CARDIOVASCULAR DISEASE AND DIABETES

Rural-to-urban migration and cardiovascular disease risk factors in young Guatemalan adults

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Background Migration to cities may increase cardiovascular disease risk factors in developing countries. We examined rural and urban individuals who were born in the same villages and shared similar childhood experiences.

Methods Blood lipids and glucose, blood pressure, anthropometry, body composition, physical activity, and food, tobacco and alcohol consumption were examined in 161 men and 193 women, 19–29 years old, living in their village of birth (76 commuted to work in Guatemala City), and in 76 men and 43 women living in the city.

Results Rural and urban women had similar prevalence of overweight (28%), elevated body fat (29.8 ± 6.1%) and low physical activity (83%). Compared to rural men, more urban men were sedentary (79 versus 27%), and they had higher body fat (15.3 ± 5.3% versus 13.3 ± 5.7%), serum cholesterol (4.27 ± 0.75 versus 3.90 ± 0.70 mmol/l [165 ± 29 versus 151 ± 27 mg/dl]), low density lipoprotein [LDL]-cholesterol (2.66 ± 0.72 versus 2.30 ± 0.62 mmol/l [103 ± 28 versus 89 ± 24 mg/dl]) and total cholesterol/high density lipoprotein [HDL]-cholesterol ratio (4.6 ± 1.0 versus 4.1 ± 0.9). Commuters showed intermediate values. Women had higher serum cholesterol (4.43 ± 0.80 mmol/l [171 ± 31 mg/dl]) than men in rural and urban areas. Urban residents ate/drank more saturated fats, red meat and sweetened beverages, and less legumes.

Conclusions High proportions of young Guatemalan women were overweight and sedentary. Migration to a city increased sedentarism and undesirable eating habits among men and women; men became fatter and their lipid profile worsened. Public health actions must address the prevention of emerging chronic diseases in countries still burdened by undernutrition and infections.

Keywords Cardiovascular disease, migration, rural, urban, sedentarism, serum lipids, blood pressure, chronic diseases, risk factors, lifestyle, obesity

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The epidemiological transition is defined by a decline in mortality from infections and malnutrition and a rise in non-transmissible chronic diseases such as cardiovascular disease (CVD), cancer and type-2 diabetes mellitus. The burden of CVD has increased in developing countries[1] where, because of its large number of inhabitants, more than 60% of world deaths attributable to CVD occur.[2] In 1990, 46.7% of CVD deaths in developing countries occurred before the age of 70 years, compared with 26.5% in the developed countries, and, as a consequence, the loss of disability-adjusted years of life in developing countries was 2.8 times greater than in developed regions.[3]

A rise in chronic diseases mortality has been projected for all developing regions of the world, due to an anticipated increase in life expectancy and changes in diet and lifestyle associated with industrialization and urbanization.[4] Within a country in

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epidemiological transition, CVD rates increase first among the affluent sectors of society, who are early adopters of a lifestyle characterized by sedentarism, high fat intake, overweight and smoking. These behaviours and the associated increased risks for CVD then permeate across the socioeconomic spectrum. For example, fat intake increases among all sectors as relatively inexpensive energy-dense foods become more available.[5] At present, there are several countries in Latin America and the Caribbean in which the poor are as likely, or more, to be obese and sedentary than the rich.[6–9]

There is scant quantitative information on CVD risk factors in rural areas of developing countries. Rural to urban migration is thought to accelerate the development of adult 'high-risk' lifestyles.[10–14] Urban environments are associated with increased opportunities for mechanized or sedentary employment, consumption of energy-dense processed foods, and other lifestyle characteristics associated with the development of CVD. However, the process of adoption of these behaviours has not been well documented. With a few notable exceptions,[15,16] most studies that have compared rural and urban populations were cross-sectional[17–23] and were not able to ensure that the urban and rural individuals studied shared similar early life experiences. This limitation prompted an investigation among young Guatemalan adults who have been studied since birth. This paper compares people still living in the rural villages of their birth with those who migrated or commuted to work in Guatemala City, with respect to blood pressure, blood chemistry, anthropometry and body composition, physical activity, and food intake.

Methods

Population and research design

Between 1969 and 1977, a longitudinal study of growth and development was conducted in Santo Domingo los Ocotes (SD), San Miguel de Conacaste (C), San Juan de las Flores (SJ) and Espiritu Santo (ES), 40–110 km from Guatemala City. Pregnant women and their offspring were provided with improved medical care and a dietary supplement containing either proteins, micronutrients and 380 kJ (90 kcal)/dl (C and SJ), or only micronutrients and 135 kJ (33 kcal)/dl (SD and ES).[24,25] The present study was done between 1997 and 1999, when each village had 1425–2175 inhabitants of mixed Spanish-Mayan descent. All are now near a major highway, where buses run regularly to the provincial capital and Guatemala City. Every village has a primary school, and most houses have electricity and piped water supply. Names of 762 people with data on birthweight, growth for at least part of the first year of life, and maternal nutrition during pregnancy were obtained from the 1969–1977 INCAP data files. All who could be located were invited to participate. Relatives, friends and neighbours provided information for tracing individuals who had migrated to nearby villages or to Guatemala City. Other migrants were approached when they visited the villages on holidays or for family events. The study protocol was approved by institutional review boards at INCAP and Emory University, and all participants provided written consent.

Two standardized field workers interviewed respondents at home and measured blood pressure. They took anthropometric measurements at project headquarters in the villages, or at INCAP headquarters in Guatemala City. Socioeconomic indicators on housing and household possessions of village residents were derived from a census taken as part of another ongoing study, or from interviews in Guatemala City.

Blood pressure

Three measurements were taken at 3- to 5-minute intervals with an oscillometric digital sphygmomanometer (Model UA-767; A&D Medical, Milpitas, CA). The instrument was validated against trained examiners using a mercury sphygmomanometer.[26] Calibration was checked periodically. The first measurement was taken after sitting comfortably on a chair for ≥5 minutes, with the left arm at heart level resting on a table. The mean of the last two measurements was used for analysis. In nine cases, where the 2nd and 3rd measures did not coincide within 10 mmHg, a fourth measurement was taken and the mean of the two closest values was used for analysis.

Blood chemistry

Blood was drawn by fingerprick after an overnight fast. Serum concentrations of total cholesterol (TC), high density lipoprotein cholesterol (HDLC), triglycerides (TG) and glucose were determined by solid-phase enzymatic reactions (Cholestech LDX, Hayward CA, USA). The method was calibrated against venous blood assayed at Emory University's Lipid Research Laboratory.[27] Low density lipoprotein cholesterol (LDLC) concentration was calculated with Friedewald's equation.[28] Standard criteria were used to classify the results as normal, borderline-high and high.[29] Triglycerides and LDLC concentrations of ten men and nine women who fasted for <8 hours, and blood glucose concentrations of seven men and six women who fasted for <4 hours, were excluded from analysis.

Haemoglobin concentration was determined in 202 men and 194 women by a solid-phase azidemethaemoglobin method (HemoCue AB, Angelholm, Sweden). Altitude-adjusted cut-off values for anaemia in men and women, respectively, were <13.0 and <12.0 g/dl among rural residents, and <13.5 and <12.5 g/dl among those living in Guatemala City.[30,31]

Anthropometry and body composition

We measured: height; weight; mid-arm, mid-thigh, calf, hip, abdominal (umbilical), and natural (smallest) waist circumference; triceps and subscapular skinfold thickness; and sagittal abdominal diameter. Measurements were taken in triplicate with weighing scales that were calibrated periodically, measuring tapes, Holtein-Harpenden skinfold calipers, and a sagittal abdominal caliper.[32] The sagittal abdominal diameter and thigh circumference to calculate the sagittal/thigh ratio were measured supine. All other measurements were taken standing.[33,34] The mean of the three replicates was generally used for analysis. When a value was beyond acceptable limits,[34] the mean of the other two measurements was used.

Body composition was calculated with predictive equations derived from anthropometry and underwater weighing of 58 men and 57 women similar to the study participants. Men with body fat <8.0%, ≥24% and ≥29% were classified as very lean, with excess fat, and obese, respectively, based on the 15th, 85th and 95th percentiles of 20–29-year-old men in the US.[35] For women, the corresponding threshold values were <16%, ≥30% and ≥35% body fat.

Physical activity

The time allocated to work, leisure, and other activities across a typical 24-hour period on weekdays and weekends was assessed by questionnaire. A test-retest evaluation of the method at 1–6 month intervals gave similar mean, standard deviation, median and range values for both genders, with a linear correlation of 0.90 for men and 0.82 for women.[36] Mean 24-hour physical activity level (PAL) was calculated from the time spent in each activity or task, the effort involved[37–40] and predictive equations of basal metabolism.[41] Men were classified as having very-light, light, moderate and heavy habitual activity when their PAL was, respectively, <1.48, 1.48–1.65, 1.66–1.93, and >1.93 METS.[40] The corresponding PAL categories for women were <1.48, 1.48–1.59, 1.60–1.72, and >1.72 METS.

Food intake and dietary pattern

A food frequency questionnaire was validated against repeated 24-hour dietary recall surveys (Rodriguez *et al.* submitted for publication). The frequency of consumption of specific foods (e.g. corn tortillas, black beans) and food groups (e.g. fruits, vegetables) was calculated as the number of days per month that the food was consumed. Quantitative estimates were calculated using local recipes, measuring devices and portion sizes, INCAP's food composition tables,[42] and the USDA food composition database for fatty acids.[43] Dietary data of 37 people who reported intakes of inordinate amounts of food amounting to >23 MJ (5500 kcal) of dietary energy/day were excluded from analysis.

Statistical analysis

Data for men and women were analysed separately. Proportions were compared using standard approaches for categorical data.[44] Means were compared by analysis of variance. Comparisons of rural non-migrants to both commuters and urban migrants were adjusted for age and village of birth.[45] Statistical significance was declared at $P < 0.05$, with no adjustment for multiple comparisons.

Results

Coverage, migration and place of work

In all, 473 people (237 men and 236 women, 19.4–29.5 years old), representing 78% of those known to be living in a study village or in Guatemala City, were studied. Three other people had died, 151 had moved to distant or unknown places, 36 were not contacted despite multiple attempts, 4 were excluded due to serious handicaps and chronic illness, 25 women were excluded because they were pregnant or nursing babies <6 months old, and 70 people refused to participate. Maternal height and nutrition, weight, length and socioeconomic characteristics at birth, growth velocity, dietary supplement intake, incidence of illness in childhood, and anthropometric and socioeconomic characteristics during adolescence were similar for the participants and the 288 people who were not studied (Table 1).

Seventy-six men (32%) and 43 women (18%) were 'migrants' who had lived in the city for 1–23 years (mean ± SD: 7.1 ± 4.5); 70% of them for at least 5 years. Twenty men and 18 women commuted to work in Guatemala or other cities (4 women). Most were from SD, probably due to its closer proximity to the city (Table 2). Seventeen, 21 and 27% of the men born in SD, C and SJ, respectively, resided in the villages but worked and ate in a nearby cement factory. The day-commuters and the cement factory workers were collectively designated as 'commuters'. 'Migrants' and 'non-migrants' had similar anthropometric and socioeconomic characteristics at birth and adolescence (Table 3). Families of migrant women had a somewhat better socioeconomic status factor score than non-migrants in the 1970s (0.2 ± 1.1 versus −0.2 ± 0.8), and more migrant women (47 versus 21%) had completed 6th grade at school by 1988.

Blood pressure

Mean systolic (SBP) and diastolic (DBP) blood pressures were similar among rural and urban groups of the same gender, but men had higher blood pressure than women in both settings

Table 1 Selected characteristics at birth, childhood and adolescence of people who did or did not participate in cardiovascular disease risk factor study

	Non-participants			Participants		
	n	Mean	SD	n	Mean	SD
Initial study, 1969–1977						
Mother's height (cm)	268	149.1	5.4	452	149.6	5.1
Birthweight (kg)	288	3018	494	473	3092	460
Length at birth (cm)	239	49.7	2.5	397	50.0	2.2
Head circumference at birth (cm)	240	34.8	1.3	397	35.0	1.4
Socioeconomic status factor score at birth	259	0.00	0.86	445	−0.13	0.90
Follow-up, 1988–1989						
Weight (kg)	229	41.6	10.3	414	41.8	10.0
Height (cm)	230	147.8	11.4	414	147.7	11.2
Body mass index (kg/m^2)	229	18.8	2.5	414	18.9	2.7
Head circumference (cm)	230	51.4	1.7	414	51.1	1.6
Socioeconomic status factor score	252	0.11	0.95	441	−0.01	0.85
Completed 6th grade in school (%)	288	27%		473	27%	

Table 2 Place of birth, current residence and work of migrants and non-migrants

Current residence	Place of work	Migration category	Santo Domingo	Conacaste	Espiritu Santo	San Juan	All
Men			n = 48[a]	n = 70	n = 63	n = 56	n = 237
Village[c]	Village	Non-migrants	14 (29)[b]	36 (51)	42 (67)	11 (20)	103 (43)
Village	Cement factory	Commuters	8 (17)	15 (21)	0 (0)	15 (27)	38 (16)
Village	City	Commuters	18 (38)	2 (3)	0 (0)	0 (0)	20 (8)
City[d]	City	Migrants	8 (17)	17 (24)	21 (33)	30 (54)	76 (32)
Women			n = 60	n = 74	n = 59	n = 43	n = 236
Village[c]	Village	Non-migrants	40 (67)	61 (82)	46 (78)	28 (65)	175 (74)
Village	City[e]	Commuters	14 (23)	0 (0)	1 (2)	3 (7)	18 (8)
City[f]	City	Migrants	6 (10)	13 (18)	12 (20)	12 (28)	43 (18)

[a] Number of men and women studied in each village.

[b] In parenthesis: % of men or women born in that village.

[c] Includes one man and two women living in other rural areas similar to study villages.

[d] Includes three men living in cities other than Guatemala City, and six who live in Guatemala 3 weeks of every month.

[e] Includes four women who commute to work in cities other than Guatemala City.

[f] Includes one woman who lives in Guatemala City 3 weeks of every month.

Table 3 Selected anthropometric and socioeconomic characteristics at birth and adolescence of migrants and non-migrants

	Men (n = 237)				Women (n = 236)			
	Non-migrants (n = 161)		Migrants (n = 76)		Non-migrants (n = 193)		Migrants (n = 43)	
	Mean or %	SD	Mean or %	SD	Mean or %	SD	Mean or %	SD
At birth, 1969–1977								
Weight (g)	3125	519	3151	451	3053	423	3040	382
Length (cm)	50.4	2.4	50.9	1.7	49.5	2.2	49.7	1.7
Head circumference (cm)	35.2	1.3	35.4	1.4	34.7	1.3	34.7	1.4
Socioeconomic status factor score	−0.17	0.95	−0.06	0.88	−0.19	0.81	0.17*	1.05
Follow-up, 1988–1989								
Body mass index (kg/m²)	18.1	2.0	18.4	2.3	19.6	3.0	19.6	3.0
Weight (kg)	40.74	10.67	42.59	10.59	41.92	9.27	43.67	9.42
Height (cm)	148.7	13.6	150.8	12.1	145.5	8.2	148.3	9.1
Head circumference (cm)	51.4	1.6	51.9	1.6	50.7	1.5	50.8	1.3
Socioeconomic status factor score	0.00	0.90	0.07	0.79	−0.09	0.82	0.20	0.91
Completed 6th grade (%)	29%		29%		21%		47%**	

Migrant women differ from non-migrants: * $P < 0.05$; ** $P < 0.01$.

($P < 0.01$; Table 4). The SBP was abnormally high (>140 mmHg) in 5% of men, and only 52% had optimal values (<120 mmHg[46]). Diastolic blood pressure was high (>90 mmHg) in 3% of men, and 83% had optimal values (<80 mmHg). All women were normotensive and 96% had optimal SBP and DBP.

Blood lipids, glucose and haemoglobin

Men had low mean serum lipid concentrations, but urban migrants had the highest mean values for TC, LDLC and TC/HDLC ratio ($P < 0.05$), while commuters tended to have values intermediate between urban and rural men (Table 4). Between 5 and 11% had borderline-high concentrations of TC, LDLC and TG, only 1.3% had abnormally high concentrations of TC and LDLC, and almost half the men had HDLC <0.9 mmol/l (<35 mg/dl).

Women had higher serum concentrations of TC and LDLC than men, especially in the rural area ($P < 0.01$). Borderline-high concentrations were found in 13%, and 3% had abnormally high values. Urban women had lower TG and higher HDLC concentrations than their rural counterparts. Commuters, although few in number, also tended to have lower mean concentrations of TC and TG, and lower TC/HDLC ratio, than rural women.

Ninety-eight per cent of all men and women had normal fasting blood glucose concentrations, and only one woman had glucose >7.0 mmol/l (>125 mg/dl). No men, but 6% of the women were anaemic (Table 4).

Anthropometry and body composition

Urban men were taller and heavier than their rural counterparts (Table 5). Body mass index (BMI), subcutaneous fat, and body fat content were generally low among men, but rural inhabitants were leaner. Eleven per cent of all men were overweight and only 2% were obese. Rural men had more abdominal fat than did urban men, although the differences were small. Except for height, commuters had similar body dimensions and composition as rural men.

Overweight was common among rural and urban women. Body mass index exceeded 25 kg/m² in 28%, and 41% had body fat ≥30%. Nine per cent were obese based on BMI, and

Table 4 Blood lipids, glucose, haemoglobin and blood pressure[a]

	Men							Women						
	Non-migrants		Commuters		Migrants			Non-migrants		Commuters		Migrants		
	Mean or n	SD (%)	Mean or n	SD (%)	Mean or n	SD (%)	P^b	Mean or n	SD (%)	Mean or n	SD (%)	Mean or n	SD (%)	P^b
Total cholesterol (mmol/l)	3.90	0.70	4.11	0.72	4.27*	0.75	0.04	4.45	0.83	3.96*	0.65	4.53	0.70	0.13
≥5.2 mmol/l, n (%)	5	(5)	3	(5)	8	(11)	0.41	29	(17)	2	(11)	5	(12)	0.64
LDL-cholesterol (mmol/l)	2.30	0.62	2.64*	0.62	2.66*	0.72	0.02	2.74	0.67	2.43	0.57	2.84	0.59	0.25
≥3.4 mmol/l, n (%)	4	(4)	6	(10)	10*	(13)	0.07	22	(13)	2	(11)	7	(16)	0.89
HDL-cholesterol (mmol/l)	0.98	0.18	0.96	0.16	0.96	0.23	0.46	1.03	0.21	1.06	0.23	1.19*	0.39	0.004
<0.9 mmol/l, n (%)	40	(44)	22	(43)	36	(52)	0.82	55	(33)	7	(41)	7*	(17)	0.08
Total cholesterol/HDL ratio	4.11	0.89	4.41	0.84	4.59*	0.96	0.02	4.35	1.01	3.90*	0.94	4.05*	0.99	0.03
Triglycerides (mmol/l)	1.41	0.75	1.17	0.61	1.40	0.82	0.11	1.48	1.00	1.05*	0.49	1.13*	0.54	0.04
≥2.3 mmol/l, n (%)	10	(10)	3	(5)	12	(16)	0.06	27	(15)	0	(0)	0	(0)	–
Glucose (mmol/l)	4.88	0.61	4.83	0.50	4.83	0.50	0.51	4.72	0.94	4.61	0.39	4.66	0.44	0.4
>6.1 mmol/l, n (%)	3	(3)	1	(2)	1	(1)	0.28	4	(2)	0	(0)	0	(0)	–
Haemoglobin (g/dl)	16.4	1.3	16.9	1.2	17.2*	1.5	0.01	14.4	1.3	14.5	1.1	14.3	1.5	0.91
Men: <13 or 13.5; n (%)[c]														
Women: <12 or 12.5; n (%)[c]	0	(0)	0	(0)	0	(0)	–	6	(4)	0	(0)	5	(12)	0.12
Systolic blood pressure	121	11	119	11	120	7	0.67	104	10	100	9	104	11	0.16
≥120 mmHg, n (%)	50	(49)	26	(45)	37	(49)	0.94	9	(5)	1	(6)	4	(9)	0.27
Diastolic blood pressure	73	8	72	7	73	8	0.54	65	8	63	8	67	7	0.19
≥80 mm Hg, n (%)	19	(18)	6	(10)	16	(21)	0.17	7	(4)	1	(6)	2	(5)	0.83

[a] Mean and standard deviation, unless specified as number of cases, n, and proportions (%). Total number varies for some parameters (see text).

[b] ANOVA and logistic regressions adjusted for age and place of birth. Means or proportions with asterisks (*) differ from non-migrants at $P < 0.05$.

[c] Adjusted for altitude.

To convert mmol/l to mg/dl, multiply: cholesterol (total, LDL-cholesterol, HDL-cholesterol) × 38.67; glucose × 18.02; triglycerides × 88.54.

twice as many on the basis of body fat. Similar to men, rural women showed a tendency towards more abdominal fat.

Physical activity

Many rural men worked in non-mechanized agriculture, especially in ES. Most rural women did household chores and undertook child-care, and some were involved part-time in basket weaving, tending store and the seasonal tomato and lemon harvests. Most migrants to Guatemala City were store clerks, employees in garment factories, masons, domestic workers and policemen/watchmen. Some were store managers, technicians, office workers, students with part-time jobs, or unemployed. They generally rode a bus or car to work. Commuters worked in the city either for 5 days each week or for three consecutive weeks each month, mostly in garment factories, private police services, masonry, or selling in marketplaces.

Rural men had a higher physical activity level than commuters or urban men ($P < 0.001$; Table 5). Most rural men (73%) had a physically moderate or heavy lifestyle, and only 14% had very light activity. The reverse was seen among urban dwellers. Activity patterns of commuters were intermediate, with a closer resemblance to city dwellers.

Only 17% of all women were moderately or heavily active. Most rural women had 'light' habitual activity, while 'very light' activity was more common among urban women and commuters ($P < 0.01$). Consequently, rural women had a low PAL which, nevertheless, was higher than that of migrants and commuters ($P < 0.01$).

Food intake

Although generally low, total and saturated fat intakes were higher in urban than rural diets (21 ± 5 versus 19 ± 4% dietary energy from total fat; 8 ± 2 versus 7 ± 2% energy from saturated fats; $P < 0.05$). Compared with rural people, urban residents ate more often ($P < 0.05$) red meat (7 versus 4 days/month) and vegetables (16 versus 8 days/month), and drank more sweetened beverages (19 versus 12 days/month). They consumed less frequently black beans (14 versus 22 days/month) and coffee (19 versus 27 days/month). Frequency of intake of these foods and beverages among commuters tended to be intermediate between those reported by urban and rural dwellers.

Smoking and alcohol intake

Light smoking was reported by 41% and 37% of urban and rural men, respectively, and by only two women. Another 11% and 13% of urban and rural men, respectively, had stopped smoking. Overall, tobacco consumption was low, with a mean lifetime consumption of 6681 cigarettes, corresponding to an average of 2.5 ± 4.0 cigarettes per day.

There were several bars in all villages, but liquor and beer intakes were reported very seldom, both there and in the city.

Discussion

This study corroborates that rural to urban migration in developing countries leads to changes in lifestyle, not all of

Table 5 Selected anthropometric, body composition and physical activity characteristics[a]

	Men									Women								
	Total		Non-migrants		Commuters		Migrants			Total		Non-migrants		Commuters		Migrants		
	Mean or n	SD (%)	Mean or n	SD (%)	Mean or n	SD (%)	Mean (%)	SD or n	P[b]	Mean or n	SD (%)	Mean or n	SD (%)	Mean or n	SD (%)	Mean or n	SD (%)	P[b]
Height, cm	164.5	6.5	163.2	7.0	165.1	6.3	165.9*	5.8	0.03	152	5	151.4	4.6	153.0	7.5	152.6	5.8	0.15
Weight, kg	60.0	8.0	58.4	7.7	59.4	8.6	62.4*	7.4	0.002	54.4	10.2	54.7	10.6	50.5	8.5	54.9	9.3	0.17
BMI, kg/m^2	22.1	2.4	21.9	2.4	21.8	2.5	22.7*	2.3	0.05	23.6	4.1	23.8	4.3	21.5*	3.0	23.6	3.9	0.04
BMI >25, n (%)	25	(11)	7	(7)	6	(10)	12*	(16)	0.09	66	(28)	53	(30)	1*	(6)	12	(28)	0.03
BMI >30, n (%)[c]	4	(2)	3	(3)	1	(2)	0		0.14	21	(9)	17	(10)	1	(6)	3	(7)	0.60
Subscapular skinfold thickness (mm)	12	5	11	4	11	4	14*	6	<0.001	20	9	20	9	15	5	21	9	0.16
Triceps skinfold thickness (mm)	9	4	8	4	8	4	10*	4	0.001	18	6	18	6	16*	4	19	5	0.03
Natural waist/hip ratio	0.87	0.04	0.87	0.04	0.87	0.04	0.86*	0.04	0.05	0.81	0.05	0.82	0.05	0.77*	0.06	0.78*	0.04	<0.001
Men >0.90; Women >0.85; n (%)	48	(20)	24	(25)	12	(21)	12	(16)	0.38	40	(17)	37	(22)	2	(11)	1*	(2)	0.003
Abdomen/hip ratio	0.90	0.04	0.91	0.03	0.90	0.03	0.89*	0.04	0.007	0.95	0.05	0.95	0.05	0.93*	0.05	0.93*	0.05	0.004
Men >1.0; Women >0.90; n (%)	1	(0.4)	1	(1)	0		0		–	190	(81)	147	(86)	12*	(67)	31*	(72)	0.02
Sagittal diameter/ thigh ratio	0.35	0.03	0.36	0.02	0.34	0.02	0.34*	0.03	0.01	0.36	0.03	0.37	0.03	0.34*	0.03	0.34*	0.03	<0.001
Body fat, % of body weight	14.0	5.6	13.3	5.7	13.7	5.6	15.3*	5.3	0.01	29.8	6.1	30.1	6.3	27.2	2.8	30.1	6.3	0.16
Men >23.9; Women >29.9; n (%)	11	(5)	4	(4)	4	(7)	3	(4)	0.79	96	(41)	75	(43)	1*	(6)	20	(47)	0.01
Men >28.9; Women >34.9; n (%)[c]	3	(1)	3	(3)	0		0		–	43	(18)	37	(21)	0		6	(14)	0.03
PAL, MET/24 h	1.63	0.27	1.76	0.23	1.55*	0.27	1.52*	0.27	<0.001	1.52	0.10	1.53	0.08	1.43*	0.14	1.48*	0.11	<0.001
Very light activity, n (%)	101	(43)	14	(14)	32*	(55)	55*	(72)	<0.001	67	(28)	34	(19)	14*	(78)	19*	(44)	<0.001
Light activity, n (%)	28	(12)	14	(14)	9	(16)	5	(7)	0.18	129	(55)	109	(62)	2*	(11)	18*	(42)	<0.001
Moderate-heavy activity, n (%)	108	(46)	75	(73)	17*	(29)	16*	(21)	<0.001	40	(17)	32	(18)	2	(11)	6	(14)	0.81

BMI: body mass index; MET: multiples of basal metabolism; PAL: physical activity level; TDEE: total daily energy expenditure.

[a] Mean and standard deviation, unless specified as number of cases, n, and proportions (%). Total number varies for some parameters (see text).

[b] ANOVA and logistic regressions adjusted for age and place of birth. Means or proportions with asterisks (*) differ from non-migrants at $P < 0.05$.

[c] Also included in preceding category.

which are desirable. Living or working in an urban environment increased sedentarism. This was more evident among men, most of whom were moderately or heavily active in the rural area, while the majority of their urban counterparts had occupations with low energy demands. A reduced physical activity was also detected among urban women, but the contrast was small due to the already low physical activity of women living in villages where electricity, piped water, transportation and other facilities were available. Although urban residents had a relatively 'healthy' diet, migration to the city was associated with higher intake of saturated fat and red meat, lower consumption of legumes and, especially among men, larger intake of sweetened soft drinks. The changes, although small, are in the direction of increased CVD risk.

Adverse changes in body composition and lipid metabolism were more notable among men than among women. Urban men had more body fat than their rural counterparts, probably associated with the marked decrease in physical activity, and their serum lipid profile worsened. These changes may have been obscured among women by the high prevalence of overweight, excessive body fat and low physical activity in the rural setting, and by serum cholesterol concentrations that were already relatively high in rural women, compared with those of rural and urban men. The excess in body weight and fat among these young women in both rural and urban settings merits attention. Their mean body fat of 29.8% corresponded to the 75th percentile of women of this age group in the US.[35] The prevalence of overweight (28%) and obesity (9%) were similar to reports from Guatemalan and other Latin American women with a broader age span (15–49 years),[9,47] and these proportions are likely to increase further as the women in our study grow older. Both men and women in the rural area had higher proportions of abdominal fat than urban counterparts. The reason for this and its metabolic associations remain to be determined.

It must also be noted that the mean SBP found in both urban and rural men (120 ± 10 mmHg) was normal but suboptimal, according to current international guidelines.[46] Whether these men are at risk for hypertension as they grow older, especially if they gain weight and/or become more sedentary, requires longer term surveillance. Another notable finding was the high proportion of urban and rural men with serum concentrations of HDLC below 0.9 mmol/l (35 mg/dl), despite the high physical activity level sustained in the villages and the low fat diet in both environments. Finally, the low level of tobacco consumption by participants in this study was a positive finding in the context of CVD risk. Maintenance of this behaviour must be enforced, as smoking is highly prevalent among other population sectors in Guatemala.[48]

The use of digital sphygmomanometers and solid-phase chemical reactions performed on capillary blood samples, which are not generally used in CVD epidemiological studies, raises the question of a loss of accuracy and precision. However, the instruments and methods used in this study were calibrated with, and when necessary adjusted to conventional methods with rigorous quality control. As to the comparisons between the urban, rural and commuting populations, and between genders, the same techniques were used for all participants.

There was little suggestion of selection bias among study participants, nor was there major evidence of a 'healthy migrant' effect derived from a self-selection of the population of origin. Birthweight, linear growth velocity, weight gain, morbidity, supplement intakes by children and mothers, and a variety of socioeconomic indicators measured in the 1970s and in 1988 did not show important differences between respondents and other eligible people who could not be located or refused to participate. Among participants, urban men—but not women—were taller than their rural counterparts, and except for better schooling among urban women, there were no anthropometric nor socioeconomic differences between migrants and non-migrants at birth and adolescence. While we lack quantitative information about the pre-migrant CVD risk in study participants, the comparison of rural and urban residents who were born in the same villages and shared similar experiences in childhood indicated that moving to an urban environment was associated with behavioural and physiological changes related to greater risk of CVD. Such changes were already evident at the early age of 20–29 years.

The number of commuters in the current study was too small to show a clear intermediate transition from a rural to an urban epidemiological or nutritional profile. However, the detection of several intermediate changes among those who still lived in the rural area but worked outside the villages on a daily basis, supports our inference that migration from the countryside to a large city is responsible for the observed effects. We recommend that investigators should consider including people with a mixture of rural and urban lifestyles in future studies of migration and health.

The migration process did not involve a radical cultural modification in the present study, since people in the four Guatemalan villages have been undergoing for several decades a transition from a traditional rural lifestyle. By 1997, nearly all houses had electricity, and about 80% had piped water supply. There is a primary school in every village, and villagers have access to radio, television and newspapers. Improved transportation and easier access to urban centres have increased mobility and the availability of services, industrially processed foods and other goods. Changes in lifestyle and risk factors as a consequence of urban migration might be even greater when migration takes place from less developed rural settings, where people are less exposed to modern facilities and commodities, and must perform heavier physical work.

In conclusion, this study showed that high proportions of young Guatemalan women in both rural and urban areas are overweight and sedentary, and that migration to a city further augments sedentarism and undesirable eating habits among both men and women. The known association of these factors with a variety of chronic diseases supports a call for increased public health actions to address these deleterious changes in lifestyle and prevent an inordinate increase of such diseases, even in countries that may still be burdened by undernutrition and infections.

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KEY MESSAGES

- Overweight and sedentarism are highly prevalent among rural and urban women.
- Sedentarism increases with migration to a city, specially among men.
- Public health actions are needed to combat overweight and sedentarism, and to prevent an increase of cardiovascular diseases in developing countries where urbanization is on the rise.

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