Experimental Gerontology 79 (2016) 55–60

Contents lists available at ScienceDirect

Experimental Gerontology

journal homepage: www.elsevier.com/locate/expgero

Frailty prevalence and associated factors in the Mexican health and aging study: A comparison of the frailty index and the phenotype

Carmen García-Peña [a], José Alberto Ávila-Funes [b], Elsa Dent [c], Luis Gutiérrez-Robledo [a], Mario Pérez-Zepeda [d,*]

[a] Instituto Nacional de Geriatría, Mexico
[b] Instituto Nacional de Ciencias Médicas y Nutrición "Salvador Zubirán", Mexico
[c] Centre for Research in Geriatric Medicine, The University of Queensland, Brisbane, Australia
[d] Geriatric Epidemiology Unit, Research Department, Instituto Nacional de Geriatría, Mexico

ARTICLE INFO

Article history:
Received 3 October 2015
Received in revised form 17 March 2016
Accepted 24 March 2016
Available online 29 March 2016

Section Editor: Diana Van Heemst

Keywords:
Frailty
Socio-economic determinants of health
Epidemiology of aging

ABSTRACT

Background: Frailty is a relatively new phenomenon described mainly in the older population. There are a number of different tools that aim at categorizing an older adult as frail. Two of the main tools for this purpose are the Fried's frailty phenotype (FFP) and the frailty index (FI). The aim of this report is to determine the prevalence of frailty and associated factors using both FFP and the FI.
Methods: Secondary analysis of 1108 individuals aged 60 or older is participating in the third (2012) wave from the Mexican Health and Aging Study (MHAS). The FFP and the FI were constructed and a set of variables from different domains were used to explore associations. Domains included were: socio-demographic, health-related, and psychological factors. Regarding prevalence, concordance was tested with a kappa statistic. To test significant associations when classifying with each of the tools, multiple logistic regression models were fitted.
Results: Mean (SD) age was 69.8 (7.6) years, and 54.6% (n = 606) were women. The prevalence of frailty with FFP was 24.9% (n = 276) while with FI 27.5% (n = 305). Kappa statistics for concordance between tools was 0.34 ($p < 0.001$). Age, years in school, number of past days in bed due to health problems, number of times that consulted a physician last year for health problems, having smoked in the past, and life satisfaction were associated with frailty when using any of the tools.
Conclusions: There is a persistent heterogeneity on how frailty is measured that should be addressed in future research.

1. Introduction

There is an urgent need to obtain accurate data about human aging, particularly in those societies which have an accelerated rate of population aging combined with scarce human and material resources (Gutierrez-Robledo, 2002). A main concern of aging population is frailty. Frailty is a geriatric condition characterized by multi-system decline and an increased vulnerability to external stressors (Clegg et al., 2013). Frailty places a large burden on individuals, their carers, and on health care systems (Avila-Funes et al., 2008; Clegg et al., 2013; Xue, 2011). Frailty prevalence has found to be heterogeneous in different populations, primarily due to the different measurements used for its identification (Collard et al., 2012). In particular, in Mexico, previously reported prevalence using the frailty phenotype has ranged from 14.1% to 37.2% (Aguilar-Navarro et al., 2012; Alvarado et al., 2008; Diaz de Leon Gonzalez et al., 2010; Ruiz-Arregui et al., 2013; Sanchez-Garcia et al., 2014). Regarding the frailty index, there is only one report in Mexican older adults, showing a prevalence of 27% (with a 0.21 cut-off value) (Garcia-Gonzalez et al., 2009).

An on-going debate without an agreement on the definition of frailty is reflected by the numerous tools used to measure this phenomenon (Garcia-Garcia et al., 2011; Karunananthan et al., 2009; Morley et al., 2013), particularly around whether frailty is: (i) a distinct condition with common contributing factor/s or; (ii) if there are several "frailties", each with different risk factors (At et al., 2015; Walston et al., 2006). To tackle this dilemma in defining frailty, research comparing the commonality between associated factors of frailty measurements is required (Theou et al., 2014). However, to date, research studies comparing this similarities of associated factors between the two dominant frailty measures [Fried's frailty phenotype (FFP) (Fried et al., 2001) and Rockwood and Mitnitski's frailty index (FI)] (Rockwood et al., 2007) is scant. Literature has been mainly focused in the prediction capacity of adverse outcomes, both to the FFP and FI and also with different variations of FFP (At et al., 2015; Blodgett et al., 2015; Rodriguez-Manas and Fried, 2015; Ensrud et al., 2008; Ensrud et al., 2009).

* Corresponding author at: Periférico Sur 2767, Colonia San Jerónimo Lídice, Delegación Magdalena Contreras, Código Postal 10200, México Distrito Federal, Mexico.

http://dx.doi.org/10.1016/j.exger.2016.03.016
0531-5565/

Moreover, using different approaches to measure frailty, and test their association with different domains –from health-related to social and psychological features– could help to quantify, detect, and better understand this emerging health condition (Hoogendijk et al., 2014).

Therefore, the aim of this research study was to: (i) describe the prevalence of frailty and associated factors using both FFP and the FI and (ii) to determine associated factors (from different domains) with frailty, also defined by both FFP and the FI.

2. Materials and methods

2.1. Setting and participants

This is a cross-sectional analysis of the third (2012) wave from the Mexican Health and Aging Study (MHAS), a prospective panel study conducted in Mexico. The aim and design of the MHAS is published elsewhere (Wong et al., 2007; Wong et al., 2015; MHAS, Mexican Health and Aging Study, 2012). In brief, there are three waves of this study (2001, 2003, and 2012, respectively) with a representative sample of community-dwelling Mexican older adults. In order to determine factors that influence aging in Mexican older adults, a set of questionnaires (socio demographic characteristics, health-related issues, access to health services, cognitive performance, functional status, and financial resources) was applied to all the participants, by interviewers at the older adult's home. In addition, each wave included a sub-sample in which anthropometry and blood samples were included.

In the last wave of 2012, 18,465 participants were assessed, including 12,569 follow-up participants from 2001 onwards, and 5896 new participants in order to refresh the sample (including spouses of the chosen subject, regardless of age). In this wave, anthropometry, gait speed, and handgrip strength were additionally obtained in a subsample of 2089 older adults. In order to have the objective measurements required by the FFP (gait speed and handgrip strength), this sub-sample of the last wave was chosen. Only 1108 were 60-year or older representing the final sample for this work.

2.2. Definitions of frailty

Similar approaches to both the FFP and the FI were taken from previously reported studies in Mexican older adults and in particular from the MHAS (Aguilar-Navarro et al., 2012; Garcia-Gonzalez et al., 2009), using in this manuscript physical performance measures instead of self-report for slowness and weakness of the FFP.

The FFP was constructed with five components: slowness, weakness, exhaustion, low physical activity, and weight loss (Fried et al., 2001); older adults with three or more of this components were considered to be frail. Slowness was considered present if the individual was in the lower 20% of its group of sex and mean height, based on the time to walk at usual pace departing from a standing position along a path of 4 m. Weakness was considered present if handgrip strength score was in the lowest quintile of the older adult specific group –sex and quartiles of body mass index (see Supplementary Table 1 for cut-off values). Exhaustion was considered present if the answer to the question "During the last two years, have you frequently had severe fatigue or exhaustion?" was "Yes" Regarding low physical activity it was considered present if the older adult answered "no" to the following question "During the last two years have you exercised or done hard physical work on average at least three times a week?" Finally, weight loss was considered present if the subject reported unintentional weight loss of 5 kg or more in the previous two years.

Regarding FI, a previously reported index used in Mexican older adults was also integrated (Garcia-Gonzalez et al., 2009), with a total of 32 so-called deficits: serious adverse events during childhood (tuberculosis, rheumatic fever, poliomyelitis, typhoid fever, serious head injury, serious health problem), comorbidities (hypertension, diabetes mellitus, cancer, chronic obstructive pulmonary disease, stroke, arthritis, falls, fractures, vision problems), difficulty in basic (ADL) and instrumental (IADL) activities of daily living, a list of common symptoms in the previous two years (fatigue, respiratory symptoms, involuntary urine loss, gastrointestinal symptoms, bodily pain, depressive symptoms), and self-rated health. The FI was composed following the standardized procedure by Searle et al., (Searle et al., 2008), which includes transforming each variable into a score of 0 (deficit absent) to 1 (deficit present) with possible intermediate scores (see supplementary Table 2 for complete description of deficits and scoring procedures). All deficit scores were summed and then divided by 32 (total number of deficits in the current list) for each participant, with total scores for the FI ranging from 0 (no deficit present) to 1 (all deficits present). Older adults with a FI score ≥ 0.21 or higher were considered as frail, this cut-off value has been validated in this same data set (Garcia-Gonzalez et al., 2009; Rockwood et al., 2007).

2.3. Covariates

In order to describe the association between frailty and other factors, different domain variables were included (socio-demographic, health-related, and psychological factors). The rationale of inclusion of the variables was of those that most likely have been present for years and therefore previous to current frailty status of the older adult, in addition to possibly contributing to the genesis of frailty (e.g. conditions that could eventually transform into a deficit or worsen older adults' overall health).

Socio-demographic variables included: age, sex, number of inhabitants in the current location (>100,000; 5000–99,999; 2500–14999; and <2500), marital status (married or not), education level (completed years in school), social support, and negative events. Social support was assessed with a questionnaire that explored the interaction with relatives (spouse, children and friends or colleagues), the higher the score the better the social support. At least one negative event from out of a list of ten negative events in the last ten years, including: changing from one city to another, residence in different cities, to reside sometime in the USA, major health issues (stroke, hospitalization, recent diagnosis of cancer, heart attack or surgery), major events in his/her neighborhood (natural disaster, accident, crime or any other event that affected his/her health or family situation.

Health-related variables included: health-care service use (number of days in bed in the last two years because of a health problem; number of physician consultations in the past year), and smoking status (never smoked, formerly smoked, and currently smoking).

Psychological factors included: life satisfaction, locus of control, and self-rated financial status. Locus of control was defined as the beliefs of oneself regarding the potential to influence important life events, and was assessed using a previously validated questionnaire (Angel et al., 2009). The total locus of control score was integrated with the addition of individual question scores, with a score of 32 being the maximum locus of control possible. Life satisfaction was assessed by five questions: 1. In most things, my life is close to my ideal, 2. The conditions of my life are excellent, 3. I am satisfied with my life, 4. So far, I have gotten the things that are important to me in life, 5. If I were to be born again, I would change almost nothing of my life. Summing the score for each answer gave a final score with the lowest possible total punctuation of 5 and the highest of 15 (meaning the best satisfaction with its own life) (Diener et al., 1985).

2.4. Statistical analysis

Two approaches were used, the first one to determine prevalence and the concordance of it with the different tools; the second one was to assess the association of the different domain factors with frailty status when using either FFP or FI.

Variables were described using frequencies and proportions or arithmetic means and standard deviations where appropriate; accordingly

prevalence was considered the proportion of older adults classified as frail with either categorization approaches (FFP or FI). In order to assess concordance in classifying frailty, a kappa statistic was performed to obtain chance-adjusted agreement.

Bivariate analysis in order to assess difference between groups of frailty status was performed for each of the frailty assessments; using chi square for nominal variables and t-tests for continuous variables, and stratified by sex for descriptive purposes. Also bivariate analysis was performed contrasting between robust, pre-frail and frail with Both Approaches (FFP and FI) (supplementary material). Adjusted multiple logistic regression models were fitted including all the covariates (age, sex, marital status, years in school, social support, times consulting a physician, smoking status, life satisfaction, locus of control and poor self-rated financial status), reporting odds ratio (OR), 95% confidence intervals (CI) and the Naegelkerke R^2 along with the p-value for the model. All analyses were performed with the software statistical package STATA 13.1© (Texas, USA).

2.5. Ethical issues

The Institutional Review Boards or Ethics Committees of the University of Texas Medical Branch in the United States, the Instituto Nacional de Estadistica y Geografia and the Instituto Nacional de Salud Pública in Mexico approved the study. All study subjects signed informed consent. The study adhered to the ethical guidelines of the Declaration of Helsinki. This secondary analysis is also registered at the Instituto Nacional de Geriatría (DI-PI-006/15).

3. Results

The analysis included 1108 participants. Mean age was 69.8 (±SD 7.6) and 54.6% (n = 606) were women. Most of the participants (58%) lived in locations with more than 100,000 inhabitants. Men were more likely to be married. Average number of education years and social support score had a global mean (SD) of 4.6 (4.3) years and 21.6 (8.6) points respectively (Table 1).

For the FFP prevalence was 24.9% (n = 276) while for FI 27.5% (n = 305). Observed agreement between the tools when categorizing in two groups was 61.2% with a kappa statistic of 0.34 ($p < 0.001$). The most prevalent component of the FFP was low physical activity 60.8% (n = 674) and the least prevalent was slowness, with a frequency of 25.2% (n = 280). Distribution of the FI was skewed to the right with a mean of 0.175 (±SD 0.101) (Table 1). Regarding the components of the FI, hypertension was the most frequent with a proportion of 49.9% and

Table 1
General characteristics of the sample.

Variable	Total (n = 1108)		Men (n = 502)		Women (n = 606)	
Age in years, mean (SD)	69.8	(7.6)	69.7	(7.5)	69.8	(7.7)
Number of inhabitants in current location, n (%)						
>100,000	643	(58)	266	(41.3)	377	(58.6)
5000–99,999	131	(11.8)	58	(44.2)	73	(55.7)
2500–4999	123	(11.1)	57	(46.3)	66	(53.6)
<2500	211	(19)	121	(57.3)	90	(42.6)
Married, *n* (%)	626	(56.5)	358	(57.1)	268	(42.8)
Years in school, n (%)	4.6	(4.3)	5	(4.5)	4.27	(4)
Social support score, mean (SD)	21.62	(8.6)	24.43	(8.1)	19.29	(8.3)
At least one negative event in the last ten years, n (%)	423	(38.1)	205	(48.4)	218	(51.5)
Number of days in bed in the last two years because of a health problem, mean (SD)	3.4	(21.4)	2.1	(10.5)	4.6	(27.2)
Number of times consulting a physician last year, mean (SD)	5.4	(5.8)	4.7	(5.5)	5.9	(6.1)
Smoking status, n (%)						
Never	675	(60.9)	186	(27.5)	489	(72.4)
Formerly	311	(28.1)	228	(73.3)	83	(26.6)
Currently	122	(11.1)	88	(72.1)	34	(27.8)
Life satisfaction score, mean (SD)	12.5	(2.4)	12.6	(2.3)	12.4	(2.6)
Locus of control score, mean (SD)	24.5	(3.8)	24.8	(3.8)	24.2	(3.8)
Poor self-rated financial status, mean (SD)	907	(81.8)	419	(46.2)	488	(53.8)
Frailty phenotype components (type), n (%)						
Slowness	280	(25.2)	130	(46.4)	150	(53.5)
Weakness	284	(25.6)	112	(22.3)	172	(28.3)
Exhaustion	442	(39.8)	181	(40.9)	261	(59.5)
Low physical activity	674	(60.8)	270	(53.7)	404	(66.6)
Weight loss	313	(28.2)	120	(38.3)	193	(61.6)
Frailty phenotype components (number), n (%)						
0	156	(14.1)	95	(18.9)	61	(10.1)
1	354	(31.9)	159	(31.6)	195	(32.1)
2	322	(29)	129	(25.7)	193	(31.8)
3	187	(16.8)	84	(16.7)	103	(17)
4	75	(6.7)	31	(6.1)	44	(7.2)
5	14	(1.26)	4	(0.8)	10	(1.6)
Categories according to the frailty phenotype, n (%)						
Not-frail	832	(75.1)	383	(76.2)	449	(74.1)
Frail	276	(24.9)	119	(23.7)	157	(25.9)
Frailty index, mean (SD)	0.175	(0.101)	0.156	(0.093)	0.191	(0.105)
Categories according to the frailty index, n (%)						
Not-frail (<0.21)	803	(72.4)	407	(81.1)	396	(65.4)
Frail (≥0.21)	305	(27.5)	95	(18.9)	210	(34.6)

SD = standard deviation, BMI = body mass index, h/week = hours per week, ADL = activities of daily living.

Table 2
Bivariate analysis stratified by frailty status for each tool (phenotype and index).

Variable	Frailty phenotype			Frailty index		
	Not frail ($n = 832$ [75.1%])	Frail (n = 276 [24.9%])	P	Not frail ($n = 803$ [72.4%])	Frail ($n = 305$ [27.5%])	P
Age, mean (SD)	68.7 (7)	73 (8)	<0.001	68.9 (6.9)	72.15 (8.9)	<0.001
Women, *n* (%)	449 (53.9)	157 (56.8)	0.399	396 (49.3)	210 (68.8)	<0.001
Number of inhabitants in current location, *n* (%)						
> 100,000	492 (59.1)	151 (54.7)		486 (60.5)	157 (51.4)	
5000–99,999	100 (12)	31 (11.2)	0.14	94 (11.7)	37 (12.1)	0.012
2500–4,999	82 (9.8)	41 (14.8)		76 (9.4)	47 (15.4)	
< 2500	158 (18.9)	53 (25.1)		147 (18.3)	64 (20.9)	
Married, n (%)	492 (59.1)	134 (48.5)	0.002	482 (60)	144 (47.2)	<0.001
Years in school, mean (SD)	5 (4.43)	3.3 (3.7)	<0.001	5.14 (4.4)	3.19 (3.5)	<0.001
Social support, mean (SD)	22.2 (8.5)	19.6 (8.6)	<0.001	22.3 (8.6)	19.17 (8.4)	<0.001
Negative event, n (%)	301 (36.1)	122 (44.2)	0.017	277 (34.4)	146 (47.8)	<0.001
Days in bed sick, mean (SD)	2.4 (20.5)	6.5 (23.5)	0.006	1.64 (10)	8.38 (37)	<0.001
Times consulting a physician, mean (SD)	4.9 (5.5)	7 (6.6)	<0.001	4.95 (5.8)	6.72 (5.7)	<0.001
Smoking status, *n* (%)						
Never smoked	492 (59.1)	183 (66.3)		481 (59.9)	194 (63.6)	
Smoked in the past	245 (29.4)	66 (23.9)	0.105	227 (28.2)	84 (27.5)	0.313
Smokes currently	95 (11.4)	27 (9.7)		95 (11.8)	27 (8.8)	
Life satisfaction score, mean (SD)	12.7 (2.3)	11.8 (2.7)	<0.001	12.92 (2.2)	11.56 (2.7)	<0.001
Locus of control, mean (SD)	24.7 (3.8)	23.9 (3.6)	0.004	24.9 (3.7)	23.5 (3.8)	<0.001
Poor self-rated financial status, n (%)	673 (80.8)	234 (84.7)	0.146	631 (78.5)	276 (90.4)	<0.001

the less frequent were three childhood problems, with a proportion of 0.6% (tuberculosis, poliomyelitis, typhoid fever) (see Supplementary Table 2).

In the bivariate analysis, when comparing those considered to be frail by the FFP with the FI, age, marital status, years in school, social support, having had a negative event, number of days in bed, number of times consulting a physician, satisfaction with life and locus of control were significantly different (Table 2) between frail and non-frail. Apart from having had a negative event, when categorizing with the FI, frail older adults were more frequently women, lived in sites with <2500 habitants, and had a poor self-rated financial status compared to non-frail.

In the adjusted logistic regression model, age (OR = 1.05, 95% CI 1.03–1.07; p < 0.001), living in a location with <2500 habitants (OR = 1.94, 95% CI 1.28–2.96; p = 0.002), years in school (OR = 0.91, 95% CI 0.86–0.95; p < 0.001), number of days in bed (OR = 1.02, 95% CI 1.01–1.03; p = 0.032), number of times consulting a physician (OR = 1.06, 95% CI 1.03–1.08; p < 0.001), formerly smoked (OR = 1.63, 95% CI 1.43–1.92; p = 0.019), and life satisfaction (OR = 0.86, 95% CI 0.81–0.91; p < 0.001) were independently associated with FFP. Regarding the FI: age, years in school, days in bed, times consulting a physician, formerly smoked and life satisfaction scores were also significant in the logistic model with similar OR. Additional variables associated when using FI to classify were: being women (OR = 2.77, 95% CI 1.88–4; p < 0.001), living in a location with 2500 habitants or more but less than 5000 (OR = 1.92, 95% CI 1.21–3.07; p = 0.006), having had at least one negative event (OR = 1.72, 95% CI 1.26–2.35; p = 0.001), locus of control (OR = 0.95, 95% CI 0.91–0.99; p = 0.041), and poor self-rated

Table 3
Logistic regression for each tool with frailty as dependent variable and adjusted for all variables in respective models.[a]

Variable	Frailty phenotype		Frailty index	
	OR (95% CI)	P	OR (95% CI)	P
Age	1.05 (1.03–1.07)	<0.001	1.04 (1.02–1.07)	<0.001
Women	1.36 (.94–1.95)	0.2	2.77 (1.88–4)	<0.001
Number of inhabitants in current location				
> 100,000	Reference		Reference	
5000–99,999	0.98 (0.6–1.6)	0.618	1.27 (0.78–2.08)	0.326
2500–4,999	1.53 (0.94–2.51)	0.086	1.92 (1.21–3.07)	0.006
< 2500	1.94 (1.28–2.96)	0.002	1.31 (0.86–2)	0.195
Married	0.71 (0.47–1.06)	0.101	0.84 (0.59–1.25)	0.448
Years in school	0.91 (0.86–0.95)	<0.001	0.92 (0.88–0.96)	0.001
Social support	0.99 (0.97–1.01)	0.746	1.01 (0.98–1.03)	0.446
Negative event	1.16 (0.85–1.58)	0.337	1.72 (1.26–2.35)	0.001
Days in bed sick	1.02 (1.01–1.03)	0.032	1.01 (1.01–1.02)	0.005
Times consulting a physician	1.06 (1.03–1.08)	<0.001	1.03 (1.01–1.06)	0.004
Smoking status				
Never smoked	Reference		Reference	
Smoked in the past	1.63 (1.43–1.92)	0.019	1.4 (1.01–2.18)	0.04
Smokes currently	0.74 (0.43–1.25)	0.26	1.18 (0.68–2.04)	0.545
Life satisfaction score	0.86 (0.81–0.91)	<0.001	0.81 (0.76–0.86)	<0.001
Locus of control	0.99 (0.95–1.03)	0.733	0.95 (0.91–0.99)	0.041
Poor self-rated financial status	0.81 (0.53–1.25)	0.36	1.73 (1.08–2.77)	0.02

OR = odds ratio; CI = confidence interval.
[a] Adjusted models were fitted with all the other variables present, reporting the estimate for the specific variable in the row.

financial status (OR = 1.73, 95% CI 1.08–2.77; p = 0.02) were also independently associated with FI. The squared R for the FFP model was of 0.11 (p < 0.001) while for FI of 0.197 (p < 0.001) (See Table 3).

4. Discussion

Our findings support the fact that the main tools used to classify frailty are similar, but still there is heterogeneity when using them simultaneously in a same population. This points to the fact that as stated by Cesari et al., the instruments are intended to have different purposes (Cesari et al., 2014). A recent report of Blodgett et al. compared the FFP and the FI using the National Health and Nutrition Examination Survey (NHANES); in which a FI was integrated by 46 deficits and FFP with 4 items. Authors found that higher levels of frailty in both tools were associated with poor health and higher health services utilization rates. Prevalence reported by FI was much higher (34%) than with the modified version of FFP (3.6%) (Blodgett et al., 2015). According to these authors, the FI might be capturing better the lower spectrum of the older adults with frailty. This phenomenon was similar in our results, FI classified more people as frail. Also, variables that were associated with the FI but not with the FFP are those reflecting an adverse socio-cultural background such as having a lower locus of control and a poor self-rated financial status. In addition, a lower locus of control has been described previously in Mexican older adults when compared to same age American older adults (Angel et al., 2009). In particular, both locus of control and life satisfaction are related between each other and with frailty. A recent prospective study in 1751 community dwelling older adults found that FI is associated and it can predict five years later life satisfaction (St John et al., 2013). However, because only few confounders were considered, it is not clear the causal relationship but it represents how FI posses a broader perspective and it can capture other dimensions of health and life. In addition, it is important to stress how using datasets from countries with high inequalities such as MHAS or CRELES (Costa Rican cohort of older adults), help to complete the picture of how frailty relates to factors that are rooted in sociocultural features such as locus of control or life satisfaction.

Frailty prevalence when using FFP in this report is lower than previously reported, mainly because of the use of objective measurements rather than self-report (Aguilar-Navarro et al., 2012; Alvarado et al., 2008). With the FI a similar prevalence of 27% was found, as described previously (Garcia-Gonzalez et al., 2009). Regarding associations with the FFP, previous reports showed similar results (e.g. age, sex and years in school) (Aguilar-Navarro et al., 2012; Alvarado et al., 2008; Diaz de Leon Gonzalez et al., 2010; Ruiz-Arregui et al., 2013; Sanchez-Garcia et al., 2014). To our knowledge, there are no studies in Mexican older adults with reported associations, similar as those reported in our work.

Prevalence differences between and within gender were found in the descriptive and bivariate analysis. FI scores more women as frail (34.6%) than FFP (25.9%) where FFP classifies as frail more men (23.7%) versus FI (18.9%) When analyzing stratified results by gender (Supplementary Tables S3 and S4), associations regarding robust to frail are more consistent between tools, this might reflect a gross boundary between the classifications, that is easily distinguished by any of the instruments, however when it gets to transitions from robust to pre-frail or form pre-frail to frail, both instruments fall short in distinguishing characteristics of the respective groups. In addition, the components of the FI seem to play a significant role in how it relates to other characteristics, those characteristics more associated with comorbidity or affective status, are strongly associated along frail status in FI. These last characteristics may also explain differences between genders.

Overestimation of frailty prevalence when using self-reported variables has also been described in European countries (Theou et al., 2015). Regarding FI, percentages of frail participants were also similar compared to the recent report of Rockwood et al. (27.5 vs. 34%) (Blodgett et al., 2015) in which frailty was considered present with a score equal or over 0.21, which is the same, applied in this paper.

In our study, age and number of years in school were consistently associated with frailty regardless of the tool used to measure it. On the one hand, it has been hypothesized that frailty measurement could be a close proxy to biological age (Mitnitski et al., 2002). On the other hand, years in school have shown to be closely related to frailty in other populations (Hoogendijk et al., 2014).

Number of days in bed and number of visits to a physician has been also consistently associated with frailty. This could be due to a two-way relationship: frailty can increase the risk of being in bed or increases the number of visits to a physician because of a disease. It is also possible that health issues act as stressors and precipitate frailty in an older adult previously not frail, a phenomenon previously described, in which the vulnerability to stressors holds also to the transition between frailty statuses (Gill et al., 2006). In addition, a possible meaning that the older adult already starts to feel sick or to continuous non-specific complaints from which physicians do not give a satisfactory response, such as fatigue or other subjective symptoms (Zengarini et al., 2015), including poor satisfaction with own life.

There is an increasing need to fill the gap of knowledge of what can give rise to frailty. In contrast to this, what factors are associated previously with frailty are not that clear, therefore making difficult to establish primary prevention. Moving forward to the detection of what frailty actually could improve care of older adults by increasing the accuracy in the detection of those who currently have the condition known as frailty (Rockwood and Hubbard, 2004). Somehow, comprehensive geriatric assessment could be taken as the "state of the art" in detection of frailty, however in locations with scarce specialized professionals on geriatrics, the continuous search for an instrument that gets closer to this approach is still necessary.

4.1. Study strengths and limitations

The FI, by design, is a continuous variable. However, for the purposes of our study, it was necessary to have a cut-off value for the FI in order to compare it to the FFP. The cut-off value to define frailty by the FI in our study was arbitrary, although was based on previous research (Garcia-Gonzalez et al., 2009). In addition, we included 32 items in our FI (self-rated hearing and abdominal pain were not available in the 2012 wave), compared to Garcia-Gonzalez that included 34. However as stated by Searle et al. having 30 items is enough to construct a FI. In addition categorization of physical activity in the FFP was different from previous reports. No study in Mexican population has applied the original categorization for physical activity however frequencies reported in our population for this component had been very similar (Aguilar-Navarro et al., 2015); low physical activity in our study had a frequency of 60.8% compared to 69.8% in the work from Aguilar-Navarro. Caution should also be made when interpreting the results, given that the study was cross-sectional. As such, no causality can be implied, and it is not known what the direction of the associations are, for example if frailty affects poor health and socio demographic characteristics, or vice versa. The present study also had strengths, including the large comprehensive dataset, and using previously validated classifying tools (FFP and FI).

5. Conclusion

Frailty as a concept is clearly understood in aging research and the clinical settings. However there is an urgent need to have an accurate operative definition in order to advance in the field. Future research should make an effort on the standardization of a unique operational definition of frailty in order to avoid chaos in the already complex care of older adults.

Conflicts of interest

None.

Funding

Dr. Pérez-Zepeda was funded by the Universidad Nacional Autónoma de México, Gerontopole/Toulouse Université Paul Sabatier.

The MHAS (Mexican Health and Aging Study) is partly sponsored by the National Institutes of Health/National Institute on Aging (grant number NIH R01AG018016). Data files and documentation are public use and available at www.MHASweb.org.

Funding agencies had no role in this secondary analysis; in the analysis and interpretation of data; in the writing of the report; nor in the decision to submit the article for publication.

Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.exger.2016.03.016.

References

Aguilar-Navarro, S., Gutiérrez-Robledo, L.M., Garcia-Lara, J.M., Payette, H., Amieva, H., Avila-Funes, J.A., 2012. The phenotype of frailty predicts disability and mortality among Mexican community-dwelling elderly. J. Frailty Aging 1, 11–118.

Aguilar-Navarro, S., Amieva, H., Gutiérrez-Robledo, L.M., Ávila-Funes, J.A., 2015. Frailty among Mexican community-dwelling elderly: a story told 11 years later. the Mexican health and aging study. Salud Publica Mex. 57, S62–S69.

Alvarado, B.E., Zunzunegui, M.V., Beland, F., Bamvita, J.M., 2008. Life course social and health conditions linked to frailty in Latin American older men and women. J. Gerontol. A Biol. Sci. Med. Sci. 63, 1399–1406.

Angel, R.J., Angel, J.L., Hill, T.D., 2009. Subjective control and health among Mexican-origin elders in Mexico and the United States: structural considerations in comparative research. J. Gerontol. B Psychol. Sci. Soc. Sci. 64, 390–401.

At, J., Bryce, R., Prina, M., Acosta, D., Ferri, C.P., Guerra, M., Huang, Y., Rodriguez, J.J., Salas, A., Sosa, A.L., Williams, J.D., Dewey, M.E., Acosta, I., Liu, Z., Beard, J., Prince, M., 2015. Frailty and the prediction of dependence and mortality in low- and middle-income countries: a 10/66 population-based cohort study. BMC Med. 13, 138.

Avila-Funes, J.A., Helmer, C., Amieva, H., Barberger-Gateau, P., Le Goff, M., Ritchie, K., Portet, F., Carriere, I., Tavernier, B., Gutierrez-Robledo, L.M., Dartigues, J.F., 2008. Frailty among community-dwelling elderly people in France: the three-city study. J. Gerontol. A Biol. Sci. Med. Sci. 63, 1089–1096.

Blodgett, J., Theou, O., Kirkland, S., Andreou, P., Rockwood, K., 2015. Frailty in NHANES: comparing the frailty index and phenotype. Arch. Gerontol. Geriatr. 60, 464–470.

Cesari, M., Gambassi, G., van Kan, G.A., Vellas, B., 2014. The frailty phenotype and the frailty index: different instruments for different purposes. Age Ageing 43, 10–12.

Clegg, A., Young, J., Iliffe, S., Rikkert, M.O., Rockwood, K., 2013. Frailty in elderly people. Lancet 381, 752–762.

Collard, R.M., Boter, H., Schoevers, R.A., Oude Voshaar, R.C., 2012. Prevalence of frailty in community-dwelling older persons: a systematic review. J. Am. Geriatr. Soc. 60, 1487–1492.

Diaz de Leon Gonzalez, E., Tamez-Perez, H.E., Gutierrez-Hermosillo, H., Cedillo-Rodriguez, J.A., Torres, G., 2010. Frailty and its association with mortality, hospitalization and functional dependence in Mexican aged 60-years or older. Med. Clin. (Barc.) 138, 468–474.

Diener, E., Emmons, R.A., Larsen, R.J., Griffin, S., 1985. The satisfaction with life scale. J. Pers. Assess. 49, 71–75.

Ensrud, K., Ewing, S., Taylor, B., Fink, H., Cawthon, P., Stone, K., Hillier, T., Cauley, J., Hochbert, M., Rodondi, N., Tracy, K., Cummings, S., 2008. Comparison of 2 frailty indexes for prediction of falls, disability, fractures, and death in older women. Arch. Intern. Med. 168, 382–389.

Ensrud, K., Ewing, S., Cawthon, P., Fink, H., Taylor, B., Cauley, J., Dam, T., Marshall, L., Orwoll, E., Cummings, S., 2009. A comparison of frailty Indees for the prediction of falls, disability, fractures, and mortality in older men. J. Am. Geriatr. Soc. 57, 492–498.

Fried, L.P., Tangen, C.M., Walston, J., Newman, A.B., Hirsch, C., Gottdiener, J., Seeman, T., Tracy, R., Kop, W.J., Burke, G., McBurnie, M.A., 2001. Cardiovascular health study collaborative research, G. Frailty in older adults: evidence for a phenotype. J. Gerontol. A Biol. Sci. Med. Sci. 56, M146–M156.

Garcia-Garcia, F.J., Larrion Zugasti, J.L., Rodriguez Manas, L., 2011. Frailty: a phenotype under review. Gac. Sanit. 25 (Suppl. 2), 51–58.

Garcia-Gonzalez, J.J., Garcia-Pena, C., Franco-Marina, F., Gutierrez-Robledo, L.M., 2009. A frailty index to predict the mortality risk in a population of senior Mexican adults. BMC Geriatr. 9, 47.

Gill, T.M., Gahbauer, E.A., Allore, H.G., Han, L., 2006. Transitions between frailty states among community-living older persons. Arch. Intern. Med. 166, 418–423.

Gutierrez-Robledo, L.M., 2002. Looking at the future of geriatric care in developing countries. J. Gerontol. A Biol. Sci. Med. Sci. 57, M162–M167.

Hoogendijk, E.O., van Hout, H.P., Heymans, M.W., van der Horst, H.E., Frijters, D.H., Broese van Groenou, M.I., Deeg, D.J., Huisman, M., 2014. Explaining the association between educational level and frailty in older adults: results from a 13-year longitudinal study in The Netherlands. Ann. Epidemiol. 24, 538–544, e532.

Karunananthan, S., Wolfson, C., Bergman, H., Beland, F., Hogan, D.B., 2009. A multidisciplinary systematic literature review on frailty: overview of the methodology used by the Canadian initiative on frailty and aging. BMC Med. Res. Methodol. 9, 68.

MHAS, Mexican Health and Aging Study, 2012. Data Files and Documentation (Public Use): Mexican Health and Aging Study, (Frailty Prevalence and Associated Factors in the Mexican Health and Aging Study: A Comparison of the Frailty Index and the Phenotype). (Retrieved from www.MHASweb.org on 2014).

Mitnitski, A.B., Graham, J.E., Mogilner, A.J., Rockwood, K., 2002. Frailty, fitness and late-life mortality in relation to chronological and biological age. BMC Geriatr. 2, 1.

Morley, J.E., Vellas, B., van Kan, G.A., Anker, S.D., Bauer, J.M., Bernabei, R., Cesari, M., Chumlea, W.C., Doehner, W., Evans, J., Fried, L.P., Guralnik, J.M., Katz, P.R., Malmstrom, T.K., McCarter, R.J., Gutierrez Robledo, L.M., Rockwood, K., von Haehling, S., Vandewoude, M.F., Walston, J., 2013. Frailty consensus: a call to action. J. Am. Med. Dir. Assoc. 14, 392–397.

Rockwood, K., Hubbard, R., 2004. Frailty and the geriatrician. Age Ageing 33, 429–430.

Rockwood, K., Andrew, M., Mitnitski, A., 2007. A comparison of two approaches to measuring frailty in elderly people. J. Gerontol. A Biol. Sci. Med. Sci. 62, 738–743.

Rodriguez-Manas, L., Fried, L.P., 2015. Frailty in the clinical scenario. Lancet 385, e7–e9.

Ruiz-Arregui, L., Avila-Funes, J.A., Amieva, H., Borges-Yanez, A., Villa-Romero, A., Aguilar-Navarro, S., M.U., P-Z, Gutierrez-Robledo, L.M., RC, C.-P., 2013. The Coyoacan cohort study: design, methodology, and participants´ characteristicas of a Mexican study on nutritional and psychosocial markers of frailty. J. Frailty Aging 2, 68–76.

Sanchez-Garcia, S., Sanchez-Arenas, R., Garcia-Pena, C., Rosas-Carrasco, O., Avila-Funes, J.A., Ruiz-Arregui, L., Juarez-Cedillo, T., 2014. Frailty among community-dwelling elderly Mexican people: prevalence and association with sociodemographic characteristics, health state and the use of health services. Geriatr. Gerontol. Int. 14, 395–402.

Searle, S.D., Mitnitski, A., Gahbauer, E.A., Gill, T.M., Rockwood, K., 2008. A standard procedure for creating a frailty index. BMC Geriatr. 8, 24.

St John, P., Tyas, S.L., Montgomery, P.R., 2013. Life satisfaction and frailty in community-based older adults: cross-sectional and prospective analyses. Int. Psychogeriatr. 25, 1709–1716.

Theou, O., Brothers, T.D., Pena, F.G., Mitnitski, A., Rockwood, K., 2014. Identifying common characteristics of frailty across seven scales. J. Am. Geriatr. Soc. 62, 901–906.

Theou, O., Cann, L., Blodgett, J., Wallace, L.M., Brothers, T.D., Rockwood, K., 2015. Modifications to the frailty phenotype criteria: systematic review of the current literature and investigation of 262 frailty phenotypes in the survey of health, ageing, and retirement in Europe. Ageing Res. Rev. 21, 78–94.

Walston, J., Hadley, E.C., Ferrucci, L., Guralnik, J.M., Newman, A.B., Studenski, S.A., Ershler, W.B., Harris, T., Fried, L.P., 2006. Research agenda for frailty in older adults: toward a better understanding of physiology and etiology: summary from the American Geriatrics Society/National Institute on aging research Conference on frailty in older adults. J. Am. Geriatr. Soc. 54, 991–1001.

Wong, R., Espinoza, M., Palloni, A., 2007. Mexican older adults with a wide socioeconomic perspective: health and aging. Salud Publica Mex. 49 (Suppl. 4), S436–S447.

Wong, R., Michaels-Obregon, A., Palloni, A., 2015. Cohort profile: the Mexican health and aging study (MHAS). Int. J. Epidemiol.

Xue, Q.L., 2011. The frailty syndrome: definition and natural history. Clin. Geriatr. Med. 27, 1–15.

Zengarini, E., Ruggiero, C., Perez-Zepeda, M.U., Hoogendijk, E.O., Vellas, B., Mecocci, P., Cesari, M., 2015. Fatigue: relevance and implications in the aging population. Exp. Gerontol. 201.