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The relationship between neighborhood-level socioeconomic characteristics and individual mental disorders in five cities in Latin America: multilevel models from the World Mental Health Surveys

Laura Sampson[1] · Silvia S. Martins[2] · Shui Yu[1] · Alexandre Dias Porto Chiavegatto Filho[3] · Laura Helena Andrade[4] ·
Maria Carmen Viana[5] · Maria Elena Medina-Mora[6] · Corina Benjet[6] · Yolanda Torres[7] · Marina Piazza[8] ·
Sergio Aguilar-Gaxiola[9] · Alfredo H. Cia[10] · Juan Carlos Stagnaro[11] · Alan M. Zaslavsky[12] · Ronald C. Kessler[12] ·
Sandro Galea[1,2]

Abstract

Purpose Our understanding of community-level predictors of individual mental disorders in large urban areas of lower income countries is limited. In particular, the proportion of migrant, unemployed, and poorly educated residents in neighborhoods of these urban areas may characterize group contexts and shape residents' health.

Methods Cross-sectional household interviews of 7251 adults were completed across 83 neighborhoods of Buenos Aires, Argentina; Medellín, Colombia; São Paulo, Brazil; Lima, Peru; and Mexico City, Mexico as part of the World Mental Health Survey Initiative. Past-year internalizing and externalizing mental disorders were assessed, and multilevel models were used.

Results Living in neighborhoods with either an above-average or below-average proportion of migrants and highly educated residents was associated with lower odds of any internalizing disorder (for proportion migrants: OR 0.75, 95% CI 0.62–0.91 for the bottom tertile and OR 0.79, 95% CI 0.67–0.94 for the top tertile compared to the middle tertile; for proportion highly educated: OR 0.76, 95% CI 0.64–0.90 for the bottom tertile and OR 0.58, 95% CI 0.37–0.90 for the top tertile compared to the middle tertile). Living in neighborhoods with an above-average proportion of unemployed individuals was associated with higher odds of having any internalizing disorder (OR 1.49, 95% CI 1.14–1.95 for the top tertile compared to the middle tertile). The proportion of highly educated residents was associated with lower odds of externalizing disorder (OR 0.54, 95% CI 0.31–0.93 for the top tertile compared to the middle tertile).

Conclusions The associations of neighborhood-level migration, unemployment, and education with individual-level odds of mental disorders highlight the importance of community context for understanding the burden of mental disorders among residents of rapidly urbanizing global settings.

Keywords Urban health · Neighborhood effects · Internalizing disorders · Externalizing disorders · Latin America

Introduction

In Latin America and the Caribbean, neurological and mental disorders account for over 20% of the total disease burden, as measured by disability-adjusted life years [1]. An

✉ Laura Sampson
Lsamps@bu.edu

Extended author information available on the last page of the article

estimated 5.7% of adults per year suffer from alcohol abuse or dependence; 5.0% from major depression; and 3.4% from generalized anxiety disorder [2]. In São Paulo, the largest metropolitan area in Latin America with more than 21 million inhabitants, the estimated prevalence of any past-year mental disorder is estimated to be as high as 30% [3]. Prevalence of any disorder in Mexico City, the next most populous metropolitan area in the region with about 21 million inhabitants, is estimated to be 12% [4].

Latin America has experienced rapid urbanization in recent years, with more than 80% of the population currently living in urban areas [5]. This proportion is expected to increase to 90% by as early as 2020 in Brazil and by

2050 in the remainder of the region [6]. Urbanization is associated with a range of demographic changes at the individual level, such as changes in employment conditions, that may contribute to mental disorders [3, 7–10].

Additionally, demographic changes at a community level, such as the creation of migrant enclaves, can influence individual mental health. Community-level characteristics have long been known to play a role in individual-level health outcomes in higher income countries [11] and more recently in other countries throughout the world [12]. In Latin America, although ample work has shown that individual-level socio-demographics such as migrant status, employment, education, and income are associated with mental health [13–16], very few studies have focused on the contextual, neighborhood-level determinants of mental disorders [17].

Three contextual characteristics may be particularly important forces shaping mental health in Latin American cities. First, these cities have grown primarily due to an influx of internal migrants. Brazil in particular has recently experienced mass internal migration from lower income rural areas to urban areas such as São Paulo, largely for education and employment opportunities [3]. Regions with recent terrorism or political upheaval such as Peru and Colombia have also seen heavy internal migration in recent years [16, 18]. The target cities of such migration often lack the infrastructure to house, employ, or provide general resources to larger populations [3, 19]. High movement within countries also transforms the demographics of a particular area, creating low-income migrant neighborhoods that often lack the social capital available elsewhere in the cities and can lead to increases in socioeconomic inequality. Evidence from existing work in high-income countries suggests that these changing urban landscapes may influence population burden of mental disorders [9, 20], but less is known about the effects in lower income countries.

Second, overall employment patterns in a community may contribute to mental health indicators. This may be particularly important in the context of Latin American cities, many of which have experienced recent high levels of unemployment and economic hardship that are exacerbated by the influx of internal migrants [21, 22]. The relationship between community-level unemployment and other health-related outcomes has been demonstrated in other urban locations. For example, one US study found that women living in urban neighborhoods with higher unemployment rates had increased odds of reporting that they experienced domestic violence compared to women in the same city and at the same income level but who lived in neighborhoods with lower unemployment rates, after adjusting for individual-level unemployment status and other demographics [23]. Furthermore, unemployment levels can contribute to social disorganization at the neighborhood level, which has been shown as an aggregate factor to be associated with mental disorder in US studies [24].

Third, group education levels may be associated with mental disorders. Using the São Paulo sample of the World Mental Health (WMH) study, Silveira et al. found that neighborhood social deprivation, an index that included education level in addition to other socio-demographics that were collected from census data, was associated with higher odds of alcohol-related disturbances and disorders [25]. Similarly, Orozco et al. found that increases in a neighborhood disadvantage index which included low access to education was associated with increased odds of alcohol use disorder at the individual level in Northern Mexico [26].

Like employment, education contributes to group-level social class, which may affect residents' capacity to advocate for needs within the neighborhood and, therefore, increase social capital in the area. Greater social capital in communities can be associated with more resilience after natural disasters and better overall navigation of health systems, among other positive effects on health [27]. Although neighborhood-level education on its own, not in combination with other socio-demographics, has not been found to be a strong predictor of mental health in other geographic contexts [28], no studies to our knowledge have addressed this particular question in Latin America or other lower income areas.

Finally, we expect neighborhood-level migrant status, unemployment levels, and education to have differential effects on mental disorders depending on the type of disorder, based on the knowledge that different types of disorders have different predictors at the individual level in this population [3, 4]. One way of categorizing different disorders is to split them into internalizing and externalizing disorders [29]. Internalizing disorders include those whose symptoms are generally expressed inwardly, such as depression and anxiety, while externalizing disorders are defined as those that present outwardly with behavior, and include intermittent explosive disorder and substance abuse. To our knowledge, no other studies have addressed neighborhood-level socioeconomic variables in terms of their potential effects on externalizing and internalizing disorders in Latin America.

Therefore, in an effort to expand our knowledge of the aforementioned contextual factors, our objective in the current study was to examine the associations of neighborhood-level migration, unemployment, and education levels with the presence of internalizing disorders (posttraumatic stress disorder, panic disorder, specific phobia, social phobia, agoraphobia, adult separation anxiety, generalized anxiety disorder, major depressive disorder, dysthymic disorder and bipolar/sub-threshold bipolar disorders) and externalizing disorders (intermittent explosive disorder and alcohol and drug abuse with or without dependence) while adjusting for the comparable individual-level variables in a pooled sample of residents in Buenos Aires, Argentina; Medellín,

Colombia; São Paulo, Brazil; Lima, Peru; and Mexico City, Mexico.

Methods

Sample

Data came from the WMH surveys in five different countries in Latin America. The sample was comprised of non-institutionalized residents aged 18 years or older in Argentina (collected in 2015), Colombia (collected in 2011–2012), Brazil (collected in 2005–2007), Peru (collected in 2004–2005), and Mexico (collected in 2001–2002). Table 1 provides more detail on each country's survey. The Medellín, Colombia data ($n = 1673$) and the São Paulo, Brazil data ($n = 2942$) were each from studies carried out in only those cities within each country (the Medellín Mental Health Household Study and the São Paulo Megacity Study, respectively). For the remaining three countries, due both to our content focus on neighborhood effects within very large urban areas, and further to justify multilevel analyses, we restricted to data from cities that were large enough and had enough geographic dispersion to statistically support using neighborhoods as a second level, as well as to ensure that the constructed sampling weights remained representative of the areas. These cities included Buenos Aires, Argentina ($n = 834$); Lima, Peru ($n = 1350$); and Mexico City, Mexico ($n = 460$).

Each country carried out a multi-stage sampling design consisting of selecting nested geographic areas (e.g., the equivalent of towns within counties, city blocks within towns, and households within blocks) to arrive at a representative sample of households, from which individuals were randomly chosen to be interviewed [4, 30, 31]. All WMH interviews were administered face-to-face at the homes of participants by trained lay interviewers. The surveys were translated using a standardized World Health Organization (WHO) translation, back-translation, and harmonization protocol [32]. Written and informed consent was obtained from all participants after a full description of the study. These consent procedures were approved by the human subjects committees of the organizations carrying out the surveys in each of the countries.

Table 1 WMH sample characteristics by World Bank income categories

Country (city) by income category	Survey[a]	Sample characteristics	Field dates	Age range	Sample size		Response rate[b]
					Part I	Part II	
I. Low and lower-middle income countries							
Peru (full country sample that includes Lima)	EMSMP	Five urban areas of the country—approximately 38% of the total national population	2004–2005	18–65	3930	1801	90.2
II. Upper-middle income countries							
Brazil—São Paulo	São Paulo Megacity	São Paulo metropolitan area	2005–2007	18–93	5037	2942	81.3
Colombia—Medellín	MMHHS	Medellín metropolitan area	2011–2012	19–65	3261	1673	97.2
Mexico (full country sample that includes Mexico City)	M-NCS	All urban areas of the country—approximately 75% of the total national population	2001–2002	18–65	5782	2362	76.6
Subtotal					(14,080)	(6977)	82.3
III. High-income countries							
Argentina (full country sample that includes Buenos Aires)	AMHES	Eight largest urban areas of the country—approximately 50% of the total national population	2015	18–98	3927	2116	77.3
IV. Total					(21,937)	(10,894)	82.7

The World Bank (2012) Data. Accessed May 12, 2012 at: http://data.worldbank.org/country. Some of the WMH countries have moved into new income categories, since the surveys were conducted. The income groupings above reflect the status of each country at the time of data collection. The current income category of each country is available at the preceding URL

[a]EMSMP (La Encuesta Mundial de Salud Mental en el Peru); MMHHS (Medellín Mental Health Household Study); M-NCS (The Mexico National Comorbidity Survey); AMHES (Argentina Mental Health Epidemiologic Survey)

[b]The response rate is calculated as the ratio of the number of households in which an interview was completed to the number of households originally sampled, excluding from the denominator households known not to be eligible either because of being vacant at the time of initial contact or because the residents were unable to speak the designated languages of the survey. The weighted average response rate is 82.7%

The shorter Part I of the survey was completed by all WMH participants and assessed core disorders and demographics, while the longer Part II, which assessed more detailed life events and less common disorders, was completed by all respondents who met lifetime criteria for any Part I disorder and a random 25% of the remaining Part I respondents. The sample was then weighted to adjust for differential sampling of Part I respondents into Part II, for differential probability of selection within households, and to match socio-demographic distributions in the cities [33]. The weighted Part II sample is thus representative of the distribution of mental disorders and marital status in each subpopulation and statistically accounts for differences observed in the distribution of age, sex, and marital status between the sample and the population. The analyses reported in this manuscript are from the weighted Part II sample (pooled $n = 7259$ across the five cities).

Neighborhood definition

Neighborhoods were defined by local areas of residence within each city or surrounding metropolitan area, which were used as either the primary or secondary sampling stages in each of the cities, depending on sampling design for each country and whether the city was part of a larger country-wide survey. In Mexico City, these were census count areas, similar to US census tracts. In São Paulo, they were administrative areas throughout the main city and geographic census clusters throughout the surrounding metropolitan area. In Medellín, they were geographic areas called comunas and corregimientos. In Buenos Aires, they were census radii, and in Lima, they were neighborhoods of about 80 housing units each called conglomerados. In total, 83 neighborhoods were included in our sample across the five cities, with a mean of 87, a median of 86, and a range of 30–176 respondents per neighborhood.

To mitigate the concern that some neighborhoods may not have a large enough number of respondents within them to validly represent the neighborhood, we completed a sensitivity analysis in which we removed approximately 10% of participants ($n = 720$ or 16 neighborhoods) that were neighborhoods represented by the smallest number of participants, for all analyses described below. We found our results to be extremely robust (see Supplementary Appendix Tables I–II), suggesting that this was not a likely concern.

Individual-level measures

Internalizing and externalizing disorders (primary outcomes)

Mental disorders were assessed using the WHO Composite International Diagnostic Interview (CIDI) Version 3.0 [34]. The past-year diagnoses of these disorders were based on the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria [35]. Outcomes included internalizing disorders (posttraumatic stress disorder, panic disorder, specific phobia, social phobia, agoraphobia, adult separation anxiety, generalized anxiety disorder, major depressive disorder, dysthymic disorder, and bipolar/subthreshold bipolar disorders) and externalizing disorders (intermittent explosive disorder and alcohol and drug abuse with or without dependence). Diagnoses based on the CIDI showed good concordance with blinded clinical reappraisal interviews using the Structured Clinical Interview for DSM-IV [36, 37].

Individual-level fixed effects

We included the following individual-level demographic indicators as potential confounders: age (categories of 35–49, 50–64 and 65 + vs. 18–34); sex (female vs. not); marital status (currently married vs. otherwise); employment status (currently unemployed vs. not); relative individual income; educational attainment (highly educated vs. not); and migrant status (migrant to city vs. not).

Individual income was defined as the combined income of all family members living in the household divided by the number of family members. The ratio of individual income to the median city-level income was then calculated using the entire Part I sample and used as a continuous predictor for relative income after being centered. Individual education was dichotomized as a binary indicator of having above vs. below the median country-level education based on the full Part I sample, to describe being more highly educated relative to the rest of the country.

Migration was defined as answering the question of where the respondent was mostly raised with any choice other than "in a large city" (all participants in this sample lived in large cities at the time of the survey); we did not have information on the specific location of birth or childhood in all of the country's surveys. In the Buenos Aires survey, a more detailed question was asked of how many years the respondent has lived in the current city. As a sensitivity analysis, we used the responses to this question and the value of age at interview to compute a variable that represents the age at which the respondent moved to the current city. We then dichotomized that variable at age 18 and compared whether the respondent said they moved to the current city after age 18 (i.e., were an adult migrant to the city) as a "gold standard" to our variable for migrant status used in the full sample, to ascertain how well the two variables overlapped in Buenos Aires.

Contextual measures

Neighborhood-level fixed effects

For each of the 83 neighborhoods, we calculated three contextual variables, using the individual variables described above: (1) the weighted percent of residents raised mostly outside of a large city (a neighborhood-level indicator of migrants to the city,); (2) the weighted proportion of unemployed individuals (a neighborhood-level indicator of unemployment); and (3) the weighted proportion of relatively highly educated individuals, using the binary definition for higher individual education described above. Each of these variables was then categorized into tertiles to classify each neighborhood as relatively high, intermediate, or low on each of these three contextual measures and used as categorical explanatory variables, due to the non-linearity of their relationships with the outcomes, and to aid in interpretability.

Handling of missing data

Missing values (due to responses of "don't know" or refusals to answer) on income were imputed using single imputation in SAS PROC MI. Missing values on marital status and education were imputed using hot-deck imputation.

For disorder symptom questions, to be as conservative as possible, if a participant responded "don't know" or refused to answer a question, they were recorded as not having that symptom, which is the most prevalent response. The same approach was taken for the unemployment question; if a respondent answered don't know or refused to answer this question, they were recorded as not being currently unemployed (i.e., as 0), which was also the most prevalent response.

For the migration variable, since being migrant was a more common occurrence in this sample (as opposed to being unemployed or having symptoms of disorder) and since we did not have an a priori assumption of the direction in which a potential effect of this variable might go, there was no obvious conservative approach. Furthermore, there were only 8 respondents (0.04% of the weighted Part II sample) who refused to answer or answered "don't know" on the question of where the respondent was raised, which was used to construct the migrant variable. Thus, we removed these 8 participants from our analysis, resulting in our final analytic sample of 7251 respondents.

There were no missing values on the aggregate neighborhood-level variables, as they were constructed from overall proportions using the variables described above.

Data analysis

Data analysis was carried out using SAS version 9.4. Population-weighted frequencies and means were calculated using SAS survey procedures to calculate valid design-based standard errors. Weighted, multilevel, multivariate logistic regression models were carried out with either past-year internalizing or externalizing disorder as the outcome, first with individual-level exposures only and then with each neighborhood-level variable as the primary exposure of interest, controlling for the individual-level covariates. We also checked multiplicative interactions between city and each neighborhood-level variable.

SAS Proc Glimmix was used for multilevel modeling. To allow the predicted probabilities of the outcome for each model to vary by both city and neighborhood, we included random intercepts at the city level and at the neighborhood level nested within city for all models. The intraclass correlation coefficients (ICC) for variation at each level were calculated from random-intercept-only models. Zero G tests were run to test the random effects of the intercepts in each model.

As sensitivity analyses, we also ran multilevel models using SAS Survey logistic regressions to account for survey design without repeated measures correction, and found very similar results across the two methods, suggesting robust results (see Supplementary Appendix Tables III–IV).

Finally, after assessing the results and to try to put the three neighborhood-level determinants together, we ran a model with individual-level variables and one binary variable for whether individuals lived in neighborhoods that fit the profile of being in the middle tertile of proportion of migrants, the middle tertile of proportion highly educated, and the top tertile of proportion of unemployed residents, which were each individually associated with higher odds of internalizing disorder.

Results

Prevalence of mental disorders

Among the 7251 respondents in our sample, 17.1% met criteria for the past-year internalizing disorder and 4.7% met criteria for the past-year externalizing disorder (Table 2).

Distributions of independent variables

Almost half (43.4%) of the weighted sample was younger than 35 years of age and just over half (52.6%) were women (Table 2). The weighted mean ratio of individual income to median city income was 1.84. Two-thirds of the sample was in the top 50% of country-level education and 57.8% were

Table 2 Distributions of independent and dependent variables among 7251 residents of 5 cities in Latin America

	Unweighted n	Weighted (%)	Weighted mean or mean proportion (%)
Cities			
Mexico City	460	4.63	–
Lima	1350	18.51	–
Medellín	1673	21.32	–
São Paulo	2934	37.45	–
Buenos Aires	834	18.09	–
Individual-level variables			
Age 18–34	2832	43.44	
Age 35–49	2443	31.18	–
Age 50–64	1538	19.00	–
Age 65 +	438	6.38	–
Female	4388	52.60	–
Ratio of individual income to median city income	–	–	1.84
In top 50% of country-level education	4474	66.63	–
Currently married	4175	57.83	–
Migrant to megacity	3099	38.89	–
Unemployed	602	7.88	–
Mental disorders			
Any past-year internalizing disorder[a]	2120	17.05	–
Any past-year externalizing disorder[b]	492	4.74	–
Neighborhood-level variables			
Bottom tertile of % migrants to city	2163	33.93	23.48
Middle tertile of % migrants to city	2062	33.26	37.71
Top tertile of % migrants to city	3026	33.81	56.01
Bottom tertile of % unemployed	2638	34.90	3.89
Middle tertile of % unemployed	2119	33.63	8.88
Top tertile of % unemployed	2494	31.47	14.73
Bottom tertile of % in top 50% of country-level education	2365	33.07	48.79
Middle tertile of % in top 50% of country-level education	2681	34.18	64.97
Top tertile of % in top 50% of country-level education	2205	32.75	84.19

[a]Internalizing disorders include anxiety (posttraumatic stress disorder, panic disorder, specific phobia, social phobia, agoraphobia, adult separation anxiety, generalized anxiety disorder) and mood (major depressive disorder, dysthymic disorder and bipolar/sub-threshold bipolar) disorders

[b]Externalizing disorders include behavioral (intermittent explosive disorder) and substance use (alcohol and drug abuse with or without dependence) disorders

married. Nearly 40% were migrants and about 8% endorsed being currently unemployed.

The bottom section of Table 2 shows the distribution of contextual fixed effect variables. Neighborhoods in the bottom, middle, and top tertile of percent migrants comprised of an average of 23.5%, 37.7%, and 56.0% migrants, respectively. The weighted mean proportion of unemployment among neighborhoods was 3.9%, 8.9%, and 14.7% in the bottom, middle, and top tertile of percent unemployed, respectively. Finally, the mean proportion of highly educated residents in each neighborhood was 48.8%, 65.0%, and 84.2% for the bottom, middle, and top tertile of percent highly educated residents, respectively.

Intraclass correlation coefficients from random-intercept-only models

For any past-year internalizing disorder, the ICCs (not shown in tables) were 0.0324 for city and 0.0371 for neighborhood. For any past-year externalizing disorder, the ICCs were 0.0571 for city and 0.0398 for neighborhood. Both sets of random effects were statistically significant according to the Zero G tests (all $p < 0.0001$), justifying the statistical use of multilevel models with random intercepts. Neighborhoods and cities were associated with a greater overall proportion of the variation of externalizing disorders (nearly 10% total) compared to internalizing disorders (about 7% total).

Past-year internalizing disorder

Table 3 reports multivariate logistic regression results from four multilevel models with any past-year internalizing disorder as the outcome. The first column shows a model with individual-level variables only; the second column shows a model with the same individual-level variables as in the first column but with neighborhood-level percentage of migrants as the main independent variable of interest; the third column shows a model with neighborhood-level percentage of unemployed individuals as the main independent variable of interest; and the final column shows a model with neighborhood-level education as the main independent variable of interest.

Among the individual-level variables, the odds of meeting criteria for the past-year internalizing disorder were lower for those aged 65 + (OR 0.36, 95% CI 0.25–0.51), those more highly educated (OR 0.70, 95% CI 0.54–0.90 for having above-average education compared to below-average) and married individuals (OR 0.75, 95% CI 0.64–0.87), and higher for women (OR 2.40, 95% CI 1.92–3.00) and unemployed individuals (OR 1.14, 95% CI 0.99–1.33).

The neighborhood-level fixed effects were each associated with the odds of any past-year internalizing disorder, independently of the individual-level variables. Living in neighborhoods with both relatively high and relatively low proportions of migrants and was associated with lower odds of any past-year internalizing disorder (OR 0.75, 95% CI 0.62–0.91 for the bottom tertile and OR 0.79, 95% CI 0.67–0.94 for the top tertile, both compared to the middle tertile).

Living in neighborhoods with a relatively higher proportion of unemployed individuals was associated with higher odds of having any past-year internalizing disorder (OR 1.49, 95% CI 1.14–1.95 for the top tertile compared to middle tertile). Finally, living in neighborhoods with both relatively high and relatively low proportions of educated residents was associated with lower odds of any past-year internalizing disorder (OR 0.76, 95% CI 0.64–0.90 for the bottom tertile and OR 0.58, 95% CI 0.37–0.90 for the top tertile, both compared to the middle tertile).

In all four models, the random effects of the intercepts varying at the neighborhood and city levels were statistically significant (all $p < 0.0001$; bottom row of table), further illustrating that the probability of having disorder varied across neighborhoods and cities.

The binary indicator for potential neighborhood disadvantage according to our results (living in neighborhoods in the middle tertile of proportion of migrants, the middle tertile of proportion of highly educated, and the top tertile of proportion of unemployed residents) was associated with 38% greater odds of having any past-year internalizing disorder (OR 1.38, 95% CI 1.05–1.81; results not shown in table).

Past-year externalizing disorder

Table 4 shows the same models as in Table 3, but with any past-year externalizing disorder as the outcome. In the individual-level variables only model, age showed an inverse dose–response relationship with odds of disorder (OR's ranged from 0.10 to 0.60), with those of older age being less likely to have externalizing disorder. Being female (OR 0.39, 95% CI 0.26–0.58) and being more highly educated (OR 0.63, 95% CI 0.56–0.71) were both associated with lower odds of externalizing disorder, while being unemployed was associated with 2.4 times greater odds of having a disorder (95% CI 1.93–3.06).

At the neighborhood level, neither the proportion of migrants nor the proportion of unemployed residents was significantly associated with externalizing disorder (OR's ranged from 0.77 to 1.29). Living in neighborhoods in the top tertile of highly educated residents (fourth column) was associated with 46% decreased odds of the past-year disorder (OR 0.54, 95% CI 0.31–0.93 for the top tertile of highly educated residents vs. the middle tertile).

In all four models, similar to any past-year internalizing disorder, the random effects of the intercepts varying at the neighborhood and city levels were statistically significant (all $p < 0.0005$; bottom row of table), illustrating that the probability of having the past-year externalizing disorder varied across neighborhoods and cities.

Sensitivity and specificity of migration variable

When comparing the more detailed question in the Buenos Aires survey for age that the respondent moved to the current city (considered the "gold standard" in this situation, and using a cutoff of 18 years as the definition of an adult migrant) with the response of whether one was not "mostly raised in a large city," we found a higher specificity (76%) compared to sensitivity (63%). In other words, if a respondent was not an adult migrant to the city (i.e., born in or moved to Buenos Aires prior to age 18), he or she was more likely to answer that they were, in fact, raised mostly in a large city and, therefore, coded as a non-migrant in this study. However, sensitivity was slightly lower; some respondents who were adult migrants to their current city based on the more detailed question also responded that they were raised in a large city (likely a different large city).

Discussion

In a sample of five large cities in Latin America, we found that neighborhood distributions of migrants, unemployed individuals, and educated individuals were associated with the odds of a past-year individual-level mental disorder.

Table 3 Multilevel logistic regression models with any past-year internalizing disorder as the dependent variable among 7251 residents of 5 cities in Latin America

	Individual-level exposures only			Individual-level exposures and neighborhood-level migrant status		
	Odds ratio	95% CI lower limit	95% CI upper limit	Odds ratio	95% CI lower limit	95% CI upper limit
Individual-level fixed effects						
Age 35–49	1.10	0.94	1.29	1.10	0.93	1.30
Age 50–64	0.99	0.78	1.25	0.99	0.79	1.24
Age 65 +	0.36	0.25	0.51	0.36	0.25	0.51
Female	2.40	1.92	3.00	2.40	1.92	3.00
Ratio of individual income to city income	1.00	0.95	1.04	1.00	0.95	1.04
In top 50% of country-level education	0.70	0.54	0.90	0.70	0.54	0.91
Married	0.75	0.64	0.87	0.75	0.64	0.87
Migrant to megacity	0.93	0.83	1.03	0.93	0.84	1.02
Unemployed	1.14	0.99	1.33	1.14	0.99	1.32
Neighborhood-level fixed effects						
Bottom tertile of % migrants to city				0.75	0.62	0.91
Middle tertile of % migrants to city				Reference		
Top tertile of % migrants to city				0.79	0.67	0.94
Bottom tertile of % unemployed						
Middle tertile of % unemployed						
Top tertile of % unemployed						
Bottom tertile of % in top 50% of country-level education						
Middle tertile of % in top 50% of country-level education						
Top tertile of % in top 50% of country-level education						

Random effects	Variance estimate	Zero G test Chi square	p value	Variance estimate	Zero G test Chi square	p value
Intercept for neighborhood	0.13	189.59	< 0.0001	0.11	180.72	< 0.0001
Intercept for city	0.11			0.11		

	Individual-level exposures and neighborhood-level unemployment			Individual-level exposures and neighborhood-level education		
	Odds ratio	95% CI lower limit	95% CI upper limit	Odds ratio	95% CI lower limit	95% CI upper limit
Individual-level fixed effects						
Age 35–49	1.10	0.94	1.28	1.10	0.93	1.29
Age 50–64	0.99	0.78	1.25	0.99	0.80	1.24
Age 65 +	0.36	0.25	0.51	0.36	0.25	0.52
Female	2.40	1.92	3.00	2.40	1.92	3.00
Ratio of individual income to city income	1.00	0.95	1.05	1.00	0.95	1.05
In top 50% of country-level education	0.70	0.54	0.90	0.71	0.54	0.92
Married	0.75	0.64	0.87	0.75	0.65	0.86
Migrant to megacity	0.93	0.83	1.03	0.91	0.82	1.01
Unemployed	1.12	0.97	1.30	1.13	0.98	1.31

Table 3 (continued)

	Individual-level exposures and neighborhood-level unemployment			Individual-level exposures and neighborhood-level education		
	Odds ratio	95% CI lower limit	95% CI upper limit	Odds ratio	95% CI lower limit	95% CI upper limit
Neighborhood-level fixed effects						
Bottom tertile of % migrants to city						
Middle tertile of % migrants to city						
Top tertile of % migrants to city						
Bottom tertile of % unemployed	0.97	0.84	1.13			
Middle tertile of % unemployed	Reference					
Top tertile of % unemployed	1.49	1.14	1.95			
Bottom tertile of % in top 50% of country-level education				0.76	0.64	0.90
Middle tertile of % in top 50% of country-level education				Reference		
Top tertile of % in top 50% of country-level education				0.58	0.37	0.90
Random effects	Variance estimate	Zero *G* test Chi square	*p* value	Variance estimate	Zero *G* test Chi square	*p* value
Intercept for neighborhood	0.10	88.28	<0.0001	0.08	130.77	<0.0001
Intercept for city	0.06			0.11		

Internalizing disorders include anxiety (posttraumatic stress disorder, panic disorder, specific phobia, social phobia, agoraphobia, adult separation anxiety, generalized anxiety disorder) and mood (major depressive disorder, dysthymic disorder and bipolar/sub-threshold bipolar) disorders

Living in neighborhoods with either below-average or above-average proportions of migrants was associated with lower odds of internalizing disorder. The neighborhood-level proportion of migrants was not, however, associated with externalizing disorder. There have been no other studies to our knowledge specifically modeling the association between proportion of migrants to an area and the prevalence of mental disorders in that area. Replication studies would consequently be of great value to further investigate the theory that a large number of individuals moving to urban areas puts pressure on existing resources and results in stress, work shortage, and consequently worse health outcomes [3].

Our finding that living in neighborhoods with a majority of migrants (in the top tertile of percent migrants living in the neighborhood) was inversely associated with disorder might suggest that the neighborhoods with the highest proportion of migrants may actually be better equipped with resources and infrastructure to receive large numbers of migrants. Another explanation could be an iteration of the healthy migrant effect [38], in which individuals who leave rural areas to migrate to urban areas are less likely to have mental disorder than those who do not leave, contributing to a resulting lower prevalence of mental disorders in migrant-dense urban areas. Alternatively, neighborhoods with a higher proportion of migrants may allow for more social support among migrants, which in general is known to be protective against internalizing disorders such as depression [39, 40]. Furthermore, living in a neighborhood with other migrants from a common region of origin may have a buffering effect against discrimination and resulting mental health problems, as has been shown in ethnic enclaves in other parts of the world [41–43]. Finally, migrants may also keep social connections to rural contexts, made more possible with increasing technology, further influencing social networks and mental health. It is also possible that there are other socio-demographic differences in migrant-majority neighborhoods that are unmeasured in our study and may contribute to this result.

In a sensitivity analysis, we found that there was no statistical multiplicative interaction between city and proportion of migrants, suggesting that the relationship between the proportion of migrants and internalizing disorder was stable across the five cities examined here, despite likely differences in typical reasons for migrating in the context of these different countries.

We also found that living in neighborhoods with a higher proportion of unemployed residents was associated with higher odds of internalizing disorder. This finding is consistent with that of Silver et al., who included the adult unemployment rate as a factor in their community-level index of neighborhood disadvantage in the US, which was associated

Table 4 Multilevel logistic regression models with any past-year externalizing disorder as the dependent variable among 7251 residents of 5 cities in Latin America

	Individual-level exposures only			Individual-level exposures and neighborhood-level migrant status		
	Odds ratio	95% CI lower limit	95% CI upper limit	Odds ratio	95% CI lower limit	95% CI upper limit
Individual-level fixed effects						
Age 35–49	0.60	0.44	0.80	0.60	0.44	0.81
Age 50–64	0.28	0.20	0.40	0.28	0.20	0.40
Age 65+	0.10	0.04	0.23	0.10	0.04	0.24
Female	0.39	0.26	0.58	0.39	0.26	0.58
Ratio of individual income to city income	1.01	0.93	1.10	1.01	0.93	1.10
In top 50% of country-level education	0.63	0.56	0.71	0.63	0.56	0.71
Married	0.85	0.75	0.97	0.85	0.74	0.97
Migrant to megacity	0.92	0.80	1.05	0.90	0.75	1.07
Unemployed	2.43	1.93	3.06	2.43	1.93	3.06
Neighborhood-level fixed effects						
Bottom tertile of % migrants to city				0.99	0.88	1.11
Middle tertile of % migrants to city				Reference		
Top tertile of % migrants to city				1.13	0.76	1.69
Bottom tertile of % unemployed						
Middle tertile of % unemployed						
Top tertile of % unemployed						
Bottom tertile of % in top 50% of country-level education						
Middle tertile of % in top 50% of country-level education						
Top tertile of % in top 50% of country-level education						

Random effects	Variance estimate	Zero G test Chi square	p value	Variance estimate	Zero G test Chi square	p value
Intercept for neighborhood	0.13	34.14	<0.0001	0.12	32.53	<0.0001
Intercept for city	0.16			0.16		

	Individual-level exposures and neighborhood-level unemployment			Individual-level exposures and neighborhood-level education		
	Odds ratio	95% CI lower limit	95% CI upper limit	Odds ratio	95% CI lower limit	95% CI upper limit
Individual-level fixed effects						
Age 35–49	0.59	0.44	0.80	0.60	0.45	0.80
Age 50–64	0.28	0.20	0.40	0.29	0.21	0.40
Age 65+	0.10	0.04	0.23	0.10	0.04	0.24
Female	0.39	0.27	0.57	0.39	0.26	0.59
Ratio of individual income to city income	1.02	0.94	1.10	1.02	0.94	1.10
In top 50% of country-level education	0.64	0.56	0.72	0.65	0.59	0.72
Married	0.85	0.75	0.97	0.85	0.75	0.97
Migrant to megacity	0.92	0.81	1.05	0.90	0.77	1.05
Unemployed	2.35	1.85	2.98	2.37	1.92	2.92

Table 4 (continued)

	Individual-level exposures and neighborhood-level unemployment			Individual-level exposures and neighborhood-level education		
	Odds ratio	95% CI lower limit	95% CI upper limit	Odds ratio	95% CI lower limit	95% CI upper limit
Neighborhood-level fixed effects						
Bottom tertile of % migrants to city						
Middle tertile of % migrants to city						
Top tertile of % migrants to city						
Bottom tertile of % unemployed	0.77	0.50	1.17			
Middle tertile of % unemployed		Reference				
Top tertile of % unemployed	1.29	0.77	2.16			
Bottom tertile of % in top 50% of country-level education				0.86	0.76	0.99
Middle tertile of % in top 50% of country-level education				Reference		
Top tertile of % in top 50% of country-level education				0.54	0.31	0.93
Random effects	Variance estimate	Zero G test Chi square	p value	Variance estimate	Zero G test Chi square	p value
Intercept for neighborhood	0.12	15.86	0.0004	0.07	29.63	< 0.0001
Intercept for city	0.08			0.22		

Externalizing disorders include behavioral (intermittent explosive disorder) and substance use (alcohol and drug abuse with or without dependence) disorders

with major depression [24]. However, Silver et al. also found neighborhood disadvantage to be associated with substance use disorder, whereas we did not find neighborhood unemployment to be associated with externalizing disorder, which is primarily comprised of alcohol and substance use disorders. In Latin America, where rapid urbanization is coupled with economic instability and high unemployment rates in urban areas [22], the relationship between unemployment and mental health outcomes is particularly important.

Finally, living among the most educated neighborhoods was associated with lower odds of both internalizing and externalizing disorders. However, living in neighborhoods with the lowest levels of educational attainment was also associated with lower odds of internalizing, but not externalizing disorder in our study, compared to median educational attainment. Very few studies have looked at the proportion of educated residents in a neighborhood as a stand-alone exposure of interest, not as part of an index of other neighborhood-level socio-demographics. One study of residents in Hawaii found that neighborhood-level education was not associated with mental health outcomes [28]. However, Hawaii is not primarily an urban area and it is likely that we are seeing a modification of this relationship by the rapidly urbanizing context of Latin America. Within the context of Latin America, our finding of residence in more highly educated neighborhoods being associated with lower odds

of externalizing disorder does align with previous studies in Latin America that used neighborhood deprivation indices that included education in relation to alcohol use disorders [25, 26].

Our study is a first step in identifying potential social determinants of mental health at the neighborhood level in several urbanizing cities throughout Latin America. However, it is not without limitations. First, we are not able to determine temporality of our exposures and outcomes due to the cross-sectional nature of the surveys. One possible explanation for our neighborhood-level findings, therefore, could be reverse causation of disorder leading individuals to self-select into certain neighborhoods, or to have lower educational attainment and subsequent income as consequences of mental disorders, leading to living in neighborhoods with lower overall socioeconomic status [44].

Second, some misclassification of our migration variable is likely, because detailed information on the city in which respondents were born and raised was not ascertained in every city in the WMH study. We relied on a common question across surveys that only asked whether the respondent was "mostly raised in a large city" as a proxy for whether he or she moved to his or her current city as an adult. As expected, we found lower sensitivity of the question compared to specificity, based on a sensitivity analysis completed in the Buenos Aires sample. This pattern of misclassification

is likely due to respondents who were raised in a different large city (not the current city) who would be coded as non-migrants despite their true migrant status. This mechanism may have contributed to the null result of individual-level migration in this study, since the misclassification was likely to be non-differential by disorder status. By extension, this may have affected the aggregated, contextual variable of proportion of migrants in each neighborhood. However, city-to-city migration is not as typical a pattern in this region compared to rural-to-urban migration, so we do not expect this potential mechanism to have had a large effect in the overall sample.

Further research may fruitfully explore the role of group-level migration in Latin America using more detailed measures that include exact origins and timing of migration. Additionally, longitudinal studies of neighborhood-level measures over time and incidence of mental disorders are needed to better ascertain potential causality.

In sum, the associations of neighborhood-level migration, unemployment, and education with individual odds of mental disorders highlight the importance of better understanding the role of neighborhood context on the mental health of residents. Results such as these and future studies assessing community characteristics may also be used to target certain neighborhoods in which mental disorder prevention, early identification, and treatment efforts are potentially most needed.

Compliance with ethical standards

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Affiliations

Laura Sampson[1] · **Silvia S. Martins[2]** · **Shui Yu[1]** · **Alexandre Dias Porto Chiavegatto Filho[3]** · **Laura Helena Andrade[4]** · **Maria Carmen Viana[5]** · **Maria Elena Medina-Mora[6]** · **Corina Benjet[6]** · **Yolanda Torres[7]** · **Marina Piazza[8]** · **Sergio Aguilar-Gaxiola[9]** · **Alfredo H. Cia[10]** · **Juan Carlos Stagnaro[11]** · **Alan M. Zaslavsky[12]** · **Ronald C. Kessler[12]** · **Sandro Galea[1,2]**

[1] Department of Epidemiology, Boston University School of Public Health, 715 Albany Street, Boston, MA 02118, USA

[2] Department of Epidemiology, Columbia University Mailman School of Public Health, 722 West 168th Street, New York, NY 10032, USA

[3] Department of Epidemiology, School of Public Health of the University of São Paulo, 715 Av Dr Arnaldo, São Paulo 01246-904, Brazil

[4] Nucleo de Epidemiologia Psiquiatrica LIM-23, Instituto de Psiquiatria, Hospital das Clinicas, Faculdade de Medicina da Universidade de Sao Paulo, Rua Dr. Ovidio Pires de Campos, 785, São Paulo 05403-010, Brazil

[5] Department of Social Medicine, Postgraduate Program in Public Health, Federal University of Espirito Santo, Av. Mal. Campos, 1355, Vitória, Espirito Santo 29043-260, Brazil

[6] Department of Epidemiology and Psychosocial Research, National Institute of Psychiatry Ramon de la Fuente Muñiz, Calzada, México-Xochimilco 101, Huipulco, 14370 Mexico City, CDMX, Mexico

[7] Center of Excellence in Mental Health Research, CES University, Calle 10A No. 22-04, Medellín 050021, Colombia

[8] Universidad Cayetano Heredia, Lima, Peru, and National Institute of Health, Capac Yapanqui 1400, Jesus María, Lima, Peru

[9] Center for Reducing Health Disparities, University of California, Davis School of Medicine, 2921 Stockton Boulevard, Sacramento, CA 95817, USA

[10] Anxiety Disorders Clinic and Research Center, Av. Santa Fe 3946-1A, CP1425 Buenos Aires, Argentina

[11] Departamento de Psiquiatría y Salud Mental, Facultad de Medicina, Universidad de Buenos Aires, Buenos Aires, Argentina

[12] Department of Health Care Policy, Harvard University Medical School, 180A Longwood Avenue, Boston, MA 02115, USA