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Frailty and health risks in an agricultural population, Chile 2014–2017

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ABSTRACT

Background: Aging presents an emerging health and social challenge. We report the prevalence of frailty, its association with chronic diseases and the risk of hospitalization or death within 29 months.

Methods: Cross-sectional and prospective study. From 2014 to 2017, we examined frailty in an agricultural population in Chile. We enrolled 619 individuals aged 60–74 years from the Maule Cohort. Measured frailty prevalence, based the presence of ≥3 of the five factors (unintentional weight loss, weakness, slowness, self-reported exhaustion, low physical activity). We explored chronic diseases as predictors of frailty with multinomial regression models (sex, age, and schooling adjusted), and the risk of hospitalization and mortality by frailty status, with Cox regression models and Kaplan-Meier survival curves.

Results: 6% of participants were frail; women had higher prevalence of frailty (8.2%) than men (2.3%, < 0.001). Diabetes was a risk factor of frailty (Relative Risk Ratio: 3.91; 95% CI: 1.84–8.32). The incidence of hospitalization was 32% in frail (Hazard Ratio, HR: 3.68; 95% CI: 1.77–7.63), 16% in pre-frail (HR: 1.91; 95% CI: 1.19–3.08) and 9% in robust participants. Among the participants, men had higher risk of hospitalization than women (7.1 and 4.1 per 1000 person-month, p = .014). In all mortality was higher among men than women (1.0 and 0.2 per 1000 person-month, p = .031).

Conclusions: In this agricultural population, diabetes was main chronic disease as risk factor of frailty. Frail older adults had higher risk of hospitalization than robust people, and especially men, had higher risk of adverse health event in a short-term.

1. Introduction

Aging represents an emerging health and social challenge in Chilean society, where in 2015, the population over 60 years of age reached 16 percent and by 2030 it is expected to reach 24 percent (ONU, 2015). Between 1980 and 2015, life expectancy increased from 74.2 to 82.2 and 67.4 to 76.1 years, for women and men (National Institute of Statistics Chile, 2017). This is due to reductions in infant mortality and the control of most vaccine-preventable infectious diseases, along with improvements in socioeconomic conditions and health insurance coverage (ONU, 2015). Chile will soon become a "super-aged" population and its health system must adapt to these changes faster than what is being experienced in most developed countries. Thus, a challenge for Chile's public health sector is to secure a healthy aging population in a country characterized by high income inequality (Gitlin & Fuentes, 2012).

Frailty is an age-related recognized as geriatric syndrome characterized by a decrease in the physiological reserves of various corporal systems (Fried et al., 2001). A minimal internal or external stress in frail persons may cause a functional impairment that could trigger loss of independence. Frail people experiences severe impairments to physical and mental function that restrict their ability to complete necessary activities of daily living. This syndrome is a predictor of physical disability, hospitalization and mortality (Walston et al., 2006). Frailty is more frequent among women and people of low-income (Szanton, Seplaki, Thorpe, Allen, & Fried, 2010), aggravating the health disparities of older people. The frailty phenotype analysis is the most common instrument used and evaluates weight loss, weakness, slowness, exhaustion and low physical activity (Sternberg, Wershof Schwartz, Karunananthan, Bergman, & Mark Clarfield, 2011).

Only three studies of frailty have reported on Chilean populations: two in urban populations of Santiago (7,1 million inhabitants in 2017)

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(Albala et al., 2017; Alvarado, Zunzunegui, Béland, & Bamvita, 2008); and one in the mining city of Antofagasta (607,534 inhabitants in 2017) (Tapia et al., 2015) with 3% and 2% of rural population respectively.

This study examines frailty in a rural agricultural population in Chile. We report the prevalence of frailty; its association with chronic diseases; and the risk of hospitalization or death within 29 months of enrollment.

2. Methods

2.1. Study design and study population

This study was drawn from the Maule Cohort (MAUCO), a prospective population-based cohort of chronic diseases in Molina County, in the Maule Region of Chile. Molina is an agricultural county with a population of 45,976 inhabitants in 2017. Over thirty percent of their population lives in rural areas. Molina's population is characterized by low levels of education, low socioeconomic status, and a high prevalence of cardiovascular diseases (Ferreccio et al., 2016).

During 2014 and 2017, MAUCO enrolled 7500 individuals from which 29 percent were between 60 and 74 years of age (n = 2250). Based on an estimated prevalence of frailty of 10 percent, we estimated a sample size of 600 MAUCO participants meeting two additional inclusion criteria for our study: being 60 to 74 years of age at the time of enrollment and being able to walk without assistance. Exclusion criteria included terminal illnesses; myocardial disease events in the past three months; unstable medical conditions; bone fractures in the past three months; and dementia.

From August 2014 to July 2017, a systematic sample of adults aged 60–74 years was evaluated at baseline with complete follow-up after 29 months. We invited 725 older adults to participate in a frailty evaluation approved by The Institutional Ethics Committee for this study (Nº 14–164) in accordance with Declaration of Helsinki.

2.2. Measurements

At enrollment, participants provided baseline data on demographic characteristics; medical and dietary history (Mediterranean score) (Echeverría et al., 2016); and tobacco and alcohol history. Participants underwent anthropometric measurements (weight, height, waist circumference); handgrip strength, bio-impedance, and peak expiratory flow (PEF) measurements; cognitive assessment (Mini-Mental, cut-point < 22 MM previously validated in Chile (Quiroga, Albala, & Klaasen, 2004); and a metabolic panel (sugar, lipids, liver enzymes). In a second visit, participants answered surveys about quality of life (SF-12); recent falls ("an event that results in a person coming to rest inadvertently on the ground or floor or other lower level"); functional status according to the basic (BADL, Barthel index) and instrumental (IADL, Lawton scale) activities of daily living scales. Their physical condition was evaluated by the Timed Up and Go test (3 m); 6-minute walking; Short Physical Performance Battery (SPPB); physical activity recommended for the World Health Organization (WHO) defined as ≥150 min/week of Moderate-to-Vigorous Physical Activity (MVPA), and sedentary time spent in activities ≤1.5 metabolic equivalent (WHO, 2010) were measured during 7 days' activity by accelerometer (GTX3+, ActiGraph, Pensacola, FL, USA) (Cochrane et al., 2017).

Hypertension was based in a previous medical diagnosis, use of antihypertensive drugs, or the mean of three measurements at rest > 140/90 mm/Hg (Williams et al., 2018). Diabetes was defined by a medical diagnosis, diabetes medication, or a fasting plasma glucose ≥126 mg/dL.

2.3. Frailty indicators

Frailty was determined based on the frailty phenotype by the presence of three or more of the following five factors: (1) unintentional weight loss; (2) weakness; (3) slowness; (4) self-reported exhaustion; and (5) low levels of physical activity. Pre-frailty was determined by the presence of 1 or 2 factors; and Robust was determined by the absence of all five indicators (Fried et al., 2001). *Unintentional weight loss* was self-reported based on the question: "Have you lost 4.5 kg or more of weight in the last year, not due to dieting or exercise?" *Weakness* was assessed by grip strength as the average of three measurements with the dominant hand, using a digital dynamometer (T.K.K. 5401, Grip-D; Takei, Tokyo, Japan). *Weakness* was defined by the lowest quintile of grip strength adjusted for sex and body mass index (BMI). Walking speed was considered as the fastest pace a person could walk while they felt safe, in meters per second (m/s) during 2 repetitions of a 4-meter walk. *Slowness* was defined by the lowest quintile of walking speed adjusted for sex and height. *Exhaustion* was based on the Center for Epidemiologic Studies Depression Scale (CES-D) (Fried et al., 2001) and defined when participants gave positive responses to the following questions: "In the last week, how often have you felt that everything you did was an effort?" and "How often couldn´t you get going?" Physical activity was measured with the accelerometer programmed at a rate of 30 Hz. Participants had to use a belt on the right hip for seven consecutive days, with a minimum of 10 or more hours/day for at least 3 days, maintaining one's usual activities (except during bathing and at night). *Low physical activity* was defined by the lowest quintile by sex of MVPA.

2.4. Adverse health outcomes

Hospitalization was defined as the first hospital admission after entry into our study and until exit or the end of study period, May 31, 2018. A participant's *death* was defined as a death that occurred during the study period and that was confirmed by a national civil registry death certificate.

2.5. Statistical analysis

We used two multinomial regression models of frailty to explore hypertension and diabetes as predictors of frailty, adjusting for sex, age, and level of education. To evaluate the risk of hospitalization and mortality by frailty status, we used Cox regression models adjusted by sex, age, and education, and we compared Kaplan-Meier survival curves with frailty status. Statistical analyses were done with the statistical software SPSS version 20.0 (IBM, Corp., Armonk, NY) and STATA version 15.0 (Stata Corp., College Station, Texas).

3. Results

Among the 725 MAUCO participants who met our inclusion criteria and were invited to enter the study, 80 (11%) refused to participate and 26 (3.6%) had missing data on 3 or more frailty criteria and could not be evaluated. Thus, 619 (85.4%) MAUCO participants were included in our analysis. Participants' mean age was 66.0 ± 4.5 years; 58% were women; 40% were agricultural workers; and 7% were illiterate. The prevalence of frailty in our study sample was six percent; 48% were pre-frail; and 46% were robust. Women were more than three times more likely to be frail than men: 8.2% versus 2.3%, respectively. Women represented 82% of frail participants. Frailty doubled from the 6th to the 7th decades, from 4% to 8%. Most frail participants reported exhaustion (77%), low physical activity (74%), slowness (69%), weakness (60%) and unintentional weight loss (37%).

Frail participants had the highest prevalence of self-reported poor health, diabetes, hypertension, multi-morbidity, falls in the last year and difficulty in performing IADL and BADL activities. In comparison to robust and pre-frail participants, frail participants had on average two years of schooling less; used multiple medications; had a lower quality of life; a lower mini-mental score, the lowest lung function. Frail participants also had the highest rates of depressive symptoms; more than double that of robust participants, Table 1.

Table 1
Demographic Characteristics and Health by Frailty Status: MAUCO, 2015–2017 (Adjusted by Sex, Age and School years).

Demographic Characteristics and Health	Total N = 619	Robust N = 286 (46%)	Pre-Frail N = 299 (48%)	Frail N = 34 (6%)	Frail vs. Robust	Frail vs. Pre-Frail
Sex: Female[a] %	58	53	59	82	< .001	< .001
Age, mean[a] (SD)	66.0 (4.5)	65.2 (4.3)	65.7 (4.7)	66.4 (4.1)	.106	.371
School years, mean (SD)	7.3 (4.5)	7.6 (4.6)	7.2 (4.4)	5.4 (3.4)	< .001	< .001
Self-reported Health %					< .001	< .001
Excellent to Good	41	49	37	13		
Fair	45	44	48	43		
Poor	13	7	15	43		
Heart Disease[b] %	11	9	12	14	.225	.698
Diabetes[c] %	22	18	24	46	< .001	.001
Hypertension[d] %	72	72	68	97	.002	< .001
Osteoarthritis %	11	10	12	12	.259	.400
Renal %	8	7	10	7	.809	.465
Digestive %	12	12	11	14	.640	.567
Cancer %	6	5	6	6	.727	.911
Lung Diseases %	9	8	9	13	.164	.287
Multi-morbidity ≥2 Diseases %	43	40	43	71	< .001	.001
Medications, mean (SE)	3.6 (0.1)	3.3 (0.2)	3.7 (0.2)	5.3 (0.4)	< .001	< .001
Depressive Symptoms %	16	12	19	28	.001	.062
SF-12, mean (SE)						
Physical Component	45.5 (0.3)	47.4 (0.5)	44.5 (0.5)	35.0 (1.5)	< .001	< .001
Mental Component	49.1 (0.5)	50.6 (0.7)	48.2 (0.7)	45.1 (2.0)	.002	.079
Mini-Mental Test (MM), mean (SE)	25.1(0.9)	25.3(0.2)	24.9(0.2)	24.3(0.7)	.001	.041
Low Cognitive Function %						
< 22 Score MM	20	19	21	19	.163	.366
Current Smoker %	21	19	22	32	.415	.441
Lung Function, mean (SE)						
PEF L/min	348.5 (3.8)	358.5 (5.6)	341.8 (5.6)	320.1 (16.6)	< .001	.009
≥1 Falls Last Year %	32	26	35	51	< .001	.001
Difficulty ≥1 IADL Tasks %	19	16	19	35	< .001	< .001
Difficulty ≥1 BADL Tasks %	5	2	6	19	.001	.016

Notes:
Abbreviations: SD: Standard Deviation; SE: Standard Error; PEF: Peak Expiratory Flow; IADL: Instrumental Activity of Daily Living; BADL: Basic Activity of Daily Living; SF-12: Quality of Life Questionnaire Short Form.
[a] Values unadjusted.
[b] Includes myocardial infarction, coronary and cerebrovascular disease, self-reported, or use of cardiovascular drugs.
[c] Self-reported, use of diabetes drugs, or fasting plasma glucose ≥ 126 mg/dL.
[d] Self-reported, use of antihypertensive drugs, or diastolic blood pressure ≥90 mm Hg and systolic blood pressure ≥ 140 mm Hg.

Table 2
Lipid Profile, Blood Pressure & Body Composition by Frailty State: MAUCO 2015–2017 (Adjusted by Sex, Age and School years).

	Total N = 619	Robust N = 286 46%	Pre-Frail N = 299 48%	Frail N = 34 6%	Frail* vs Robust	Frail* vs Pre-frail
Lipid Profile						
High Total Cholesterol %						
> 200 mg/dL	36	36	37	31	.702	.610
Low HDL %						
W: < 50 mg/dL	51	48	52	72	.001	.007
M: < 40 mg/dL						
High Triglycerides %						
> 150 mg/dL	41	39	40	61	.011	.016
High Fasting Glucose%						
≥ 100 mg/dL	37	34	36	59	.006	.011
Blood Pressure						
SBP mm/Hg, mean (SE)	140.7 (0.8)	141.8 (1.2)	139.2 (1.2)	145.3 (3.6)	.638	.224
High SBP ≥ 140 mm Hg %	45	47	42	50	.908	.445
DBP mm/Hg mean (SE)	75.8 (0.4)	76.9(0.6)	74.9 (0.6)	73.9 (1.8)	.009	.173
High DBP ≥ 90 mm Hg %	10	12	7	8	.235	.804
Body Composition						
Obese, BMI ≥ 30 kg/m^2 %	43	41	43	55	.046	.075
AMM kg, mean (SE)	8.9 (0.1)	8.9 (0.1)	8.9 (0.1)	9.2 (0.2)	.128	.332
Activity with Accelerometer						
Sedentary, min/week, mean (SE)	2619.7 (77.1)	2503.0 (71.7)	2600.6 (69.4)	2750.0 (207.4)	.046	.309
MVPA, min/week, mean (SE)	221.9 (8.3)	283.9 (12.0)	180.5 (11.4)	104.1 (32.9)	< .001	.028
WHO guidelines MVPA, %	54	74	44	16	< .001	< .001

Abbreviations: HDL: High density lipoprotein; W: Women; M: Men; SE: Standard Error; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; BMI: Body Mass Index; AMM: Appendicular Muscle Mass; MVPA: minutes moderate-to-vigorous physical activity; WHO: World Health Organization.
* *p* value.

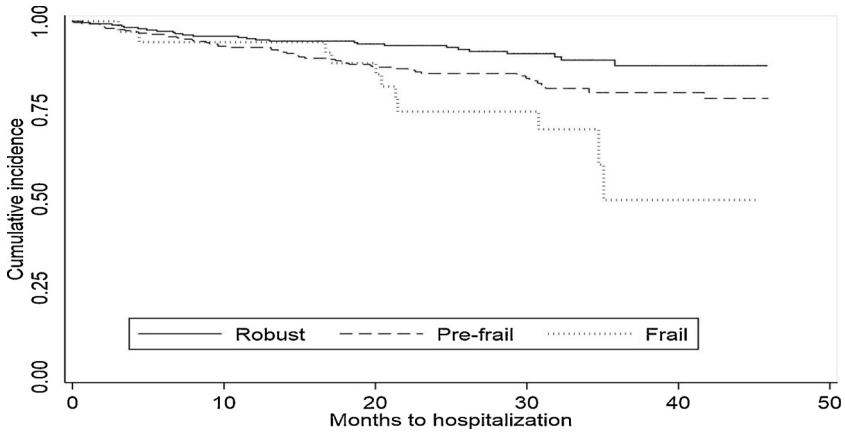

Fig. 1. Kaplan-Meier survival curves by incidence of hospitalization according to frailty state.

The lipid profile in the frail participants showed the worst indicators for high-density lipoprotein, triglycerides, and feasting glucose. Frail participants spent seven hours per day in sedentary activities such as sitting or reclining; this time means one-hour more than robust participants. Frail participants spent less time doing MVPA per week than pre-frail and robust participants, and only 16% of frail participants met current WHO guidelines for PA, being 2.8 and 4.6-time lower than pre-frail and robust participants receptively, Table 2.

Diabetes was the only chronic disease significantly associated with frail state in the multinomial model (Risk Relative Ratio [RRR]: 3.91; 95% CI: 1.84–8.32).

Hospital admissions and deaths were followed for a median of 29 months (range 0.15–45 months). Incidence of hospitalization was 32% in frail participants; 16% in pre-frail participants; and 9% in robust participants (Log Rank $\chi^2 = 15.4$, $p < 0.001$) (Fig. 1). Risk of hospitalization was higher for pre-frail (Hazard Ratio [HR]: 1.91; 95% CI: 1.19–3.08) and frail (HR: 3.68; 95% CI: 1.77–7.63) than robust participants (Cox regression hazard model). Among the participants, men had higher risk of hospitalization than women (7.1 and 4.1 per 1000 person-month respectively, p = .014). The risk of hospitalization showed the direction expected by frailty state, nevertheless, the effect of these association diminished or disappeared, among robust (4.9 and 2.1 per 1000 person-month, p = .05), pre-frail (7.8 and 5.2 per 1000 person-month, p = .14) and frail state (15.7 and 10.9 per 1000 person-months, p = .63) when analyzed by gender, men and women respectively. Main causes of hospitalization were digestive, circulatory, respiratory and cancer, similar among robust and non-robust participants.

Deaths occurred in nine participants and in all mortality was higher among men than women with an incidence rate of 1.0 and 0.2 per 1000 person-month, respectively (p = .03, adjusted by age and frailty state). Mortality rate was similar among robust and pre-frail state (0.5 cases per 1000 person-month, p = .05), and frail state (1.6 cases per 1000 person-month, p = .34) showed a dose-response according to direction expected by frailty state, nevertheless there was no significant difference. Main causes of death were cardiovascular, cancer, renal and infectious diseases, similar among robust and non-robust participants.

4. Discussion

In the MAUCO population in Chile, the prevalence of frailty was six percent. Most frail persons were older women and diabetes was strongly associated with frailty. The criteria for frailty most frequently met were exhaustion and low physical activity. Frail participants had twice as higher risk of hospitalization or death during at 29 months of follow-up than robust participants.

Variations in the prevalence of frailty depend on the characteristics of the population, such as rural residence, socioeconomic support and features of the healthcare system (Jang et al., 2016). Prevalence of frailty may also vary based on the model of frailty and how rigorously is measured e.g., qualitative reports versus quantitative measurements. The reported prevalence of frailty in Asia, Europe and North America ranges from 4.9% to 27.3% (Choi, Ahn, Kim, & Won, 2015; Kojima et al., 2017); in Latin America and the Caribbean, it ranges from 5.2% to 42.6% (Da Mata et al., 2016; Gray et al., 2016). Thus, our finding of six percent is within the lower ranges of these previous reports.

Notably, this is the first study of frailty in Chile that included a significant proportion of agricultural workers (40%) and follow-up of health events. Previous studies in rural locations with a high rate of agriculture employment as a main activity and people 70 years of age and older reported a wide range of frailty (5.4%–21.5%) (Llibre Rodriguez et al., 2018). Our prevalence rate was six percent, which is within the reported range. Most studies determine frailty criteria based only on questionnaires. Thus, our findings may be stronger and more plausible, given the more objective assessment of frailty components, along with physical measurements of weakness, slowness, and low physical activity.

Our results are consistent with previous reports of Mexican Americans and studies from Spain and the United Kingdom (UK) of the association of chronic diseases as diabetes with frailty (García-Esquinas et al., 2015; Hanlon et al., 2018; Howrey, Al Snih, Markides, & Ottenbacher, 2018) and higher risk of hospitalization showed in pre-frail (range HR: 1.13–1.47) and frail (range HR: 1.25–1.68) compared with robust people (Alonso Bouzón et al., 2017; Kojima, 2016; Vermeiren et al., 2016). In our study, the risk of hospitalization was significantly higher in men than women (7.1 and 4.1 per 1000 person-month, p = .014), previously other study evaluated frailty factors associated at risk of hospitalization by gender among 87,780 US participants > 65 years, and women had 16% lower risk of hospitalization than men (Lohman, Scherer, Whiteman, Greenberg, & Bruce, 2017).

Our study, mortality was higher in men than women, nonetheless the short-term of follow-up did not show an increase the risk of mortality by frail state such as the evidence has reported (Chang & Lin, 2015; Hanlon et al., 2018; Vermeiren et al., 2016; Zhang, Guo, Gu, & Zhao, 2018).

The objective measurement of the prevalence of frailty in a population is the first step toward designing preventive strategies to identify frailty and intervene much earlier. Our findings indicate this need and focus on people aged younger than 75 years for future prevention strategies with an interdisciplinary approach.

Only 16% of frail met WHO minimum guidelines of MVPA, and this level of PA is predictor for maintaining independence, better life-expectancy and optimal health, characteristics associated with healthy aging of the population (McPhee et al., 2016; World Health Organization, 2018).

The recent Third National Health Survey in Chile demonstrated that chronic conditions continue to rise among adults over 65 years of age:

obesity increased from 28% in 2003 to 36% in 2017; diabetes from 21% in 2003 to 31% in 2017; and the high rate of hypertension decreased only slightly from 79% in 2003 to 73% in 2017 (Health Ministry of Chile, 2018). Farther, physical inactivity (no met WHO guidelines of MVPA) is one of the strongest risk factor for frailty along with aging (Mañas, del Pozo-Cruz, García-García, Guadalupe-Grau, & Ara, 2017; Zhang et al., 2018). Consequently, the increase of sedentary time, characteristic in older age, is associated in early onset of ill health, metabolic disease and frailty (Mañas et al., 2017).

Given this scenario, we expect that frailty prevalence will increase rapidly in Chile. Accessible interventions to reduce or delay frailty can have favorable results and are more cost-effective than treating consequences of frailty (Llibre Rodriguez et al., 2018). There is a need for longitudinal studies to assess the risks and protective factors of frailty as well as more intervention trials to estimate reversibility of frailty and its consequences.

The strengths of this study include its population-based design and the complete follow-up of adverse health outcomes. Frailty was objectively measured, and slowness, weakness, and physical activity were evaluated with the use of cut-off points derived from the same population under study. Whereas previous studies were based on questionnaires and evaluated only four of the five criteria for frailty (Tapia et al., 2015) or among measurements only included grip strength (Alvarado et al., 2008). Main weaknesses of this study are the cross-sectional assessment of risk factors of frailty, its relatively small sample size and insufficient follow-up time to measure with more precision health risks associated with frailty, and the interaction of sex with frailty in causing adverse health events.

5. Conclusion

In this agricultural population, women had higher frailty than men, and diabetes was the main risk factor. Frail older adults had higher risk of adverse health events than robust people, being evident at 29 months of follow-up. Men had higher risk of hospitalization than women.

In this agricultural population, frailty was lower than expected and diabetes was its main predictor. Frail older adults, especially men, may be at higher risk of adverse health events, particularly death.

Statement of authorship

Natalia Bustamante-Ara was involved in designing the experiments, performing data analysis and writing the manuscript. Luis Villarroel and Fabio Paredes provided statistical advice; Andrea Huidobro supervised the study; Catterina Ferreccio, conceived and critically revised the manuscript for important intellectual content, and gave final approval of the version to be submitted.

Declarations of interest

None.

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