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Frailty and Social Vulnerability in Mexican Deprived and Rural Settings

Betty Manrique-Espinoza, PhD[1], Aarón Salinas-Rodríguez, MSc[1], Nelly Salgado de Snyder, PhD[1], Karla Moreno-Tamayo, MSc[1], Luis Miguel Gutiérrez-Robledo, MD, PhD[2], and José Alberto Avila-Funes, MD, PhD[3]

Abstract

Objective: To estimate the prevalence of frailty in a sample of rural elderly living in socially vulnerable circumstances as well as to determine its correlates. **Method:** Cross-sectional study of 558 rural elderly participating in a prospective study conducted in Mexico. Frailty was defined using the Fried criteria. Ordinal logistic regression model was used to identify the correlates of frailty levels. **Results:** Prevalence of frailty was 8.6%. Disability in basic activities of daily living and illiteracy increase the probability of being pre-frail and/or frail (odds ratio [OR] = 2.72, $p < .01$; OR = 1.45, $p = .05$, respectively), while living in households with higher socioeconomic status reduces this probability (OR = 0.85, $p < .01$). **Discussion:** A high prevalence of frailty was found among these young elderly, who did not yet

[1]National Institute of Public Health, Cuernavaca, Morelos, Mexico
[2]National Institute of Geriatrics, Mexico City, Mexico
[3]National Institute of Medical Sciences and Nutrition Salvador Zubiran, Mexico City, Mexico

Corresponding Author:
Aarón Salinas-Rodríguez, Research Center for Evaluation and Surveys, National Institute of Public Health, Avenida Universidad No. 655, Colonia Santa María Ahuacatitlán, 62100 Cuernavaca, Morelos, Mexico.
Email: asalinas@insp.mx

fully show adverse health events. Also the social vulnerability of rural elderly is associated with frailty status. These findings highlight the health needs of socially and economically vulnerable elderly population.

Keywords
frailty, social vulnerability, rural elderly

Frailty syndrome has been defined as the result of a decline in homeostatic reserve and resistance to stress (Fried et al., 2001). Individuals can spend years in this state before dying, thus enduring substantial deterioration in their quality of life (Bergman et al., 2004; Fried et al., 2001; Morley, Perry, & Miller, 2002). Although there is no universal definition for frailty, the phenotype proposed by the Cardiovascular Health Study Collaborative Research Group has gained widespread use and recognition (Fried et al., 2001).

The study of frailty has been addressed according to its physiological underpinnings and the health needs of elderly persons, almost without considering social factors as a pathway to adequately understanding and attending the problem under a comprehensive approach. However, in recent times, the intimate relationship between the social dimensions of aging and frailty has been recognized taking into account the biological changes accumulated over time, changes that can be determined by lifestyles and social contexts (Gutiérrez-Robledo & Avila-Funes, 2012). In Latin America, it has been found that frailty differentials between sexes can be partly explained by social inequality in terms of social disadvantages aggregated over time, from early childhood to senescence (Alvarado, Zunzunegui, Beland, & Bamvita, 2008). It has also been proposed that individuals "incorporate" in their bodies the social inequalities, which they have been exposed to all their lives, starting at conception (Krieger, 2005, 2012).

In developing countries, social inequality poses a prevalent problem, particularly for the indigenous, the population group facing the lowest levels of education, health, social security, housing, food, and income with the concomitant deterioration in health conditions and quality of life (Consejo Nacional de Evaluación de la Política de Desarrollo Social, 2013, 2014; Juárez-Ramírez et al., 2014; Rubio & Garfias, 2010). Elderly persons living in adverse social contexts are exposed to inequities and poor health conditions, all of them potential factors in the emergence or advancement of frailty. With the role of social determinants in frailty still uncertain, particularly among vulnerable populations, the aim of this study was to estimate the prevalence of frailty in a sample of elderly residing in deprived and rural settings of Mexico as well as to determine its correlates.

Method

Sample and Procedures

The sample of the present study was formed for 558 subjects who had participated in the Impact Evaluation Study of the social pension program *70 y más* in Mexico. Implemented nationally throughout Mexico, program *70 y más* was aimed at improving the living conditions among adults aged 70 years and older. Centered on two components, *70 y más* pursues a twofold objective: (a) to raise the income of the elderly and (b) to improve the social protection of the elderly. Under the first program objective, elderly received a direct unconditional cash transfer of 500 Mexican pesos (approximately US$31) every month, which can be collected every 2 months. A brief description of the Impact Evaluation Study of the program *70 y más* is shown here.

In 2007, the Ministry of Social Development established two criteria for selecting program beneficiaries: first, being ≥70 years old, and, second, residing in a rural locality of ≤2,500 inhabitants. Both were used in the Impact Evaluation Study as the basis for setting up four study groups. Power analysis and sample size calculation determined a total of 6,000 elderly persons distributed in four study groups (1,500 per group). According to an empirical comparison group formation analysis, it was determined that individuals aged between 65 and 74 years would be included in the evaluation study, with an intervention group composed of subjects aged 70 to 74 years residing in rural areas. The remaining elderly persons were distributed among three control groups. The first included individuals, aged 70 to 74 years, living in communities slightly larger than rural localities (2,501-2,700 inhabitants); the second, individuals aged 65 to 69 years, living in rural localities; and the third, individuals aged 65 to 69 years, living in localities of 2,501 to 2,700 inhabitants. Impact Evaluation Study was conducted in 516 Mexican rural localities. The program description and methodological details of evaluation design of *70 y más*, as well as the sampling procedures and results, have been previously reported (Salinas-Rodríguez, Torres-Pereda, Manrique-Espinoza, Moreno-Tamayo, & Tellez-Rojo Solis, 2014).

Frailty Study Sub-Sample

During the second follow-up in 2009, a secondary study was designed with the objective to estimate the frailty prevalence among a sample of elderly residing in rural areas of Mexico. The sampling frame consisted of the same 6,000 subjects interviewed at the baseline. The inclusion criterion was that participants had complete information on all variables that were measured during the baseline. Simple random sampling was used to select a sub-sample of 600 subjects who were contacted and invited to participate in the frailty

study. The size of the sub-sample was calculated to detect prevalence rates of at least 4% with power = 80% and $\alpha = 5\%$. Participants underwent a functional assessment including physical performance tests and measurement of balance, walking speed, and grip strength (Fried et al., 2001; Guralnik et al., 1994). The study was approved by the Ethics Committee of the National Institute of Public Health, and written informed consent was obtained from all subjects. Response rate for the sub-sample was 93%.

Measures

Frailty definition. The phenotype of frailty was determined according to a slightly modified version of the Fried et al. (2001) proposal. The composite measure was defined as follows:

Slowness. The slowest quintile of the sample was defined based on timed 4-meter walking test, adjusting for sex and height as recommended. The lowest quintile was used to identify subjects with slowed walking speed.

Weakness. Grip strength was measured in kilograms using a hand-held dynamometer and taking into account the dominant hand of the subject. Three measurements were taken for each participant; the results were averaged and stratified by sex. The body mass index (BMI) quartiles were also considered by sex. The subjects in the lowest grip strength quintile for each BMI quartile were considered frail in terms of strength.

Low physical activity. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ) short form (IPAQ group, 2005) which collects data on last-week physical activity in three domains: Vigorous-intensity activities, moderate-intensity activities, and walking. The number of Metabolic Equivalent of Task (MET)–minutes/week was added up for each domain, and weekly energy expenditure in kilocalories was obtained for each subject. This variable was stratified by sex, and 20th percentile of the kilocalories expended per week was computed. The subjects in this percentile were considered frail in terms of low physical activity.

Exhaustion. Exhaustion was established by a negative answer to the following two questions from the Geriatric Depression Scale (GDS): “Do you feel full of energy?” and “Do you have enough energy for your everyday life?”

Weight loss. Weight loss was defined as a self-reported, unintentional weight loss of ≥5 kg in the previous 6 months. Subjects who responded positively were classified as frail for this component.

As proposed, those with three or more positive answers were cataloged as frail, considered pre-frail if they fulfilled one or two criteria, and non-frail if none (Fried et al., 2001).

Covariates. The following variables were used: age, sex, illiteracy (self-report about not known read or write), being indigenous people (self-report about speaking an indigenous language), and labor status (paid job). Multimorbidity was determined by asking whether participants had a physician's diagnosis of hypertension, diabetes, hypercholesterolemia, arthritis or osteoporosis .

Depressive symptoms (DS) were assessed using the GDS 15-item version (Yesavage et al., 1983). We defined a dummy variable equal to 1 if the individual showed significant DS (GDS ≥ 6) and 0 otherwise. The questions used for the frailty definition was excluded from the total GDS score. Self-perception of health was obtained and treated as a categorical variable (good/very good, fair, and poor/very poor).

Two domains of disability were investigated: Basic activities of daily living (ADL) and instrumental ADL (IADL). ADL were measured according to the five activities on the Katz scale: Walking, bathing, toileting, transferring from bed, and dressing (Katz et al., 1983). IADL were measured according to the six activities on the Lawton scale: Preparing meals, shopping for food, managing medications, managing finances, handling transportation, and doing housework (Lawton & Brody, 1969). Participants who reported needing assistance or being unable to perform at least one of the activities in each domain were considered as having ADL or IADL disability. BMI (BMI = weight [kg] / height^2 [m]) was also included as a covariate.

At the household level, an asset index was constructed (as a proxy indicator of socioeconomic status [SES]) with a count of 18 household assets (which includes ownership of the following goods at the moment of the survey: own house, TV, radio, car, bike, stereo, computer, etc.). Using principal components analysis (and a tetrachoric correlation matrix) a continuous index was computed, where higher values indicating higher household SES.

As context variable, we used, as a proxy of social vulnerability, the deprivation index (DI) for the localities where the elderly person lived. This variable has been constructed by the Mexican National Population Council using information of the Census 2010. Broadly validated and utilized in Mexico, 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, municipality, and state. The locality dimensions are: Education (percentage of illiterate individuals aged 15 years and older 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 US$8.67 per month in 2010). The index is a continuous variable, where higher values denote greater socioeconomic deprivation (Consejo Nacional de Población, 2013).

Statistical Analysis

Variables were described using arithmetic means and standard deviations (*SD*) or proportions where appropriate. The following statistical procedures were used according to the characteristics of each variable: chi-square test for categorical data and ANOVA for continuous data. Given the ordinal nature of the categories associated to the dependent variable (non-frail, pre-frail, frail), we used an multivariate ordinal logistic regression model to identify the correlates of frailty, including the context variable DI as potential determinant of frail status. Statistical analyses, included the verification of the proportional odds assumption, were carried out using Stata 13.0 software (StataCorp LP, Texas, USA). The final model was evaluated in terms of collinearity, goodness of fit, and residuals. Differences were considered statistically significant if p value < .05, and marginally significant if .05 < p value < .10, and 95% confidence intervals (CI) are given.

Results

Table 1 shows the socio-demographic characteristics and health status of the participants according to the frailty status. Among the participants, 70.3% were elderly people aged 70 years and above, 47.5% were female, 58.8% were illiterate, and 43.9% reported speaking an indigenous language; 19.6% reported depressive symptoms. Overweight and obesity prevalence was 35% and 13%, respectively. Of all participants, 12.2% were ADL and 15.2% IADL disabled.

Frailty was present in 8.6% of participants; 52.9% were pre-frail, and 38.5% were non-frail. Twenty-nine percent of participants were frail in terms of exhaustion, 2.3% in low physical activity, 25% in slowness, 2% in weight loss, and 22.9% in weakness. In comparison with non-frail and pre-frail persons, participants classified as frail were older, more likely to be illiterate, and spoke an indigenous language. In the same vein, frail subjects presented more frequently depressive symptoms, and experienced greater ADL and IADL disability, and worse self-reported health status compared with the pre-frail and non-frail participants. Pre-frail (−0.034) and frail (−0.150) individuals presented

Table 1. Socio-Demographic and Health Characteristics of Analytical Sample.

Variables	Non-frail *n* = 215 38.5%	Pre-frail *n* = 295 52.9%	Frail *n* = 48 8.6%	*p* value[a]	Total *n* = 558
Age					
<70 years (%)	32.6	30.9	10.4		29.8
≥70years (%)	67.4	69.2	89.6	.008	70.3
Female (%)	47.4	46.4	54.2	.610	47.5
Illiteracy (%)	51.6	61.4	75.0	.005	58.8
Speaking an indigenous language (%)	37.4	46.3	58.3	.015	43.9
Paid job (%)	47.4	46.8	10.4	<.001	43.9
Civil union (%)	39.1	43.8	51.1	.281	42.7
Self-perception of health					
Good/very good (%)	72.1	62.1	39.5	.001	64.5
Depressive symptoms (%)	12.1	21.7	47.4	<.001	19.6
Hypertension (%)	20.9	27.8	33.3	.095	25.6
Diabetes (%)	10.7	12.5	18.8	.306	12.4
Hypercholesterolemia (%)	5.6	9.2	4.2	.207	7.4
Arthritis (%)	12.6	9.8	6.3	.365	10.6
Osteoporosis (%)	8.4	8.1	6.3	.886	8.1
ADL disability (%)	4.7	14.6	31.3	<.001	12.2
IADL disability (%)	9.8	14.9	41.7	<.001	15.2
Asset index (*M*)	1.806	−0.250	−0.100	.001	−0.008
Deprivation index (*M*)	−0.209	−0.034	−0.150	.004	−0.111

Note. ADL = activities of daily living; IADL = instrumental activities of daily living.
[a]z-proportion test or ANOVA test.

higher deprivation levels in their communities than their non-frail counterparts (−0.209; $p = .004$).

Table 2 shows the results of the ordinal logistic regression model of frailty correlates. The following variables at the individual level were associated with a greater probability of being pre-frail and/or frail: ADL (odds ratio [OR] = 2.72, $p = .001$) and IADL (OR = 1.72, $p = .055$) disability, presence of depressive symptoms (OR = 2.17, $p = .001$), illiteracy (OR = 1.45, $p = .054$), and fair (OR = 1.83, $p = .004$) or poor/very poor (OR = 2.03, $p = .049$) self-reported health status. However, the probability of being pre-frail or frail was inversely associated with the fact to reside in households with higher SES (OR = 0.85, $p = .007$). Finally, the context variable DI of the elderly persons' localities was not significantly associated with frailty.

Table 2. Correlates of Frailty: Multivariate Ordinal Logistic Regression Results.

Variables	Odds ratio	95% confidence interval	*p* value
Age (≥70 years)	1.23	[0.84, 1.79]	.278
Female	0.75	[0.49, 1.15]	.200
Illiteracy	1.45	[0.99, 2.11]	.054
Speaking an indigenous language	1.13	[0.77, 1.69]	.529
Paid job	0.79	[0.51, 1.22]	.290
ADL disability	2.72	[1.49, 4.95]	.001
IADL disability	1.72	[0.99, 2.97]	.055
Depressive symptoms	2.17	[1.36, 3.47]	.001
Number of chronic diseases	0.97	[0.80, 1.18]	.807
Self-perception of health[a]			
Fair	1.83	[1.21, 2.69]	.004
Poor/very poor	2.03	[1.01, 4.12]	.049
Household SES (asset index)	0.85	[0.76, 0.96]	.007
Deprivation index	1.03	[0.73, 1.45]	.880

Note. ADL = activities of daily living; IADL = instrumental activities of daily living; SES = socioeconomic status.
[a]Reference category: Good/very good.

Discussion

The aim of this study was to estimate the prevalence of frailty and determine its correlates among a socially vulnerable population. All participants in the present study were elderly dwelling in rural communities marked by conditions of profound vulnerability—for example, high illiteracy and deprivation levels.

Our work demonstrates that individuals who know how to read and write and present higher SES are less prone to frailty. Although the association between SES and frailty was estimated using current data from SES (using a current asset index as proxy), it could be hypothesized that present SES of these rural elderly persons has not been changed, as it is a population with very low rates of migration, and their entire lives have been lived in the same deprived areas, which in turn could confirm the rationale that frailty is associated with disadvantages in early life (Alvarado et al., 2008). According to Lang et al. (2009) poor elderly persons residing in the most deprived neighborhoods are the most vulnerable, thereby suggesting that frailty is independently linked to the socioeconomic conditions of places of residence. Similarly, Alvarado et al. (2008) have documented that, in comparison with

urban elderly persons, rural older persons are exposed to a greater number of social deficits throughout their life courses, and to more precarious socioeconomic and health conditions. The elderly participating in the present study seemed to mirror in their physical ailments the disadvantages and deficits they had accumulated as a result of the social inequality they had been exposed to all their lives, circumstances which, in the end, has morphed into frailty (Krieger, 2005, 2012).

Frailty does not suddenly appear; it has been found to correlate with other ailments. Our findings reveal that subjects with DS are particularly susceptible to being frail, as are those who self-rate their general health condition as fair or poor as opposed to good or very good. It has been found that variables such as morbidity, low physical activity, self-perception of poor health, and presence of DS, ADL, and IADL are all determinants of frailty (Aguilar-Navarro et al., 2012; Avila-Funes et al., 2008; Avila-Funes et al., 2011). In addition, other study has shown that elderly persons become frail through a common pathway of illnesses or comorbidity, thereby making a case that frailty relates not only to the natural physiological changes of aging but also to illness (Curcio, Henao, & Gomez, 2014). Specifically, self-perception of health has been identified as a highly sensitive variable in elderly health estimations and a valid predictor of morbidity (Bailis, Segall, & Chipperfield, 2003) or even mortality (DeSalvo, Bloser, Reynolds, He, & Muntner, 2006; Jylha, 2009) among elderly population. The role of self-perception of health as a frailty predictor can be explained through the Jylha (2009) model, where self-appraisal has biological and cognitive underpinnings that correlate with objective or hard measures (biomarkers) of health, thus suggesting that self-appraisal captures the physiological state of individuals (Casale-Martinez, Navarrete-Reyes, & Avila-Funes, 2012; Jylha, Volpato, & Guralnik, 2006).

The prevalence of frailty in our study is consistent with the findings of other national and international studies that have measured frailty according to the Fried et al. proposal. For example, frailty prevalence found in a systematic review of population studies oscillated between 4% and 17% in subjects aged 65 years and older, with a weighted prevalence of 9.9% (95% CI = [9.6, 10.2]; Collard, Boter, Schoevers, & Oude Voshaar, 2012). In addition, their review yielded 15.7% and 26.2% frailty prevalence rates in participants aged 80 to 84 years and ≥85, respectively, thus confirming that prevalence increases with age.

Our results also converge with reports on the rural population in Latin America. In the Colombian rural population it was reported 12.2% of frailty prevalence (Curcio et al., 2014). Remarkably, we found no studies reporting frailty prevalence in Mexican rural elderly persons. It is noteworthy that the rates yielded by other national studies oscillate widely between 7% and 37%

(Aguilar-Navarro et al., 2012; Alvarado et al., 2008; Avila-Funes et al., 2014). Maybe, this high variability reflects the use of different conceptual and operational definitions of frailty (Collard et al., 2012).

The results of the present study also suggest that the social and economic deprivation of rural elderly contributes to increased frailty in that population, with high prevalence rates found among relatively young participants, who did not yet fully show adverse health events. This apparently indicates that frailty prevalence increases with age. It must be borne in mind that the rates in our study may be higher than those reported by other studies given the precarious economic and social conditions of our sample. This can be partly explained because social disadvantages are linked to frailty, particularly when they occur in the first years of life, and they reproduce throughout a person's life span, thereby suggesting that the onset of frailty can befall the poor at earlier ages. Social disadvantages may even result in survival bias, with only a select group of elderly participants who have survived death, deprivation, infections, and disease throughout their lives reaching more advanced ages and manifesting the impact of frailty more noticeably (Manrique-Espinoza et al., 2014).

One limitation of this study is we relied on cross-sectional design and were therefore unable to establish causality relationships—or even discard the possibility of reverse causality—in the associations observed. An additional limitation of our study is the definition of the analytical sample due to the non-response rate, even if this rate has been as low as 7%. Excluded elderly people from the analytical sample, were mostly illiterate, with greater ADL and IADL disability, and a greater prevalence of depressive symptoms. It is possible that along with the presence of poorer health, also there was a higher prevalence of frailty, which means that our measures of association (odds ratios) could be underestimated. Even so, our study used the objective frailty measures according to Fried's original proposal, which allowed us to produce reliable and precise findings, comparable with those of other studies.

Conclusion

In conclusion, our work represents an important contribution in that its findings provide a reference tool for characterizing this population group, and highlight the health needs of socially and economically vulnerable elderly population. Our results show a high prevalence of frailty rates among these relatively young elderly, who did not yet fully show adverse health events. Identifying frailty opportunely is essential not only to prevent or reverse the frailty development process but also to serve as an indicator for health system financing, especially as regards the achievement of adequate planning for

elderly people health care costs. Frailty in the elderly, therefore, constitutes a public health issue of significant relevance to this sector (Collard et al., 2012) considering the sustained growth observed in this population segment.

Authors' Note

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Declaration of Conflicting Interests

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