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Examining the Nonstationary Spatial Association Between International Migration and Vulnerable Older People Living Alone in Mexico

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Abstract

Research on the intersection of migration and ageing is becoming increasingly relevant as older populations grow in developing countries. Understanding the challenges older people face, often left behind due to their vulnerable position, is essential for policy-making. This research examines the geographical variation in the impact of international migration on the living alone status of older people in Mexico, particularly those most at risk. The following municipal-level information was obtained from the 2020 Census: international migration, living alone, receipt of remittances, and disability. Using geographically weighted regressions, we found geographical variations in the association between international migration and living alone or being more vulnerable. Controlling for socio-demographic factors, in the southern states international migration is associated with a reduction in the proportion of adults living alone and vulnerability due to disability or lack of support from other households. This relationship holds for both men and women. However, in some border regions the proportion of older adults living alone and experiencing greater vulnerability increases with migration, especially for women.

Keywords: *International migration, Ageing, Living alone, Remittances, Vulnerability.*

1. Introduction

One of the most relevant demographic processes of this century, and one that is occurring more rapidly in less developed countries, is population ageing (Bloom et al., 2015; Shetty, 2012; Wang et al., 2019). This demographic phenomenon is mainly due to lower fertility and mortality rates. However, migration also contributes to this socio-demographic change, as the population of reproductive age seeks better life opportunities in different places from where it was born (Wang et al., 2019; Zhongdong and Guowei, 2009). Therefore, the well-being of the elderly population is becoming more important in the design of public policies (Alidoust et al., 2022; Bloom et al., 2015; Kokorelias et al., 2019; Vasquez, 2019).

Previous studies have analysed the impact of international migration on the well-being of older adults left behind at the household level (Antman, 2010; Kumar, 2021; Pfau and

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Long, 2010; Thapa et al., 2020; Yahirun and Arenas, 2018; Zhongdong and Guowei, 2009). We aim to assess the impact of the migration process on the probability of living alone at the regional level. To do this, we use the municipalities of Mexico, the country with the second-highest number of emigrants and the third-highest number of remittances in the world in 2020 (IOM, 2022), with a migration flow that is geographically differentiated, with the sources of international migration historically being regions in the west of the country (Durand et al., 2001; Massey et al., 2010). Mexico is also characterised by an accelerated ageing process, as indicated by data from the 2020 census (INEGI, 2021a); 12.0% of the total population is 60 years or older; this age group is expected to double in 17.4 years. This demographic phenomenon is taking place in a heterogeneous context of economic and social inequalities in the country; therefore, our interest in observing the geographical variation in the impact of international migration lies in the possibility of designing targeted policies through local governments to counteract the adverse effects or enhance the positive impact of international migration, given the great heterogeneity of the migratory phenomenon in Mexican territory.

The data used were obtained from the 2020 Population and Housing Census. Geographically weighted regressions were used in which the relationship between the independent and dependent variables could be modified spatially. Our study's dependent variable is the probability of living alone, and international migration intensity is our main explanatory variable. International migration in Mexico is correlated with sociodemographic factors that also influence the probability of living alone; therefore, in our main model, these factors are added to discount their effect on the relationship between migration and living alone.

The results of our main model indicate that migration is associated with a decrease in the probability of living alone and in extreme vulnerability, mainly in the country's south. For women, there is a positive association between greater migration intensity and living alone or in extreme vulnerability in regions near the border with the United States. For men, there are only small regions in the centre and north of the country where migration is associated with a greater probability of living alone. Furthermore, the size of the positive or negative impacts is minimal, and other factors could increase the risk conditions in which older adults live, such as an increase in the dependency ratio, which causes a considerable increase in the probability of living alone.

The following section describes the theoretical foundations of our analysis. Section 3 describes the data and the econometric model used. In Section 4, we present the results of our estimates. Finally, in Section 5 the research conclusions are provided.

2. Theoretical framework

Traditionally, it has been thought that older adults live under a protective network of care provided mainly by their family when they have health problems or disabilities (Bongaarts and Zimmer, 2002; Kokorelias et al., 2019). However, not all older adults have these family support networks due to various circumstances, for example, a decrease in marriages, smaller family size, and increases in divorces and separations, all accompanied by increased life expectancy (Djundeva et al., 2019). Therefore, it is increasingly common to find older adults living alone in rural and urban communities (Burnette et al., 2021). The proportion of older adults living alone has increased in developed and developing countries (United Nations, 2017). In high-income countries, living alone can cause more significant mortality among the older population (Holt-Lunstad et al., 2015; Pimouguet et al., 2016). Comparatively, there is a lack of research about older adults living alone in lower-income countries. However, regarding mental health indicators, the situation for older adults is worse than that for high-income countries (Banerjee et al., 2022).

Migration is a process that can influence the well-being of older adults in developing countries. International migration mainly occurs among the young population, which implies an ageing place of departure and a decrease in the number of close people who can offer care and support to the elderly who remain in the country of origin. In contrast, the flow of remittances to economically disadvantaged regions can allow greater access to goods and services, including those related to health (Antman, 2010, 2012; Pfau and Long, 2010). This exchange of workers for remittances can be negative or only weakly positive for the country of origin if remittances are low in relation to the number of workers sent to other countries as has been suggested to be the case of Mexico (Escobar-Latapí, 2012). Previous studies have tried to identify which of these effects may be dominant, particularly in the health of older adults (Antman, 2010; Kumar, 2021; López Ramírez, 2008; Thapa et al., 2020; Yahirun and Arenas, 2018). The positive or negative impacts of migration on the health and well-being of older adults may depend on the context of the place of residence and the migratory flow. For example, in the case of Indonesia, the adverse effects of the international migration of children can be counteracted if migration destinations are higher-income regions and older adults continue to have co-residency opportunities. In contrast, migration to regions with few economic opportunities for children worsens the mental health of older adults (Kumar, 2021). In general, the possibility of a positive effect of migration increases when migration is a family decision to increase income and diversify risk (Zhongdong and Guowei, 2009) without breaking the networks of intergenerational solidarity on which the care of the elderly traditionally rests in lower-income regions.

Although the residential status of living alone is a risk factor for mortality, older adults may live alone to feel independent, especially those with the economic resources to do so or those who live in individualistic cultures (López Ramírez, 2008). Therefore, in our analysis, we added a variable to account for older adults who live alone and have a greater degree of functional and economic vulnerability, i.e., functional problems in daily life and no financial support from other households. We consider that these adults live in conditions of extreme vulnerability. Another factor that we consider in our estimates is differences by sex. International migration in Mexico has been an experience marked by gender differences. Among adults over 60, approximately 10 percent of older adults are return migrants, with men representing approximately 80 percent of these individuals (Aguila and Zissimopoulos, 2013). In addition, as in other countries, in Mexico, there is an ageing process differentiated by sex, in which the conditions of living alone and of greater vulnerability are more prevalent among women.

3. Methodology

3.1 Data

All the information necessary for our research was obtained from the 2020 Population and Housing Census, designed and conducted by the National Institute of Statistics and Geography (INEGI) in 2020. We obtained the following municipal-level data for the population of adults over 60 years of age: proportion of adults living alone, age, number of children born alive (for women), modified dependency index (ratio of the adult population over 60 years of age among the population aged 15 to 59 years), years of average schooling, indigenous population by self-identification and rurality, measured as the proportion of the population that lives in localities with less than 2,500 inhabitants. For this, we used the expanded census questionnaire applied to approximately 10 percent of the national population. Three of the 2469 municipalities could not be surveyed using the expanded questionnaire (INEGI, 2021b).

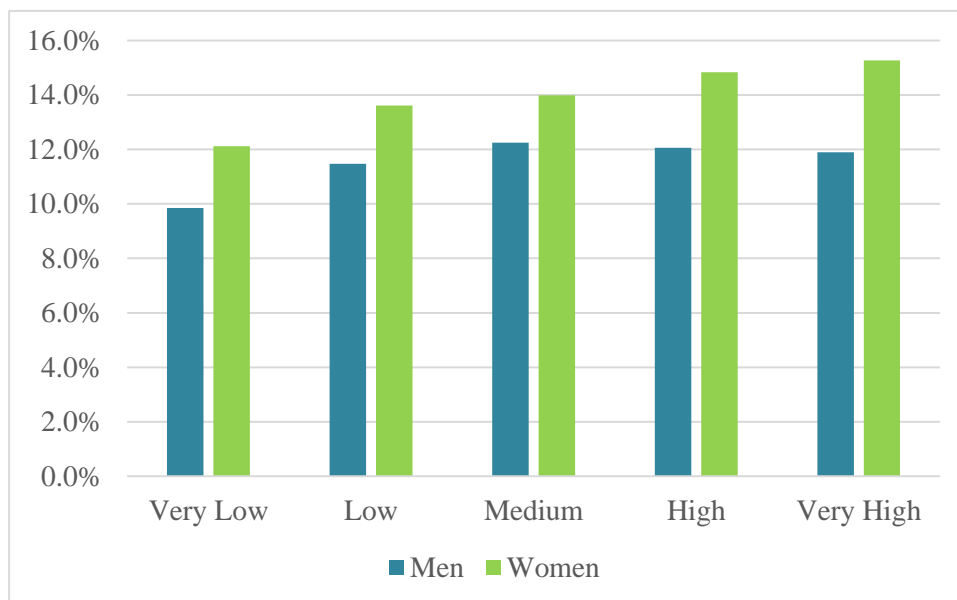
To measure the importance of the migratory phenomenon in each municipality, we used the index of migratory intensity, constructed by the National Population Council (CONAPO) from census information on dwellings with emigrants to the United States,

with circular migrants, and with return migrants in the last five years, in addition to the proportion of households that receive remittances (CONAPO, 2021).

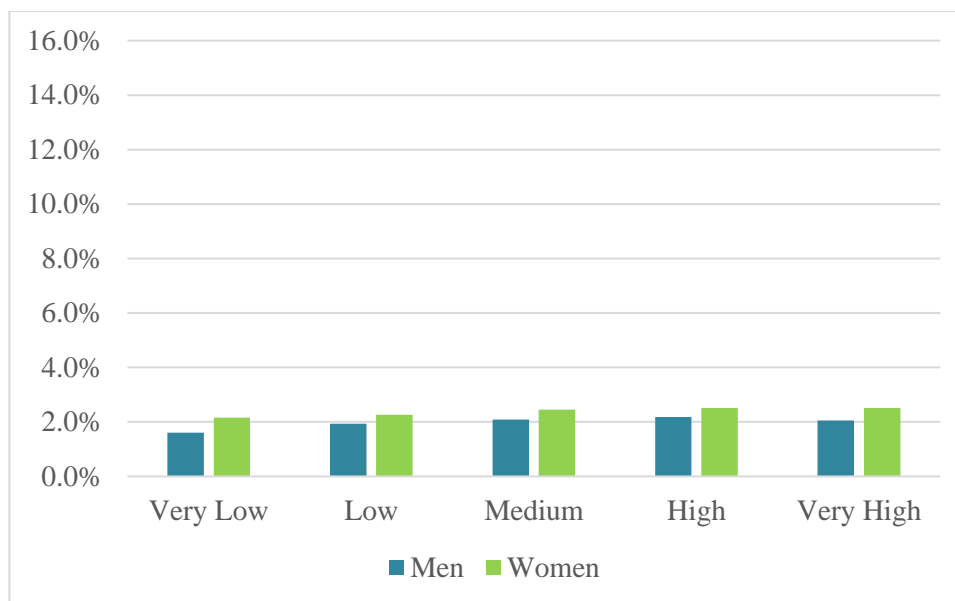
To observe the effects on older adults with a higher degree of vulnerability, we used the following as indicator: older adults who live alone, do not receive economic support from other households, either within the national territory or abroad, and who have a physical or mental limitation that affects their ability to carry out daily activities. Possible physical and mental limitations include the inability or substantial difficulty in the ability to i) see, ii) hear, iii) walk and go up or down stairs, iv) remember or concentrate, v) bathe, dress or eat, or vi) speak or communicate and vii) a mental problem or condition. This information is available in the expanded questionnaire.

Figure 1.a. shows the relationship between living alone and migratory intensity, measured in 5 categories, following the CONAPO classification but combining the municipalities with zero degree of migratory intensity with those with very low migratory intensity. The proportion of older adults who live alone tends to increase as the degree of migratory intensity increases. For women, it increases by more than two percentage points. For men, a slight decrease is observed for municipalities with high and very high migratory intensities. Additionally, as seen in Figure 1.a, women are the most likely to live alone regardless of the degree of migratory intensity.

In Figure 1.b. we present our measure of greatest vulnerability, which we refer to as extreme vulnerability; these adults, in addition to living alone, have some physical or mental limitations and do not receive financial support from other households. The proportion of adults in this circumstance is much lower than adults living alone (11.96 vs 2.04 percent), but the growth trend as the degree of migratory intensity increases is similar. Notably, for the highest degree of migratory intensity, this growing trend stops and is even reversed for men. Figure 1 shows a positive correlation between international migration and measures of the vulnerability of elderly individuals. The international migration process in Mexico is concentrated in regions with sociodemographic characteristics that can influence the vulnerability of older adults.



1.a. Living alone by the degree of migratory intensity



1.b. Extreme vulnerability by the degree of migratory intensity

Figure 1. Living alone, extreme vulnerability and migratory intensity

Note: The number of municipalities and the total population of older adults (in millions and parentheses) in each category are as follows: Very low: 873 (7.7), Low: 686 (4.9), Medium: 432 (1.5), High: 341 (0.8), and Very High: 137 (0.3).

Table 1 shows that migratory intensity correlates with variables that can affect the probability of living alone or extreme vulnerability, and the average value for each variable is presented. The greater the migratory intensity is, the older the elderly and the number of children among women. At older ages, there could be a greater probability of living alone or having some limitation, and as the number of children increase, there could be a greater chance of co-residence for older adults. Migration intensity is negatively correlated with schooling and the proportion of the retired population, indicating that migration originates in regions with lower socioeconomic levels, potentially increasing vulnerability; however, these variables may also indicate greater availability of resources for adults to live independently. Finally, migration intensity is a phenomenon concentrated in regions with a high proportion of rurality. There may be a greater probability of residing alone because of the lower prices of housing and goods. These factors are relevant for studying older adult couples at the household level in Mexico (López Ramírez, 2008). Greater international migration is also positively correlated with the dependency ratio, which decreases the amount of the young adult population that can provide financial support or care for elderly individuals. It is also possible that the social norms of co-residence and support for the elderly differ between the general and indigenous populations; however, Table 1 shows a minimum correlation with migratory intensity. For this reason, a multivariate model is needed to isolate the association between the migratory phenomenon and the living conditions of older people controlling for the socioeconomic or cultural conditions of the regions of origin.

	Correlation with migratory intensity	Average
Age	0.47	70.02
Surviving children (women)	0.58	4.41
Dependency	0.21	0.21
Schooling	-0.40	6.43

Retired	-0.40	0.21
Indigenous	-0.03	0.21
Rurality	0.43	0.21
Notes: Own elaboration with data from the Population and Housing Census 2020		

3.2 Geographically weighted regressions

In our case, the geographically weighted model can be represented by the following equation:

$$y_i = \sum_k \beta_k(u_i, v_i)x_{k,i} + \varepsilon_i \quad (1)$$

The variable y represents the average of the result variable, the proportion of older adults living alone or with extreme vulnerability in each municipality i among the adult population aged 60 years and over. $x_{k,i}$ represents the value of the variable k in municipality i . In our model, the crucial variable is the index of migratory intensity. We control for age, number of children among women, the dependency ratio, the average years of schooling, indigenous population, retired and rurality. The model also includes a constant. The coefficient of each variable β_k depends on the geographical location, denoted by the coordinates (u_i, v_i) of the centroid of each municipality. The purpose is to estimate a coefficient for each municipality to establish the geographic variation in the relationship between each independent variable and the outcome variables. Finally, the error term, ε_i , is included.

The observations are weighted according to distance to estimate different β_k coefficients. Different ways of weighting can be used, but the concept is that municipalities with greater proximity have a greater weight. Herein, Gaussian adaptive weighting is chosen, i.e., all the municipalities in the sample are included with the weighting:

$$w_{ij} = \exp\left(-\frac{d_{ij}^2}{\theta_{i(k)}^2}\right) \quad (2)$$

According to Formula (2), as the distance between the municipalities increases, d_{ij} , the weight decreases. For construction, the optimal band must also be chosen, θ , which is used to establish how fast the weight decreases with distance. This band is adaptive when it is modified based on the municipality and the variables included in the model so that a certain number of municipalities are within it. Akaike's criteria are used to choose the optimal band (Nakaya, 2016).

4. Results

Table 2 shows some statistics of the estimates carried out using Equation (1). The first column pertains to the estimation in which the explained variable is the proportion of older adults who live alone, and the explanatory variable is the index of migratory intensity. The second column includes sociodemographic controls. The last two columns are similar estimates but with extreme vulnerability as the explained variable. Panel A shows the estimates for women, and Panel B shows the estimates for men. In each case, the average, minimum and maximum are shown for the coefficients for every 2466 municipalities.

When controls are included, the average association between living alone changes sign for men and women. Without controls, there is a positive association; with controls, the association is negative. This occurs because the migratory intensity is correlated with some of the characteristics included in the set of controls that increase the probability of living alone. The difference between the 10th and 90th percentiles of the migratory

intensity index is approximately five units. Therefore, for women, the probability of living alone increases by 0.018 among the municipalities located within those percentiles; when controls are added, the probability decreases by -0.0015. In the case of extreme vulnerability, without controls, the coefficient is slightly negative for women and positive for men. This relationship does not seem as strong as the correlation suggested in Figure 1.b, potentially because in the municipalities with the highest migratory intensity, the association is not as strong, and a more significant proportion of these municipalities are in the centre and west of the country, having greater geographical weight. When controls are added, the average association between migratory intensity and extreme vulnerability becomes negative for both sexes, with a greater absolute effect. Adding controls also decreases the difference between the maximum and the minimum of the estimated effects as well as the interquartile range. Regarding the differences by sex, on average, for women, there is a lesser decrease in living alone as the migratory intensity increases, once the sociodemographic aspects have been discounted; however, for women, the migratory intensity is associated with a greater decrease in extreme vulnerability.

The control variables are relevant in most of the models in Table 2. The most important effect is that an increase in the dependency ratio significantly impacts the probability of living alone and increases extreme vulnerability. Schooling and rurality also have relevant effects; the former decreases the probabilities of living alone and extreme vulnerability, and in the case of rurality, it increases these probabilities. We performed F tests of geographic variability; results support the geographic variation model.

Table 2. Effect of migratory intensity on living alone and extreme vulnerability. Geographically weighted regression.

	Living alone		Extreme vulnerability	
	No controls	With controls	No controls	With controls
<i>A. Women</i>				
Average	0.0036	-0.0003	-0.0002	-0.0013
Minimum	-0.0442	-0.0093	-0.0089	-0.0051
Maximum	0.1402	0.0192	0.0217	0.0042
Interquartile Range	0.0093	0.0047	0.0024	0.0010
<i>B. Men</i>				
Average	0.0024	-0.0008	0.0000	-0.0007
Minimum	-0.0455	-0.0106	-0.0100	-0.0029
Maximum	0.0925	0.0179	0.0165	0.0012
Interquartile Range	0.0083	0.0041	0.0023	0.0012
Notes: Descriptive statistics associated with the migratory intensity parameter for each of the 2466 municipalities in the country. The controls included are indicators at the municipal level for the population aged 60 years and over: age, number of children among women, years of schooling, indigenous population, retired population, and rurality.				

Figure 2 shows the locations of the municipalities where the relationship is statistically significant in the model that includes controls for women and men: intense blue indicates the municipalities in which the relationship is negative and statistically significant at a level of $\alpha=0.05$, and intense red indicates the municipalities in which the relationship is positive and statistically significant. The lighter tones correspond to municipalities where statistical significance is not found.

In the southern states of the country, the results are very similar for men and women; the intensity of migration decreases the probability of living alone and extreme vulnerability. However, there are relevant differences in the states close to the border. For women, the

probability of living alone increases in almost all municipalities located on the border with the United States, in some cases covering the entire state. For men, in a few municipalities, there is a significant positive effect: in a cluster of municipalities in the states of Coahuila, Tamaulipas and Nuevo León. For both sexes, there is also an increase in the probability of living alone in some regions of the country's centre, such as Mexico City, the country's capital. In the case of extreme vulnerability, there are significant effects on women in the country's north. The migration intensity decreases extreme vulnerability in states such as Tamaulipas, Nuevo León, and Coahuila, reaching some regions of states such as Zacatecas, San Luis Potosí, and Guanajuato. In the municipalities near the border of the state of Sonora, the migratory intensity is associated with an increase in extreme vulnerability. There are no critical clusters of significant effects in extreme vulnerability beyond the south for men.

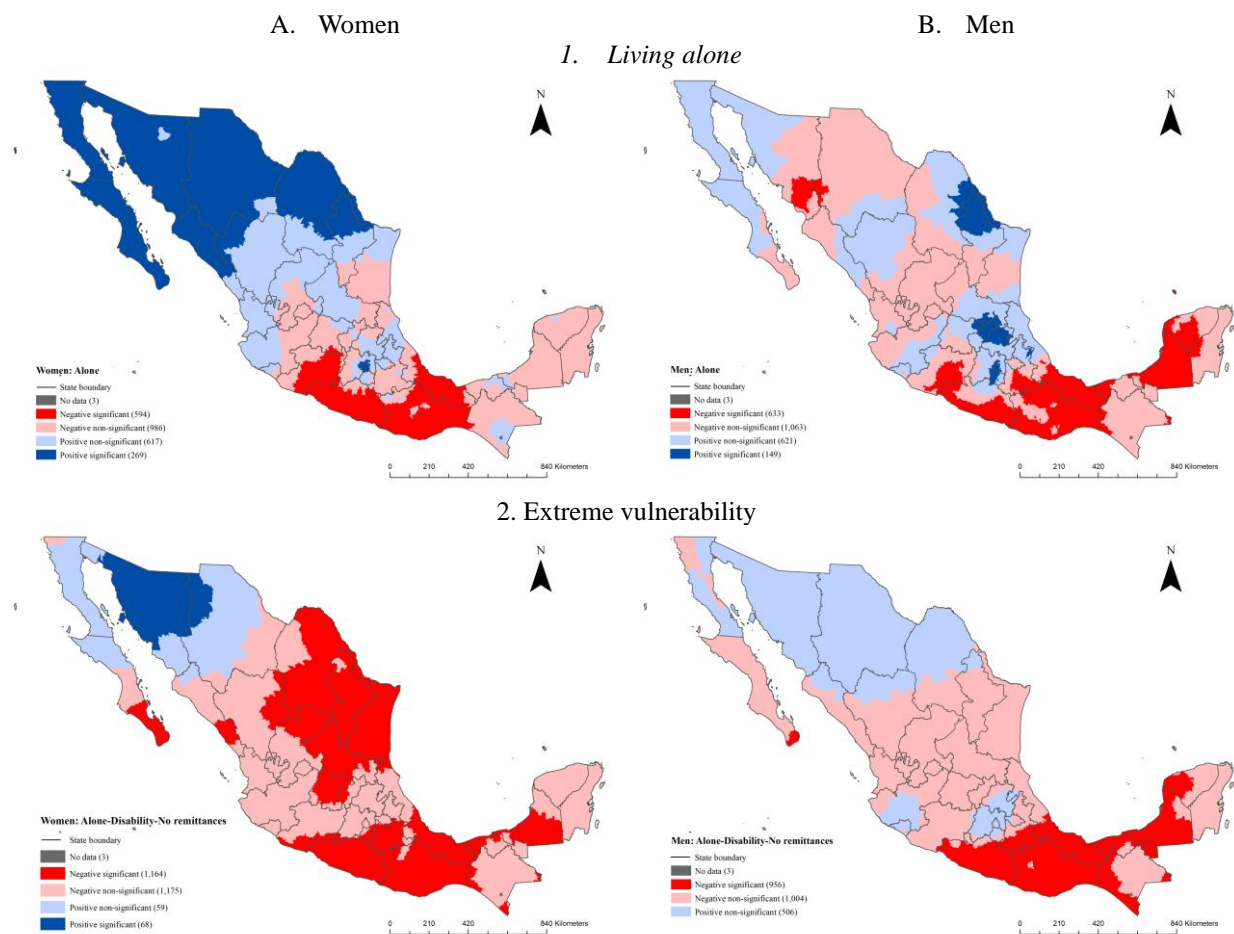


Figure 2. Statistically significant effects of the migratory intensity index

There are relevant aspects that must be considered outside this study's scope. Although international migration does not seem to put older people at greater risk because there are still possibilities of co-residence with other people, the absence of international migrants may still have negative impacts on subjective well-being, as noted in prior literature about Mexico. Unfortunately, there are no surveys on subjective well-being among the elderly population that have the level of representativeness required to carry out a study with geographic disaggregation like the aspects of residence and vulnerability we have carried out in this study. Therefore, attention to emotional health for the elderly population may still be relevant in the regions with the highest migratory intensity in the country.

It is often assumed that migration takes place primarily among the young. However, in regions with a long migratory tradition, such as Mexico, current generations of older

adults also had opportunities to migrate in the past or to reunite with their relatives recently in the United States. To corroborate these possibilities, more research is needed on the possible impact of a decades-long migration on the demographic structure or the migration of older adults to the United States from Mexico for family reunification reasons.

Notably, Mexican migration to the United States has decreased in intensity in recent periods, with less emigration and greater return; therefore, the possible adverse effects of the absence of migrants may have been moderated in recent years. Thus, the possible negative effects of international migration on older people's living and support conditions may have greater relevance in a stronger recent migration process or other geographical and economic contexts.

The favourable effects for older people in some regions are relatively small; therefore, the problems experienced by elderly people have not been resolved in these regions. The positive effects of international migration on older adults may be the object of policies that can facilitate the well-being of this population and their families, who are not close enough to provide them with economic support or care. For example, the older adult population may have difficulties accessing financial services for remittances, especially considering that the regions with the highest migratory intensity are rural areas; schemes should be designed to facilitate these support flows.

5. Conclusions

The aim of this work was to investigate the association between migratory intensity and the conditions of living alone and vulnerability among older adults at the municipal level in Mexico. We show that the positive association is reversed when sociodemographic aspects are considered at the municipal level in Mexico. There is research investigating the effects of international migration on the physical and economic vulnerability of elderly individuals, but they were carried out at the individual level. This study was conducted with municipal-level data, contributing to understanding the vulnerability of older adults in specific regions of the country. The result shows that the relationship has regional heterogeneity, with more significant evidence of the positive effects of international migration among older adults in the country's south. This study identified the necessary intervention in the face of possible adverse effects among older women in the region near the northern border, emphasising the need to prioritise health care systems and formal care to guarantee the well-being of elderly individuals in that part of the country.

The percentage of older adults living alone or in conditions of greater vulnerability in the country is relatively small; however, given the rapid demographic ageing that is foreseen, the increase in separations and divorces, and the decrease in the birth rate, it is expected that this percentage may increase, as is occurring in other regions of the world. Therefore, countries like Mexico must look for care alternatives for their older adult population. Older adults may not have a vast network of intergenerational support or be able to rely on cultural factors that protect the older population; policies aimed at improving the quality of life of this population from a life course perspective and universal care systems are needed.

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