The hypertriglyceridemic waist phenotype in young adults from the Southern Region of Brazil

Cintura hipertrigliceridêmica em adultos jovens no Sul do Brasil

Cintura hipertrigliceridémica en adultos jóvenes en el sur de Brasil

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Abstract

The present study aimed to assess the prevalence of the hypertriglyceridemic waist phenotype and its associated factors among subjects that have been followed up from birth. In 1982, all maternity hospitals in the city of Pelotas, in the Southern Region of Brazil, were visited and all births were recorded. Babies whose parents lived in the urban area of Pelotas were subsequently followed up on several occasions. A 22 to 23-year follow-up of this birth cohort was carried out in 2004 and 2005. The presence of the hypertriglyceridemic waist phenotype was defined as waist circumference ≥ 90cm and triglyceride levels ≥ 177mg/dL for males, and waist circumference ≥ 85cm and triglyceride levels ≥ 133mg/dL for females. The prevalence of the hypertriglyceridemic waist phenotype was 5.9% and 4.5% among men and women, respectively. Among males, a sedentary lifestyle during leisure time, smoking and obesity were associated with the presence of the hypertriglyceridemic waist phenotype, whereas among females the condition was positively associated with skin color, family income, obesity and dietary fat intake.

Waist Circumference; Abdominal Obesity; Triglycerides

Resumo

O presente estudo teve como objetivo determinar a prevalência do fenótipo da cintura hipertrigliceridêmica e seus fatores associados entre indivíduos que foram seguidos desde o nascimento. Em 1982, as maternidades de Pelotas, sul do Brasil, foram visitadas e todos os nascimentos foram identificados. Em 2004-2005, buscou-se acompanhar toda a coorte. A presença de fenótipo da cintura hipertrigliceridêmica foi definida como circunferência da cintura ≥ 90cm e triglicerídeos ≥ 177mg/dL para o sexo masculino, e circunferência da cintura ≥ 85cm e triglicerídeos ≥ 133mg/dL para as mulheres. A prevalência de fenótipo da cintura hipertrigliceridêmica foi de 5,9% e 4,5% entre os homens e mulheres, respectivamente. Para os homens, o sedentarismo no lazer, tabagismo e obesidade estiveram associados com fenótipo da cintura hipertrigliceridêmica. Por outro lado, entre as mulheres, fenótipo da cintura hipertrigliceridêmica foi positivamente associado com a cor da pele, renda familiar, obesidade e consumo de gordura.

Circunferência da Cintura; Obesidade Abdominal; Triglicerídeos

Introduction

Chronic non-communicable diseases, such as cardiovascular disorders, cancer and diabetes are the leading causes of mortality worldwide, accounting for approximately 60% of all deaths [1,2]. In the United States, the American Cardiology Association estimates that more than one in three adults have some form of cardiovascular disease [3].

In 2000, Lemieux et al. [4] reported that adults with increased waist circumference and high plasma triglyceride levels were more likely to present metabolic markers of cardiovascular risk and called this association the hypertriglyceridemic waist phenotype. Several studies have reported that this condition is associated with the cardiometabolic risk profile (higher levels of insulin, Apolipoprotein B, C-reactive protein and small dense LDL cholesterol) as well an increased risk of coronary artery disease [4,5,6,7,8,9,10]. Studies have identified the following factors related to the presence of hypertriglyceridemic waist phenotype: sedentary lifestyle [11,12,13], obesity [9,11,14], lower levels of schooling [11,13], and low intake of grains [15]. However, despite the marked association between cardiovascular disease and metabolic risk factors, few studies have evaluated the risk factors for hypertriglyceridemic waist phenotype, especially in young adults.

This study aimed to assess the prevalence of hypertriglyceridemic waist phenotype and its association with skin color, family income, smoking, sedentary lifestyle, fat consumption and fiber intake among 23-year-olds from a city in the Southern Region of Brazil.

Methods

During 1982, all maternity hospitals in the city of Pelotas were visited on a daily basis and 7,392 births were recorded. Those babies whose parents lived in the urban area of Pelotas (N = 5,914) were examined and have been followed up on several occasions. Further details regarding study methodology have been described elsewhere [16].

A 22 to 23-year follow-up of this birth cohort was carried out between October 2004 and August 2005. The subjects that were located answered a questionnaire and were examined and asked to donate a blood sample collected by venipuncture.

The presence of hypertriglyceridemic waist phenotype was defined as waist circumference ≥ 90cm and triglycerides ≥ 177mg/dL for males, and waist circumference ≥ 85cm and triglycerides ≥ 133mg/dL for females [4,14,17]. Waist circumference was measured using a fiberglass tape (Cardiomed, 1mm precision, Curitiba, Brazil), halfway between the iliac crest and last costal arch. Pregnant women or those who had had children in the last six months were excluded. Triglyceride levels were assessed using the colorimetric enzymatic method.

The following metabolic cardiovascular risk factors were measured:

- Blood pressure was measured at the beginning and at the end of the interview using a calibrated digital wrist blood pressure monitor (Omron HEM-629, Kyoto, Japan) on the left arm. Before each measurement the individual should sat rest for at least five minutes. Mean arterial pressure was estimated as 2/3 mean diastolic blood pressure plus 1/3 mean systolic blood pressure.
- Random blood glucose was assessed from blood drawn from the fingertip using a portable glucose meter (Accu-Check Advantage, Roche, Indianapolis, USA). Since glucose levels are related to fasting time, glucose estimates were corrected for the time elapsed since the last meal [18].
- HDL cholesterol was measured with a Selectra 2 analyzer (Merck, Darmstadt, Germany) using an ultra sensitive direct method.
- High-sensitivity C-reactive protein (hs-CRP) was measured using the chemiluminescent immunoassay system (Siemens, DPC Immulite 2500, Los Angeles, USA). Measurements below the lower detection limit of 0.1mg/L were converted to 0.05mg/L. Subjects with hs-CRP > 10mg/L, pregnant women and those using oral contraceptives were excluded from the hs-CRP analysis.

The following socioeconomic, demographic and behavioral characteristics were also assessed as possible risk factors:

- Self-reported skin color;
- Family income in adulthood;
- Leisure-time physical activity: a score representing weekly physical activity based on the sum of time spent walking and on moderate physical activity and time spent on vigorous activities multiplied by two was calculated using the long version of the previously validated *International Physical Activity Questionnaire* (IPAQ) [19]. Subjects with a score of less than 150 minutes were classified as sedentary;
- Tobacco smoking: subjects who smoked at least one cigarette per day were considered as smokers;
- High fat and low fiber diet: dietary pattern in the preceding 12 months was evaluated using the *Block Questionnaire*, which includes 24 scored items regarding the weekly consumption of each food. Individuals who scored less than 20 points were considered as having a low dietary

fiber intake and those who scored 25 points and above were considered as having a high dietary fat intake [20].

Triglycerides and hs-CRP values were asymmetrically distributed and a natural log transformation was performed with these variables and results are given as the back-transformed geometric means.

A sex-stratified statistical analysis was performed using the software Stata 12.0 (Stata Corp., College Station, USA). Chi-square test with Yates correction for 2x2 tables was used to test comparisons between proportions and analysis of variance was used to compare means. Multivariate analysis was performed using Poisson regression with robust adjustment of variance based on the hierarchical model shown in Figure 1.

In order to assess whether the presence of enlarged waist and hypertriglyceridemia was related to higher values of cardiovascular risk factors, an interaction term was included in the analysis of the association between waist circumference and triglyceride levels and cardiovascular risk factors.

The study was approved by the Ethical Review Board of the Faculty of Medicine of the Pelotas Federal University, and written informed consent was obtained from participating subjects.

Results

A total of 4,297 subjects were interviewed between October 2004 and August 2005. After taking into account 282 recorded deaths, this number corresponds to a follow-up rate of 77.4%.

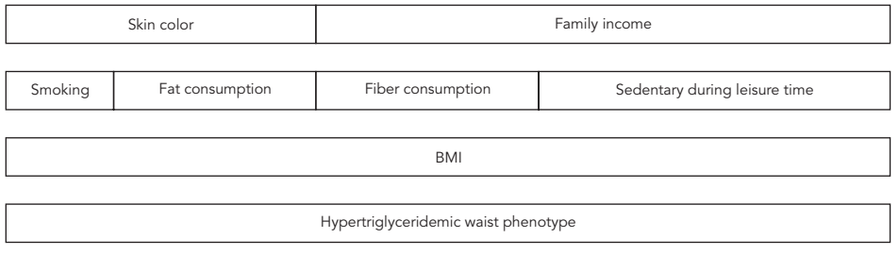
Table 1 shows that approximately 75% of the sample was white. Prevalence of overweight and obesity was 23.1% and 7.5% among men and 17.9% and 9.1% among women, respectively. Table 1 also shows the mean values for triglyceride levels, HDL cholesterol, non-fasting blood glucose, high-sensitivity C-reactive protein and blood pressure for men and women. Prevalence of the hypertriglyceridemic waist phenotype among men and women was 5.9% and 4.5%, respectively. Furthermore, 69.9% of men and 68.6% of women had a low dietary fiber intake and 54.8% of men and 45.4% of women had a high dietary fat intake. Approximately 25% of the sample was smokers and 80% of women and 50% of men were sedentary during leisure time.

Table 2 shows that HDL cholesterol levels were higher and blood pressure, non-fasting blood glucose and body mass index were lower, in individuals with normal waist circumference and triglyceride levels. The presence of hypertriglyceridemia, or enlarged waist circumference, was associated with slight changes in metabolic cardiovascular risk factors, lower HDL cholesterol and higher blood pressure and hs-CRP. The test of interaction between hypertriglyceridemia and each of the cardiovascular metabolic risk factors was statistically significant suggesting that the presence of the phenotype accentuates metabolic cardiovascular risk factors.

Tables 3 and 4 present the prevalence, prevalence ratio and adjusted prevalence ratio of the hypertriglyceridemic waist phenotype according to sample characteristics by gender. With respect to males, being sedentary during leisure time, smoking and obesity was associated with the hypertriglyceridemic waist phenotype, whereas among females the condition was positively associated with skin color, family income, fat consumption and body mass index.

Figure 1

Hierarchical model for the hypertriglyceridemic waist phenotype.



BMI: body mass index.

Table 1

Key characteristics of the study sample.

Sample characteristics	Male	Female
Skin color [n (%)]		
White	1,658 (74.9)	1,580 (75.9)
Non white	555 (25.1)	503 (24.2)
Family income (tertiles) [mean R$ (SD)]		
1st	463.2 (171.2)	443.8 (179.8)
2nd	1,054.3 (206.3)	1,046.1 (205.6)
3rd	3,170.8 (2,696.4)	3,189.6 (2,518.4)
Body mass index (kg/m^2) [n (%)]		
< 18.5	107 (4.9)	150 (7.2)
18.5 -24.9	1,424 (64.6)	1,370 (65.8)
25.0-29.9	509 (23.1)	372 (17.9)
≥ 30.0	166 (7.5)	190 (9.1)
Sedentary during leisure time [n (%)]	1,091 (49.3)	1,676 (80.5)
Smoking [n (%)]	611 (27.6)	492 (23.6)
Triglycerides (mmol/l) [geometric mean (SD)]	1,00 (1.78)	1,03 (1.62)
Waist circumference (cm) [mean (SD)]	80,9 (10.1)	75,6 (11.1)
HDL cholesterol (mg/dL) [mean (SD)]	51,6 (11.2)	59,4 (13.5)
Non-fasting glucose (mg/dL) [mean (SD)]	99,8 (15.6)	94,8 (14.1)
Hs-CRP (mg/dL) [geometric mean (SD)]	0,78 (3.17)	1,31 (3.33)
Mean arterial blood pressure (mmHg) [mean (SD)]	91,6 (11.9)	84,6 (11.1)
Hypertriglyceridemic waist phenotype [n (%)]	113 (5.9)	80 (4.5)

Table 2

Biological cardiovascular risk factors and the hypertriglyceridemic waist phenotype.

	Hypertriglyceridemic waist phenotype [mean (95%CI)]				p-value of interaction
	No	Only hypertriglyceridemia	Only enlarged waist	Hypertriglyceridemic waist phenotype	
HDL cholesterol (mg/dL)	56.0 (55.5; 56.5)	55.2 (53.7; 56.6)	53.0 (51.7; 54.3)	48.9 (47.3; 50.6)	0.02
Non-fasting blood glucose (mg/dL)	96.8 (96.3; 97.4)	98.5 (97.0; 100.1)	98.9 (97.3; 100.5)	101.5 (99.6; 103.5)	0.50
Mean blood pressure (mmHg)	87.1 (86.7; 87.5)	88.6 (87.5; 89.8)	91.9 (90.6; 93.3)	97.9 (96.2; 99.5)	< 0.00
Hs-CRP (mg/dL)	0.82 (0.78; 0.86)	1.26 (1.17; 1.42)	1.72 (1.52; 1.93)	2.03 (1.79; 2.34)	0.06
BMI (kg/m^2)	22.2 (22.1; 22.3)	23.2 (22.9; 23.4)	30.5 (30.0; 30.9)	31.7 (31.1; 32.3)	< 0.00
Total [N (%)]	2,745 (74.6)	376 (10.2)	368 (10.0)	193 (5.2)	

BMI: body mass index; 95%CI: 95% confidence interval.

Discussion

The present study may be considered a cross-sectional analysis because we only analyzed data gathered in the 2004/2005 follow-up visit of 1982 Pelotas birth cohort.

With regard to the limitations of this study, it is important to mention that the measurement of food consumption is a significantly challenging task and the instrument used has not yet been formally validated for use with the Brazilian population. However, it should be noted that more complex methods of measuring food frequency were tested and showed similar results to the *Block Questionnaire* [20].

Another important limitation is that, despite being a nested cohort study with good information on confounders, cross-sectional studies are vulnerable to reverse causality.

Table 3

Prevalence, prevalence ratio and adjusted prevalence ratio of the hypertriglyceridemic waist phenotype by sample characteristics (males).

Characteristics	n	p-value (%)	PR (95%CI)	PR * (95%CI)
Skin color		p = 0.13	p = 0.13	p = 0.21
White	1,425	6.4	1.00	1.00
Non-white	489	4.5	0.70 (0.45; 1.11)	0.74 (0.45; 1.18)
Family income (tertiles)		p = 0.23	p = 0.23	p = 0.35
1st	605	5.0	0.70 (0.45; 1.08)	0.80 (0.53; 1.23)
2nd	650	5.5	0.78 (0.51; 1.18)	0.73 (0.46; 1.15)
3rd	659	7.1	1.00	1.00
Smoking		p = 0.06	p = 0.07	p = 0.05
No	1,378	6.5	1.00	1.00
Yes	536	4.3	0.66 (0.42; 1.03)	0.65 (0.41; 1.01)
Sedentary lifestyle during leisure time		p = 0.05	p = 0.05	p = 0.03
No	967	4.9	1.00	1.00
Yes	947	7.0	1.43 (1.00; 2.06)	1.49 (1.03; 2.14)
Fat score (g)		p = 0.50	p = 0.50	p = 0.51
< 25	48	5.5	1.00	1.00
≥ 25	65	6.2	1.13 (0.79; 1.63)	1.14 (0.78; 1.69)
Fiber score (g)		p = 0.55	p = 0.55	p = 0.49
< 20	1,335	5.7	1.00	1.00
≥ 20-29	579	6.4	1.12 (0.77; 1.64)	1.15 (0.78; 1.69)
BMI (kg/m2)		p < 0.00	p < 0.00	p < 0.00
< 25.0	3	0.2	1.00	1.00
25.0-29.9	40	9.0	39.90 (12.40; 128.50)	39.91 (12.32; 129.32)
≥ 30.0	70	48.6	215.00 (68.60; 674.40)	209.53 (66.58; 659.38)

* Adjusted for variables of the same level and upper level.

BMI: body mass index; PR: prevalence ratio; 95%CI: 95% confidence interval.

Recent studies indicate that the atherosclerosis process starts at an early age and is linked to obesity and other components of the metabolic syndrome during childhood [21]. The identification of asymptomatic individuals at high risk of coronary heart disease and diabetes has important public health implications for prevention of cardiovascular diseases, given the increased incidence of these diseases [22]. The prevalence of the hypertriglyceridemic waist phenotype was 5.9% among males and 4.5% among females and its presence was associated with a higher level of metabolic cardiovascular risk. A number of authors [8,9,10,14,23,24,25,26,27], including Lemieux et al. [4,5] and Hiura et al. [7], have also reported such an association, demonstrating that the hypertriglyceridemic waist phenotype is an important marker of cardiovascular risk.

Studies show that the prevalence of this phenotype among adults of both sexes ranges from 12.7 to 36.5% [10,13,17,27]. In 2003, Kahn observed a prevalence rate of 24.8% among a sample of adults aged 18 to 90 years in the United States; the same study found that prevalence was lowest (6.2%) among the 18 to 24 year age group [23]. Prevalence among healthy adults in Israel, the Netherlands and Spain was 12.7%, 31% and 14.5%, respectively [13,17,27]. A study of a sample of 14,770 adults aged between 35 and 74 years carried out in China by Yu et al. [28] in 2010 showed that the hypertriglyceridemic waist phenotype was present in 35.4% of men and 33.6% of women. Prevalence was 9.6% among men and 23.6% among women in a study of Iranians aged between 30 and 55 years [29].

Although research involving young people is rare, two studies conducted with adolescents in Iran in 2006 and 2008 reported prevalence rates of 6.4% [30] and 8.5% [11], respectively.

In the present study, individuals with the hypertriglyceridemic waist phenotype had lower HDL cholesterol and higher mean blood pressure, non fasting blood glucose levels and hs-CRP levels than those with normal waist circumfer-

Table 4

Prevalence, prevalence ratio and adjusted prevalence ratio of the hypertriglyceridemic waist phenotype by sample characteristics (females).

Characteristics	n	p-value (%)	PR (95%CI)	PR * (95%CI)
Skin color		p = 0.04	p = 0.05	p = 0.01
White	1,333	5.1	1.00	1.00
Non-white	435	2.8	0.54 (0.30; 0.99)	0.45 (0.25; 0.82)
Family income (tertiles)		p = 0.00	p = 0.00	p < 0.00
1st	642	6.5	2.73 (1.48; 5.03)	1.92 (0.99; 3.73)
2nd	584	4.3	1.78 (0.92; 3.45)	3.11 (1.69; 5.74)
3rd	542	2.4	1.00	1.00
Smoking		p = 0.78	p = 0.78	p = 0.88
No	1,349	4.5	1.00	1.00
Yes	419	4.8	1.07 (0.65; 1.76)	0.96 (0.59; 1.58)
Sedentary lifestyle during leisure time		p = 0.24	p = 0.24	p = 0.51
No	357	3.4	1.00	1.00
Yes	1,411	4.8	1.43 (0.78; 2.61)	1.23 (0.67; 2.24)
Fat score (g)		p = 0.00	p = 0.00	p = 0.01
< 25	57	5.9	1.00	1.00
≥ 25	23	2.8	0.48 (0.30; 0.77)	0.52 (0.32; 0.85)
Fiber score (g)		p = 0.47	p = 0.47	p = 0.24
< 20	1,214	4.3	1.00	1.00
≥ 20-29	554	5.1	1.18 (0.75; 1.85)	1.31 (0.84; 2.05)
BMI (kg/m2)		p < 0.00	p < 0.00	p < 0.00
< 25.0	5	0.4	1.00	1.00
25.0-29.9	23	7.5	19.50 (7.50; 50.90)	20.18 (7.67; 53.08)
≥ 30.0	52	33.8	88.20 (35.80; 217.50)	87.74 (34.69; 221.92)

* Adjusted for variables of the same level and upper level.

BMI: body mass index; PR: prevalence ratio; 95%CI: 95% confidence interval.

ence and triglyceride levels. Similar findings have been reported in another studies [5,6,7,8,9,10,12,13,14,17,23,24,25,26,27,31,32], suggesting that the presence of an enlarged waist and increased triglyceride levels is related to metabolic cardiovascular risk factors. Therefore, the presence of the hypertriglyceridemic waist phenotype should be considered a marker for the presence of cardiovascular disease risk factors.

A sedentary lifestyle during leisure time, smoking and obesity were factors associated with the presence of the hypertriglyceridemic waist phenotype in males. Three other studies have also reported that a sedentary lifestyle increases the prevalence of the hypertriglyceridemic waist phenotype [11,12,13]. In females, a sedentary lifestyle during leisure time was also associated with an increase in the prevalence of the condition but the association was not statistically significant. The variables associated with the presence of the hypertriglyceridemic waist phenotype in women were white skin color, low family income, low dietary fat intake and obesity.

We also found that physical activity had a protective effect even among obese individuals.

Studies involving adults aged between 45 and 79 years have reported that obesity is related to the presence of the hypertriglyceridemic waist phenotype [9,11,14,30]. We also observed that body mass index was positively related to prevalence of the hypertriglyceridemic waist phenotype which was present in four in every ten obese individuals included in this study. This indicates that, even among young adults, there is a direct relationship between obesity and a higher risk of carrying a phenotype that is strongly related to the presence of atherogenic risk factors, thus reinforcing the need to prevent obesity at an early age.

Other studies have reported that low socioeconomic status is related to a higher risk of the presence of the hypertriglyceridemic waist phenotype [11,13]. The present study observed that the association between income and prevalence of the condition is positive among males and a negative among females. A previous study [33] posed the hypothesis that poorer women have

more children and therefore a larger waist circumference; however, even after controlling for socioeconomic status, this factor was still associated with the presence of the phenotype in women. On the other hand, the association vanished after controlling for obesity and overweight. Therefore, the association between low socioeconomic status and presence of the hypertriglyceridemic waist phenotype is mediated by overweight/obesity.

Esmaillzadeh et al. [15] reported that a higher consumption of refined grains was associated with higher prevalence of the hypertriglyceridemic waist phenotype, and Alavian et al. [11] showed that the risk of the presence of the hypertriglyceridemic waist phenotype rose with the consumption of solid hydrogenated fat and white bread. Given these findings, an inverse association is unlikely. One possible explanation is that our analysis is cross-sectional, and therefore susceptible to reverse causality bias. Among females, for example, low dietary fat intake is also positively associated with overweight and obesity. However, given that they are overweight or obese it is possible that these individuals have a low dietary fat intake because they are dieting. On the other hand, a longitudinal analysis of a subset of 19-year-old girls found that the risk of the presence of the hypertriglyceridemic waist phenotype was not dependent on dietary fat intake ($p = 0.57$).

Smoking is a well-known cardiovascular risk factor and its association with other factors continues to be a subject of research. In our study, smoking was inversely associated with the presence of the hypertriglyceridemic waist phenotype among men; with a prevalence of 6.5% among smokers compared to 4.3% in nonsmokers ($p = 0.06$). In this study, 18.2% of male smokers were overweight, compared to 25% of nonsmokers, and 5.9% were obese, compared to 8.2% of nonsmokers ($p < 0.05$). No significant differences were found between triglyceride levels between smokers and nonsmokers.

In conclusion, prevalence of the hypertriglyceridemic waist phenotype among young adults is strongly associated with cardiovascular risk factors. The association between waist circumference and triglyceride levels seems to be a good and cost effective method and less invasive alternative for screening individuals at risk of developing cardiovascular disease.

Resumen

El presente estudio tuvo como objetivo determinar la prevalencia del fenotipo de la cintura hipertrigliceridémica y sus factores asociados entre individuos que fueron observados desde su nacimiento. En 1982, las maternidades de Pelotas, sur de Brasil, fueron visitadas y todos los nacimientos fueron identificados. En 2004-2005, se decidió realizar un seguimiento de toda la cohorte. La presencia del fenotipo de la cintura hipertrigliceridémica se definió como una circunferencia de la cintura ≥ 90cm y triglicéridos ≥ 177mg/dL para el sexo masculino y circunferencia de la cintura ≥ 85cm y triglicéridos ≥ 133mg/dL para las mujeres. La prevalencia del fenotipo de la cintura hipertrigliceridémica fue de un 5,9% y un 4,5% entre los hombres y mujeres, respectivamente. Para los hombres, el sedentarismo en el ocio, tabaquismo y obesidad estuvo asociado con el fenotipo de la cintura hipertrigliceridémica. Por otro lado, entre las mujeres, el fenotipo de la cintura hipertrigliceridémica fue positivamente asociado con el color de la piel, renta familiar, obesidad y consumo de grasa.

Circunferencia de la Cintura; Obesidad Abdominal; Triglicéridos

Contributors

R. L. Haack contributed to study design, data analysis and interpretation and to drafting and approval of the final version of this paper. B. L. Horta contributed to study design and to drafting and approval of the final version of this paper. D. P. Gigante, F. C. Barros, I. Oliveira and V. M. Silveira contributed to study design, critical review and approval of the final version of this paper.

Acknowledgments

The 1982 birth cohort study is currently supported by the Wellcome Trust initiative entitled Major Awards for Latin America on Health Consequences of Population Change. Previous phases of the study were supported by the International Development Research Center, The World Health Organization, Overseas Development Administration, European Union, PRONEX, CNPq and Brazilian Ministry of Health.

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Submitted on 16/Apr/2012
Final version resubmitted on 22/Oct/2012
Approved on 06/Dec/2012