Income Inequality, Socioeconomic Deprivation and Depressive Symptoms among Older Adults in Mexico

Julián Alfredo Fernández-Niño[1], Betty Soledad Manrique-Espinoza[1]*, Ietza Bojorquez-Chapela[2], Aarón Salinas-Rodríguez[1]

1 Center for Evaluation Research and Surveys, National Institute of Public Health, Cuernavaca, Morelos, Mexico, 2 Department of Population Studies, El Colegio de la Frontera Norte, Tijuana, Baja California, Mexico

Abstract

Objective: Depression is the second most common mental disorder in older adults (OA) worldwide. The ways in which depression is influenced by the social determinants of health – specifically, by socioeconomic deprivation, income inequality and social capital - have been analyzed with only partially conclusive results thus far. The objective of our study was to estimate the association of income inequality and socioeconomic deprivation at the locality, municipal and state levels with the prevalence of depressive symptoms among OA in Mexico.

Methods: Cross-sectional study based on a nationally representative sample of 8,874 OA aged 60 and over. We applied the brief seven-item version of the Center for Epidemiologic Studies Depression Scale (CES-D) to determine the presence of depressive symptoms. Additionally, to select the principal context variables, we used the Deprivation Index of the National Population Council of Mexico at the locality, municipal and state levels, and the Gini Index at the municipal and state levels. Finally, we estimated the association of income inequality and socioeconomic deprivation with the presence of depressive symptoms using a multilevel logistic regression model.

Results: Socioeconomic deprivation at the locality (OR = 1.28; p<0.10) and municipal levels (OR = 1.16; p<0.01) correlated significantly with the presence of depressive symptoms, while income inequality did not.

Conclusions: The results of our study confirm that the social determinants of health are relevant to the mental health of OA. Further research is required, however, to identify which are the specific socioeconomic deprivation components at the locality and municipal levels that correlate with depression in this population group.

Introduction

The study of depression in older adults (OA) has acquired critical importance in that it ranks as the second most common mental disorder worldwide, surpassed only by dementia [1]. According to estimates, by 2030, depression will have escalated to first place in the global burden of disease, accounting for 6% of the total disability-adjusted life years [2]. Current prevalence of clinical depression among OA fluctuates between 1% and 9% [1], exerting a high impact on quality of life, perception of health, functionality, occurrence of comorbidity and economic productivity [1].

In 2005, prevalence of clinical depression in Mexico was estimated at 5% and 9.5% among men and women, respectively [3]. Alongside major clinical depression, depressive symptoms [4]

have drawn considerable attention from public health initiatives. While they share a number of probable etiological explanations with clinical depression [5–6] and have been directly associated with mortality and suicide in this age group [6–7], it is estimated that their prevalence may eventually affect four times as many individuals as clinical depression [8]. In the case of Mexico, the prevalence of subclinical depression in OA over 65 years, using the Geriatric Examination for Computer Assisted Taxonomy (GMS–AGECA), was estimated at 31.9% and 32.2% in urban and rural areas, respectively, which is more than twice that the estimated prevalence using DSM-IV or ICD-10 criteria [9].

It has been amply documented that the social determinants of health (mainly contextual poverty, income inequality and social cohesion across the social organization – from the neighborhood

up to the national level-) play a prominent role in a wide array of health outcomes, including maternal and child mortality, cardio-vascular disease and infectious diseases [10]. However, only recently has research recognized the impact of social determinants on mental health indicators, particularly on depression [11].

According to the ecosocial theory, the health-disease process is part of a hierarchical system where causal interactions flow organically across organization levels [12] and in consequence, social influences become literally "embodied" into individuals [13]. Kim has recently adapted this model to analyze the etiology of the depression [14] by organizing the individual and contextual factors hierarchically under an explanatory model. By interweaving the two, Kim's perspective now makes it possible to understand depression as an interaction between the social context and individual susceptibility [12,14].

Various studies have analyzed the individual and contextual aspects of depression across a variety of OA populations, with the literature identifying the following risk factors: being female, mourning as a result of a significant life event, especially the loss of a partner, functional limitations, existence of a prior depressive episode, physical pain, presence of other pathologies, an inadequate social support network, a low educational level, living alone, social isolation, a perception of being inadequately cared for, limited access to health services and, especially, a precarious economic situation [1,15–18]. On the other hand, with regard to contextual factors, it has been observed that socioeconomic disadvantage and, in general, different measures of poverty and deprivation regarding the place of residence (neighborhood, community or locality) correlate with depression in adults overall and, particularly, in OA [14].

It has been advanced that, in general, economically precarious contexts tend to generate hostile social environments (marked by insecurity and few suitable areas for recreation) [19–21], thus heightening exposure to everyday risks. In turn, these conditions are known to breed psychosocial stress, depleted social capital, limited access to resources and low-quality health services, all of which interact with individual susceptibility as catalysts of depression [14,19–21].

Acknowledging that the different levels of contextual conditions are relevant to depression not only expands the explanatory framework for this disorder by incorporating the role of social determinants, but also provides evidence for creating interventions that transcend the individual realm. The objective of this study was to estimate the association of income inequality and socioeconomic deprivation at place of residence with the occurrence of depressive symptoms in OA aged 60 and over in Mexico.

Methods

Ethics statement

The sample for our work was derived from the National Health and Nutrition Survey (ENSANUT -for its initials in Spanish). This survey was approved by the Ethics and Research Committees of the National Institute of Public Health. All subjects provided written informed consent.

Sample

ENSANUT 2012 was a probabilistic multi-phase survey conducted in Mexico in 2012 with national and state-level representativeness and a geographic breakdown by urban-rural strata. The total sample consisted of 55,008 households throughout Mexico, with only one adult aged 20 and over selected from each household to respond to an individual questionnaire. Out of

the total 46,277 adults in this age bracket, 8,874 OA ages 60 and over constituted the analytical sample of our study. The survey design was developed to obtained representativeness for this age group at the national level. Therefore, this sample is representative of the overall older adult population in Mexico. A detailed description of the methodology and design of ENSANUT-2012 has been published elsewhere [22].

Data collection instruments

ENSANUT 2012 was based on two key components: nutrition and health. The latter was probed with three individual-level questionnaires involving: age groups (children aged 9 and under, adolescents from 10 to 19, and adults aged 20 and over), health service utilization, and households. We extracted the data for our study from the individual-level questionnaire for adults aged 20 and over, and the household questionnaire. The first included the following sections: sociodemographic characteristics, self-esteem and satisfaction, overweight and obesity, principal morbidities (high blood pressure, diabetes, cardiovascular disease and hyper-cholesterolemia), family health history, reproductive health, immunization, preventive programs, accidents, aggression and violence, and risk factors. Additionally, this questionnaire included a module for OA aged 60 and over with the following sections: cognitive status, sight and hearing impairments, functionality, depression and falls [22]. On the other hand, the household questionnaire explored sociodemographic characteristics of all household members, health service utilization, physical housing characteristics, assets and goods, expenditures, and social protection in health.

Variables

Outcome: Depressive symptoms. To measure this variable, we used the brief seven-item version of the Center for Epidemiologic Studies Depression Scale [CES-D]. The Scale covers five dimensions: dysphoric mood, motivation, concentration, loss of pleasure, and sleep disturbance [23] and it has been previously validated in Mexico [24]. The presence of clinically significant depressive symptoms was operationalized according to the total CES-D score, and a dichotomous variable was constructed where 1 (CES-D$\geq$5) indicates the presence of significant symptoms [24].

Context variables: As principal exposure variables, we considered income inequality and socioeconomic deprivation in the localities, municipalities and states where OA resided.

Income inequality. We quantified this variable using the Gini coefficient derived from the Lorenz curves [25]. As a measure of statistical dispersion for income distribution of a nation's residents, the coefficient is expressed as a number between 0 and 1, where 0 indicates perfect equality (everyone receives equal incomes), and 1, total inequality (one person receives all the incomes while the others receive none) [25]. We constructed the Gini coefficient with data from the Population and Housing Census 2010 enlarged sample, which is representative of the 2,456 municipalities in Mexico [26]. The extended questionnaire used in this sample contained the following sections: fertility, child mortality, migration, indigenous language, disability, education, health services, marital status, housing characteristics and public services, household members, and economic characteristics. With regard to the last section, respondents were asked about their total household income in the previous month, in Mexican pesos. This household-specific variable served to construct the Gini coefficient for each municipality and state in Mexico using the *ineqdeco* routine developed by Jenkins for STATA 12 [27], and in which is used the following expression:

$$1 + \left(\frac{1}{n}\right) - \frac{2}{m * n^2} \left[\sum \left[n - r_i + 1 \right] y_i \right]$$

where n is the sample size for each group, m the arithmetic mean of incomes, r_i the rank-ordered income values for each household, and y_i the income value for each household.

Inequality indices estimated by this method have been widely used in the literature [28]. Sen [29] and Jenkins [30] provide some empirical illustrations with this same approach.

Socioeconomic deprivation. To measure this variable, we used the Mexican National Population Council (*CONAPO* for its initials in Spanish) Deprivation Index adjusted to 2010. Broadly validated and utilized in Mexico [31], this measurement groups a series of socioeconomic indicators (eight under a locality index and nine under a municipal and state index) into four major socioeconomic deprivation dimensions (plus a rurality indicator for municipalities and states). These, in turn, are estimated in three levels of geographic aggregation: by locality, municipal and state. The locality dimensions are: education (percentage of illiterate individuals aged 15 and above who lack elementary school), household (percentage of households with any level of overcrowding, earth floors, and no drainage, sanitary services, piped water or electricity), and work-related income (percentage of individuals earning less than two minimum wages, which equaled approximately 8.67 USD per month in 2010). The municipal and state index also includes a rurality indicator reflecting the percentage of individuals dwelling in localities with fewer than 5,000 inhabitants. Constructed using the principal component analysis, the municipal and state index allows identifying the intensity of deprivation and social exclusion by geographic area, specifically with regard to localities and municipalities/states [32]. The index is continuous, where the higher values denote greater socioeconomic deprivation.

Covariates: We included both -individual and household-specific variables identified by the literature as key factors associated with the occurrence of depressive symptoms in the OA population.

Individual covariates. These included: age, gender, civil status (without a partner = 1, married/cohabited = 0), paid job, schooling (years of formal education), difficulty in performing at least one of the basic activities of daily living under the Katz scale [33], difficulty in performing at least one of the instrumental activities under the Lawton scale [34], number of chronic illnesses (diabetes, high blood pressure, hypercholesterolemia, cardiovascular disease, depression, stroke and cancer), participation in household decision-making, history of any type of physical violence (broadly defined as self-reported health damage resulting from theft, aggression or battery of any type) and accidents (broadly defined as self-reported health damage resulting from an accident of any type in the last 12 months).

Household covariates. To measure the household socioeconomic level, we constructed an asset index with a total of 16 dichotomous [yes/no] variables related to a set of housing characteristics and the ownership of household assets. This index has been widely referred to in the literature and has been validated across a variety of contexts [35–37]. We built our index using a polychoric correlation matrix and the principal component analysis. The first component explained 54% of observed variance in data. The asset index was continuous, with the higher values denoting higher socioeconomic levels. We also included data on OA living arrangements using a dichotomous variable as to whether or not the OA lived alone [1 = yes].

Statistical Analysis

We used exploratory analysis techniques, including graphics (histograms and dispersion/correlation diagrams) and descriptive statistics (means and variances), to examine properties and distributions of outcome and contextual variables. Furthermore, we applied the Mann-Whitney U and chi-square tests to analyze the bivariate association between the outcome and the independent variables (continuous and categorical, respectively). Specifically, during the exploratory analysis, we tested the linearity between the outcome and continuous contextual variables.

During the statistical analysis, we also explored the pertinence of considering the data aggregated by locality, municipality and state. For this purpose, we estimated the Intraclass Correlation Coefficient (ICC) for a three-level model [38]. ICC has two main interpretations: first, the extent to which the explained percentage of variance in the outcome variable was attributable to the different aggregation levels; and second, the extent to which individual-level observations are correlated within each aggregation level. If the observations were independent (ICC = 0), nothing would be gained by incorporating different aggregation levels. Given that the outcome variable was dichotomous, we used a multilevel logistical regression model to analyze its association with the contextual variables (income inequality and socioeconomic deprivation), controlling for covariates. This allowed us to identify any relationships within the different aggregation levels which would otherwise have been biased under other statistical techniques ignoring the hierarchical nature of data. Moreover, unlike other approaches, the multilevel analysis estimates not only the relationship of each variable to the most basic aggregation level, but also the strength of the association among variables at different levels by using terms of interaction among the different levels [38].

We adjusted three consecutive models to analyze the contribution of each aggregate level: (1) one with a random intercept at the locality level; (2) other with random intercepts for localities and municipalities, and (3) the third with random intercepts for localities, municipalities and states. We also compared the performance of the different models using the log-likelihood value, the likelihood ratio test (LRT), and the Akaike Information Criterion [AIC] [39]. Finally, we explored the possibility of having models with random slopes for the continuous contextual variables, and we used the LTR to compare these last models with the first that apply just random intercepts [38]. We used the STATA 12 program (Stata Corporation, College Station, TX, USA) for all our statistical analyses.

Results

Of the 8,874 OA who participated in *ENSANUT* 2012, we excluded those who were unable to respond to the interview personally. The principal reasons for failure to respond were hearing or speech impairment (694 OA) and memory loss (320 OA). The final analytical sample thus consisted of 7,867 OA, of whom 53.4% were female, with an average age of 69.3 years (standard error (S.E.) = 0.15) and 6.1 years of formal education (S.E. = 0.11). Finally, 22.3% had difficulty performing at least one of the basic activities of daily living and 18.0% at least one of the instrumental activities.

The prevalence of depressive symptoms was 35.6% (CI95%: 33.8%–37.4%). Table 1 displays the characteristics of the sample according to the presence of depressive symptoms. The following variables showed a significant association with depressive symptoms: female, absence of an intimate partner, paid job, few years of formal education, difficulty in performing basic or instrumental

activities of daily living, presence of comorbidity, not being consulted about household decisions, occurrence of violent incidents or accidents in the previous 12 months, living alone, and a low household socioeconomic status (p<0.05). The bivariate analysis yielded no statistically significant relationship among the different income inequality levels. The estimated ICC values were: 6.3% (CI95%: 3.9%–9.6%) at the locality level; 4.0% (CI95%: 2.0%–7.7%) at the municipal level, and 1.5% (CI95%: 0.07%–3.3%) at the state level.

Table 2 presents the results of the multilevel logistic regression models. As the exploratory analysis indicated that the household asset and locality deprivation indices were not linearly associated with to the logarithm of odds on the presence of depressive symptoms, both variables were incorporated as tertiles in the regression models. Additionally, we adjusted all models using the locality and municipality population sizes as well as to the percentage of rural population at both levels.

In general, the association of the outcome variable with the individual and household variables was consistent across estimated models, in particular with regard to the following variables: female, absence of an intimate partner, not being consulted on household decisions, few years of schooling, difficulty in performing the basic or instrumental activities of daily living, presence of comorbidities and the tertiles of asset index. In comparing the three estimated models, the third (with random intercepts for the three levels) demonstrated the best fit, not only by the log-likelihood and AIC values, but also and most importantly, by the LRT results.

The third model showed a statistically significant association between the presence of depressive symptoms and the following individual variables: female (OR = 1.37; CI95%:1.23–1.54), absence of an intimate partner (OR = 1.16; CI95%; 1.03–1.32), not being consulted about household decisions (OR = 1.64; CI95%: 1.37–1.97), years of schooling (OR = 0.97; CI95%: 0.95–0.98), presence of multimorbidity (OR = 1.32; CI95%: 1.25–1.38), difficulty in performing at least one instrumental activity of daily living (OR = 1.45; CI95%: 1.26–1.68), difficulty in performing at least one basic activity of daily living (OR = 1.85; CI95%: 1.62–2.10) and self-reported accidents (OR = 1.53; CI95%: 1.26–1.85) or violent incident(s) (OR = 2.41; CI95%: 1.57–3.69) during the previous 12 months. Finally, at the household level, we observed a significant and protective association between the outcome variable and a higher socioeconomic status (OR = 0.79; CI95%: 0.66–0.94, when comparing tertiles 1 and 3).

Regarding the association of the contextual variables with the presence of depressive symptoms, on comparing tertiles 3 versus 1, the association of socioeconomic deprivation index was marginally significant at the locality level (OR = 1.28; p<0.10), and significant at the municipality level (OR = 1.16, p<0.01). While income inequality showed no association at any of the aggregation levels

Table 1. Sociodemographic characteristics according to the presence of depressive symptoms in the study sample.[‡]

	Depressive symptoms		
	No (n = 5,040)	Yes (n = 2,827)	p-value[†]
Individual			
Age (years)	69.27(0.19)	69.24(0.23)	n.s
Gender (Female)	0.49	0.60	***
No current intimate partner	0.35	0.42	***
Paid work	0.29	0.25	**
Years of schooling	6.42(0.15)	5.53(0.14)	***
Difficulty in performing basic activities of daily living	0.13	0.18	***
Difficulty in performing instrumental activities	0.13	0.26	***
No. of chronic illnesses	0.88(0.03)	1.14(0.03)	***
Participation in household decision-making (1 = no).	0.06	0.12	***
Accident in the last 12 months (1 = yes)	0.06	0.09	***
Violence in the last 12 months (1 = yes)	0.01	0.03	***
Household			
Asset index	−0.04 (0.02)	−0.40 (0.03)	***
Older adult lives alone	0.23	0.26	***
Locality			
Deprivation Index	−1.00(0.01)	−0.93(0.01)	***
Municipality			
Deprivation Index	−0.93(0.01)	−0.78(0.02)	***
Income inequality (Gini coefficient)	0.45(0.01)	0.45(0.01)	n.s
State			
Deprivation Index	0.01(0.01)	0.11(0.02)	***
Income inequality (Gini coefficient)	0.45(0.01)	0.45(0.01)	n.s

[‡]Share or mean (standard error).
[†]p values under the chi-square and Mann-Whitney U tests..
*p<0.10; **p<0.05; ***p<0.01.
n.s.: non-significant.
doi:10.1371/journal.pone.0108127.t001

Table 2. Multilevel logistical regression models for the association between the presence of depressive symptoms and contextual variables: income inequality and socioeconomic deprivation[‡].

Variables	Model 1			Model 2			Model 3		
	OR[†]	CI 95%	p	OR	CI 95%	p	OR	CI 95%	p
Individual									
Age (years)	1.00	0.99–1.00	n.s	0.99	0.99–1.00	n.s	0.99	0.99–1.00	n.s
Female gender	1.38	1.23–1.55	***	1.38	1.23–1.54	***	1.37	1.23–1.54	***
No intimate partner	1.16	1.02–1.31	**	1.16	1.02–1.32	**	1.16	1.03–1.32	**
Paid work	0.94	0.83–1.06	n.s	0.94	0.83–1.06	n.s	0.93	0.82–1.06	n.s
Not consulted in household decision-making	1.66	1.39–1.99	***	1.65	1.38–1.98	***	1.64	1.37–1.97	***
Years of Schooling	0.97	0.95–0.98	***	0.97	0.95–0.98	***	0.97	0.95–0.98	***
Number of illnesses	1.32	1.25–1.39	***	1.32	1.26–1.38	***	1.32	1.25–1.38	***
Difficulty in performing instrumental activities	1.45	1.26–1.67	***	1.46	1.26–1 68	***	1.45	1.26–1.68	***
Difficulty in performing basic activities	1.85	1.63–2.11	***	1.85	1.62–2.10	***	1.85	1.62–2.10	***
Accident in the previous 12 months	1.50	1.24–1.82	***	1.50	1.24–1.82	***	1.53	1.26–1.85	***
Violence in the previous 12 months	2.40	1.56–3.67	***	2.30	1.56–3.67	***	2.41	1.57–3.69	***
Household									
Asset index [Reference tercile 1]									
Tercile 2	0.87	0.78–0.97	**	0.87	0.77–0.97	**	0.86	0.77–0.97	**
Tercile 3	0.80	0.67–0.95	**	0.79	0.67–0.95	**	0.79	0.66–0.94	***
Older adult living alone	1.09	0.95–1.26	n.s	1.10	0.95–1.26	n.s	1.10	0.96–1.27	n.s
+ Locality									
Rurality	1.10	0.89–1.36	n.s	1.08	0.88–1.33	n.s	1.06	0.86–1.31	n.s
Deprivation index [Reference tercile 1]									
Tercile 2	1.19	0.98–1.45	*	1.18	0.97–1.44	*	1.15	0.94–1.40	n.s
Tercile 3	1.33	1.02–1.73	**	1.31	1.00–1.70	**	1.28	0.98–1.67	*
Municipality									
Income inequality (Gini Coefficient)	1.68	0.40–7.03	n.s	1.72	0.40–7.52	n.s	1.68	0.37–7.30	n.s
Deprivation index	1.17	1.05–1.30	***	1.16	1.04–1.30	***	1.16	1.04–1.30	***
State level									
Income inequality (Gini coefficient)	0.41	0.03–4.88	n.s	0.49	0.04–6.54	n.s	0.45	0.01–16.14	n.s
Deprivation Index	1.01	0.93–1.09	n.s	1.01	0.93–1.09	n.s	1.00	0.91–1.11	n.s
Variance components									
	Variance	SE		Variance	SE		Variance	SE	
Locality	0.097	0.037		0.023	0.047		0.021	0.046	
Municipality				0.075	0.038		0.054	0.036	
State level							0.026	0.013	

Table 2. Cont.

Variables	Model 1			Model 2			Model 3		
	OR†	CI 95%	p	OR	CI 95%	p	OR	CI 95%	p
Log-likelihood value	−4745.401			−4743.051			−4738.582		
LRT				4.70 (p<0.05)*			8.94 (p<0.01)£		
AIC	9542.802			9540.103			9533.164		

‡ Model 1: Random intercept at locality level; random intercepts for localities and municipalities; random intercepts for localities, municipalities and states.
† OR = Odds ratio; CI 95%: 95% Confidence Interval.
* Model 2 versus Model 1.
£ Model 3 versus Model 2.
*p<0.10; **p<0.05; ***p<0.01.
LRT: Likelihood Ratio Test.
AIC: Alkaike Information Criterion.
n.s.: non-significant.
+Mexico is organized politically and administratively into states, which are composed of municipalities, the smallest administrative units in the country. In turn, municipalities are composed of localities, which are defined as "any place occupied by one or more buildings utilized as housing - inhabited or not – and which are designated by a name recognized by law or custom." Rural localities are those with less than 2500 inhabitants and which are not municipal centers. Source: National Geostatistical Framework 2010. National Institute of Statistics, Geography and Data Processing.
doi:10.1371/journal.pone.0108127.t002

analyzed (locality, municipality or state). Furthermore, no evidence was found to support the use of random slopes at either the municipality (LRT = 0.10; p = 0.99) or the state (LRT = 0.22; p = 0.89) levels.

Discussion

In line with other recent studies on OA, we found significant association between the presence of depressive symptoms and a number of variables at the individual level, in particular: female [17,40–43], absence of an intimate partner [17,41–43], a low educational level or illiteracy [17,41–42], lack of empowerment in household decision-making (especially with regard to financial matters) [43–44], disability or functional limitations [40–41], presence of comorbidity [40–43], and chronic exposure to psychosocial stress [42]. The latter could be an important factor in the strong connection we found between depressive symptoms and self-reported incidents of physical violence or accidents in the previous 12 months. This is consistent with a recent Brazilian study [45], which found a strong association between exposure to violent, traumatic events and the prevalence of various psychiatric disorders, including major clinical depression. Other studies have established an association between a low socioeconomic status at either the individual or household level and depression among OA [15–17,43–48].

Our principal finding was a strong link between the presence of depressive symptoms and socioeconomic deprivation at both the locality and municipality levels. Other studies have reported such a link at even more immediate aggregation levels, namely, the neighborhood [49–55]. In this regard, a recent theoretical framework for exploring the role of the social context has suggested that the highly adverse social conditions in the areas immersed in steepest socioeconomic deprivation –specifically, crime and restricted access to resources of all sorts, such as nutritional diversity, an adequate physical environment and health care– erode interpersonal relationships and social capital, inter-acting with individual susceptibility to heighten the risk of depression [14]. This explanatory framework could well apply to higher-level conditions, such as those characterizing the localities [43] and municipalities inhabited by our sample of OA.

The link between socioeconomic deprivation at the locality level and the presence of depressive symptoms in Mexico has already been described. OA living in deprived environments routinely confront more adverse conditions leading to feelings of impotence and hopelessness, both, recognized factors in depression [43]. Multilevel analyses in Belgium [56] and Japan [57] have reported connections between socioeconomic deprivation and depression in OA at the municipality level, while another work has correlated poverty and depression in the United States at the county level [58]. While clearly recognizing the importance of the individual-level factors identified in this study, we emphasize the need to comprehend the impact of socioeconomic disadvantages at place of residence as a critical social determinant of depression in OA.

The association found by other studies between income inequality and the presence of depressive symptoms at the state level was not encountered in our work [59]. The failure of this and other studies to find this association may stem from the fact that income inequality and socioeconomic deprivation have separate causal pathways. While socioeconomic deprivation mainly refers to the material conditions of the environment and access to various social services, income inequality is a more complex social determinant because it refers to not only the deficit but also the social distribution of available resources and the social conse-quences of the inequality [59].

In consequence, the effect of the first determinant would be more direct, as suggested in the Kim model [14]; while, in contrast, the effect of socioeconomic marginalization on mental health could be explained by more indirect etiologies, such as the ecological effects of social disorganization [59]. In one of the most explored theoretical models, inequality generates social corrosion, corruption and alterations in social capital, thereby creating a hostile social environment, which produces a risk to overall health, including mental health [60]. However, these pathways have not been fully elucidated and, therefore, this constitutes a promising field of research. In addition, its associations reported for this determinant vary by level and tend to be particularly salient at the aggregation levels most proximate to the event being studied.

The findings of this work can be clearly understood under the theory of the social determinants of health, particularly under the ecosocial theory [12]. The social context - measured in our study by socioeconomic deprivation at the locality and municipal levels - is a fundamental factor in the incidence of numerous chronic illnesses, such as cardiovascular disease, obesity, cancer and infant mortality [19,61]. In our work, locality and municipal level deprivation is a multidimensional construct indicative of restricted access to essential public services, such as education, housing and income, which, in turn, can be important determinants of health outcomes. Disaggregating the potential impact of the deprivation index on the presence of depressive symptoms in OA at the municipal level would probably provide more conclusive data, given that, as a summary indicator, the deprivation index simultaneously reflects the combined association of numerous interrelated social determinants –social capital, physical environment and violence - that are also known to exert an impact on depressive symptoms [40,43,49]. In fact, alternative contextual variables incorporated into our secondary analyses –homicide rates, levels of health coverage, criminality indicators, and government spending at the municipality and locality levels– revealed no significant association with the presence of depressive symptoms. On the other hand, the multidimensional character of the index may precisely constitute its strength, since it expands the conceptual horizon to encompass a host of interlocking associations, including that of depression and socioeconomic deprivation at the locality and municipal levels.

The results of our study suggest that the current public health approach to depression needs to be expanded. Policy makers might consider that transforming the social environment and generating economic development in the poorest areas could be important strategies that would have both a multidimensional impact on health promotion and protect OA from the social risks to mental health. Additionally, providing some resources in the immediate environment– such as access to health services and recreational and social support – would strengthen the individual resilience of OA to mental disorders [14].

This study has several limitations. One is related with its cross-sectional design, which does not permit drawing firm conclusion about causal associations. Our findings are thus limited to suggesting potential connections requiring more in-depth analysis in subsequent studies. Another limitation derives from the different timing of the various measurements, with the contextual and individual/household measurements conducted in 2010 and 2012, respectively. Nonetheless, it can be expected that, on the one hand, relative differences in the deprivation index would hold for two years, and most importantly, on the other, a potential effect at the municipal level would correlate more with prolonged exposure to socioeconomic deprivation than with a simultaneous event. A final weakness in our study is the fact that, due to lack of information, we were unable to explore other important factors in OA depression, such as significant life events and social networks, which have been recognized as crucial in the etiology of depression.

Conclusions

The results of this study suggest that deprivation at the municipal and locality levels is associated with depressive symptoms, thus inviting proposals for comprehensive public policy actions that view the problem of depression in older adults also as an expression or symptom of more generalized social malaise. Evidence on the role of socioeconomic deprivation will gain scientific and political importance only to the extent that epidemiologic findings translate into a transformation of the social systems [62]. Recognizing that poverty at the municipal and locality levels impacts the health of older adults should galvanize our society to undertake the profound changes required in the social structure.

Author Contributions

References

1. Rodda J, Walker Z, Carter J (2011) Depression in older adults. BMJ 343: d5219.
2. Mathers C, Fat DM, Boerma JT (2008) The global burden of disease: 2004 update. Geneva: World Health Organization.
3. Bello M, Puentes-Rosas E, Medina-Mora ME, Lozano R (2005) Prevalencia y diagnóstico de depresión en población adulta en México. Salud Pública Mex 47: S4–S11.
4. American Psychiatric Association (2000) Task Force on D-I. Diagnostic and statistical manual of mental disorders: DSM-IV-TR. Washington, DC: American Psychiatric Association.
5. Wancata J, Friedrich F (2011) Depression: a diagnosis aptly used?. Psychiatr Danub 23:406-411.
6. Chapman DP, Perry GS (2008) Depression as a major component of public health for older adults. Prev Chronic Dis 5. Avalaible: http://www.cdc.gov/pcd/issues/2008/jan/07_0150.htm. Accessed 2014 Mar 25.
7. Cho HJ, Lavretsky H, Olmstead R, Levin M, Oxman MN, et al. (2010) Prior depression history and deterioration of physical health in community-dwelling older adults: A prospective cohort study. American J Geriatr Psychiatry 18: 442–451.
8. Urbina JR, Florez JM, García MP, Torres L, Torrubias RM (2007) Depressive symptoms in the eldery. Prevalence and associatted factors. Gac Sanit 21: 37–42.
9. Guerra M, Ferri CP, Sosa AL, Salas A, Gaona C, et al. (2009) Late-life depression in Peru, Mexico and Venezuela: the 10/66 population-based study. Br J Psychiatry 195:510–515.
10. Wilkinson RG (1997) Income, inequality and social cohesion. Am J Public Health 87: 104–106.
11. Fisher M, Baum F (2010) The social determinants of mental health: implications for research and health promotion. Aust N Z J Psychiatry 44: 1057–1063.
12. Krieger N (2001) New theories for social epidemiology in the 21st century: an eco-social perspective. Int J Epidemiol 30:668–677.
13. Krieger N (2005) Embodiment: a conceptual glossary for epidemiology. J Epidemiol Community Health 59:350–355.
14. Kim D (2008) Blues from the Neighborhood? Neighborhood Characteristics and Depression. Epidemiol Rev 30:101–117.
15. Lue BH, Chen LJ, Wu SC (2010) Health, financial stresses, and life satisfaction affecting late-life depression among older adults: a nationwide, longitudinal survey in Taiwan. Arch Gerontol Geriatr 50:S34–S38.
16. Koster A, Bosma H, Kempen GI, Penninx BW, Beekman AT, et al. (2006) Socioeconomic differences in incident depression in older adults: The role of psychosocial factors, physical health status, and behavioral factors. J Psychosom Res 61:619–627.
17. Li N, Pang L, Chen G, Song X, Zhang J, et al. (2011) Risk factors for depression in older adults in Beijing. Can J Psychiatry 56:466–473.
18. Juhasz G, Eszlari N, Pap D, Gonda X (2012) Cultural differences in the development and characteristics of depression. Neuropsychopharmacol Hung 14:259–265.

19. Link BG, Phelan J (1995) Social conditions as fundamental causes of disease. J Health Soc Behav 1:80–94.

20. Wilkinson R, Marmot M (2003) Social determinants of health: the solid facts. Oxford: Oxford University Press. 31 p.

21. Rose G (2001) Sick individual and sick population. Am J Epidemiol 30:417–432.

22. Romero-Martínez M, Shamah-Levy T, Franco-Núñez A, Villalpando S, Cuevas-Nasu, et al. (2013) Encuesta Nacional de Salud y Nutrición 2012: diseño y cobertura. Salud Pública Mex 55: S332–S340.

23. Herrero J, Gracia E (2007) Una Medida Breve de la Sintomatología Depresiva (CESD-7). Salud Mental 30:40–46.

24. Salinas-Rodríguez A, Manrique-Espinoza B, Acosta-Castillo I, Franco-Núñez A, Rosas-Carrasco O, et al. (2014) Validación de un punto de corte para la versión breve de la Escala de Depresión del Centro de Estudios Epidemiológicos en adultos mayores mexicanos. Salud Pública Mex 56:279–285.

25. Farris FA (2010) The gini index and measures of inequality. Am Math Mon 117: 851–864.

26. Instituto Nacional de demografía y estadística (2010) Diseño de la muestra censal. México DF: Instituto Nacional de demografía y estadística.

27. Jenkins SP (2006) Estimation and interpretation of measures of inequality, poverty, and social welfare using Stata. Presentation at North American Stata Users' Group Meetings, Boston MA.

28. Atkinson AB (1970) On the measurement of inequality. J Econ Theory 2: 244–263.

29. Sen AK (1976) Real national income. Rev Econ Stud 43: 19–39.

30. Jenkins SP (1997) Trends in real income in Britain: a microeconomic analysis. Empirical Economics 22: 483–500.

31. Almejo R, Téllez Y, López J (2010) Índices absoluto de Marginación 2000–2010. México DF: Consejo Nacional de Población.

32. Anzaldo C, Prado M (2010) Índices de marginación 2010. México DF: Consejo Nacional de Población.

33. Katz S, Branch LG, Branson MH, Papsidero JA, Beck JC, et al. (1983) Active life expectancy. N Engl J Med 309:1218–1224.

34. Lawton MP, Brody EM (1969) Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 9:179–186.

35. Booysen F, van der Berg AE, Burger R, von Maltitz M, du Rand G (2008) Using an Asset Index to Assess Trends in Poverty in Seven Sub-Saharan African Countries. World Development 36:1113–1130.

36. Filmer D, Pritchett L (1998) Estimating wealth effects without expenditure data – or tears: An application to educational enrollments in states of India. In: World Bank Policy Research Working Paper No. 1994. Washington DC: World Bank.

37. Moser C (2008) Assets and livelihoods: a framework for asset-based social policy. In: Moser C, Anis D, eds. Assets, livelihoods, and social policy. Washington DC: The World Bank.

38. Snijders T, Bosker R (2012) Multilevel Analysis. An introduction to basic and advanced multilevel modeling. Oxford: SAGE Publications Ltda.

39. Akaike H (1974) A new look at the statistical model identification. IEEE Trans Automat Contr 19: 716–723.

40. Millán-Calentí JC, Sánchez A, Lorenzo T, Maseda A (2012) Depressive symptoms and other factors associated with poor self-rated health in the elderly: Gender differences. Geriatr Gerontol Int 12: 198–206.

41. Arslantas D, Unsal A, Ozbabalik D (2013) Prevalence of depression and associated risk factors among the elderly in Middle Anatolia. Turkey Geriatr Gerontol Int 14: 100-108.

42. Munhoz TM, Santos IS, Matijasevich I (2013) Major depressive episode among Brazilian adults: A cross sectional population-base study. J Affect Disord 150:401–407.

43. Bojorquez-Chapela I, Manrique-Espinoza BS, Mejía-Arango S, Téllez-Rojo MM, Salinas-Rodríguez A (2012) Effect of social capital and personal autonomy on the presence of depressive symptoms in the elderly: Evidence from a longitudinal study in Mexico. Aging Ment Health 16: 462–471.

44. Abe Y, Fujice N, Fukunaga R, Nakagawa Y, Ikeda M (2012) Comparisons of the prevalence of and risk factors for elderly depression between urban and rural populations in Japan. Int Psychogeriatr 24: 1235–1241.

45. Ribeiro WS, Mari JJ, Quintana MI, Dewey ME, Evan-Lacko S, et al. (2013) The impact of epidemic violence on the prevalence of psychiatric disorders in Sao Paulo and Rio de Janeiro, Brazil. PLoS One 8:e63545.

46. Roy K, Chaudhuri A (2008) Influence of socioeconomic status, wealth and financial empowerment on gender differences in health and healthcare utilization in later life: Evidence from India. Soc Sci Med 66: 1951–1962.

47. Bulut S (2009) Late life depression: A literature review of late-life depression and contributing factors. Anales de psicología 25: 21–26.

48. Blazer DG, Hybels CF (2005) Origins of depression in later life. Psychol Med 35: 1241–1252.

49. Ostir GV, Eschbach K, Markides KS, Goodwin JS (2003) Neighbourhood composition and depressive symptoms among older Mexican Americans. J Epidemiol Community Health 57: 987–992.

50. Kubzansky LD, Subramanian SV, Kawachi I, Fay ME, Soobader MJ, et al. (2005) Neighborhood Contextual Influences on Depressive Symptoms in the Elderly. Am J Epidemiol: 162:253-260.

51. Walters K, Breeze E, Wilkinson P, Price GM, Bulpitt CJ, et al. (2004) Local area deprivation and urban-rural differences in anxiety and depression among people older than 75 years in Britain. Am J Public Health 94:1768–1774.

52. Wight RG, Aneshensel CS, Cummings JR, Karlamangla AS (2009) Urban neighborhood context and change in depressive symptoms in late life. J Gerontol Ser B Psychol Sci Soc Sci 64:247–251.

53. Yen Y-C, Rebok GW, Yang M-J, Lung F-W (2008) A multilevel analysis of the influence of Apolipoprotein E genotypes on depressive symptoms in late-life moderated by the environment. Prog Neuropsychopharmacol Biol Psychiatry 32:479–486.

54. Hybels CF, Blazer DG, Pieper CF, Burchett BM, Hays JC, et al. (2006) Sociodemographic characteristics of the neighborhood and depressive symptoms in older adults: using multilevel modeling in geriatric psychiatry. Am J Geriatric psychiatry 14(6):498–506.

55. Menec VH, Shooshtari S, Nowicki S, Fournier S (2010) Does the relationship between neighborhood socioeconomic status and health outcomes persist into very old age? A population-based study. J Aging Health 22:27–47.

56. Patty E, Praag LV, Verhaeghe M, Levecque K, Bracke P (2011) The association between residential area characteristics and mental health outcomes among men and women in Belgium. Arch Public Health 69: 3.

57. Murata C, Kondo K, Hirai H, Ichida Y, Ojima T (2008) Association between depression and socio-economic status among community-dwelling elderly in Japan: the Aichi Gerontological Evaluation Study (AGES). Health Place 1:406–414.

58. Muramatso N (2003) County-Level Income Inequality and Depression among Older Americans. Health Serv Res 38: 1863–1884.

59. Wilkinson RG, Picket KE (2006) Income inequality and population health: A review and explanation of the evidence. Soc Sci Med 62:1768–1784.

60. Idrovo AJ, Ruiz-Rodríguez M, Manzano-Patiño AP (2010) Beyond the income inequality hypothesis and human health: a worldwide exploration. Rev Saude Publica 44:695–702.

61. Davey Smith G, Gunnell D, Ben-Shlomo Y (2001) Poverty, Inequality and Health: An International Perspective. Oxford: eds Leon D, Walt G. pp 88–124.

62. Beckfield J, Krieger N (2009) Epi + demos + cracy: Linking Political Systems and Priorities to the Magnitude of Health Inequities—Evidence, Gaps, and a Research Agenda Epidemiol Rev31: 152–77.