). The National Nutrition and Health Survey 2006[2] is a cross-sectional survey conducted on a representative sample of the Mexican population and included objective anthropometric measurements among other evaluations (*n* 33 624 participants, among whom 9848 women were ≥20 years old). In that study, the median BMI was 26·8 kg/m^2, similar to our results[4,28].

High intakes of carbohydrates, sweet drinks and refined foods were strongly related to larger silhouettes and BMI. Although we were able to measure only current diet, our results also suggest that this dietary pattern was related to an increase in silhouette and BMI over time. This pattern was highly weighted by fast-absorbed carbohydrates (simple carbohydrates), in particular sugar-sweetened soft drinks, which are major contributors to energy intake and have been associated with high body fat and increased weight gain in other populations[14,29]. The expert committee in charge of developing the beverage consumption recommendations for the Mexican population has observed that beverages contribute to one-fifth of all energy consumed by Mexicans and are strongly related to obesity. Among the biggest contributors are beverages high in sugar and low in nutritional value (soft drinks and other beverages with significant amounts of added sugar, such as juices, flavoured water, coffee and tea)[30].

In our population, an intake pattern rich in fruits, vegetables and cereals was associated with a thin figure, low BMI and the smallest change in silhouette and gain in BMI over time. Other studies have observed that a 'prudent pattern' with high intakes of fruit and vegetables is negatively associated with higher BMI[31]. In prospective settings, Newby *et al.* reported an association of a diet high in reduced-fat dairy products, whole grains and fruit and low in refined grains, processed and red meat, fast food and soda with smallest gain in BMI and waist circumference[11,32].

Two recent studies have evaluated dietary patterns in Mexican Americans and identified differences among them. In the NHANES 2001–2002, which included 659 Mexican-American adults, four dietary patterns were identified: poultry and alcohol, milk and baked products, traditional Mexican food and meat. None of these patterns

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Table 5 Association of current silhouette and change in silhouette with dietary patterns in women from Veracruz; the EsMaestras Cohort Study, Mexico

	Dietary pattern*			
	Low (tertile 1)	Moderate (tertile 2)	High (tertile 3)	*P* value†
Current silhouette		Fruit and vegetables pattern		
Largest (7–9) *v.* thinnest (1–3)				
OR	1·00	0·92	0·68	0·000
95 % CI		0·80, 1·07	0·57, 0·82	
		Meat and dairy pattern		
Largest (7–9) *v.* thinnest (1–3)				
OR	1·00	1·07	1·06	0·876
95 % CI		0·93, 1·24	0·90, 1·24	
		Carbohydrates, sweet drinks and refined foods pattern		
Largest (7–9) *v.* thinnest (1–3)				
OR	1·00	1·43	1·86	0·001
95 % CI		1·24, 1·64	1·56, 2·22	
Change of silhouette		Fruit and vegetables pattern		
Change of ≥3 silhouettes *v.* no change or decreased silhouette				
OR	1·00	0·99	0·76	0·000
95 % CI		0·86, 1·14	0·64, 0·90	
		Meat and dairy pattern		
Change of ≥3 silhouettes *v.* no change or decreased silhouette				
OR	1·00	1·15	1·21	0·443
95 % CI		1·00, 1·32	1·04, 1·42	
		Carbohydrates, sweet drinks and refined foods pattern		
Change of ≥3 silhouettes *v.* no change or decreased silhouette				
OR	1·00	1·37	1·56	0·100
95 % CI		1·19, 1·58	1·31, 1·85	

All models were adjusted for age, socio-economic level, total energy intake, hours spent watching television and physical activiy in MET-h/week (MET = metabolic equivalents).
*Data are presented as multivariate OR and 95 % CI.
†Test for trend.

Table 6 Association of current BMI and change in BMI with dietary pattern in women from Veracruz; the EsMaestras Cohort Study, Mexico

	Dietary pattern*			
	Low (tertile 1)	Moderate (tertile 2)	High (tertile 3)	*P* value†
Current BMI		Fruit and vegetables pattern		
≥30·0 kg/m^2 *v.* <25·0 kg/m^2				
OR	1·00	0·92	0·77	0·003
95 % CI		0·83, 1·03	0·67, 0·88	
		Meat and dairy pattern		
≥30·0 kg/m^2 *v.* <25·0 kg/m^2				
OR	1·00	1·08	1·05	0·702
95 % CI		0·96, 1·20	0·93, 1·19	
		Carbohydrates, sweet drinks and refined foods pattern		
≥30·0 kg/m^2 *v.* <25·0 kg/m^2				
OR	1·00	1·15	1·47	0·000
95 % CI		1·03, 1·29	1·28, 1·69	
Change in BMI‡		Fruit and vegetables pattern		
Highest tertile of BMI change *v.* the lowest tertile				
OR	1·00	0·95	0·79	0·001
95 % CI		0·85, 1·05	0·69, 0·90	
		Meat and dairy pattern		
Highest tertile of BMI change *v.* the lowest tertile				
OR	1·00	1·06	1·15	0·127
95 % CI		0·96, 1·17	1·02, 1·29	
		Carbohydrates, sweet drinks and refined foods pattern		
Highest tertile of BMI change *v.* the lowest tertile				
OR	1·00	1·06	1·27	0·001
95 % CI		0·95, 1·17	1·11, 1·44	

All models were adjusted for age, socio-economic level, total energy intake, hours spent watching television and physical activity in MET-h/week (MET = metabolic equivalents).
*Data are presented as multivariate OR and 95 % CI.
†Test for trend.
‡Tertiles of BMI: −4·9–4·8 kg/m^2; >4·8–8·3 kg/m^2 and >8·3–30·5 kg/m^2.

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was specifically related to obesity. The traditional Mexican pattern had a high percentage of energy from tortillas, tacos, flavoured and sweetened drinks and legumes. Surprisingly, no 'healthy' pattern group was identified in this population. The small sample size and assessment of dietary intake based on 24 h recall may explain the lack of significant findings. That analysis with NHANES data as well as ours observed low levels of leisure-time PA. In another study conducted among women living in southwestern USA, including 871 Hispanic women and 1599 non-Hispanic women, five dietary patterns were determined: Western, native Hispanic, prudent, Mediterranean and dieter. The native Hispanic pattern was heavily loaded with Mexican cheese, soups, meat, legumes, tomato sauce and sugar-sweetened drinks. Although not significant, the highest tertile of a native Mexican diet was related to a 64 % increased risk of being obese (95 % CI 0·83, 3·18) and the highest tertile of a prudent diet was related to a decreased risk of being obese (OR = 0·54; 95 % CI 0·29, 1·03). Although these results are concordant with ours, the small sample size of Mexican women might have limited the ability of the study to detect significant associations[7]. A recently published study of data from the National Health Survey in Mexico has also observed in a sample of men and women that overweight and obesity are significantly related to a dietary pattern rich in refined foods and sweets[33].

Several issues need to be discussed. A limitation for interpretation of our results is the cross-sectional nature of our data. Current body silhouette and BMI were reported at the same time as dietary intake; hence, we cannot conclude causality. Heavy women might have gone through changes in dietary pattern to lose weight and may therefore report a diet different from their usual one. However, had this occurred, we would have found a positive association between obesity and the fruit and vegetable pattern, which is not the case. In addition, the consistency of the results using body silhouette, which women appear to underestimate, and BMI strengthens the validity of our results. Our results are consistent with the fact that intake of a diet high in carbohydrates, sweet drinks and refined foods is associated with obesity, whereas a diet rich in fruit and vegetables is protective against obesity. Another limitation is that because dietary intake was reported at baseline, misclassification might have occurred, in particular when considering diet over a long period of time, as in our analysis of change in silhouette. Although previous studies have shown a reasonable tracking of diet over time[34], we do not have data to confirm this in our population. However, our results suggest that dietary pattern may explain part of the change of body silhouette over time, given that random misclassification in dietary pattern would tend to underestimate the association.

The overall consistency of our observations with both body shape silhouette and BMI suggests that in our population women who follow the carbohydrates, sweet drinks and refined foods pattern have a risk factor for large body size and for an increase in body size over time. Body silhouette appears to classify individuals by body size well and hence could be used in epidemiological studies to study obesity and its determinants.

The present study included a large sample of Mexican women, using a validated FFQ to evaluate common diet, anthropometric measurements and self-reported body silhouette. Self-reported body silhouette had a good agreement with observed body silhouette in other studies[15–18]. In addition, the validation study showed good agreement between reported and measured BMI and perceived and observed body silhouettes. Must *et al.*[35] have shown good concordance between recalled and observed body silhouette. Although some misclassifications cannot be avoided, they would most likely be random because women were not influenced by their dietary pattern when reporting body silhouette at different ages. Among Mexican women, knowledge of dietary factors related to obesity is very limited. The association that we observed would therefore be underestimated.

Conclusion

The significant associations observed between a dietary pattern high in carbohydrates, sweet drinks and refined foods and larger body figures and BMI plus an increase in body figure and BMI over time, as well as the protective effect of a dietary pattern high in fruit and vegetables, strongly support the fact that a diet with a high glycaemic load (corresponding to the carbohydrate content of one serving multiplied by the glycaemic index value of that food) is a risk factor for obesity and weight gain in Mexican women. Such foods, in particular sugar-sweetened drinks, pastry and jam, should be restricted. This is particularly important because the intake of carbohydrates is high for the Mexican population (a mean daily carbohydrate intake of 357 g/d), accounting for 64 % of total energy intake[1], whereas the intake of fruit and vegetables is low (97 % of Mexican women consume $<$400 g/d). In addition, Mexicans appear to have a genetic susceptibility to insulin resistance and altered carbohydrate and lipid metabolism[6], with a potential for severe health consequences. As part of a weight-control programme, a decreased intake of quickly absorbed carbohydrates, sweet drinks and refined foods coupled with an increased intake of fruit and vegetables should be promoted along with PA. Several actions could be further developed: improving knowledge on food-based dietary guidelines for our population; providing healthy food choices within canteens and promoting PA such as walking to work and gym activity during lunch break; emphasizing on the responsibility of role modelling of teachers towards students; and supporting the regulation of refined foods, high sugar-sweetened foods and sweet drinks.

https://doi.org/10.1017/S1368980011001182 Published online by Cambridge University Press

Acknowledgements

The present study was supported by the American Institute for Cancer Research (Grant no. 05B-047) and by Mexican Sciences and Technology Council (CONACYT; Grant no. 2005-02-14429). The authors have no conflict of interest to declare. I.R. developed the protocol, obtained funding for the project and directed the data analysis and the writing of the manuscript; M.C.E.-N. participated in the protocol and in data collection; L.M.S.-Z. participated in data analysis; R.L. participated in the protocol, in coordination of data collection and in writing of the manuscript; G.T.-M. participated in the protocol and in interpretation of data; E.M.Y. participated in data collection and in standardization of the questionnaires; M.L. participated in the protocol and in interpretation of data; J.A.R.-D and E.L.-P. participated in the interpretation of data and in writing of the manuscript. All authors approved the final report. We are grateful to all participant teachers, who provided invaluable information for the study, for their time and commitment. We would like to thank the Federal *Coordinación Nacional de Carrera Magisterial* (Coordination Office of the Magisterial Career Program), with special thanks to Victor Sastré, Director of Regulation, Dolores Cruz and María del Carmen Placencia, coordinators from Veracruz and Jalisco States, as well as all their staff for their continued support. We thank also all educational and health authorities who have actively collaborated in the project.

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Appendix

Food or food groups	Food items
Fruity vegetables	Courgette, chayote, cucumbers, beet, courgette flower, green beans, tomato sauce, raw tomato, tomato, avocado, nopal
Leafy vegetables (except cabbage)	Spinach, lettuce, broccoli
Other fruits	Banana, apple, pear, plums, strawberries, pineapple, raisins, grapes, watermelon, mango, mamey, tuna, sapote, papaya, guava, jicama
Carrots	Carrots
Fruits with β-carotene	Peach, melon, mango
Potatoes	Potatoes
Legumes	Lentils, legumes
Elote	Elote
Cabbage	Cabbage
Fruits with citric acid	Oranges, grapefruit
Orange juice	Orange juice
Breakfast cereals	Breakfast cereal, high-fibre cereal, oatmeal
Nuts	Nuts
Onion	Onion
Pasta and rice	Pasta and rice
Gelatin	Gelatin or pudding
Fish	Skipjack, snapper, dried fish
Bread	White bread, sliced bread, whole-wheat bread, flour tortilla
Water	Flavoured water, natural water
Red meat	Sausage, beef, pork, beef jerky, chicharron
Processed meat	Bacon, sausage, ham, pork, turkey, ham, other sausage
Seafood	Shrimp, octopus
Butter	Butter, low-fat butter
Cream	Cream
Cheese	Manchego cheese, fresh cheese, non-specified cheese
Fast food	Hamburger, hot dog, pizza
Offal	Liver
Ice cream	Ice cream
Yoghurt	Yoghurt and danonino
Mexican food	Carnitas, barbacoa, birria, pancita, pozole
Semi-skimmed cheese	Cream cheese, Oaxaca cheese
Tuna and sardines	Canned tuna and sardines
Antojitos mexicanos	Tacos, torta, sope, tamal
Margarine	Normal margarine, low-fat margarine
Poultry	Chicken
Milk beverages	Yakult
Milk	Whole milk, skimmed milk, semi-skimmed milk, soya milk
Cakes, pies, pastries	Cake, sweet bread, cream cake, jam
Junk food	Chips, peanuts
Dry cakes, biscuits	Dry biscuits
Salty biscuits, aperitif biscuits	Salted biscuits
Chocolate	Candy bars, chocolate bars
Tortilla	Corn tortilla
Coffee and tea	Coffee and tea
Chilles	Salsa, canned chillies, dried chillies
Carbonated/soft/isotonic	Soft drinks, sweetened soft drinks, light soft drinks
Atole	Atole
Alcohol beverages	Beer, whisky, rum, brandy, wine, tequila, mezcal, aguardiente, pulque

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