Symposium: Obesity in Developing Countries: Biological and Ecological Factors

Independent Effects of Income and Education on the Risk of Obesity in the Brazilian Adult Population[1]

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ABSTRACT With a view to assess the independent effects of income and education on the risk of obesity we studied cross-sectional randomly selected samples of the adult population (20 y and over) living in 1996/97 in the less (northeastern) and the more (southeastern) developed region of Brazil (1971 and 2588 northeastern and 2289 and 2549 southeastern men and women, respectively). Independent effects of income and education on obesity (BMI $\geq$ 30 kg/m^2) were assessed through logistic regression analyses that controlled for age, ethnicity, household setting (urban or rural) and either education or income. The risk of obesity in men strongly increased with income in the two regions. The level of education did not influence the risk of male obesity in the less developed region but, in the more developed one, better-educated men had slightly less chance to be obese. In the less developed region obesity in women was strongly associated with both income (direct association) and education (inverse association). In the more developed region only the women's education influenced the risk of obesity, and the association between the two variables was inverse and strong as in the less developed region. Findings from this study reveal a scenario that is far from what has been generally admitted for the social distribution of obesity in the developing countries. They indicate that in transition societies income tends to be a risk factor for obesity, whereas education tends to be protective and that both gender and level of economic development are relevant modifiers of the influence exerted by these variables. J. Nutr. 131: 881S–886S, 2001.

KEY WORDS: • *income* • *education* • *obesity* • *Brazil*

Association between obesity and a series of adverse health outcomes such as noninsulin-dependent diabetes mellitus, cardiovascular disease, hypertension, gall bladder disease and certain types of cancer is well established (Pi-Sunyer 1993, Zimmet et al. 1997). At the same time, in countries in North America and Europe, nationally representative surveys previously indicated increasing prevalence of obesity among the adult population (Millar and Stephens 1993, Kuczmarski et al. 1994, Seidell 1995). Despite the scarcity of nationally representative secular trend information for other regions, available data suggest that obesity is increasing worldwide at an alarming rate and it tends to become a major public health problem in both developed and developing societies (Boyle et al. 1994, Monteiro et al. 1995, Hodge et al. 1995, 1996, Popkin and Doak 1998). The availability of a diet high in energy density and a sedentary lifestyle are the two environmental factors most likely associated with the increased prevalence of obesity (Bray and Popkin 1998).

In developed countries there is vast evidence of a consistent strong inverse association between different measures of socioeconomic status, including income and education levels, and the risk of women's obesity, whereas weaker and more variable association with socioeconomic status characterizes obesity in men (Sobal and Stunkard 1989).

There is much less empirical research on socioeconomic determinants of obesity in developing countries. Although a review of the modest published literature on this topic may point to a general positive association between socioeconomic status and obesity in both men and women (Sobal and Stunkard 1989, Popkin et al. 1995), that may be not true for all developing societies. For instance, an analysis of national data collected in the mid-1990s by demographic health surveys of women of childbearing ages from Latin America and the Caribbean revealed an inverse association between education levels and obesity in five of the nine studied countries (Mar-

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torell et al. 1998). In urban areas of Brazil, over the period 1989–1997, increases in the prevalence of obesity have been relatively higher for the poorest population strata. This trend determined the attenuation of the positive association between obesity and income in men and reverted into negative the same association in women (Monteiro et al. 2000a).

In fact, the distinct and changing economic, social and cultural environments, which characterize the so-called developing countries, point to the existence of diversified, complex and dynamic patterns of social determination of obesity. Moreover, the regional heterogeneity that usually exists within the developing countries, coupled with possibly existing gender differences in the relationship between socioeconomic variables and obesity, may produce in a single country a mosaic of situations. In more specific terms it is reasonable to expect in any developing society, only up to a certain level of economic and technological development, that the level of material wealth remains the basic determinant of how much food an individual may obtain and how much energy he or she will spend along the day. Beyond that level, differences in income will determine distinct access to several commodities but not necessarily to food, particularly staple food, and energy expenditure during the work will tend to converge to low or moderate values in all social classes. In this situation rich and poor will tend to be equally exposed to obesity. As economic development progresses, the energy balance of the individuals will be less and less dependent on access to food and type of work and more on informed choices regarding food intake (type and quantity) and levels of energy expenditures outside work (during leisure for instance). In this new context education rather than income will influence the risk of obesity. Empirical research in developing societies is obviously needed to confirm these transition hypotheses as well as to identify the transition stages faced by specific countries or regions in the countries. This study was designed to assess the independent role played by income and by education on the risk of obesity in men and women living in the mid-1990s in the less economically developed (northeast) and the more economically developed (southeast) regions of Brazil.

MATERIALS AND METHODS

Study populations and sampling

Data used in this study come from a World Bank Living Standard Measurement Survey (LSMS) undertaken in Brazil from March 1996 to March 1997 (IBGE 1998). This survey was executed by the Instituto Brasileiro de Geografia e Estatística (IBGE), the federal agency in charge of national statistics in Brazil. The LSMS studied a random sample of households located in two of the five macroregions of Brazil: the northeast and the southeast. The reason to choose these two regions was twofold: *1*) they are the two most populated regions in Brazil and together they correspond to more than two thirds of the total country's population, and *2*) they represent the less economically developed (northeast) and the more economically developed (southeast) regions in the country. The gross per capita regional product in the southeast is almost threefold higher than that in the northeast, which reflects a large regional gap in family income, formal employment opportunities, salaries, literacy and education levels (Lavinas and Magina 1996).

Probabilistic multistage stratified clustering sampling procedures were employed to select the households studied in the two regions. These procedures included the previous constitution of five strata in each region (three metropolitan areas, all other cities and all rural areas) and the random selection of 60 census tracts (clusters) within each strata and eight households within each cluster, except for the rural areas where 30 census tracts and 16 households per tract were selected. Total sampled households were 2452 in the northeast and 2441 in the southeast. Although the LSMS collected anthropometric data for all household members, this study is restricted to the sample of adults aged 20 y or over. Sampled adults in this age group, already excluding pregnant women, were 5648 in the northeast and 5385 in the southeast. The coverage attained by the anthropometric examination in adults was around 90% in the two regions and data on family income were obtained for nearly 95% of the examined individuals. The lack of anthropometry was not associated with income groups and the weight and height distributions of individuals with unknown income were similar to the ones found when income was informed. The other data relevant to this study—years of schooling, age, ethnicity and urban or rural household setting—were obtained for the totality of the studied individuals. The number of individuals with complete demographic, socioeconomic and anthropometric data, used in the multivariate analyses, were 4559 in the northeast (1971 men and 2588 women) and 4838 in the southeast (2289 men and 2549 women).

Data collection

Weight and height measurements were obtained at the households by pairs of trained and standardized interviewers. Weight was measured using microelectronic scales to weigh up to 150 kg with intervals of 100 g with the individuals wearing light clothes and no shoes. Height was measured in barefooted individuals with the head held in the Frankfort plane using portable stadiometers with the capacity to measure up to 200 cm with intervals of 0.1 cm. Socioeconomic and demographic data were obtained using standardized IBGE questionnaires. Family income took into consideration all possible sources of income and per capita income was the result of the division of total family income by the number of residents in the household. Age of all individuals was calculated based on birth certificate or equivalent documents. Ethnicity categories were solely based on the color of the skin of the interviewed: white, black (including mulattos) and other (mostly Asian and indigenous populations). Because the category "others" was very rare (0.1% in the northeast and 0.6% in the southeast), only two ethnic categories were considered: white and nonwhite. Households were classified as urban or rural according to official classification of the census tract where the household was located.

Data analysis

Obesity status, the dependent variable of our study, was evaluated based on the individual's body mass index (BMI, weight in kg divided by the squared height in meters). Following largely accepted international recommendations, both adult men and adult women were classified as obese when their BMI was higher than or equal to 30 kg/m^2 (WHO 1995, 1998). Two potential predictors of adult obesity were considered in this study: levels of family income and levels of formal education. Both income and education levels were established based on quartiles of the variable distribution observed in each region. Besides allowing for an optimum sample size in each income and education category, this procedure provides meaningful levels of the predictors in each region. Age group (20–24, 25–34, 35–44, 45–54, 55–64 and 65 y and over), household setting (urban or rural) and ethnicity (white or nonwhite) were control variables for the association between predictors and obesity. Independent effects of income and education on the risk of obesity were evaluated in each region, separately for men and women, through unconditional logistic regression analysis and corresponding adjusted odds ratios with 95% confidence intervals. The statistical significance of the association between income and education and the risk of obesity was assessed through the test of Wald. When appropriate, tests for linear trends were calculated by unfactoring the ordered income and education categories. Simple chi square tests were employed to assess the statistical significance of differences between the northeastern and the southeastern adult population with regard to the distribution of demographic and socioeconomic characteristics and intervals of the body mass index.

RESULTS

Table 1 displays demographic and socioeconomic characteristics of the northeastern and southeastern adult popula-

TABLE 1

Demographic and socioeconomic characteristics of the northeastern and southeastern adult population (20 y and over) of Brazil (1997)

Characteristics	Northeast % (n = 5648)	Southeast % (n = 5385)	P level
Age (years)			
20–24	16.9	14.3	0.002
25–34	26.8	24.4	
35–44	20.0	24.3	
45–54	14.6	16.0	
55–64	10.5	10.6	
65+	11.3	10.4	
Sex			
Male	47.1	48.5	0.08
Female	52.9	51.5	
Ethnicity			
White	30.6	72.5	< 0.001
Nonwhite	69.4	27.5	
Household setting			
Urban	64.2	90.4	< 0.001
Rural	35.8	9.6	
Family income (R$ per capita)			
0–99	42.6	11.1	< 0.001
100–199	25.6	20.0	
200–400	18.5	30.5	
400+	13.3	38.4	
Education (years of schooling)			
0	33.1	12.5	< 0.001
1–7	40.6	49.1	
8–10	9.5	14.0	
11+	16.8	24.4	

tions of Brazil. As expected, the population from the northeast is significantly poorer and less educated than the population from the southeast. The frequency of illiteracy and low family income (monthly income less than approximately US$ 100 per capita) in the northeast is three- to fourfold higher than that in the southeast. Moreover, most adults from the northeast are nonwhite (69% against 27% in the southeast) and a large proportion is < 35 y old (44% against 39% in the southeast) and live in rural settings (36% against only 10% in the southeast). Taken together these data confirm the unprivileged socioeconomic status of the northeastern region and the relatively higher wealth and development stage attained in the southeast of Brazil.

Table 2 shows the distribution of the body mass index (BMI) of Brazilian adults living in the two studied regions. Average BMI is 0.7 kg/m^2 higher in the southeast than in the northeast with the difference higher for males (1.2 kg/m^2) than for females (0.4 kg/m^2). The prevalence of obesity (BMI $\geq$ 30.0 kg/m^2) is almost twofold higher in the southeast for males and similar in the two regions in the case of females. On the other hand, the prevalence of both male and female thin individuals (BMI < 18.5 kg/m^2) is almost 50% higher in the northeast than in the southeast [this BMI cutoff is used by the World Health Organization (1995) to reflect chronic energy deficiency in adults]. The ratio obesity:thinness is 1:1 (males) and 1.6:1 (females) in the northeast and 2.8:1 (males) and 2.4:1 (females) in the southeast. In other words the nutrition transition seems to be far more advanced in the southeast than in the northeast.

Table 3 presents intervals of income and education (proxied by years of schooling) corresponding to quartiles of the global distribution of these two variables in the total adult population of each region. As noted earlier expected, different quartile cutoffs prevail in each region with a systematically higher income and education cutoffs existing in the southeast. It should also be noted that both income and education are strongly unevenly distributed within the two regions. Average income of the 25% richest adults exceeds in 14 (southeast) to 22 times (northeast) the average income of the 25% poorest adults. On the other hand, average years of schooling for the 25% less-educated adults is zero (northeast) or near zero (southeast), whereas the 25% better-educated adults have 10.8 and 12.6 y of average schooling.

Table 4 (males) and **Table 5** (females) examine the effect of family income and education on the risk of obesity in each of the two regions. Categories employed to express changes in income and education correspond to region-specific quartiles of these two variables, as in Table 3.

In the case of males prevalence of obesity increases significantly as we move from the first to the fourth income quartile in both regions (from 1.9% to 8.2% in the northeast and from 3.8% to 10.0% in the southeast). Adjusted odds ratios that control for age, ethnicity, setting (urban/rural) and also education confirm the direct association existing in the two regions between increases in family income and the risk of male obesity. The influence of education on the risk of male obesity

TABLE 2

Distribution (%) of the body mass index (BMI) and mean BMI of the northeastern and southeastern adult population of Brazil (1997)

	Northeast			Southeast		
BMI (kg/m^2)	Male (n = 2126)	Female (n = 2793)	All (n = 4919)	Male (n = 2404)	Female (n = 2667)	All (n = 5071)
< 18.5	4.3[1]	7.5[2]	6.1[1]	2.9	5.3	4.2
18.5–24.9	67.2	53.9	59.8	54.3	55.4	54.9
25.0–29.9	24.1	26.4	25.4	34.6	26.6	30.4
30.0+	4.4	12.2	8.8	8.2	12.6	10.5
Mean (and SD)	23.5[1] (3.4)	24.3[3] (4.7)	24.0[1] (4.2)	24.7 (3.9)	24.7 (4.8)	24.7 (4.4)

[1] P < 0.001, when compared to the southeastern population.
[2] P = 0.12, when compared to the southeastern population.
[3] P < 0.05, when compared to the southeastern population.

TABLE 3

Quartiles of family income and education in the northeastern and southeastern adult population of Brazil (1997)

Variable	Northeast		Southeast	
	Range	Mean (and SD)	Range	Mean (and SD)
Income (R$ per capita)				
1st quartile	0–58.6	34.7 (14.7)	0–170.0	103.4 (40.6)
2nd quartile	58.7–119.5	86.5 (16.9)	170.4–298.9	230.3 (36.5)
3rd quartile	119.6–240.5	170.1 (34.4)	299.0–590.2	418.0 (81.8)
4th quartile	240.6–11,269.1	761.2 (1090.5)	590.3–22,298.9	1500.0 (1573.0)
Education (years of schooling)				
1st quartile	0–0	0 (0)	0–3	1.3 (1.3)
2nd quartile	1–3	2.2 (0.8)	4–5	4.2 (0.4)
3rd quartile	4–7	4.9 (1.1)	6–10	7.8 (1.2)
4th quartile	8–16	10.8 (2.3)	11–16	12.6 (1.9)

is less clear. In the northeast obesity tends to increase with education but the adjusted odds ratios (which, in this case, also controls for income) do not confirm a true independent education effect. In the southeast both the crude and adjusted relationships between education and male obesity are nonsignificant, although adjusted analysis indicates lower risk of obesity in better-educated men (adjusted odds ratio in the highest education quartile when compared with all other education groups: 0.75, 95% CI 0.47–1.21).

In the case of northeastern females, obesity tends to increase with income (from 7.8% to 14.2%) and to decrease with education (from 14.5% to 10.0%). Both the crude and the adjusted analyses of the risk of obesity indicate a significant direct association with income and a significant inverse association with education. For this female population moving from the first to the fourth income quartile more than doubles the chance to be obese (adjusted odds ratio: 2.33, 95% CI 1.15–4.71), whereas the analogous movement with regard to education more than halves that chance (adjusted odds ratio: 0.44, 95% CI 0.23–0.85). In the case of southeastern females, the crude analyses reveal an inverse association between obesity risk and increases in both income and education, although a clear dose–response effect is seen only with increases in education (prevalence of obesity declines from 18.2% to 6.3% as we move from the better-educated to the poorly educated women). The adjusted analyses confirm that education, rather than income, protects southeastern women against obesity. For these women moving from the first to the fourth education quartile more than also halves the risk of obesity (adjusted odds ratio: 0.42, 95% CI 0.23–0.77).

DISCUSSION

This review coupled with other research on Brazil (Monteiro et al. 1995, 2000a, 2000b) documents a remarkable shift in the patterns of obesity in the population. Brazil, along with other more developed countries in Latin America and selected subpopulation groups from Asia and the Middle East, is further along in the nutrition transition. The shift in the structure of employment and overall time allocation pattern has pushed Brazilians into a more sedentary lifestyle. The dietary shift over the past half century has been equally profound and for much of the population there was a shift in the structure of diet to a diet considered a "Western style" higher fat diet. The joint effect for the period up to 1989 was a rapid increase in obesity among all segments of society. However, as with more developed countries, Brazil has now reached a level of economic and social development where some segments of the

TABLE 4

Prevalence (%) of obesity (BMI ≥ 30 kg/m²) in males by income and education quartiles with corresponding odds ratios: northeastern and southeastern adult population of Brazil (1997)

Region-specific quartiles of	Northeast				Southeast			
	% (n = 1971)	Odds ratio		(95% CI)	% (n = 2289)	Odds ratio		(95% CI)
		Crude	Adjusted[1]			Crude	Adjusted[1]	
Income		P = 0.001[2]	P = 0.09[2]			P = 0.005[2]	P = 0.03[2]	
1st	1.9	1.00	1.00	—	3.8	1.00	1.00	—
2nd	3.3	1.79	1.80	(0.51–6.30)	9.5	2.67	2.44	(1.15–5.16)
3rd	3.6	1.94	1.79	(0.50–6.43)	10.0	2.81	2.63	(1.24–5.57)
4th	8.2	4.65	3.38	(0.95–12.06)	10.0	2.81	2.76	(1.23–6.19)
Education		P = 0.002	P = 0.10			P = 0.69	P = 0.47	
1st	2.5	1.00	1.00	—	6.8	1.00	1.00	—
2nd	2.1	0.83	0.64	(0.22–1.89)	9.6	1.46	1.16	(0.63–2.15)
3rd	6.5	2.71	1.82	(0.65–5.10)	8.6	1.29	0.95	(0.48–1.89)
4th	6.5	2.71	1.04	(0.37–2.96)	8.5	1.27	0.78	(0.37–1.63)

[1] Adjusted for age group, ethnicity, urban/rural setting and education or income.
[2] Test for linear trend.

TABLE 5

Prevalence (%) of obesity (BMI ≥ 30 kg/m²) in females by income and education quartiles with corresponding odds ratios: northeastern and southeastern adult population of Brazil (1997)

	Northeast				Southeast			
		Odds ratio				Odds ratio		
Region-specific quartiles of	% (n = 2588)	Crude	Adjusted[1]	(95% CI)	% (n = 2549)	Crude	Adjusted[1]	(95% CI)
Income		$P = 0.04$[2]	$P = 0.06$[2]			$P = 0.005$[2]	$P = 0.43$	
1st	7.8	1.00	1.00	—	14.1	1.00	1.00	—
2nd	14.0	1.91	1.90	(1.03–3.50)	12.1	0.84	0.86	(0.57–1.30)
3rd	14.0	1.90	1.76	(0.93–3.33)	14.1	1.00	1.11	(0.76–1.62)
4th	14.2	1.95	2.33	(1.15–4.71)	8.9	0.59	0.78	(0.49–1.26)
Education		$P = 0.03$[2]	$P = 0.01$[2]			$P < 0.001$[2]	$P = 0.004$[2]	
1st	14.5	1.00	1.00	—	18.2	1.00	1.00	—
2nd	14.8	1.03	1.00	(0.62–1.59)	13.5	0.70	0.77	(0.52–1.15)
3rd	11.0	0.73	0.66	(0.40–1.08)	10.1	0.50	0.71	(0.44–1.17)
4th	10.0	0.66	0.44	(0.23–0.85)	6.3	0.30	0.42	(0.23–0.77)

[1] Adjusted for age group, ethnicity, urban/rural setting and education or income.
[2] Test for linear trend.

population have attained the economic and education levels that afford them the time and other resources to consider alternate lifestyles.

This study more rigorously looks at a key dimension—the independent influence on obesity exerted by income and education. To accomplish this we applied multivariate analyses on demographic, socioeconomic and anthropometric data collected from representative samples of men and women living in the less and the more economically developed region of Brazil. In the less developed region female obesity was positively associated with income and negatively associated with education, whereas obesity in men was associated only with income (positively, as in women). In the more developed region obesity in women was associated only with education (negatively, as in the less developed region), while obesity in men was positively associated with income and, to a certain extent, negatively associated with education. These findings reveal a scenario, which is very far from what has been generally reported for the social distribution of obesity in the developing countries (Sobal and Stunkard 1989, Popkin et al. 1995). They also confirm our hypotheses that in transition societies income tends to be a risk factor for obesity while education tends to be protective and that both gender and level of economic development are relevant modifiers of the influence exerted by these variables. They also indicate that, similar to what is often found in higher income countries, women tend to shift their diet and activity patterns more rapidly than do men.

The scarcity of population-based studies on the socioeconomic determination of obesity in the developing countries and the fact that most existing studies in the developed countries do not address the independent influence of income and education, but rather use these variables as indiscriminate "markers" of socioeconomic status (Sobal and Stunkard 1989, Popkin et al. 1995, Stunkard 2000), make difficult the comparison of the findings we obtained in Brazil.

One of the few studies, which looked for the independent effect of income and education on obesity, used data from successive cross-sectional national surveys of the U.S. adult population (Flegal et al. 1988a, 1988b). The study showed that in the second national health and nutrition examination survey (NHANES II, 1976–1980) BMI and skinfold thickness in women were independently associated with education (a strong negative association) but not with income, whereas in men the same obesity indicators were independently associated with income (a slight positive association) but not with education: in sum, a pattern of socioeconomic associations with obesity not different from what we found in the more economically developed region of Brazil. It is interesting to note that the negative association between women's obesity and education became stronger in the United States over the period 1960–1980 while the differentiation of female BMI by income category decreased. In the U.S. male population, over the same period, the slight positive association of obesity indicators with income remained unchanged and a slight positive association with education was reverted into a slight negative association. This indicates that the pattern of socioeconomic associations with obesity presently found in the less economically developed region in Brazil could be similar to the one prevailing decades ago in the United States.

A recent multivariate analysis of national data for women ranging in age from 15 to 45 y collected by demographic health surveys in nine Latin American and Caribbean countries (including Brazil) confirmed the existence of complex and diversified patterns of socioeconomic associations with obesity in the developing countries (Martorell et al. 1998). As normally admitted for these countries, a proxy of income (number of possessions plus home characteristics) was found positively and significantly related to women's obesity in eight of the nine studied countries. However, in five of the nine countries (Brazil, Colombia, Dominican Republic, Honduras and Mexico), after controlling for income, formal education appeared negatively and significantly associated with obesity. In only two countries (Guatemala and Haiti, probably the two countries undertaking the earliest stages of the nutrition transition) formal education remained positively and significantly associated with obesity after the income control. A more detailed analysis of data collected by the Brazilian demographic health survey demonstrated that, for women living in the more modern parts of Brazil (e.g., urban areas, where three quarters of the population is concentrated), both formal education and access to information (habit of reading newspaper and watching TV cultural-educational programs) were inde-

pendently and negatively associated with obesity (Monteiro et al. 2000b).

The positive association between income and obesity and the absence of independent effects of education, as was described in the present study for the less developed male population of Brazil, resembles the pattern of associations usually ascribed for developing countries and it is easily understandable: absolute poverty limits in an absolute way food availability besides inducing high energy expenditures. (Sobal and Stunkard 1989). In the other extreme the negative association between education and obesity and the lack of an independent income influence, as found for the female population in the more developed region, resembles the pattern observed in several developed countries and could also be easily explained by the expected associations between levels of education and diet and nutrition knowledge, concern with weight control and standards of physical attractiveness (Sobal and Stunkard 1989). In the middle of this we found a more complex pattern of socioeconomic relationships with obesity, in which a linear positive association with income appears coupled with an also linear but negative association with education. This pattern, found in women from the less developed region and in men from the more developed one, may reflect intermediate stages of the nutrition transition where energy intake and energy expenditures are influenced simultaneously (but in inverse directions) by both income-related and education-related factors. Secular trend analyses of the socioeconomic determination of obesity in the two regions, presently being carried out using additional data collected by the national health and nutrition surveys of 1975 and 1989, should better clarify the plausibility of this transition hypothesis.

Regardless of the reasons explaining the complex and diversified patterns of socioeconomic associations of obesity found in Brazil (and, possibly, in other Latin American and Caribbean countries), two main public health implications arise from our findings. The first is that Brazil and other similar developing countries should carefully monitor their populations with regard not only to the prevalence of obesity but also to its social distribution. Ignoring the social distribution of the disease or assuming patterns of distribution reported in other countries may determine the wrong targeting of interventions and the consequent reduction of their effectiveness. The second implication is the indication that in countries like Brazil both low and high income individuals are or tend to be equally vulnerable to obesity and access to education/information appears to be the key element to control the disease, particularly in women.

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