

Excessive meat consumption in Brazil: diet quality and environmental impacts

Aline Martins de Carvalho¹, Chester Luiz Galvão César², Regina Mara Fisberg¹ and Dirce Maria Lobo Marchioni^{1,*}

¹Department of Nutrition, School of Public Health, University of São Paulo, Av. Dr. Arnaldo 715, São Paulo, CEP 01246-904, SP, Brazil: ²Department of Epidemiology, School of Public Health, University of São Paulo, São Paulo, SP, Brazil

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Abstract

Objective: To evaluate red and processed meat intake, and the impact meat consumption has on diet quality and the environment.

Design: A large cross-sectional health survey performed in São Paulo, Brazil.

Setting: Diet was assessed by two 24 h dietary recalls. Usual intakes were calculated using the Multiple Source Method. The World Cancer Research Fund recommendation of an average of 71.4 g/d was used as the cut-off point to estimate excessive red and processed meat consumption. To investigate the relationship between meat consumption and diet quality we used the Brazilian Healthy Eating Index Revised. The environmental impact was analysed according to estimates of CO₂ equivalent emissions from meat consumption.

Subjects: Brazilians (*n* 1677) aged 19 years and older were studied.

Results: The mean red and processed meat intake was 138 g/d for men and 81 g/d for women. About 81 % of men and 58 % of women consumed more meat than recommended. Diet quality was inversely associated with excessive meat intake in men. In Brazil alone, greenhouse gas emissions from meat consumption, in 2003, were estimated at approximately 18 071 988 tonnes of CO₂ equivalents, representing about 4 % of the total CO₂ emitted by agriculture.

Conclusions: The excessive meat intake, associated with poorer diet quality observed, support initiatives and policies advising to reduce red and processed meat intake to within the recommended amounts, as part of a healthy and environmentally sustainable diet.

Keywords

Red and processed meat
Food intake
Diet quality
Environmental impact

Meat is an important food item for human nutrition because it contains 20 to 40 % protein, and also minerals such as iron, zinc and selenium, and vitamins B₆ and B₁₂⁽¹⁾. The unsaturated and the conjugated fatty acids from meat may help prevent CVD⁽²⁾. However, excessive meat consumption leads to high intakes saturated fat, cholesterol, potentially carcinogenic substances such as heterocyclic amines and polycyclic aromatic hydrocarbons⁽³⁾ formed during the cooking process, and sodium and nitrite that are added in processed meats. Therefore excessive meat consumption has been linked to chronic diseases⁽⁴⁾ such as CVD, diabetes⁽⁵⁾, colorectal cancer⁽³⁾, weight gain and stroke^(6–8).

Excessive meat consumption has been negatively associated with diet quality in some countries^(6,9). In the USA, meat consumption has been a public health concern since late 1950s, when the American Heart Association released recommendations to prevent CVD⁽⁴⁾. Today, the World Cancer Research Fund (WCRF) recommends limited consumption (500 g/week) of cooked red meats

(beef and pork) and processed meats (cured, salted, smoked or containing chemical preservatives) for cancer prevention⁽³⁾. The Brazilian Ministry of Health recommends one serving of meat daily (100 g/d) for a healthy diet⁽¹⁾, but there are few studies evaluating meat intake in Brazil.

Livestock production already takes up 30 % of the world's useable land area and causes major impacts on the environment due to: deforestation for livestock grazing; emission of greenhouse gases by animals; water pollution by discharge of organic matter, pathogens, drug residues and antibiotics into lakes, rivers and seas; and loss of biodiversity⁽¹⁰⁾. Cattle-ranching is an important economic activity in Brazil. The country is one of the world's largest beef exporters⁽¹⁰⁾. However, this sector of the economy is the second-largest emitter of greenhouse gases in Brazil, mainly due to enteric fermentation by ruminant herbivores (one of the greatest sources of methane emissions in the country) and also due to handling of animal wastes⁽¹¹⁾.

Considering the possible deleterious effects of excessive meat consumption on human health and the environment, monitoring the production and consumption of meat is important to promoting healthy eating policies. The aim of the present study was to evaluate red and processed meat intake and also to assess the impact of this consumption on diet quality and the environment.

Experimental methods

Study design and participants

The data come from a cross-sectional population-based survey entitled 'Health Survey for São Paulo', conducted in 2003 (ISA-Capital 2003)⁽¹²⁾. A two-stage cluster sampling was used: census tracts and households. Census tracts were grouped into three strata based on the percentage of household heads with higher education. More details on sampling are available in Castro *et al.*⁽¹³⁾. In the present study, the final sample comprised 1677 individuals (both males and females): 847 adults and 830 elderly people.

Information about health, food intake and life conditions was collected in a representative sample of residents of the city of São Paulo, Brazil, by a structured questionnaire applied at participants' homes. This questionnaire concerning demographic (age, gender), socio-economic (family income, education level of the household head) and lifestyle characteristics (smoking, alcohol consumption) was administered by trained interviewers at the participants' homes.

A follow-up study was completed in 2007 with a second household dietary survey. The final sample comprised 486 individuals (both males and females): 195 adults and 291 elderly people. Loss in the sample was due absence in the house after three attempts, refusal and change of address.

The project was approved by the Ethics Committee of the School of Public Health, University of São Paulo.

Assessment of dietary intake

Dietary assessment consisted of two 24 h dietary recalls (24HR) adapted from Thompson and Byers⁽¹⁴⁾. Interviewers were trained on using standard forms for administering the 24HR and received a manual explaining how to fill it out, thus standardizing data collection. Data were collected in 2003 and in 2007 at participants' households, every day of the month for the period of a year.

The household measures reported were converted into grams and millilitres, according to Pinheiro *et al.*⁽¹⁵⁾ and Fisberg and Villar⁽¹⁶⁾. Recipes were broken down into ingredients to estimate the amount of meat in each preparation.

Data from the 24HR were entered into the Nutrition Data System for Research program version 5.0 (2007) developed by the Nutrition Coordinating Center, University of Minnesota (Minneapolis, MN, USA) and were converted to energy and nutrients (total fat, saturated fat, dietary fibre and vitamin C).

Definition of red and processed meat intake

The variable 'red and processed meat' was calculated using the sum of red meat (beef and pork) and processed meat (cured, salted, smoked or containing chemical preservatives).

The Multiple Source Method (MSM), a statistical modelling technique, was used to estimate the usual dietary intake of red and processed meat. This technique uses two 24HR and a probability of consumption^(17,18). The MSM calculates dietary intake for individuals first and then constructs the population distribution based on the individual data. Age group and date of interview were included as covariates of the model. All participants were considered daily meat consumers in MSM, because meat, especially red and processed meat, is consumed by almost all of São Paulo's population according to previous data^(19,20).

The WCRF maximum recommended intake of red and processed meat of 500 g/week, corresponding to an average of 71.4 g/d, was the cut-off point to estimate excessive red and processed meat intake⁽³⁾.

Diet quality

To investigate the relationship between meat consumption and diet quality, we used the Brazilian Healthy Eating Index Revised (BHEI-R)⁽²¹⁾. The BHEI-R evaluates a combination of different types of foods, nutrients and other components of the diet according to current dietary recommendations, especially the Brazilian Dietary Guidelines⁽¹⁾. The BHEI-R is similar to the Healthy Eating Index-2005⁽²²⁾ and comprises twelve components: nine are food groups expressed in terms of energy density (per 4174 kJ/1000 kcal: 'total fruits', 'whole fruits', 'total vegetables', 'dark green and orange vegetables and legumes', 'total grains', 'whole grains', 'milk and dairy', 'meat, eggs and legumes', 'oils'); two are nutrients (sodium and saturated fat); and the other is energy from solid fat, added sugars and alcohol (SoFAA). The maximum score for the first six components is 5, for the next five components is 10 and for the last component is 20. Intermediate scores are calculated proportionately. Thus, the final score of the BHEI-R ranges from zero to 100. The following components were analysed: SoFAA, total vegetables, whole fruits, whole grains, and milk and dairy.

Environmental impact

To evaluate the environmental impact caused by meat consumption, we estimated the amount of red and processed meat consumed by the population of São Paulo in 2003 (10 615 844 people)⁽²³⁾. Then, we estimated greenhouse gas emissions from total meat consumption, knowing that the production of 1 kg of Brazilian beef generates about 44 kg of CO₂ equivalents⁽²⁴⁾. There is no available information on the carbon footprint of pig and processed meat production in Brazil, so we used red and processed meat intake from beef production as proxy.

Statistical analyses

Mean values, 95% confidence intervals and proportions of participants who consumed red and processed meat were calculated considering the predicted usual intake distribution by MSM, adjusted by age group and year of interview, separated by sex.

Differences between means and proportions were analysed using the lincom test, which calculates point estimates using the *t* statistic and considers the weights from complex samples⁽²⁵⁾.

The association between energy intake, nutrient intakes and selected BHEI-R scores according to categories of red and processed meat consumption (moderate intake; high intake) was investigated by ANOVA.

For all analyses, the STATA statistical software package version 10 (2007) was used and $P < 0.05$ was considered statistically significant.

Results

Daily per capita consumption of red and processed meat was 106 g; 138 g for men and 81 g for women. Daily consumption of pork was 8 g, of beef was 73 g and of processed meat was 25 g (data not shown).

The average daily red and processed meat intake according to socio-economic, demographic and lifestyle variables is shown in Table 1.

The proportion of participants with high red and processed meat intake was 81% of men and 58% of women (Table 2). There were no significant differences according to the characteristics analysed, except that adult females had a higher proportion of high consumers than elderly women ($P < 0.05$; Table 2).

We also found that those who had high red and processed meat intake had higher intakes of energy, total and saturated fat, in both sexes (all $P < 0.01$). For men and women who consumed meat in excess, energy intake was respectively 1.4 times and 1.3 times higher; total fat intake was respectively 1.7 times and 1.5 times higher; and saturated fat intake was respectively 2.0 times and 1.6 times higher, compared with those who had moderate intake. Consumption of vitamin C and dietary fibre were not different among the groups (Table 3).

When we evaluated the BHEI-R score, it was significantly lower ($P < 0.01$) among males who had high intake of red and processed meat; that is, diet quality was inversely associated with excessive meat consumption among men (Table 3).

Scoring for SoFAA was significantly lower in men ($P < 0.01$) and women ($P < 0.05$) with high red and processed meat intake, showing that these individuals consumed more solid fat, added sugars and alcohol than the other participants. High consumption of red and processed meat was also negatively related to

Table 1 Usual red and processed meat intake (g/d) according to sex and socio-economic variables: Brazilian adults (n 1677) aged ≥ 19 years, São Paulo, 2003

	Males			Females		
	<i>n</i>	Mean	95% CI	<i>n</i>	Mean	95% CI
Age group						
Adult	347	143	138, 148	399	84	79, 88
Elderly	395	105	101, 109	421	64	60, 68
<i>P</i> *		<0.05			<0.05	
Education of household head						
≤ 7 years	436	135	128, 141	490	79	74, 85
≥ 8 years	298	142	135, 148	317	83	77, 88
<i>P</i> *		0.14			0.42	
Family income per capita						
Low income	202	131	122, 139	299	82	76, 88
Middle income	226	141	133, 150	234	83	73, 92
High income	254	139	132, 146	226	80	74, 86
<i>P</i> *		0.16			0.81	
Smoking						
Non-smoker	331	138	131, 145	572	78	74, 82
Smoker and ex	390	136	130, 142	226	87	78, 95
<i>P</i> *		0.42			0.06	
Alcohol consumption						
Did not drink for 1 year	299	133	127, 140	542	79	74, 84
Drinks at least twice a month	419	139	132, 145	251	85	79, 91
<i>P</i> *		0.26			0.14	
Race						
White	482	135	128, 141	551	83	78, 87
Other	258	143	135, 150	267	77	71, 84
<i>P</i> *		0.17			0.19	
Total	742	138	133, 142	820	81	77, 85

**P* value for *F* statistic (lincom test).

milk and dairy and positively related to total vegetables in women (both $P < 0.01$). Total fruit and whole grains did not show statistical difference among groups (Table 4).

The estimated amount of red and processed meat consumed by the population of São Paulo, in 2003, was about 410 727 tonnes. The production of this amount of meat released 18 071 988 tonnes of CO₂ equivalents into the environment, which represents 4.1% of the total CO₂ emitted by agriculture in Brazil in 2003.

Table 2 Proportion (%) of individuals with high daily red and processed meat intake according to sex and socio-economic variables: Brazilian adults (n 1677) aged ≥ 19 years, São Paulo, 2003

	Males (%)	Females (%)
Age group		
Adult	82	61
Elderly	77	41
<i>P</i> *	0.08	<0.05
Education of household head		
≤ 7 years	79	58
≥ 8 years	83	58
<i>P</i> *	0.46	0.99
Family income per capita		
Low income	73	57
Middle income	85	63
High income	84	56
<i>P</i> *	0.12	0.66
Smoking		
Non-smoker	80	55
Smoker and ex	81	65
<i>P</i> *	0.72	0.06
Alcohol consumption		
Did not drink for 1 year	79	57
Drinks at least twice a month	81	61
<i>P</i> *	0.61	0.41
Race		
White	80	61
Other	82	53
<i>P</i> *	0.67	0.16
Total	81	58

**P* value for *F* statistic (lincom test).

Discussion

The present study is one of the few representative surveys that estimate meat consumption in Brazil. The results show that meat is consumed almost universally in the city of São Paulo.

We observed that average meat intake exceeded the maximum intake limit recommended by the WCRF⁽³⁾ by 1.9 and 1.1 times for men and women, respectively. Similar results were observed elsewhere. In the UK, daily average consumption of red and processed meat is 78 g and 47 g for men and women, respectively; in Ireland, 94 g for men and 58 g for women; in Spain, 127 g for men and 68 g for women⁽²⁾; and in the USA, 116 g for men and 71 g for women⁽⁴⁾. What draws attention in our study is that meat consumption in São Paulo was even greater than in the USA, the world's largest beef consumer⁽⁴⁾.

Excessive consumption of red and processed meat is not considered healthy. It is known that processed meat intake of only 50 g/d is associated with 42% increased risk of CVD and 19% increased risk of diabetes⁽⁵⁾, and there is convincing evidence that meat increases the risk of colorectal cancer⁽³⁾.

In our study, excessive meat intake was related to poor diet quality in men, showing that meat consumption had a negative effect on the diet quality. It was also associated with higher energy intake from fats, added sugars and alcohol, and lower intake of milk and dairy in women. In Ireland, high processed meat consumption was also associated with lower intakes of wholegrain breads, fruits, vegetables and fish, and higher soft drinks consumption, when compared with no or little meat consumption⁽⁶⁾. In Japanese women, the ratio of fish to meat intake was positively associated with fruits, vegetables, milk and alcohol intakes, and negatively associated with soft drinks, fat and oil intakes, showing that those who consume less red meat have a healthier dietary pattern⁽⁹⁾.

Table 3 Average daily energy and nutrient intakes and diet quality according to level of red and processed meat consumption and sex: Brazilian adults (n 1677) aged ≥ 19 years, São Paulo, 2003

	Red and processed meat intake	Males				Females			
		<i>n</i>	Mean	95% CI	<i>P</i> *	<i>n</i>	Mean	95% CI	<i>P</i> *
Energy (kJ)	Moderate	142	7063	6368, 7761	<0.01	344	5632	5176, 6088	<0.01
	High	600	9636	9255, 10 012		476	7272	6912, 7632	
Energy (kcal)	Moderate	142	1688	1522, 1855	<0.01	344	1346	1237, 1455	<0.01
	High	600	2303	2212, 2393		476	1738	1652, 1824	
Total fat (g)	Moderate	142	52.3	45.0, 59.7	<0.01	344	46.3	41.3, 51.3	<0.01
	High	600	90.4	85.7, 95.0		476	71.0	66.6, 75.3	
Saturated fat (g)	Moderate	142	14.5	12.1, 16.9	<0.01	344	14.1	12.2, 16.0	<0.01
	High	600	28.8	27.1, 30.5		476	23.0	21.3, 24.8	
Dietary fibre (g)	Moderate	142	19.2	16.6, 21.7	0.66	344	13.0	12.1, 14.0	0.19
	High	600	18.5	17.5, 19.6		476	13.8	12.9, 14.6	
Vitamin C (mg)	Moderate	142	63.0	44.1, 82.0	0.57	344	64.3	33.6, 95.1	0.74
	High	600	71.1	50.8, 89.4		476	59.1	49.3, 68.9	
BHEI-R (score)	Moderate	142	59.6	57.9, 61.3	<0.01	344	57.9	56.2, 59.5	0.15
	High	600	54.4	53.3, 55.5		476	56.2	54.6, 57.8	

BHEI-R, Brazilian Healthy Eating Index Revised.

**P* value for *F* statistic (lincom test).

Table 4 BHEI-R components and overall BHEI-R score according to level of red and processed meat intake and sex: Brazilian adults (*n* 1677) aged ≥ 19 years, São Paulo, 2003

	Red and processed meat intake	Males			Females		
		Mean	95% CI	<i>P</i> *	Mean	95% CI	<i>P</i> *
SoFAA (max 20)	Moderate	13.2	12.0, 14.4		11.0	10.2, 11.8	
	High	8.8	8.0, 9.6	<0.01	9.2	8.2, 10.2	<0.05
Total vegetables (max 5)	Moderate	4.1	3.8, 4.4		3.8	3.5, 4.1	
	High	4.5	4.3, 4.6	0.06	4.5	4.3, 4.8	<0.01
Total fruits (max 5)	Moderate	1.7	1.2, 2.2		1.9	1.6, 2.1	
	High	1.4	1.2, 1.7	0.18	1.7	1.5, 2.0	0.51
Whole grains (max 5)	Moderate	0.3	0.1, 0.4		0.4	0.2, 0.5	
	High	0.3	0.2, 0.4	0.56	0.5	0.3, 0.6	0.37
Milk and dairy (max 10)	Moderate	3.7	2.9, 4.6		5.2	4.6, 5.8	
	High	3.2	2.9, 3.7	0.3	3.9	3.5, 4.4	<0.01
BHEI-R (range 0–100)	Moderate	59.6	57.9, 61.3		57.9	56.2, 59.5	
	High	54.5	53.3, 55.5	<0.01	56.2	54.6, 57.8	0.15

BHEI-R, Brazilian Healthy Eating Index Revised; SoFAA, energy from solid fat, added sugars and alcohol.

**P* values for *F* statistic (lincom test).

In the present study, excessive meat consumption was also associated with higher energy, total fat and saturated fat intakes; this might increase the risk of CVD and of being overweight, which are prevalent and high-costing diseases. In Brazil, the prevalence of overweight in adults is high, nearly 50%⁽²⁶⁾. In São Paulo, the latest figures released show that 44% of adults are overweight⁽²⁷⁾. In an European cohort study of more than 350 000 adults, a positive association between meat consumption and weight gain was noticed, even after adjustment for energy, dietary patterns, smoking and BMI⁽⁸⁾.

In addition to these health effects, meat production causes large impacts on the environment due to deforestation for livestock grazing, emission of greenhouse gases by animals, water pollution and biodiversity loss⁽²⁸⁾. We estimated that production of the amount of meat consumed in São Paulo in 2003 accounted for about 4% of the total greenhouse gases emitted by Brazilian agriculture that year⁽²⁹⁾.

If a car travelled between Brazil and Canada (9673 km), it would emit the same quantity of CO₂ as was released to supply the meat intake of one person in one year in São Paulo⁽³⁰⁾. Greenhouse gas emissions would have been almost 50% lower if meat consumption had not exceeded the maximum recommended by WCRF (71.4 g/d) in São Paulo.

Promoting dietary changes towards healthy eating is a challenging task, because the process of food choice is complex and driven by features beyond our knowledge, such as cultural, environmental and economic. Although meat is associated with increased risk of chronic diseases and is an expensive food item with complicated food market distribution logistics, it is highly consumed. On the other hand, intake of fruits and vegetables is very low despite their well-known beneficial effects of consumption⁽³¹⁾. This might illustrate how a food item is valued by the population in spite of its nutritional composition⁽³²⁾. This can happen because meat, especially red meat, has

cultural value. It is desired by people from different cultures and of varying degrees of economic development⁽³³⁾, making it especially attractive for consumption.

For successfully promoting healthy eating, a multi-disciplinary approach needs to be taken. Our results add evidence that public policies should focus on encouraging lower red and processed meat consumption in this population, so intake would be within the recommended range, therefore reducing the risk of chronic diseases and preventing environmental degradation.

Limitations

The ISA-Capital 2003 is a cross-sectional study in which we cannot determine causality of events, but by using a probability sample and being a population-based study, results can be extrapolated to the total population of São Paulo. The use of two 24HR allowed estimation of usual food intake but the period between assessment surveys (2003–2007) can be considered large, so one could argue that changes over time could lead to differential changes in eating patterns, as well as in within- and between-person variation. However, it is known that any adjustment gives less biased results than not adjusting distributions^(4,34,35).

Conclusion

The excessive meat intake, associated with poorer diet quality observed, support initiatives and policies advising to reduce red and processed meat intake to within recommended amounts, as part of a healthy and environmentally sustainable diet.

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