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ORIGINAL PAPER

Differential Mortality Patterns Between Nicaraguan Immigrants and Native-born Residents of Costa Rica

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Abstract *Background* This study describes the all-cause and cause-specific mortality of Nicaraguan-born and native-born inhabitants of Costa Rica and examines the influence of socioeconomic and demographic factors on differential mortality risks. *Methods* We analyzed Costa Rican vital records for the years 1996–2005 with negative binomial regression models to determine the relative mortality risks of Nicaraguan immigrants versus Costa Rican natives with adjustments for age, urbanization, unemployment, poverty, education, and residential segregation. *Results* Nicaraguan-born men and women had reduced mortality risks of 32% and 34% relative to their Costa Rican-born counterparts. Excess homicide mortality was found among Nicaraguan-born men [rate ratio (RR) = 1.35, 95% CI: 1.19–1.53] and women (RR = 1.41, 95% CI: 1.02–1.95). *Discussion* The Nicaraguan-born population had a reduced all-cause mortality risk versus Costa Rican-born people over the years 1996–2005, due to markedly lower disease mortality. Homicide is a major source of excess mortality among Nicaraguan-born immigrants versus Costa Rican natives.

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Background

Immigration is transforming health needs and public health responsibilities in Costa Rica. The immigrant population in Costa Rica has expanded rapidly due to the migration of tens of thousands of Nicaraguans during the 1990s [1, 2]. By the 2000 census, Nicaraguan immigrants totaled 226,347, accounting for over 6% of the total population and 76.4% of foreign-born inhabitants of Costa Rica [3] (Fig. 1). The Nicaraguan immigrant population is probably underestimated by the 2000 census and may actually approach 400,000 or 10% of the total population [4]. Nicaraguan-born immigrants are an important part of Costa Rican life and society and constitute a significant percentage of the national workforce in many sectors of the economy including agriculture (11%), tourism (12%), construction (17%), and domestic service (28%) [2]. Stagnant economic opportunity and population growth in Nicaragua throughout the 1980s and 1990s pushed many Nicaraguans to migrate to the relative affluence of Costa Rica [1, 5, 6]. Costa Rica enjoys a per person GNI nearly five times greater than Nicaragua's, the lowest in the Western Hemisphere outside of Haiti [7].

To date no national studies have investigated Nicaraguan-born and native-born differentials in overall health status or mortality [1, 6]. Previous research is limited to a single national survey of reproductive health in 2000 that included a sub-sample of Nicaraguan immigrants [8]. Although no precise estimates exist, a large number of Nicaraguan immigrants are likely irregular migrants

(without legal migration status), a condition that is associated with increased vulnerability to human rights violations, discrimination, and exposure to disease and hazard throughout the world. Like other mobile populations in Latin America, Nicaraguan immigrants in Costa Rica are especially vulnerable to poverty, discrimination, social isolation, and restrictive policies that limit access to social services and healthcare [9, 10]. In the absence of empirical evidence, political debate is vulnerable to an excess influence by xenophobic and discriminatory prejudices faced by immigrant communities throughout the world [11]. The need for research into the health status of this population to guide policy-making and resource allocation is urgent [1, 6].

Most previous investigation of immigrant-native mortality differentials has focused on industrialized countries in North America and Western Europe in the context of "south to north" migration. Frequently this research has found an overall mortality advantage among immigrant versus native-born populations despite lower socioeconomic status [12–19]. Despite large-scale population exchanges throughout the region, immigrant versus native mortality differentials in the context of "south to south" migration within Latin America remain largely unexamined [12, 20].

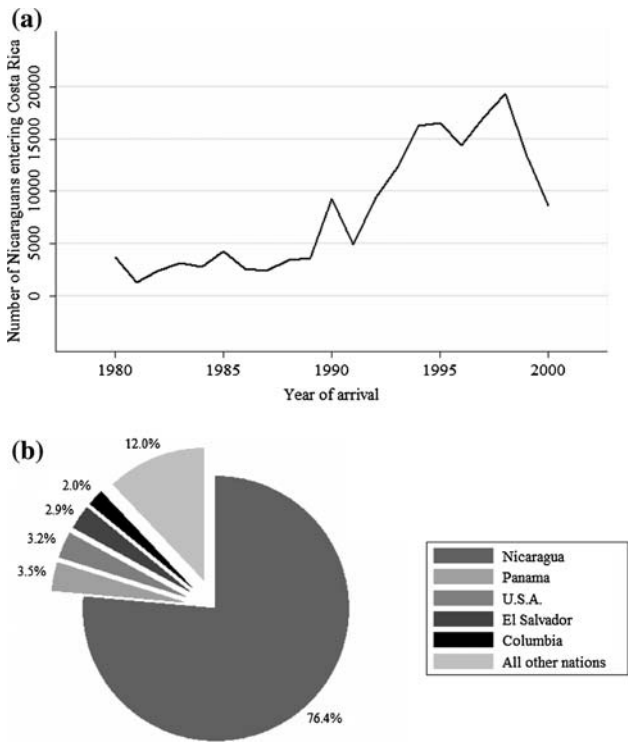

Fig. 1 (**a**) Number of Nicaraguans entering Costa Rica by year of arrival and (**b**) distribution of the immigrant population in Costa Rica in the year 2000. *Source*: Costa Rican National Census, INEC 2000

Using data from the Costa Rican census from the year 2000 and the national registry of deaths over the 10-year period from 1996 to 2005, we investigate the extent to which Nicaraguan-born compared to Costa Rican-born residents of Costa Rica differ in terms of all-cause and cause-specific mortality. We also examine the effect of socioeconomic and demographic characteristics on mortality differentials between Nicaraguan immigrants and the native Costa Rican population. To our knowledge this is the first study of Nicaraguan immigrant mortality in Costa Rica, and the first published national level study that analyzes immigrant versus native all-cause and cause-specific mortality differentials in Latin America.

Methods

Data and Measures

To calculate mortality rates, we used deaths recorded in the Costa Rican national death registry for the years 1996–2005. These records are maintained as a public use file by the *Instituto Naciónal de Estadística y Censos* (INEC). Place of birth was first included on death records in 1996, precluding analysis of previous years. Cause of death analysis included major causes of disease mortality—infection, cancer, chronic respiratory disease, cardiovascular disease, chronic liver disease—and external causes of mortality—transportation accidents, suicides, homicides, and other injury related death—coded according to the *International Classification of Diseases, Ninth Edition* (ICD-9). We analyzed all deaths recorded between 1996 and 2005, 80,220 among Costa Rican-born men, 61,588 among Costa Rican-born women, 3,294 among Nicaraguan-born men, and 2,078 among Nicaraguan-born women (Table 1). We tabulated deaths by district of residence, gender, age category, place of birth, and broad cause of death.

Analysis

All-cause and cause-specific mortality risk analyzes were conducted separately for men and women. To determine age-standardized rates, we used the average number of all-cause and cause-specific deaths occurring per year from 1996 to 2005 as the numerator in our calculations. The denominator was the corresponding population matched by age category, sex, and country of birth from the 2000 Costa Rican census (Table 2). Age standardization was completed via the direct method using the U.S. year 2000 standard as the standard population [21]. Age was divided into eight categories: 15–24 years, 25–34 years, 35–44 years,

Table 1 Socioeconomic and demographic characteristics of Nicaraguan-born versus Costa Rican-born inhabitants of Costa Rica, 2000: Costa Rican National Census for the year 2000, INEC

	Men				Women			
	Costa Rican (n = 1,755,390)		Nicaraguan (n = 113,072)		Costa Rican (n = 1,762,722)		Nicaraguan (n = 113,302)	
	No. of persons	% Population	No. of persons	% Population	No. of persons	% Population	No. of persons	% Population
All ages	1,755,390	100.0	113,072	100.0	1,762,722	100.0	113,302	100.0
Age (years)								
0–14	596,553	34.0	21,110	18.7	569,907	32.3	20,377	18.0
15–29	463,285	26.4	46,103	40.8	460,924	26.1	45,522	40.2
30–45	386,954	22.0	30,121	26.6	401,179	22.8	30,932	27.3
>45	308,598	17.6	15,738	13.9	330,712	18.8	16,471	14.5
Region								
Central Valley	1,113,430	63.4	66,077	58.4	1,144,780	64.9	72,329	63.8
Northern Pacific	140,758	8.0	10,798	9.5	137,728	7.8	10,332	9.1
Central Pacific	97,061	5.5	4,303	3.8	94,131	5.3	3,612	3.2
Southern Pacific	146,938	8.4	2,131	1.9	143,368	8.1	1,512	1.3
Caribbean	168,748	9.6	14,098	12.5	159,414	9.0	11,544	10.2
Northern Plains	88,455	5.0	15,665	13.9	83,301	4.7	13,973	12.3
Degree of urbanisation								
Urban residence	1,010,837	57.6	60,567	53.6	1,059,854	60.1	69,198	61.1
Rural	744,553	42.4	52,505	46.4	702,868	39.9	44,104	38.9
Living conditions								
Poverty[a]	583,947	32.7	52,804	46.7	551,159	31.5	45,984	40.6
Occupation[b]								
Employed	80,3921	45.8	71,946	63.6	323,145	18.3	34,302	30.3
Professional	950,900	54.2	39,923	35.3	1,437,792	81.6	78,348	69.1
Nonprofessional	804,490	45.8	73,149	64.7	324,930	18.4	34,954	30.9
No schooling beyond primary level[c]	565,366	56.2	56,248	68.3	883,800	59.8	60,507	63.2
No health insurance	333,843	19.0	47,062	41.6	251,821	14.3	43,025	38.0
Marital status[d]								
Married/Union	656,863	51.2	57,298	58.7	451,600	50.8	57,591	58.5
Divorced/Separated	47,858	3.8	2,934	3.0	666,495	2.9	6,871	7.0
Widowed	16,874	1.3	1,014	1.0	91,173	4.8	3,699	3.8
Single	556,382	43.7	36,346	37.2	63,113	37.4	30,336	30.8
Residential concentration ≥10% Nicaraguan-born residents	311,750	17.4	52,385	46.3	323,592	18.0	52,531	46.4
Self-reported health status[e]								
Current smoker		15.3		25.0		8.2		4.5
Hypertension		36.7		8.2		47.3		26.0
Activity limitation		4.4		1.3		4.4		0.0

[a] Defined by basic needs assessment (Trejos [24])

[b] For the population over 12 years of age

[c] For the population over 17 years of age

[d] For the population over 17 years of age

[e] Self-reported Health measures estimated from 2005 National Health Survey data

45–54 years, 55–64 years, 65–74 years, 75–84 years, and >84 years; children under age 15 were excluded because of the small numbers involved. Place of birth status was coded as a dichotomous variable by categorizing people as "Nicaraguan-born" or "Costa Rican-born" and excluding all others. Subjects were determined to be Nicaraguan-born

Table 2 Demographic characteristics of Nicaraguan-born versus Costa Rican-born deaths in Costa Rica, 1996–2005: Costa Rican National Mortality Registry, INEC

	Men				Women			
	Costa Rican (n = 80,220)		Nicaraguan (n = 3,294)		Costa Rican (n = 61,588)		Nicaraguan (n = 2,078)	
	No. of persons	% of deaths	No. of persons	% of deaths	No. of persons	% of deaths	No. of persons	% of deaths
All ages	80,220	100.0	3,294	100.0	61,588	100.0	2,078	100.0
Age (years)								
0–14	6,481	8.1	111	3.4	4,878	7.9	84	4.0
15–29	5,386	6.7	568	17.2	1,946	3.2	182	8.8
30–44	7,672	9.6	596	18.1	3,643	5.9	230	11.1
≥45	60,681	75.6	2,019	61.3	51,121	83.0	1,582	76.1
Region								
Central Valley	52,903	66.1	1,466	44.6	43,318	70.6	1,065	51.4
Northern Pacific	6,622	8.3	550	16.7	4,728	7.7	358	17.3
Central Pacific	4,444	5.6	157	4.8	31,65	5.2	75	3.6
Southern Pacific	5,856	7.3	196	6.0	3,800	6.2	80	3.9
Caribbean	6,993	8.7	512	15.6	4,361	7.1	255	12.3
Northern Plains	3,170	4.0	407	12.4	2,026	3.3	240	11.6
Residence								
Urban	53,969	67.3	1,902	57.7	43,452	70.6	1,307	62.9
Rural	26,251	32.7	1,392	42.3	18,136	29.4	771	37.1

or Costa Rican-born based on place of birth data contained in the death registry. Age-standardized rates for selected causes of death are presented in Fig. 2.

Age-adjusted mortality rate ratios and the contribution of socioeconomic and demographic covariates to Costa Rican-born versus Nicaraguan-born mortality differentials were estimated with negative binomial regression models using STATA version 9.0 [22]. The distribution of death counts in our data showed unexplained variation among cases likely due to differences in unobserved predictors of death. To best account for this overdispersion and a high frequency of zero counts, the negative binomial model was selected over the Poisson regression model that assumes variance is equal to the mean [23].

Men and women were analyzed separately. In our models, we matched our dependent variable (deaths) to exposure (persons-at-risk) by gender, age, and district of residence. Socioeconomic and demographic covariates directly available from the death record were sex, date of birth, country of birth, and five-digit district of residence code. Using the five-digit residence code we linked mortality data to information on district-level socioeconomic status available in the 2000 census. We transformed district level data on poverty, educational attainment, unemployment, urbanization, and portion of Nicaraguan-born residents into categorical variables by ranking all districts in Costa Rica into quartiles by each covariate. Following previous analyzes of poverty in Costa Rica by INEC we

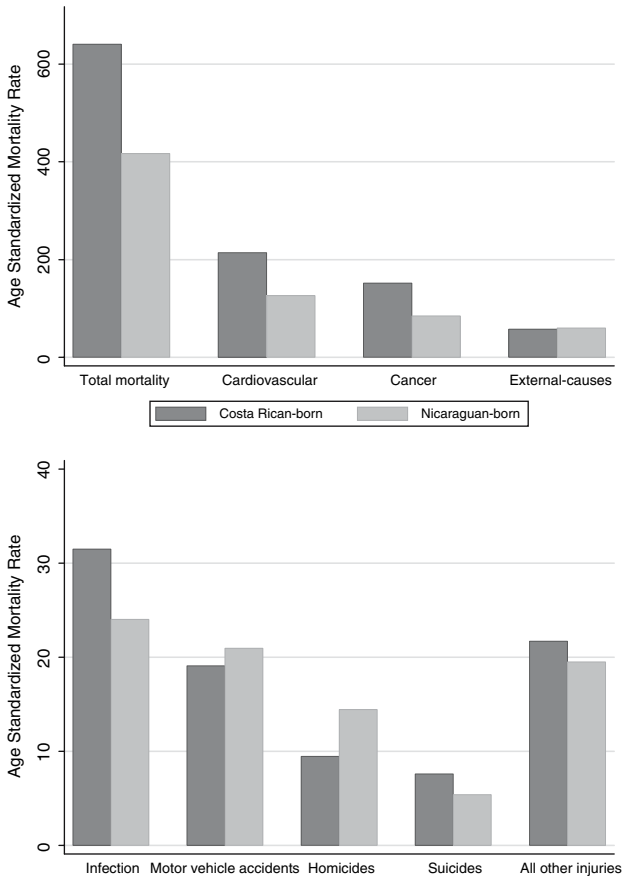

Fig. 2 Age standardized mortality rates per 100,000 for Costa Rican-born and Nicaraguan-born residents of Costa Rica by cause of death

determined poverty status using the basic needs analysis described by Trejos and Mendes [24]. Poverty quartiles were determined by the ratio of adults in the district living in poverty to the total number of residents in the district. Educational attainment quartiles were determined by the proportion of adults in the district without education beyond primary school. Unemployment quartiles were determined by the proportion of eligible adults in the district unemployed at the time of the census. Nicaraguan immigrant residential concentration quartiles were determined by ranking districts by the ratio of residents registered as Nicaraguan-born to total residents in the district. All estimates are presented as estimated rate ratios with their 95% confidence intervals.

Results

Nicaraguan-born men and women had a 23 and 30% decreased mortality risk respectively versus their Costa Rican-born counterparts after adjustment for age only. Additional adjustment for district levels of residential concentration of Nicaraguan immigrants, poverty, low educational attainment, unemployment, degree of urbanization, and region produced a small but significant strengthening of the mortality advantage among Nicaraguan immigrants.

After controlling for age and socioeconomic covariates Nicaraguan immigrant men had a 30% reduced mortality risk and Nicaraguan-born women had a 34% reduced mortality risk. Table 3 presents the results of negative binomial regression estimates for all-cause and external-cause mortality risk ratios in the combined Nicaraguan-born and Costa Rican-born population showing the effects of place of birth status and other socioeconomic covariates (only the first and fourth quartiles are shown).

Districts in the highest quartile of residents living in poverty had a total mortality risk reduction of 13% for men; there was no significant association among women. Districts with lowest educational attainment experienced a modest decrease of 7% in all-cause mortality among men, but there was no significant association among women. Among men, an increased all-cause mortality risk of 9% was found in districts in the highest quartile of unemployment. Urban districts had a 53 and 39% increased total mortality risk versus rural districts for men and women respectively. Districts in the highest quartile of the percentage of Nicaraguan-born residents had an 18% increased all-cause mortality risk for men with no significant association among women. Regions outside the metropolitan area of the nation's capital were associated with higher mortality, in particular, the Huetar Atlantic region was found to have a 21% increased total mortality risk.

Nicaraguan-born men had a 14% increased risk from external-causes of mortality when only adjusted for age. After adjusting for socioeconomic status no increased risk among either men or women remained. External-cause mortality risk was not significantly affected by district levels of poverty or unemployment. Unexpectedly, districts in the lowest quartile of educational attainment had a 19 and 28% reduced external mortality risk for men and women respectively. In urban districts men [rate ratio (RR) = 1.57] and women (RR = 1.38) had an increased external-cause mortality risk. In districts in the highest quartile for percentage of Nicaraguan residents, Nicaraguan-born men had an increased external-cause mortality risk of 26%. External-cause mortality was generally increased outside the metropolitan area, particularly in the Caribbean region of Huetar Atlantic where men were at nearly double the risk versus men in the metropolitan area of the capital.

Table 4 shows that Nicaraguan-born men and women showed substantially lower disease mortality risk than their Costa Rican-born counterparts after controlling for socioeconomic and demographic characteristics in negative binomial regression models. Covariate adjusted disease mortality was 40% lower among Nicaraguan-born men and 37% lower among Nicaraguan-born women. Nicaraguan-born men and women had significantly reduced mortality from infection (32 and 25% respectively), cancer (44 and 41% respectively), chronic respiratory disease (36 and 34% respectively), and cardiovascular disease (45 and 40% respectively). Men had a 38% reduced mortality risk from chronic liver disease, whereas among women there was no significant difference.

Among external causes of death, there was no significant difference in mortality risk for transportation-related accidents. Women had 38% reduced risk of non-transport related injury death, whereas among men there was no significant difference. Suicide risk was reduced by 21% among Nicaraguan-born men. However nativity was not significantly associated with suicide risk among women. Strikingly, the risk of homicide victimization among the Nicaraguan-born after controlling for age only greatly exceeded that for the Costa Rican-born, by 74% for men and 59% for women; after additional adjustment for socioeconomic factors, there remained a 40% excess risk among men and a 42% increased risk among women.

Further analysis of relative mortality risk by age strata, region, and quartile of Nicaraguan-born residential concentration is presented in Fig. 3. Our analysis revealed a trend toward equalization of relative risks with increasing age particularly for external causes of death; one possible explanation for such a trend would be that age is associated with duration of residence and hence degree of assimilation, a factor we could not

Table 3 All-cause and external-cause mortality rate ratios for Costa Rican native and Nicaraguan-born inhabitants of Costa Rica: 1996–2005

Covariate and adjustment	Men				Women			
	All-cause		External-cause		All-cause		External-cause	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Age adjusted[a]								
Place of birth								
Costa Rican-born	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Nicaraguan-born	0.77***	[0.73,0.80]	1.14***	[1.06,1.22]	0.70***	[0.66,0.74]	1.01	[0.86,1.18]
Covariate adjusted[b]								
Place of birth								
Costa Rican-born	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Nicaraguan-born	0.70***	[0.67,0.74]	1.02	[0.95,1.10]	0.66***	[0.62,0.70]	0.93	[0.79,1.10]
Poverty								
Lowest quartile	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Highest quartile	0.87**	[0.80,0.95]	1.06	[0.93,1.21]	0.94	[0.85,1.04]	1.01	[0.77,1.33]
Low educational attainment								
Lowest quartile	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Highest quartile	0.93*	[0.86,1.00]	0.81***	[0.72,0.91]	1.04	[0.96,1.14]	0.72**	[0.56,0.91]
Unemployment								
Lowest quartile	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Highest quartile	1.09**	[1.03,1.16]	1.06	[0.97,1.16]	1.04	[0.97,1.11]	0.87	[0.73,1.05]
Degree of urbanisation								
Lowest quartile	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Highest quartile	1.53***	[1.44,1.63]	1.57***	[1.43,1.72]	1.39***	[1.30,1.50]	1.38***	[1.16,1.65]
% Nicaraguan-born								
Lowest quartile	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Highest quartile	1.18***	[1.12,1.25]	1.26***	[1.16,1.38]	1.05	[0.99,1.12]	1.13	[0.94,1.35]
Region								
Capital Metro Area	1.00	[1]	1.00	[1]	1.00	[1]	1.00	[1]
Central Valley	1.10**	[1.04,1.17]	1.22***	[1.12,1.33]	1.07*	[1.00,1.15]	1.10	[0.93,1.31]
Chorotega	1.11**	[1.02,1.19]	1.52***	[1.35,1.70]	1.07	[0.98,1.17]	1.36**	[1.08,1.71]
Pacific Central	1.11*	[1.02,1.20]	1.49***	[1.32,1.69]	1.08	[0.98,1.19]	1.21	[0.94,1.56]
Pacific South	1.18***	[1.07,1.29]	1.60***	[1.39,1.84]	1.17**	[1.05,1.30]	1.57**	[1.19,2.09]
Huetar Altantic	1.21***	[1.11,1.32]	1.95***	[1.73,2.20]	1.25***	[1.13,1.38]	1.64***	[1.28,2.11]
Huetar North	0.98	[0.89,1.07]	1.25***	[1.10,1.43]	1.00	[0.90,1.11]	1.23	[0.94,1.63]

Note: RR = rate ratio; CI = confidence interval

[a] Adjusted for age only

[b] Adjusted for age and district residential characteristics—% living in poverty, % adults without education beyond primary level, % adults unemployed, degree of urbanisation, % Nicaraguan-born, and region

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

control for directly. There was significant variation in relative mortality risks between Nicaraguan immigrants and Costa Rican natives in different regions of the country, particularly for external cause mortality where residence in the Central Valley outside the capital metropolitan area was associated with increased risk among Nicaraguan immigrants. Residential concentration of Nicaraguan-born residents had a strong effect on external-cause mortality risk after adjusting for socio-economic covariates. In districts with relatively few Nicaraguan immigrants the relative mortality risk for Nicaraguan-born persons was over double that of their native-born counterparts whereas in districts with the highest concentration of Nicaraguan immigrants there was reduced relative risk of external-cause mortality among Nicaraguan-born persons.

Table 4 Cause specific mortality rate ratios for Costa Rican native and Nicaraguan-born inhabitants of Costa Rica: 1996–2005

Cause of death [ICD-9 codes]	Men				Women			
	Age adjusted		Covariate adjusted[a]		Age adjusted		Covariate adjusted[a]	
	RR	95% CI	RR	95% CI	RR	95% CI	RR	95% CI
Disease causes all	0.65***	[0.61,0.69]	0.60***	[0.57,0.64]	0.67***	[0.63,0.71]	0.63***	[0.59,0.67]
Infection [001–139]	0.77***	[0.66,0.89]	0.68***	[0.58,0.79]	0.81*	[0.67,0.98]	0.75**	[0.61,0.91]
Cancer [140–208]	0.55***	[0.50,0.61]	0.56***	[0.51,0.62]	0.61***	[0.55,0.67]	0.59***	[0.53,0.66]
Chronic respiratory diseases [490–496]	0.67***	[0.58,0.77]	0.64***	[0.55,0.74]	0.67***	[0.56,0.79]	0.66***	[0.56,0.78]
Cardiovascular diseases [390–448]	0.57***	[0.52,0.62]	0.55***	[0.51,0.60]	0.62***	[0.57,0.68]	0.60***	[0.55,0.66]
Chronic liver diseases [571]	0.64***	[0.52,0.78]	0.62***	[0.51,0.76]	0.86	[0.67,1.10]	0.83	[0.65,1.07]
External causes all	1.14***	[1.06,1.22]	1.02	[0.95,1.10]	1.01	[0.86,1.18]	0.93	[0.79,1.10]
Transportation accidents [E810–E825]	1.04	[0.92,1.17]	0.93	[0.82,1.05]	1.27	[0.98,1.64]	1.15	[0.88,1.49]
Injury [E800–E807, E826–E949]	1.10	[0.96,1.25]	1.00	[0.87,1.15]	0.64**	[0.49,0.83]	0.62***	[0.47,0.81]
Suicides [E950–E959]	0.77**	[0.64,0.93]	0.79*	[0.65,0.96]	0.95	[0.62,1.47]	0.94	[0.61,1.47]
Homicides [E960–E978]	1.74***	[1.51,2.00]	1.40***	[1.22,1.61]	1.59**	[1.15,2.19]	1.42*	[1.02,1.97]
Residual	0.76***	[0.67,0.86]	0.66***	[0.58,0.76]	0.71***	[0.63,0.80]	0.66***	[0.58,0.75]

Note: RR = rate ratio; CI = confidence interval; ICD-9 = International Classification of Diseases, Ninth Revision

[a] Adjusted for age, residential characteristics—poverty, low educational attainment, residential concentration of Nicaraguan immigrants, degree of urbanisation, and region

* $P < 0.10$; ** $P < 0.05$; *** $P < 0.01$

Discussion

This study provides an overview of both age-standardized death rates and covariate adjusted mortality rate ratios for Costa Rican-born and Nicaraguan-born persons in Costa Rica from 1996 to 2005. Our findings show a significantly reduced overall mortality risk for Nicaraguan-born persons in Costa Rica. Among major causes of death such as infection, cancer, cardiovascular disease, chronic respiratory disease, and chronic liver disease, immigrant Nicaraguans had large reductions in mortality risk versus their native-born counterparts. In contrast, our results show that Nicaraguan-born men and women had a substantially increased risk of death by homicide.

Our results are similar to those reported by investigators in Western Europe, Australia, and the United States that show immigrant mortality advantages [15, 19, 25–31]. The present study, to our knowledge, is the first to demonstrate immigrant mortality advantage within Latin America. Based on data from the United States National Longitudinal Mortality Study (1979–1989), Singh et al. 2001 reported that the U.S. immigrant population had a total mortality risk reduced by 18% for men and 13% for women versus the native-born population. Increased homicide mortality risk among immigrant groups has been reported by several other authors based on work in Europe and the United States. Sorenson et al. in a 1996 study of homicide deaths in California found Hispanic immigrants had a 72% increased risk over native-born Hispanics. In 2004, Bos et al. reported that in a study of vital records in the Netherlands from 1995 to 2000 immigrant men from Turkey, Morocco, Surinam, and the Antilles had increased homicide mortality risks ranging from 166 to 707% versus the native Dutch population. Though the connection between homicide perpetration and victimization is inconsistent, a recent analysis of judicial records by Mata et al. reports increased rates of homicide perpetration by Nicaraguan immigrants versus native Costa Ricans [32].

Our findings are consistent with research on immigration and mortality where, despite greater levels of socioeconomic hardship and social isolation, immigrant groups enjoy significantly reduced mortality risks. In the United States these observations have been termed the "Latino paradox" [19, 31, 33]. The origins of immigrant mortality differentials are embedded in a complex "web of causation" arising from the interaction of biological and socio-cultural factors [34]. A hypothesis termed the "healthy immigrant effect" attributes immigrant mortality to a positive selection whereby the healthiest members of the community of origin tend to migrate with a greater frequency than the community of origin as a whole [27, 29, 35]. A second potential influence is the selective return migration of seriously ill migrants termed the "salmon bias"[31]. If migrants tend to return to their country of origin when they become gravely ill and die in their country of origin the vital record will become biased toward an underestimation of mortality. Finally, health behaviors, lifestyle, and psychosocial factors may play a

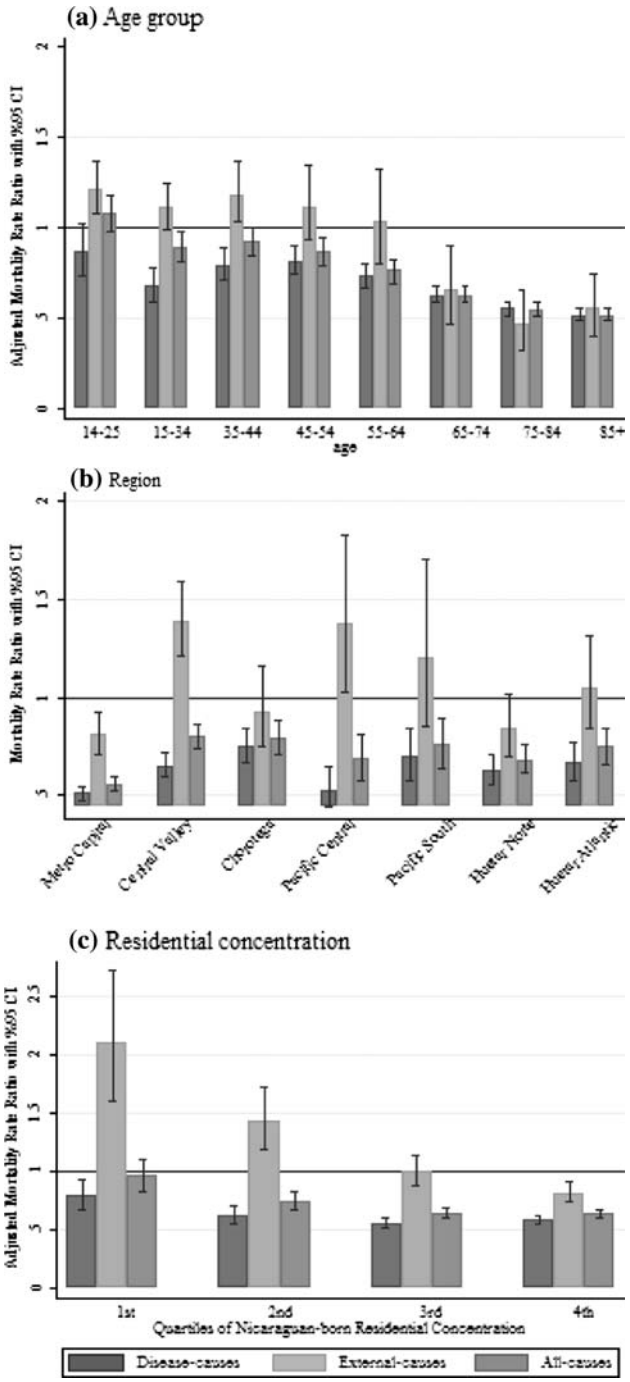

Fig. 3 Mortality rate ratio by age strata, geographic region, and quartile of Nicaraguan-born residential concentration

significant role in reducing mortality through favorable differentials in physical activity, smoking, alcohol, and drug use, dietary habits, and social support with the native population [28, 30, 33]. These hypotheses have been generally developed in the context of migration from low income developing nations to industrialized nations of Europe and North America. The relevance of these hypotheses to the developing world context remains unclear, though the data on self-reported health lend little support to a healthier lifestyle hypothesis.

Similar to our study, research in North America and Europe that has found an increased mortality risk from homicide victimization and other violent causes of death among immigrants [36–42]. Singh et al. 2001 suggests that some of the observed increase in homicide risk may be due to comparative levels of violence in the countries of origin and destination. Though the homicide mortality rate in Nicaragua was nearly double of Costa Rica both nations have relatively low homicide mortality rates. The World Report on Violence and Health reported that from 1990 to 2000 the age-standardized homicide mortality rate was 8.4 per 100,000 in Nicaragua and 4.5 per 100,000 in Costa Rica [43]. How norms toward violence in Nicaragua might impact the homicide mortality risk of Nicaraguan immigrants in Costa Rica is far from clear especially considering that the low homicide mortality risk in Nicaragua was observed despite social conditions often implicated in promoting violence—recent history of armed conflict, small arms proliferation, and poverty [44]. In their 2001 study, Singh et al. found that socioeconomic factors such as poverty and educational attainment explained excess homicide mortality among U.S. immigrants initially found in calculations that adjusted for age only. Using a methodology similar to that of Bos et al., we controlled for socioeconomic differences in the Nicaraguan-born and Costa Rican-born population through census data linked to death records by district of residence. Our results show that socioeconomic factors explain as much as 29% of the excess homicide mortality among Nicaraguan immigrants. However, even after covariate adjustments there remained a 40 and 42% increased homicide mortality risk for Nicaraguan-born men and women respectively. The genesis of violence in immigrant communities is complex and multifactorial. Social factors not available for our analysis, such as xenophobic attitudes, discriminatory social policy, and social norms of violence may play a significant role [11, 45, 46].

Our results show that the increased relative risk of external-cause mortality among Nicaraguan-born immigrants was strongly associated with residence in districts in the lowest quartile for concentration of Nicaraguan-born residents. In districts with high concentrations of Nicaraguan-born residents, Nicaraguan immigrants had significantly reduced relative mortality risk from both external and disease-related causes consistent with an "ethnic density" effect and the hypothesis that the health of a group's members is promoted by higher consonant group concentrations [47–50]. This effect is particularly strong among Hispanics in the United States where increasing concentration of other Hispanics is consistently associated with decreased mortality risk [48, 51, 52].

Our study was limited because educational attainment, household income, and other important socioeconomic covariates were not directly available from Costa Rican vital records. Although, census track level socioeconomic conditions are have been shown to be strong independent predictors of mortality in the United States, using the five-digit residential code to link death records census likely misses significant differences in the socioeconomic conditions of neighborhoods within a given district [53–58]. Neither length of stay in Costa Rica nor legal migration status were available on the death record, potentially concealing significant heterogeneity within the immigrant community.

Socioeconomic and demographic change as the result of migration and economic globalization are increasingly altering the social and biological context of health and illness in Costa Rica and throughout the world [59]. Costa Rica has one of healthiest resident populations in the world. Contrary to the fears of many policy makers in Costa Rica, Nicaraguan immigrants may be making Costa Rica's residents even healthier. Future research should examine the role of socioeconomic and cultural factors such as social norms towards violence, social integration, and institutionalized discrimination on native-born versus immigrant mortality differentials. The factors underlying the particular vulnerability of Nicaraguan immigrants to homicide victimization also deserve further investigation.

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