# Migration, Urbanization and Mortality: 5-year Longitudinal Analysis of the PERU MIGRANT Study

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**What is already known on this subject?**

* Urban lifestyles increases risk of chronic diseases, including cardiovascular disease: the health of migrants hangs in the balance between the potential for improved economic circumstances and the reality of substandard conditions and poor lifestyles associated with low-income urban communities.

**What this study adds?**

* Most of the studies regarding the impact of migration on morbimortality lack a non-migrant site-of-origin population to compare estimates against.
* Both migrant and rural participants showed lower, around 90% reduction, cardiovascular mortality than their urban counterparts.

### **Word Count**

***Manuscript:*** 1499 words (IMRD, excluding tables and references)

***Abstract:*** 197 words

## ABSTRACT

**Objective:** To compare all-cause and cause-specific mortality among three distinct groups: within-country rural-to-urban migrants, and rural and urban dwellers in a longitudinal cohort in Peru.

**Methods:** The PERU MIGRANT Study, a longitudinal cohort study, used an age- and sex-stratified random sample of urban dwellers in a shantytown community in the capital city of Peru; rural dwellers in the Andes; and migrants from the Andes to the shantytown community. Participants underwent a questionnaire, and anthropomorphic measurements at a baseline evaluation in 2007-8 and at a follow-up visit in 2012-3. Mortality was determined by death certificate or family interview.

**Results:** Of the 989 participants evaluated at baseline, 928 participants (94%) were evaluated at follow-up (mean age 48 years; 53% female). Mean follow-up time was 5.1 years, totaling 4732.8 person-years. In a multivariable survival model, and relative to urban dwellers, migrant participants had lower all cause mortality (HR=0.30; 95%CI 0.12-0.78), and both the migrant (HR=0.07; 95%CI 0.01-0.41) and rural (HR=0.06; 95%CI 0.01-0.62) groups had lower cardiovascular mortality.

**Conclusion:** Migrant’s cardiovascular mortality remains similar to the rural group, suggesting that rural-to-urban migrants do not appear to catch up with the urban mortality in spite of having a more urban cardiovascular risk factor profile.

**Keywords:** Urbanization, migration, hypertension, diabetes, non-communicable disease

## INTRODUCTION

Urbanization is rapidly occurring in low- and middle-income countries (LMIC) throughout the world, particularly in Latin America. Within country migration from rural communities to urban centers has impacted the lives of many individuals, particularly those of low socioeconomic status who are seeking better employment and educational opportunities. However, many migrants find themselves relocating to urban slums to live among a population that often lacks the infrastructure and access to public services of the more affluent urban communities [1]. Urban lifestyles often include increased environmental exposures, stress, high fat and high calorie diets and low physical activity, increasing risk chronic disease, including cardiovascular disease [2].

The health of migrants hangs in the balance between the potential for improved economic circumstances and substandard conditions and poor lifestyles associated with low-income urban communities. International migration from LMIC to high-income countries has been associated with decreased all-cause mortality in comparison to the native-born population of the same nationality [3]. Yet, the mortality impact of urbanization and within country migration from rural communities to urban centers in LMIC has not been well described.

The primary objective of this study was to compare all-cause and cause-specific mortality among three distinct groups: within-country rural-to-urban migrants, rural dwellers, and urban dwellers.

## METHODS

### Study design and setting

The PERU MIGRANT Study was designed to evaluate risk factors for cardiovascular disease in three population groups: urban dwellers in Pampas de San Juan de Miraflores, a shantytown community in Lima; rural dwellers in two communities (San Jose de Secce and Chacas) located in Ayacucho, Peru; and rural-to-urban migrants from Ayacucho to Pampas de San Juan de Miraflores. An age- and sex-stratified sampling frame from each population group was identified using household census data [4]. Randomly selected participants underwent a questionnaire and anthropometric measurements at a baseline evaluation in 2007-08 [5], and a follow-up visit in 2012-13.

### Participants

For all study groups, individuals from both sexes aged 30 years and over were considered eligible at baseline. Pregnant women and those with mental disorders precluding voluntary participation were excluded.

### Mortality

Date and cause of death were determined by death certificates. When death certificates were not available, the participant’s relatives were interviewed to verify mortality and causes. All-cause and specific-cause mortality information was grouped accordingly to standardized definitions (Supplemental file 1).

### Study variables at baseline

Cardiovascular risk factors were determined using the baseline data from the PERU MIGRANT study. Hypertension was defined as SBP ≥140 mmHg; DBP ≥90 mmHg; or by physician diagnosis with concomitant use of anti-hypertensive medications [6]. Diabetes was defined as fasting capillary blood glucose greater than or equal to 126 mg/dL or self-report of physician diagnosis [7, 8]. High total cholesterol was defined as fasting cholesterol ≥200 mg/dL [9], and obesity was defined as a BMI ≥30 Kg/m2.

Tobacco use was defined as having smoked at least one cigarette in the six months prior to the interview. Physical activity was assessed with the International Physical Activity Questionnaire (IPAQ). Categorization of this variable included total days of physical activity and metabolic equivalents (MET, minutes/week) according to international standards [10]. Alcohol use was defined as the self-report consumption of ≥6 drinks on the same occasion at least once per month. Education was categorized by schooling years (<6 years, 7-11 years, and ≥12 years). Socioeconomic status was measured using a wealth index based on household income, assets and household facilities separately for each study group [11], and then combined into a single variable.

### Statistical methods

Statistical analyses were conducted in STATA 12 (STATA Corp, College Station, USA). Non-standardized mortality rates per 1000 person-years were calculated. The association between migration status and all-cause and specific-cause mortality was estimated using Cox proportional hazards regression analyses, reporting crude and adjusted models. Multivariable models were created using a hierarchical approach [12]: Model 1 included age and sex as confounders, whereas Model 2 included also education and assets index. Because rurality is highly associated with lower education and socioeconomic status, collinearity was assessed using the VIF command in STATA.

### Ethical approval

Ethical approval was obtained from Ethics Committee at Universidad Peruana Cayetano Heredia in Peru under the ID 60014 dated on June 21, 2012. Participants provided verbal informed consent due to major illiteracy rates, especially in rural areas.

## RESULTS

### Population characteristics

A total of 928 subjects of the 989 participants included at baseline (94% follow-up rate) were evaluated. At baseline, mean age was 48 years old and 53% of the cohort was female. After a mean follow-up time of 5.1 years (4732.8 person-years), there were a total of 33 deaths (9 attributable to cardiovascular causes and 8 to cancer). Older people, male sex, low education, low asset index, and those with hypertension were more likely to die during the follow-up period (Table 1).

### Mortality patterns

In general, all-cause mortality rates were similar between rural and urban groups, but these rates were halved in the migrant group. When evaluated by specific causes of death, cardiovascular and cancer deaths occurred predominantly in the urban group, whereas infectious diseases mortality was predominant in rural dwellers (Supplemental file 2).

Table 2 shows hazard ratios for mortality by study group, using the urban group as reference, and after adjustment for potential confounders. For all-cause mortality, there was evidence of lower mortality in the rural group only, by an order of 73%. In terms of cardiovascular mortality, both migrant and rural groups had lower mortality, 87% and 93% reduction, respectively, and hazard ratios were not different between these two groups. Whilst results for cancer mortality tended towards lower mortality among migrant and rural groups, confidence intervals spanned 1.

## DISCUSSION

In a longitudinal cohort of three population groups in Peru, rural dwellers were at lower risk of all-cause mortality when compared to urban individuals. Besides, pattern of risk reduction was also seen in migrant individuals. Interestingly, both migrant and rural participants showed lower, around 90% reduction, cardiovascular mortality than their urban counterparts, and there were some signals that this pattern of lower mortality may also occur for cancer-related deaths.

Our previous migration cross-sectional work showed that while the pattern was not uniform for all measured risk factors, overall rural-to-urban migration was associated with more adverse cardiovascular risk profile: higher levels (urban/migrants > rural) or a gradient of levels (urban > migrant > rural) was observed for common cardiovascular risk factors including BMI, lipid profile, metabolic and inflammatory markers, but not blood pressure [5]. This follow-up study demonstrates that despite rural-to-urban migrants did have worse risk factors than the rural group at baseline, their mortality experience remained similar to rural dwellers: migrants did not seem to ‘catch up’ with the urban group in spite of taking on a more urban cardiovascular risk profile. Apparently, rural-to-urban migrants do not develop the full urban mortality risk because their earlier life was healthier.

Given the trend of increasing urbanization in LMIC, the association between lifelong urban shantytown residence and all-cause mortality is concerning for public health. While the health hazards of urban shantytowns have been well described [1, 13], studies of the health of within-country migrants across the globe have had conflicting results, suggesting that at times the benefits of urban migration, including better access to education, health services, and nutrition, translate into better health outcomes in comparison to individuals who remain in rural poverty [14].

Additionally, transnational migration from LMIC to high-income countries has been associated with decreased all-cause mortality when compared to native-born populations of the same nationality, widely referred to as the healthy migrant effect [3]. Most of these studies lack a non-migrant site-of-origin population to compare these estimates against; hence we do not know if, and to what extent, such effect is an artifact. In our study, we benefited from having two reference populations to compare to migrant-group against, showing that cardiovascular mortality was lower in migrants relative to urban groups. This means that despite their current urban residence status, migrants still bear some of the ‘benefits’ of lower rural mortality.

This study benefits from its prospective nature and the use of three well defined populations. However, this study has also limitations. The primary limitation of this study is the small sample size as well as the limited number of deaths, obtaining results with wide confidence intervals. In addition, the cause of death determination was limited to death certificates and family report. Classification bias may arise due to methods used to collect causes of death, especially in rural areas, as potential interpretation of death and its causes could have influenced the report; however, we believe our results regarding mortality were not affected.

 In conclusion, migrant’s cardiovascular mortality remains similar to the rural group, suggesting that rural-to-urban migrants do not appear to catch up with the urban mortality in spite of having a more urban cardiovascular risk factor profile. Given the global trend of increasing urbanization, resources should be mobilized to understand and address the negative health outcomes associated with residing in urban slum communities in LMIC, as well as to deepening our understanding of protective factors explaining the lower mortality observed in migrants.

## AUTHOR CONTRIBUTIONS

MBP, AB-O and JJM defined the analysis plan of this manuscript. AB-O led the statistical analysis. JFS, JAP and RQ coordinated and supervised fieldwork activities in Lima and Ayacucho. ABO, JFS, and JJM developed the idea for this manuscript. MBP wrote the initial draft of the manuscript, all authors participated in writing of manuscript and approved final version.

## COMPETING INTERESTS

None declared.

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## FINANCIAL DISCLOSURE

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## TABLES

**Table 1:** Baseline characteristics of the PERU MIGRANT Cohort Study by incident all-cause mortality

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Dead (n = 33)****No (%)** | **Alive (n = 895)****No (%)** | **p-value\*** |
| **Age** |  |  | <0.01 |
| 30-39 | 3 (1.1) | 259 (98.8) |  |
| 40-49 | 1 (0.4) | 263 (99.6) |  |
| 50-59 | 7 (2.7) | 252 (97.3) |  |
| 60+ | 22 (15.4) | 121 (84.6) |  |
| **Sex** |  |  | 0.005 |
| Female | 11 (2.2) | 482 (97.8) |  |
| Male | 22 (5.1) | 413 (94.9) |  |
| **Site/Migration status** |  |  | 0.07 |
| Rural | 10 (5.0) | 191 (95.0) |  |
| Migrant | 14 (2.6) | 526 (97.4) |  |
| Urban | 9 (4.8) | 178 (95.2) |  |
| **Education** |  |  | 0.01 |
| Primary School or Less | 24 (5.3) | 430 (94.7) |  |
| Secondary School or More | 9 (1.9) | 463 (98.1) |  |
| **Asset index (tertiles)** |  |  | 0.02 |
| Lowest | 19 (5.7) | 313 (94.3) |  |
| Middle | 8 (2.7) | 294 (97.4) |  |
| Highest | 6 (2.0) | 288 (96.4) |  |
| **Current smoking** |  |  | 0.11 |
| Yes | 6 (6.0) | 94 (94.0) |  |
| No | 27 (3.3) | 801 (96.7) |  |
| **Alcohol use** |  |  | 0.77 |
| High | 3 (3.9) | 75 (96.2) |  |
| Low | 30 (3.5) | 820 (96.5) |  |
| **Physical activity** |  |  | 0.69 |
| Low | 10 (4.2) | 231 (95.8) |  |
| Moderate/High | 23 (3.4) | 656 (96.6) |  |
| **High total cholesterol (>200 mg/dL)** |  |  | 0.008 |
| Yes | 5 (1.7) | 281 (98.3) |  |
| No | 28 (4.4) | 613 (95.6) |  |
| **Obesity (BMI ≥30kg/m2)** |  |  | 0.28 |
| Yes | 5 (2.6) | 185 (97.4) |  |
| No | 28 (3.8) | 710 (96.2) |  |
| **Hypertension** |  |  | 0.0001 |
| Yes | 13 (8.6) | 138 (91.4) |  |
| No | 20 (2.6) | 756 (97.4) |  |
| **Diabetes** |  |  | 0.55 |
| Yes | 2 (5.1) | 37 (94.9) |  |
| No | 31 (3.5) | 857 (96.5) |  |

\*Log rank test for equality of survivor functions

### **Table 2:** Population group as a risk factor for all-cause, cardiovascular- and cancer-related mortality

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Crude model** | **Model 1** | **Model 2** |
|  | **HR (95%CI)** | **HR (95%CI)** | **HR (95%CI)** |
| **All-cause mortality** |  |  |  |
| Urban  | 1 (Reference) | 1 (Reference) | 1 (Reference) |
| Migrant | 0.46 (0.19 – 1.08) | 0.44 (0.18 – 1.04) | **0.30 (0.12 – 0.78)** |
| Rural | 1.07 (0.43 – 2.62) | 0.90 (0.36 – 2.23) | 0.49 (0.16 – 1.43) |
| **CV mortality** |  |  |  |
| Urban  | 1 (Reference) | 1 (Reference) | 1 (Reference) |
| Migrant | **0.11 (0.02 – 0.57)** | **0.11 (0.02 – 0.54)** | **0.07 (0.01 – 0.41)** |
| Rural | 0.16 (0.02 – 1.32) | 0.12 (0.01 – 1.03) | **0.06 (0.01 – 0.62)** |
| **Cancer mortality** |  |  |  |
| Urban  | 1 (Reference) | 1 (Reference) | 1 (Reference) |
| Migrant | 0.86 (0.17 – 4.42) | 0.84 (0.16 – 4.32) | 0.67 (0.11 – 4.04) |
| Rural | 0.48 (0.04 – 5.30) | 0.41 (0.04 – 4.51) | 0.29 (0.02 – 4.11) |
| **NCD (CV + cancer) mortality**  |  |  |  |
| Urban  | 1 (Reference) | 1 (Reference) | 1 (Reference) |
| Migrant | **0.30 (0.11 – 0.83)** | **0.28 (0.10 – 0.79)** | **0.20 (0.07 – 0.62)** |
| Rural | 0.24 (0.05 – 1.12) | **0.19 (0.04 – 0.90)** | **0.11 (0.02 – 0.60)** |

Model 1: adjusted for age and sex.

Model 2: adjusted for age, sex, education, and assets index.

Of the 928 participants evaluated at follow-up, 885 participants had all of the variables available to be included in the multivariable model.