Physical activity and cardiovascular risk factors among rural and urban groups and rural-to-urban migrants in Peru: a cross-sectional study

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ABSTRACT

Objective. *To compare physical activity and sedentary behavior patterns of rural-to-urban migrants in Peru versus lifetime rural and urban residents and to determine any associations between low physical activity and four cardiovascular risk factors: obesity (body mass index ≥ 30 kg/m^2), systolic and diastolic blood pressure, hypertension, and metabolic syndrome.*

Methods. *The PERU MIGRANT (PEru's Rural to Urban MIGRANTs) cross-sectional study was designed to measure physical activity among rural, urban, and rural-to-urban migrants with the International Physical Activity Questionnaire (IPAQ).*

Results. *The World Health Organization (WHO) age-standardized prevalence of low physical activity was 2.2% in lifetime rural residents, 32.2% in rural-to-urban migrants, and 39.2% in lifetime urban residents. The adjusted odds ratios for low physical activity were 21.43 and 32.98 for migrant and urban groups respectively compared to the rural group. The adjusted odds ratio for being obese was 1.94 for those with low physical activity. There was no evidence of an association between low physical activity and blood pressure levels, hypertension, or metabolic syndrome.*

Conclusions. *People living in a rural area had much higher levels of physical activity and lower risk of being overweight and obese compared to those living in an urban area of Lima. Study participants from the same rural area who had migrated to Lima had levels of physical inactivity and obesity similar to those who had always lived in Lima. Interventions aimed at maintaining higher levels of physical activity among rural-to-urban migrants may help reduce the epidemic of obesity in urban cities.*

Key words Cardiovascular diseases; motor activity; risk factors; rural-urban migration; obesity; hypertension; metabolic syndrome X; Peru.

Globally, cardiovascular disease (CVD) is a leading cause of mortality and morbidity. Currently, 80% of deaths and 87% of disability from CVD occurs in low- and middle-income countries (1–3). Over the last three decades, Latin America has experienced major demographic, epidemiological, and nutritional transitions, accompanied by an increase in CVD

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morbidity and mortality (4). At least 75% of the burden of CVD in Latin America is attributed to tobacco use, physical inactivity, and unhealthy diet (2).

Since the publication of Dr. Jeremy Morris' study on the risk of coronary artery disease and physical activity in 1953, the public health community has been aware of the protective effect of physical activity on cardiovascular outcomes (5). Physical activity reduces the risk of CVD and type 2 diabetes by improving glucose metabolism, reducing body fat, and lowering blood pressure. Though the health benefits of regular physical activity are widely recognized, sedentary lifestyles are predominant in urban areas worldwide and are one of the top five major risk factors for CVD (6). The threat of inactivity in Latin America constitutes a substantial risk factor for many noncommunicable diseases because 60% of people live in urban environments (7). In 2000, an estimated 119 000 deaths were attributed to inactive lifestyles in Latin America. This makes physical inactivity one of the five most important causes of ill health and premature death in Latin America (7).

Over the past 30 years, Peru has had a large-scale population migration from rural villages in the Andes mountains to urban areas. This migration has been fueled by political instability in rural regions. The current research, known as the PERU MIGRANT (PEru's Rural to Urban MIGRANTs) study, investigated the magnitude of difference in CVD risk factors between rural-to-urban migrant, rural, and urban groups (8). The primary objective was to describe the differences in physical activity and sedentary behavior between rural-to-urban migrants and lifetime rural and urban residents. It also investigated the association between low physical activity and four cardiovascular risk factors: obesity (body mass index [BMI] ≥ 30 kg/m^2, as per World Health Organization [WHO] criteria (9)); systolic blood pressure (SBP) and diastolic blood pressure (DBP); hypertension, and metabolic syndrome.

MATERIALS AND METHODS

Study population

The PERU MIGRANT study is a cross-sectional survey of three population-based groups. The fieldwork for this study was completed in 2007. The study was designed to investigate the magnitude of difference in CVD risk factors among rural, urban, and rural-to-urban residents in Peru. Detailed methods of the study have been published (8).

The rural participants (*n* = 201) were born and living in the rural mountainous region of Ayacucho. The urban residents (*n* = 201) were born and living in the capital city of Lima, and the rural-to-urban migrants (*n* = 583) moved from Ayacucho to Lima. The method of selection was a single-stage simple random sampling from censuses from 2007 and 2000 in rural and urban settings respectively. In each of the three study groups, all permanent residents aged 30 years and older were eligible for the study, excluding pregnant women and those with mental disorders.

The sample size required for this study was estimated based on the main outcomes of interest: physical activity levels and obesity. Comparing the rural and migrant groups, the study had 90% power at 5% significance level to detect a difference of 10% versus 20% prevalence of low physical activity. This was a conservative power estimate given that the difference between the rural and migrant groups was expected to be slightly less than the difference between the rural and urban groups. To detect the difference in obesity (22.5% versus 15% in the low and high physical activity groups respectively), the study had 88% power at 5% significance level.

The study sample was frequency-matched on age and sex. The International Physical Activity Questionnaire (IPAQ) and standard questionnaires on demographic, socioeconomic, migration, and other risk factors were used. Community health workers with previous experience enrolled participants and conducted face-to-face interviews (8).

Ethics

Ethical approval for this study was obtained from ethics committees at Universidad Peruana Cayetano Heredia (UPCH) in Peru and London School of Hygiene and Tropical Medicine in the United Kingdom. All participants signed a written consent form to participate in the study. The purpose of the study was explained to each of the study participants and informed consent was obtained in accordance with international standards for ethical research in developing countries (10, 11).

Measurement of physical activity

In accordance with the IPAQ protocol, the categorical physical activity levels were coded based on total days of physical activity and metabolic equivalents of task (MET) minutes per week. Moderate physical activity was coded as five or more days of any combination of walking and moderate- or vigorous-intensity activities achieving at least 600 MET minutes per week. High physical activity was coded as seven or more days of any combination of walking and moderate- or vigorous-intensity activities achieving a minimum total physical activity of at least 3 000 MET minutes per week. Sedentary physical activity was defined as less than 150 MET minutes in one week. Those with low physical activity did not meet the moderate or high physical activity criteria. The binary physical activity category combined moderate and high levels of physical activity because both levels of activity meet the minimum criteria for health-enhancing physical exercise (12).

Measurement of height, weight, and cardiovascular risk factors

Height was measured to the nearest 0.1 cm using a stadiometer. Weight was measured to the nearest 0.05 kg using a SECA 940 electronic scale, with individuals wearing light clothes. All measurements in both rural and urban areas were made by the same trained personnel (8). BMI was calculated as weight in kilograms divided by height in meters squared. The categories of obese and overweight/obese were derived using standardized cutoffs (Table 1). Blood pressure was measured from the right arm, with the individual seated, using an arm support and a cuff (sized appropriately for arm circumference) with an oscillometric device (Omron M5-I, Omron Healthcare Co. Ltd., Kyoto, Japan). Hypertension was defined according to criteria established in The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (13) and European Society of Hypertension/European Society of Cardiology 2007 guidelines for management of arterial

TABLE 1. Definitions of categorical and continuous cardiovascular risk factors

Variable	Type	Definition / measurement technique
BMI[a]	Categorical	Underweight: < 18.5 kg/m^2 Normal: ≥ 18.5 kg/m^2 – < 25 kg/m^2 Overweight: ≥ 25 kg/m^2 – < 30 kg/m^2 Obese: ≥ 30 kg/m^2
Overweight or obese[b]	Binary	No: BMI < 25 kg/m^2 Yes: BMI ≥ 25 kg/m^2
Obese	Binary	No: BMI < 30 kg/m^2 Yes: BMI ≥ 30 kg/m^2
SBP[c]	Continuous	Mean of the last two SBP measurements
DBP[d]	Continuous	Mean of the last two DBP measurements
Hypertension[e]	Binary	Yes: SBP ≥ 140 mmHg or DBP ≥ 90 mmHg, or self report of physician diagnosis and currently receiving antihypertensive medication
Metabolic syndrome[f]	Binary	≥ 3 of the following: Glucose: ≥ 5.6 mmol/L or drug treatment for elevated blood glucose HDL-C[g]: < 1.0 mmol/L (men), < 1.3 mmol/L (women), or drug treatment for low HDL-C with one or more fibrates or niacin Triglycerides: ≥ 1.7 mmol/L (150 mg/dL) or drug treatment with one or more of fibrates or niacin Obesity: waist ≥ 102 cm (men) or ≥ 88 cm (women) Hypertension: ≥ 130/85 mmHg or drug treatment for hypertension

[a] BMI = body mass index.
[b] As per World Health Organization criteria (9).
[c] SBP = systolic blood pressure.
[d] DBP = diastolic blood pressure.
[e] As per criteria established by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (13) and European Society of Hypertension/European Society of Cardiology 2007 guidelines (14).
[f] As per criteria established by the American Heart Association in 2005 (15).
[g] HDL-C = high-density lipoprotein cholesterol.

hypertension (14). Metabolic syndrome was defined based on the criteria established by the American Heart Association in 2005 (15).

Statistical methods

Reporting analyses were based on the guidelines advocated by the international collaborative initiative known as STROBE (STrengthening the Reporting of OBservational studies in Epidemiology) (16, 17). The standardized methodology advocated in the IPAQ guidelines was used for data management and analysis to ensure consistency with other studies using the IPAQ physical activity questionnaire (18).

The distribution of low and moderate / high physical activity and sedentary behavior were described as frequencies and percentages across demographic, socioeconomic, and categorical cardiovascular outcomes (hypertension, BMI categories, obese, obese / overweight, and metabolic syndrome) and as a mean (± standard deviation [SD]) for continuous cardiovascular outcomes (BMI, SBP, and DBP). Direct standardization to the WHO standard population (19) was used to calculate age-standardized prevalence by seven five-year age groups (30–34, 35–39, 40–44, 45–49, 50–54, 55–59, and ≥ 60 years old).

The Pearson chi-square test and *P*-values were used to determine the strength of the association between the variables. The variables age, sex, socioeconomic status, and highest level of parental education were considered potential confounders and adjusted for with a step-wise approach using three models: 1) age and sex, 2) age, sex, and assets, 3) age, sex, assets, and highest level of parental education.

Multivariable logistic regression was used for the analysis of categorical outcomes and linear regression was used to analyze continuous outcomes. The results of logistic regression were expressed as odds ratios (ORs) with 95% confidence intervals (CIs), and multivariable logistic regression was used to adjust for confounding factors. The linear regression results for continuous outcomes were expressed as a β-coefficient and 95% CI. The baseline group for physical activity was the moderate / high group and the baseline group for migrant status was the rural group. STATA version 10 was used for all statistical analyses and power calculations (StataCorp LP, College Station, Texas, United States). All statistical analysis for this study was performed in 2009.

RESULTS

The overall response rate was 61.6% for the original PERU MIGRANT study with higher response rates in the rural group compared with the urban or migrant groups. Nonresponders did not differ by sex in the migrant and rural groups; however, 70% of the refusals in the urban group were male. Among the males who refused, a higher proportion had completed secondary-level education (70.3% in urban nonresponders versus 56.6% in urban responders). Most refusals were in the oldest age group (≥ 60 years old) in all study groups. The final population studied included similar proportions of age and sex in the strata to control any potential nonresponse biases due to age and sex differences (8).

Information was collected from 994 participants. Only those with completed questionnaires were included in the analysis. A total of four participants had missing clinical measurements and laboratory analysis and five had missing information in the physical activity questionnaire. The total number of participants included in this analysis was 985.

Table 2 presents the demographic and socioeconomic characteristics of the study sample by physical activity levels. The distributions of cardiovascular risk factors in the study sample are presented in Table 3. A higher proportion of participants with low physical activity compared to moderate / high physical activity were obese or overweight.

The most striking difference in physical activity was that low physical activity was almost 18 times higher in the urban group compared to the rural group. The odds of having low levels of physical activity were strongly associated with migrant status (Table 4). There was no evidence of a difference in the odds of low physical activity within the seven age groups or between genders after adjustment for all socio-demographic correlates studied.

Those who reported low levels of physical activity had 1.62 (1.12–2.35)

TABLE 2. Distribution and 95% confidence interval (CI)[a] of demographic and socioeconomic variables, by low and moderate/high physical activity levels, PERU MIGRANT study, Lima and Andean rural regions, 2007

Demographic and socioeconomic variables	(*n* = 985) No.	%	Low physical activity (%) (95% CI)	Moderate/high physical activity (%) (95% CI)
Age (years)				
30–34	137	14.0	32.1 (NA)[b]	67.9 (NA)
35–39	142	14.4	28.7 (NA)	73.2 (NA)
40–44	149	15.0	23.5 (NA)	76.5 (NA)
45–49	133	13.5	21.1 (NA)	79.0 (NA)
50–54	143	14.6	23.8 (NA)	76.2 (NA)
55–59	128	12.9	21.9 (NA)	78.1 (NA)
≥ 60	153	15.5	32.7 (NA)	67.3 (NA)
Sex				
Male	466	47.3	24.9 (21.2–28.7)	75.1 (71.3–78.8)
Female	519	52.7	28.3 (24.7–32.0)	71.6 (68.0–75.3)
Group				
Lifetime rural	201	20.3	2.2 (0.6–3.7)	97.8 (96.3–99.4)
Rural-to-urban migrant	583	59.4	32.2 (28.6–35.8)	67.8 (64.2–71.4)
Lifetime urban	201	20.3	39.2 (33.0–45.4)	60.8 (54.6–67.0)
Parents' education				
None	447	45.4	23.2 (19.2–27.3)	76.8 (72.7–80.8)
Some primary	224	22.7	23.4 (18.9–27.8)	76.6 (72.2–81.1)
Primary+	314	31.9	34.0 (29.2–38.8)	66.0 (61.2–70.8)
Assets				
Lowest	346	35.1	15.9 (12.3–19.4)	84.1 (80.6–87.7)
Middle	327	33.2	33.7 (29.0–38.3)	66.3 (61.7–71.0)
Highest	312	31.7	31.3 (26.3–36.3)	68.7 (63.7–73.7)

[a] Prevalences with 95% CIs were directly standardized to the World Health Organization standard population (19).
[b] NA = not applicable.

TABLE 3. Distribution and 95% confidence interval (CI)[a] of cardiovascular risk factors, by low and moderate/high physical activity levels, PERU MIGRANT study, Lima and Andean rural regions, 2007

Cardiovascular risk factors	No.	%	Low physical activity (%) (95% CI)	Moderate/high physical activity (%) (95% CI)
Hypertension[b] (*n* = 980)				
No	822	84.0	82.5 (78.8–86.2)	83.4 (80.9–85.8)
Yes	158	16.0	17.5 (13.8–21.2)	16.6 (14.2–19.1)
BMI[c] categories[d] (*n* = 979)				
Underweight	7	0.7	0.63 (NA)[e]	1.4 (0.4–2.5)
Normal	400	40.9	32.9 (27.8–38.1)	47.0 (43.5–50.5)
Overweight	376	38.4	41.7 (36.0–47.3)	35.4 (32.0–38.9)
Obese	196	20.0	24.8 (19.9–29.6)	16.1 (13.7–18.6)
Obese (*n* = 985)				
No	794	80.2	75.4 (70.6–80.2)	83.9 (81.5–86.4)
Yes	196	19.8	24.6 (19.8–29.4)	16.1 (13.6–18.5)
Obese/overweight (*n* = 979)				
No	407	41.6	33.6 (28.4–38.7)	48.4 (44.9–51.9)
Yes	572	58.4	66.4 (61.3–71.6)	51.6 (48.1–55.1)
Metabolic syndrome[f] (*n* = 985)				
No	752	76.4	75.7 (70.8–80.6)	79.1 (76.3–81.9)
Yes	233	23.7	24.3 (19.4–29.2)	20.9 (18.1–23.7)
Total	985	100	257 (26.1)	728 (73.9)

[a] Prevalences with 95% CIs were directly standardized to the World Health Organization standard population (19).
[b] As per criteria established by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (13) and European Society of Hypertension/European Society of Cardiology 2007 guidelines (14).
[c] BMI = body mass index.
[d] As per World Health Organization criteria (9).
[e] NA = not applicable.
[f] As per criteria established by the American Heart Association in 2005 (15).

times the odds (95% CI) of being obese (Table 5). This association was not changed in the fully adjusted model, which took age, sex, and socioeconomic indicators into account.

All participants in Lima lived in shantytowns or in a rural community and were evenly distributed among the lowest, middle, and highest level of assets. The odds of low physical activity were about 2.5 times higher among participants with the most assets.

Only 4.4% of all study participants had sedentary behavior (<150 MET minutes/week), of which 32 (73.1%) were in the migrant group, 12 (26.9%) were in the urban group, and none were in the rural group. Participants with sedentary behavior were analyzed as part of the low physical activity group because there was not enough power to detect meaningful differences within those with sedentary behavior.

In the adjusted linear regression analysis, the data were not consistent with a true difference in SBP or DBP between those with low and high levels of physical activity (Table 6). There was also no evidence of a true difference in blood pressure, odds of metabolic syndrome, or hypertension among those with low physical activity.

DISCUSSION

The increased risk of obesity and other chronic diseases among migrants to Westernized countries has been described in the literature (20). The current study set out to describe the differences in physical activity and sedentary behavior between rural-to-urban migrants and lifetime rural and urban residents. Marked differences were found in the patterns of physical activity and obesity among these three groups in Peru. People living in urban areas had much lower levels of activity and higher risk of obesity. The physical activity and obesity profile of migrants from rural-to-urban areas closely resembled the profile of lifelong urban dwellers. This finding strongly suggests that moving to an urban area may have led to reductions in physical activity and an increased risk of obesity.

This study also described the association between low physical activity and cardiovascular risk factors. There was no evidence of an association between low physical activity and the following cardiovascular risk factors: hypertension,

TABLE 4. Crude and multivariable adjusted odds ratio (OR) and 95% confidence interval (CI) for having low physical activity, by demographic and socioeconomic variables, PERU MIGRANT study, Lima and Andean rural regions, 2007

Demographic and socioeconomic variables	Crude analysis		Adjusted analysis Model 1[a]		Model 2[b]		Model 3[c]	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age (years)								
30–34[d]	1.0	–	1.0	–	1.0	–	1.0	–
35–39	0.77	0.46–1.29	0.77	0.46–1.29	0.77	0.45–1.30	0.78	0.46–1.32
40–44	0.65	0.39–1.09	0.65	0.39–1.09	0.65	0.38–1.11	0.63	0.37–1.08
45–49	0.56	0.33–0.98	0.56	0.33– 0.98	0.57	0.32–1.00	0.59	0.33– 1.04
50–54	0.66	0.39–1.12	0.66	0.39–1.12	0.58	0.34–1.00	0.58	0.34–1.01
55–59	0.59	0.34–1.03	0.59	0.34–1.03	0.55	0.31–0.97	0.56	0.31–0.98
≥ 60	1.03	0.63–1.68	1.03	0.63–1.68	1.17	0.70–1.94	1.17	0.69–1.97
Sex								
Female[d]	1.0	–	1.0	–	1.0	–	1.0	–
Male	0.95	0.71–1.26	1.01	0.76–1.33	0.89	0.66–1.20	0.93	0.69–1.25
Group								
Lifetime rural[d]	1.0	–	1.0	–	1.0	–	1.0	–
Rural-to-urban migrant	20.78	7.60–56.81	22.32	8.15–61.18	21.84	7.64–62.46	21.43	7.49–61.30
Lifetime urban	32.56	11.63–91.14	34.93	12.44–98.09	34.73	11.81–102.15	32.98	11.02–98.63
Assets								
Lowest[d]	1.0	–	1.0	–	–[e]	–	1.0	–
Middle	2.76	1.91–4.01	2.93	2.01–4.28	–	–	2.88	1.97–4.23
Highest	2.42	1.66–3.54	2.74	1.85–4.05	–	–	2.57	1.72–3.84
Parents' education								
None[d]	1.0	–	1.0	–	1.0	–	–[e]	–
Some primary	0.85	0.58–1.26	0.87	0.58–1.30	0.76	0.50–1.14	–	–
Primary+	1.59	1.16–2.20	1.61	1.16–2.25	1.33	0.94–1.88	–	–

[a] Model 1: adjusted for age and sex.
[b] Model 2: Model 1 + assets.
[c] Model 3: Model 2 + highest level of parental education.
[d] Reference variable.
[e] Variable adjusted for in model.

TABLE 5. Crude and multivariable adjusted odds ratio (OR) and 95% confidence interval (CI) for having low physical activity, by cardiovascular risk factors, PERU MIGRANT study, Lima and Andean rural regions, 2007

Cardiovascular risk factors	Crude analysis		Model 1[a]		Adjusted analysis Model 2[b]		Model 3[c]	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Obese (*n* = 985)								
No	1.0	–	1.0	–	1.0	–	1.0	–
Yes	1.64	1.17–2.29	1.93	1.34–2.76	1.62	1.12–2.35	1.62	1.12–2.34
Overweight/obese (*n* = 984)								
No	1.0	–	1.0	–	1.0	–	1.0	–
Yes	1.87	1.38–2.54	2.03	1.49–2.78	1.57	1.13–2.18	1.52	1.09–2.12
BMI[d] categories[e] (*n* = 984)								
Underweight	0.70	0.08–5.89	0.54	0.06–4.59	0.70	0.08–6.15	0.75	0.09–6.55
Normal	1.0	–	1.0	–	1.0	–	1.0	–
Overweight	1.71	1.23–2.39	1.80	1.29–2.53	1.44	1.01–2.05	1.41	0.99–2.00
Obese	2.18	1.48–3.24	2.56	1.72–3.90	1.97	1.29–3.02	1.94	1.26–2.97
Hypertension[f] (*n* = 985)								
No	1.0	–	1.0	–	1.0	–	1.0	–
Yes	1.34	0.93–1.95	1.32	0.89–1.98	1.23	0.82–1.85	1.22	0.81–1.83
Metabolic syndrome[g] (*n* = 985)								
No	1.0	–	1.0	–	1.0	–	1.0	–
Yes	1.29	0.81–1.57	1.23	0.8–1.74	1.08	0.76–1.54	1.05	0.74–1.51

[a] Model 1: adjusted for age and sex.
[b] Model 2: Model 1 + assets.
[c] Model 3: Model 2 + highest level of parental education.
[d] BMI = body mass index.
[e] As per World Health Organization criteria (9).
[f] As per criteria established by the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (13) and European Society of Hypertension/European Society of Cardiology 2007 guidelines (14).
[g] As per criteria established by the American Heart Association in 2005 (15).

TABLE 6. Multivariable linear analysis of continuous cardiovascular risk factors among those with low physical activity in PERU MIGRANT study, Lima and Andean rural regions, 2007

	BMI[a] β-coefficient (95% CI[d])	SBP[b] (mmHg) β-coefficient (95% CI)	DBP[c] (mmHg) β-coefficient (95% CI)
Unadjusted	1.12 (0.47–1.78)	0.74 (–1.91–+3.39)	–1.01 (–2.43–+0.41)
Adjusted Model 1[e]	1.28 (0.64–1.91)	0.52 (–1.87–+2.91)	–0.71 (–2.08–+0.66)
Adjusted Model 2[f]	0.69 (0.07–1.31)	0.26 (–2.18–+2.70)	–0.60 (–2.00–+0.80)
Adjusted Model 3[g]	0.63 (0.01–1.25)	0.06 (–2.38–+2.50)	–0.68 (–2.07–+0.72)

[a] BMI = body mass index.
[b] SBP = systolic blood pressure.
[c] DBP = diastolic blood pressure.
[d] CI = confidence interval.
[e] Model 1: adjusted for age and sex.
[f] Model 2: Model 1 + assets.
[g] Model 3: Model 2 + highest level of parental education.

metabolic syndrome, and SBP and DBP. Though there was power to detect a difference between the physical activity groups and obesity, the study may have been underpowered to detect a difference between physical activity groups and cardiovascular outcomes.

There was a positive association between higher household assets and prevalence of low physical activity. This may be because people with more assets can afford public or private transportation, whereas the poorest people have no option but to walk. These findings highlight the importance of measuring physical activity across multiple domains, instead of exclusively measuring leisure physical activity.

The study results are consistent with others that have found an indirect relationship between increased physical activity and obesity (21). Studies on the prevalence of physical inactivity in Latin America in Brazil (22), Chile (23), Mexico (24), and Peru (25) report that more than two-thirds of the populations they investigated did not meet the minimum recommended level of physical activity in a week (21, 26). This study differs from others in Latin America in that, overall (including participants in both the rural and urban groups), a higher proportion had moderate or high levels of physical activity.

In the PREVENCION study conducted in Arequipa, Peru, the prevalence of low physical activity was 57.6% among urban resident participants (27) compared with 32.2% and 39.2% in the migrant and urban groups in the current study. One reason for the difference between these two studies of urban Peruvians may be differences in the socioeconomic status of the study participants. The PREVENCION participants were more educated than participants of the current study, who were exclusively from poor shantytowns. In the current study, the highest level of education was some secondary school, which would be classified as a low level of education in the PREVENCION study. If the association between lower physical activity and higher socioeconomic status is a true association, and education is a proxy measure of socioeconomic status, then the PREVENCION study would be expected to have a higher prevalence of inactivity.

The current study found no difference in physical activity levels between males and females. It is unlikely that the similar physical activity levels between men and women were due to underrepresentation of the most active males. Physical inactivity was associated with higher household assets, and the largest group of nonresponders was urban males with higher education (70.3% versus 56.6% in urban responders) (8). The similarity in physical activity levels between men and women was inconsistent with other studies from Latin America, including cross-sectional studies in Columbia (28), Brazil (29), and the PREVENCION study (30). This study included rural residents whereas other studies only included urban residents. There may be differences in perceptions of safety between rural and urban settings. In rural areas, women may have more social support and feel safer to participate in physical activity (31). Data on the perceptions of safety were not collected in this study so that association was not described.

Limitations

A potential weakness in studies of health effects among rural-to-urban migrants stems from the fact that there are multiple reasons for migration. In some cases, various health conditions may actually be a cause rather than a symptom of migration. In other words, some people may migrate for reasons related to their health (e.g., those who are not physically able to cope with the demands of living in a rural area). On the other hand, some migrants may be healthy individuals who have the resources to move to the city and simply prefer an urban lifestyle. Another type of migrant (perhaps the most common) includes those who move to urban areas solely to find work. Because there is no "typical" migrant, making valid comparisons between migrant and nonmigrant groups can be problematic. In the current research, however, the potential for selection bias is most likely reduced (although it cannot be discounted altogether) due to the unique context offered by the Peruvian study setting. Because most mass migration to Lima was driven by fear of violence and political instability, Peruvian migrants are less likely to be atypical as a group. Therefore, compared to other migrant studies, selection bias is likely to have been less of a problem in this setting (8).

Another potential study limitation involves the survey instrument. The IPAQ questionnaire was used to assess physical activity because it has been validated in 12 countries worldwide—including Guatemala and Brazil in Latin America (32); it is culturally adaptable; and it measures physical activity across four different domains. The potential weaknesses of the questionnaire stem from three types of information bias that may be introduced during data collection: both interviewer and observer bias, which may have been present in the current research due to the use of face-to-face interviews, as recommended for studies in low- and middle-income countries (18), and recall bias, which was also likely to have been introduced in the current study's assessment of physical activity over "last seven days."

In addition, the limitations of the cross-sectional study design prohibit causal interpretation of the direction of the relationship between physical activity and obesity. However, temporal causality can reasonably be inferred: higher levels of physical activity may be one of the primary explanatory factors for lower cardiovascular risk among rural participants living in Peru. Based on the current study, the rural group had a lower mean BMI and higher levels of physical activity, whereas the migrant and urban groups had similar BMI and physical activity distributions.

Implications for public health

The PERU MIGRANT study achieved its objectives of describing both 1) the differences in physical activity and 2) the association between low physical activity and cardiovascular risk factors between migrant and nonmigrant populations in a low-income setting. It also provides a clear example of how the use of culturally specific physical activity profiles (based on typical exertion levels among residents of rural regions such as the Andes versus more sedentary environments such as Lima) can have a dramatic impact on obesity prevention strategies and the promotion of physical activity. The relationship between physical activity and obesity is culturally and contextually relevant because environments drive factors relating to the normalized quantities of physical activity.

The findings from the current study suggest that people living in rural areas have high physical activity levels that drop markedly when they migrate to an urban environment. These results are important not only for Peruvians living in urban environments but also for any migrants who move from rural-to-urban environments and adapt urbanized lifestyles. As migrants become more urbanized and their nutrition and level of physical activity adapt to a Westernized lifestyle, their risk of obesity and other chronic diseases such as type 2 diabetes increases (20).

Interventions that aim to reduce obesity and chronic diseases among migrant groups should be culturally tailored and language specific, according to a recent systematic review on obesity prevention programs among migrants in developing countries (20). These interventions should aim to maintain the higher physical activity levels associated with rural environments at an early stage of migration. Targeting migrants early may be more effective than strategies aimed at increasing their level of physical activity after they have already adapted to the sedentary lifestyle of long-term urban dwellers. Implementing intervention and evaluation programs is important for reducing the high prevalence of overweight and obesity among migrant communities in Peru.

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RESUMEN

Actividad física y factores de riesgo de enfermedades cardiovasculares en grupos rurales y urbanos y en migrantes de zonas rurales a urbanas en Perú: estudio transversal

Objetivo. Comparar los patrones de actividad física y de comportamiento sedentario de migrantes de zonas rurales a urbanas del Perú con los patrones de habitantes permanentes de zonas rurales y urbanas, e identificar cualquier asociación entre el bajo nivel de actividad física y cuatro factores de riesgo de enfermedad cardiovascular: obesidad (índice de masa corporal ≥ de 30 kg/m^2), presión arterial sistólica y diastólica, hipertensión y síndrome metabólico.

Métodos. El estudio transversal PERU MIGRANT (personas del Perú que emigran de zonas rurales a urbanas) se llevó a cabo para medir la actividad física en personas de zonas rurales y urbanas y en migrantes de zonas rurales a urbanas, por medio del uso del Cuestionario Internacional de Actividad Física (IPAQ).

Resultados. La prevalencia de actividad física baja estandarizada según la edad, de conformidad con las normas de la Organización Mundial de la Salud (OMS), fue de 2,2% en las personas que habían residido toda su vida en el campo, de 32,2% en migrantes del campo a la ciudad, y de 39,2% en habitantes de zonas urbanas durante toda la vida. Las razones de posibilidades (*odds ratios*) ajustadas para un nivel de actividad física bajo fueron 21,43 y 32,98 para individuos de grupos migratorios y urbanos, respectivamente, en comparación con el grupo de personas que vivían en el campo. El *odds ratio* ajustado para ser obeso fue de 1,94 para las personas con un bajo nivel de actividad física. No se encontraron pruebas de una asociación entre la poca actividad física y los niveles de presión arterial, hipertensión, o el síndrome metabólico.

Conclusiones. Los habitantes de zonas rurales tenían niveles de actividad física mucho más altos y un riesgo menor de tener exceso de peso o de ser obesos, en comparación con los residentes de una zona urbana de Lima. Las personas de la misma zona rural que habían emigrado a Lima presentaron niveles de inactividad física y de obesidad similares a los de las personas que habían vivido en Lima toda la vida. Las intervenciones dirigidas a mantener niveles más altos de actividad física entre las personas que emigran de las zonas rurales a las zonas urbanas pueden ayudar a reducir la epidemia de obesidad en las ciudades.

Palabras clave Enfermedades cardiovasculares; actividad motora; factores de riesgo; migración rural-urbana; obesidad; hipertensión; síndrome X metabólico; Perú.