



**ARTICLE**

## **Risk Factors and Gender Differences for Depression in Chilean Older Adults: A Cross-Sectional Analysis from the National Health Survey 2016–2017**

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### **ABSTRACT**

Depressive disorders are recognized as one of the most common mental health conditions across different age groups. However, the risk factors associated with depression among older people from low-and middle-income countries remains unclear. This study aims to identify socio-demographic, health and psychosocial-related factors associated with depression in Chilean older adults. A cross-sectional study was carried out in a representative sample of 1,765 adults aged  $\geq 60$  years participants from the Chilean National Health Survey 2016–2017. Depression was assessed with the Composite International Diagnostic Interview (CIDI-SF). Associations between the



exposure variables and depression were investigated using Poisson regression analyses. The main findings indicated that women showed higher likelihood of depression than men (Prevalence Ratio (PR) = 2.6 [95% CI: 1.40; 4.89]). An increased likelihood of depression was found in older adults with chronic pain, multimorbidity ( $\geq 2$  diseases), previous diagnose of depression, high perception of stress, financial stress, and difficulties for social participation. In women, higher likelihood of depression was found for those with the frailty phenotype (PR:8.53 [95% CI: 1.68; 43.32]), rheumatoid arthritis (PR:2.41 [95% CI: 1.34; 4.34]), insomnia (PR:2.99 [95% CI: 1.74; 5.12]) and low self-rated well-being (PR:4.94 [95% CI: 2.26; 10.79]). Men who were divorced (PR:7.10 [95% CI: 1.44; 34.90]) or widowed (PR:10.83 [95% CI: 3.71; 31.58]), obese (PR:5.08 [95% CI: 1.48; 17.42]) and who had asthma (PR: 7.60 [95% CI: 2.31; 24.99]) were associated with higher odds of depression. The current findings may have clinical implications for the early identification of older adults more susceptible to depression and also suggest the need to implement cultural and age-sensitive strategies to promote mental health in late life.

#### KEYWORDS

Depression; older adults; aging; late-life depression; risk factors

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## 1 Introduction

Globally, the progressive aging of the population entails important demands for health and sanitary systems. In fact, approximately 23% of the total global burden of disease is attributable to people aged 60 years and older [1]. Neurological and mental disorders account for nearly 6.6% of this global burden [2].

Depressive disorders are recognized as one of the most common mental health conditions across different age groups [3]. The World Health Organization (WHO) estimated that 4.4% of the worldwide population and 5.7% of older adults suffered from depression in 2015 [4]. However, the prevalence of depression varies considerably by region, with higher prevalences observed in low-and middle-income countries (LMICs) [4]. Therefore, the risk factors for depression identified in high-income countries might likely differ from LMICs.

Within the Latin American countries (LAC), Chile has experienced one of the fastest and exponentially incremented numbers of older adults. Indeed, the country had the highest life expectancy in the region [5]. The Chilean population's aging has also contributed to a higher prevalence of comorbidities in this population, including depression. The current prevalence of depression in Chilean adults aged  $\geq 60$  years is 6.2% [6]. Yet, the potential risk factors involved remain unclear. Moreover, gender differences in the risk factors associated with depressive symptoms are even more uncertain.

Therefore, this study aimed to a) identify socio-demographic, health and psychosocial-related factors associated with depression and b) to identify gender differences in risk factors for depression, in a representative sample of Chilean older adults.

## 2 Material and Methods

This cross-sectional study includes data from the Chilean National Health Survey 2016–2017 (CNHS, 2016–2017) [7], a probabilistic, stratified, multistage and representative survey that collected data from 6,233 Chilean people aged  $\geq 15$  years. The fieldwork was carried out between August 2016 to May 2017 and data were collected by trained professionals. The sample for the current study included participants aged  $\geq 60$  years, and, as suggested by CNHS 2016–2017, those with suspicion of cognitive impairment (scores MMSE  $\leq 13$  and Pfeiffer  $> 6$ ) were excluded from the study due to their potential limitation to answer the questionnaires [8,9]. Participants with prevalent dementia at the time of the first

assessment visit were also excluded from the survey as they were unfit to provide consent to take part in the study [7]. The final sample included in the study was 1,765 participants (1,134 women and 631 men).

Protocols of the CNHS 2016–2017 were approved by the Pontificia Universidad Católica de Chile Ethics Committee [7].

## 2.1 Variables

### 2.1.1 Depression

Depression was assessed using the short version of the Composite International Diagnostic Interview, CIDI-SF [10], a screening instrument to identify depressive symptoms in the last 12 months. CIDI-SF is a structured interview of 30 questions. To have suspected depression, it is necessary to inform dysphoria and/or anhedonia, and at least 4 or more of the following symptoms: fatigue, weight changes, sleep disturbances, difficulties to concentrate, feelings of worthlessness, and/or suicidal thoughts. CIDI-SF is a well known tool for assessing suspicion of depression. However, does not rule out false positives of depression due to other conditions such as other psychiatric diagnoses, i.e., bipolar disorder or substance abuse; or a grieving process [7] (MINSAL, 2016). This instrument has shown adequate reliability and validity index for major depressive episodes [11].

### 2.1.2 Predictor Variables

Three domains of potential risk factors were examined: socio-demographic variables, lifestyle behavior and health conditions, and psychosocial-related factors.

#### *Socio-Demographic Variables*

Socio-demographic information, including sex, age, geographic area (urban or rural), marital status (married, partnered, divorced, single or widow), educational level (primary, secondary school, technical or university degree) and work condition (worker, housework or retired) was self-reported and collected by trained professionals [7].

#### *Lifestyle Behavior and Health Conditions*

Physical activity (PA), sedentary time, fruits and vegetable intake, total hours of sleep per day, smoking and alcohol consumption were the lifestyle behaviors included in this study. Total PA was assessed using the Global Physical Activity Questionnaire [12] informed as MET/min/week. Physical inactivity was defined as moderate PA < 600 METs/min/week or its equivalent. Sedentary time was considered a risk behavior if a participant spent  $\geq 9$  h/day in sedentary activities. Alcohol consumption was assessed by the Alcohol Use Disorders Identification Test, (AUDIT) [13] and classified as no-risk (score < 8) and risk use (score  $\geq 8$ ). Smoking was classified as: no smoker, regular smoker, occasional smoker and ex-smoker. Fruit and vegetables intake were reported as servings/day. A lifestyle score was then obtained from seven lifestyle-related factors [14]: a) daily intake of five portions of fruits and vegetables; b) salt intake lower than < 8 g/day; c) alcohol risk consumption < 8 scores at AUDIT; d) normal sleep time (7–9 h/day); e) moderate PA > 150 min/week; f) sitting time < 9 h/day; and g) no smoking habit. Each healthy behavior was scored to 1 point, whereas unhealthy behaviors were scored as 0. The maximum score was 7 suggesting a healthy lifestyle, whereas a lower score suggests a poor lifestyle.

Nutritional status was assessed by standardized protocols using the body mass index (BMI: kg/m<sup>2</sup>) classified in line with the PAHO criteria for older adults [15]: underweight  $\leq 22.9$  kg/m<sup>2</sup>; normal weight: 23.0–27.9 kg/m<sup>2</sup>; overweight: 28.0–31.9 kg/m<sup>2</sup> and obesity  $\geq 32.0$  kg/m<sup>2</sup>. Central obesity was defined as waist circumference  $\geq 88$  cm for women and  $\geq 102$  for men [7]. Frailty was assessed using the Modified Scale of Fried Phenotype [16], which included grip strength (<20 percentile), lack of PA (<150 min/week, self-reported), slower pace of walk for slow walking pace (self-reported), BMI < 23.0 kg/m<sup>2</sup> and difficulties for conducting daily life activities (self-reported). Participants were classified as frail if they

fulfilled three or more criteria, pre-frail if they fulfilled one or two criteria and robust if they did not fulfil any criteria.

Participants were asked to inform their average sleep hours in a normal day, presence of chronic pain, the number of diseases and specific morbidities such as asthma, rheumatoid arthritis, hearing problems, migraine and insomnia. Additionally, participants were asked to report if they had ever been diagnosed with depression and whether they had received medical treatment for depression in the past.

### *Psychosocial Measures*

Participants reported their perceived well-being and health, social support as well as their perception of stress, financial stress and role as caregivers. Perceived health and well-being were measured using the following questions: “In general, you would say your health/well-being is”. Three answers were provided: a) well, b) regular or c) bad. Social support was measured by the question: “When you have problems, do you have someone to trust, ask for help or advice?” and instrumental social support was measured by the question: “Can you confidently turn to someone when you have an unforeseen expense, financial emergency, or other serious or catastrophic situation?” In both cases, the responses were a) yes, b) sometimes and c) rarely/never. The question assessed the perception of stress: “How often have you felt stressed in the last year (irritable, anxious, or unable to sleep) due to situations at home or at work?”: a) permanently, b) most of the time, c) sometimes, d) never. Financial stress was measured by the question: “What level of financial or economic stress have you felt in the last 12 months?”: a) moderate, b) high, c) too much. Being a caregiver was assessed by: “Apart from your daily activities, are you in charge of an older adult, someone with special needs or with a chronic disease?”: a) yes and b) no. More information about the CNHS can be found elsewhere [7].

## **2.2 Statistical Analyses**

Descriptive data are presented as a mean for continuous variables, and as a percentage for categorical variables, 95% confidence intervals. To explore the association between depression and the exposures of interest, Poisson regression analyses with robust standard errors were performed and the results were reported as prevalence ratio (PR) with their 95% CIs. The analyses were adjusted for age, sex and place of residency when the analyses were not stratified by sex.

Results were estimated using weighted samples from the CNHS 2016–2017 [7] using StataMP v16 software. Significance differences were set up at  $p < 0.05$ .

## **3 Results**

After excluding participants with missing data, a total of 1,765 (1,134 women and 631 men) were included in the final analyses. The prevalence of depression was 13.4% (95% CI: 10.3; 17.1) for women and 5.14% (95% CI: 2.8; 9.0) for men. The general characteristics by depression status are found in [Table 1](#). Overall, individuals with depression were more likely to be women and to live in urban areas, 34.5% were married, 25.4% were widowed, and 42.7% were retired. Compared to those without, people with depression had a higher prevalence of physical inactivity (40.5% vs. 27.5%), spent more time in sedentary activities (3.8 vs. 2.8 h/day) and a lower sleep duration (6.5 vs. 7.4 h/day). Additionally, people with depression were more likely to have multimorbidity and a lower prevalence of good self-reported health and well-being than participants without depression ([Table 1](#)).

**Table 1:** Sociodemographic data, lifestyle behavior, health antecedents and well-being according to depression in Chilean older adults

	Without depression	With depression
N	1,589	176
Men (%)	50.2 (45.4; 55.0)	26.1 (15.7; 40.1)
Women (%)	49.8 (45.0; 54.6)	73.9 (60.0; 84.3)
Age (years)	69.3 (68.1; 69.7)	68.5 (66.3; 69.9)
Geographic area (%)		
Urban	87.0 (84.8; 89.0)	87.0 (79.8; 91.8)
Rural	12.9 (11.0;15.2)	13.1 (8.2; 20.2)
Marital status (%)		
Married	58.5 (53.8; 63.0)	34.5 (24.6; 46.1)
With partner	3.9 (2.6; 5.8)	10.8 (3.9; 26.5)
Divorced	10.6 (8.2; 13.7)	17.0 (8.8; 29.5)
Widow	16.9 (14.0; 20.3)	25.4 (17.1; 36.1)
Single	10.1 (7.6; 13.2)	12.6 (6.0; 24.9)
Occupation (%)		
Worker	32.7 (28.2; 37.6)	25.0 (14.6; 39.4)
Housework	15.9 (12.7; 19.8)	20.6 (12.8; 31.6)
Retire	47.3 (42.5; 52.1)	42.7 (31.6; 54.6)
Other	3.9 (2.6; 5.7)	11.4 (4.9; 24.4)
PA (MET/min/week)	2992.4 (2293.7; 3691.1)	4534.7 (1295.9; 7773.5)
Sedentary time (h/day)	2.8 (2.5; 3.0)	3.8 (3.1; 4.4)
Physical activity (%)		
Active	72.5 (68.5; 76.2)	59.5 (46.9; 71.0)
Inactive	27.5 (23.7; 31.5)	40.5 (29.0; 53.1)
Sleep (h/day)	7.4 (7.3; 7.5)	6.5 (6.0; 6.9)
Fruits and vegetables (portions/day)	3.2 (2.8; 3.5)	3.2 (2.8; 3.7)
Alcohol (glass/day)	2.1 (1.8; 2.3)	1.7 (1.0; 2.5)
AUDIT score	2.6 (2.3; 2.9)	2.1 (1.4; 2.8)
Tobacco (%)		
Regular	13.6 (10.8; 17.1)	17.0 (8.4; 31.2)
Occasional	3.1 (1.8; 5.3)	1.8 (0.6; 5.8)
Ex-smoker	37.5 (32.9; 42.5)	34.1 (23.9; 45.9)
Non-smoker	45.7 (41.0; 50.5)	47.1 (35.2; 59.4)
Lifestyle score (%)		
Lowest	29.2 (24.7; 34.0)	16.5 (9.8; 26.7)

(Continued)

<b>Table 1 (continued)</b>		
	Without depression	With depression
Low-middle	27.4 (23.6; 31.5)	34.1 (23.2; 47.0)
Middle-high	25.8 (21.8; 30.3)	33.2 (22.4; 46.1)
Higher	17.7 (14.4; 21.5)	16.0 (9.5; 25.8)
Weight (kg)	73.4 (72.2; 74.7)	74.2 (69.9; 78.4)
BMI (kg/m <sup>2</sup> )	29.0 (28.6; 29.4)	30.2 (28.8; 31.7)
Waist circumference (cm)	97.2 (96.1; 98.3)	98.2 (94.8; 101.7)
Nutritional status (%)		
Underweight	0.8 (0.3; 2.1)	0
Normal	18.7 (15.4; 22.6)	11.6 (6.2; 20.8)
Overweight	43.2 (38.5; 48.1)	48.8 (36.7; 61.2)
Obese	37.2 (32.7; 42.0)	39.5 (28.2; 52.1)
Morbidity, n° disease (%)		
0	12.6 (9.7; 16.2)	2.0 (0.8; 4.8)
1	26.3 (22.2; 30, 9)	6.5 (3.5; 11.8)
2	18.4 (14.7; 22.9)	11.0 (6.4;18.4)
3	16.5 (13.4; 20.1)	16.8 (9.6;27.5)
4	10.6 (8.4; 13.3)	20.0 (11.4; 32.8)
5+	15.4 (12.3; 19.1)	43.6 (31.7; 56.3)
Perceived well-being (%)		
Bad	2.6 (1; 4.6)	12 (6; 23)
Regular	27 (23; 32)	41 (29; 53)
Good	70 (65; 74)	47 (34; 59)

Note: PA = Physical activity; OH = Alcohol consumption.

Associations between depression and socio-demographic factors are shown in [Table 2](#). In women, the likelihood of being diagnosed with depression was 2.6 times higher than men. The likelihood of depression was also higher for those who were partnered than those married and lower for the group with technical and university degrees compared to the group with primary educational level. In men, the likelihood of depression was more than 8 times higher for men who were partnered, 7.1 times higher for those divorced and 10.8 times higher for widowed men compared to married men. As in women, the likelihood of depression was lower for those with technical and university degrees.

**Table 2:** Sociodemographic factors associated with depression for women and men

	Women	<i>p</i>	Men	<i>p</i>
Sex				
Men	1.00		0.38 (0.21; 0.72)	<0.001
Women	2.60 (1.40; 4.89)	<0.001	1.00	

(Continued)

<b>Table 2 (continued)</b>				
	Women	<i>p</i>	Men	<i>p</i>
<b>Geographic area</b>				
Urban	1.00		1.00	
Rural	1.17 (0.68; 1.99)	0.57	0.53 (0.18; 1.62)	0.27
<b>Educational level</b>				
Primary	1.00		1.00	
Secondary school	1.45 (0.92; 2.26)	0.20	1.71 (0.64; 4.58)	0.28
Technical/university degree	0.09 (0.03; 0.26)	<0.001	0.09 (0.02; 0.37)	<0.001
<b>Marital status</b>				
Married	1.00		1.00	
Partnered	2.88 (1.03; 8.06)	0.04	8.96 (1.63; 49.36)	0.01
Divorce	1.32 (0.70; 2.48)	0.39	7.10 (1.44; 34.90)	0.02
Widow	1.04 (0.58; 1.89)	0.89	10.83(3.71; 31.58)	<0.001
Single	1.27 (0.52; 3.10)	0.59	2.43 (0.5.; 10.17)	0.22
<b>Employment status</b>				
Worker	1.00		1.00	
Housework	1.38 (0.61; 3.14)	0.44	(—)	
Retired	1.31 (0.62; 2.77)	0.47	0.56 (0.21; 1.51)	0.25
Other	4.01 (1.54; 10.44)	0.34	0.35 (0.04; 2.99)	0.34

Note: Data presented as prevalence ratio (PR) and their 95% CI. The reference group is denoted as 1. Exposures with insufficient cases to estimate the risk ratios are denoted as (—).

Association between depression, lifestyle behavior and health conditions are presented in [Table 3](#). In women, higher likelihood of depression was observed for those who slept  $\leq 6$  h/day and informed insomnia than those who slept 7–8 h/day without insomnia. The frailty phenotype was also related to depression, which was 5.6 times higher in pre-frail women and 8.5 times higher in frail women than robust ones. Women with severe chronic pain showed 9.3 times higher likelihood of depression, and an increased likelihood of depression was also found for women with rheumatoid arthritis, three hearing problems and  $\geq 2$  chronic diseases, compared to their counterparts. In men, the likelihood of depression was higher for those who sleep  $\leq 6$  h/day, had low to middle lifestyle scores and had obesity. The likelihood of depression was more than 6 times higher in men with severe chronic pain and  $\geq 2$  chronic diseases. Men who informed asthma also show an increased probability of depression compared to those who did not.

**Table 3:** Lifestyle behaviors and health conditions factors associated with depression for men and women

	Women	<i>p</i>	Men	<i>p</i>
<b>Physical activity</b>				
Active	1.00		1.00	
Inactive	1.51 (0.91;2.51)	0.11	1.61 (0.48; 5.39)	0.44

(Continued)

<b>Table 3 (continued)</b>				
	Women	<i>p</i>	Men	<i>p</i>
<b>Sedentary time</b>				
<9 h/day	1.00		1.00	
≥9 h/day	1.71 (0.74; 3.95)	0.21	0.57 (0.14; 2.39)	0.44
<b>Sleeping hours</b>				
7–8 h/day	1.00		1.00	
≤6 h/day	2.68 (1.51; 4.74)	<0.001	4.36 (1.54; 12.35)	<0.001
≥9 h/day	0.95 (0.43; 2.09)	0.90	1.04 (0.33; 3.27)	0.94
<b>Tobacco use</b>				
Never	1.00		1.00	
Regular smoker	1.52 (0.72; 3.21)	0.27	0.96 (0.15; 6.18)	0.97
Occasional smoker	1.14 (0.33; 3.95)	0.83	(—)	<0.001
Ex-smoker	1.55 (0.88; 2.70)	0.13	0.42 (0.16; 1.14)	0.09
<b>Alcohol use</b>				
No-risk	1.00		1.00	
Risk	(—)		0.36 (0.04; 3.07)	0.35
<b>Lifestyle score</b>				
Highest	1.00		1.00	
Middle-high	1.41 (0.72; 2.78)	0.32	3.13 (0.56; 17.49)	0.19
Low-middle	1.07 (0.52; 2.20)	0.85	4.54 (1.02; 20.33)	0.05
Lowest	0.66 (0.27; 1.59)	0.35	1.65 (0.40; 6.79)	0.49
<b>Weight status</b>				
Underweight	0.74 (0.25; 2.17)	0.58	0.43 (0.10; 1.85)	0.26
Normal	1.00		1.00	
Overweight	0.68 (0.35; 1.29)	0.24	2.28 (0.71; 7.36)	0.17
Obese	0.71 (0.39; 1.25)	0.23	5.08 (1.48; 17.42)	0.01
<b>Central obesity</b>				
No			1.00	
Yes	0.91 (0.52; 1.59)	0.73	2.50 (0.80; 7.79)	0.11
<b>Frailty phenotype</b>				
Normal	1.00		1.00	
Pre-frailty	5.66 (1.47; 21.78)	0.01	0.45 (0.06; 3.32)	0.43
Frailty	8.53 (1.68; 43.32)	0.01	(—)	<0.001

(Continued)



<b>Table 3 (continued)</b>				
	Women	<i>p</i>	Men	<i>p</i>
<b>Chronic pain</b>				
No	1.00		1.00	
Light/moderate	3.87 (1.81; 8.27)	<0.001	2.27 (0.65; 7.92)	0.20
Severe/extreme	9.32 (4.44; 19.59)	<0.001	6.03 (1.52; 23.89)	0.01
<b>Morbidity (n° diseases)</b>				
0	1.00		1.00	
1	1.68 (0.37; 7.59)	0.50	1.14 (0.22; 6.02)	0.88
≥2	7.08 (1.82; 27.48)	0.01	6.41 (1.64; 25.15)	0.01
<b>Asthma</b>				
No	1.00		1.00	
Yes	1.36 (0.59; 3.09)	0.46	7.60 (2.31; 24.99)	0.01
<b>Arthritis rheumatoid</b>				
No	1.00		1.00	
Yes	2.41 (1.34; 4.34)	<0.001	0.99 (0.16; 6.43)	0.99
<b>Hearing problems (n°)</b>				
0				
1	1.72 (0.92; 3.23)	0.09	0.59 (0.14; 2.43)	0.46
2	1.29 (0.59; 2.82)	0.52	0.54 (0.11; 2.64)	0.44
3	2.1 (1.03; 4.28)	0.04	1.79 (0.36; 8.87)	0.48
<b>Migraine</b>				
No	1.00		1.00	
Yes	1.57 (0.81; 3.04)	0.18	(-)	<0.001
<b>Insomnia</b>				
No	1.00		1.00 (Ref)	
Yes	2.99 (1.74; 5.12)	<0.001	0.49 (0.08; 3.00)	0.44
<b>Depression ever diagnosed</b>				
No	1.00		1.00	
Yes	4.06 (2.55; 6.47)	<0.001	6.41 (2.13; 19.31)	<0.001
<b>Treatment for depression</b>				
No	1.00		1.00	
Yes	2.01 (1.23; 3.33)	<0.001	6.81 (2.30; 20.16)	<0.001

Note: Data presented as risk ratio and their 95% CI. The reference group is denoted as 1. Exposures with insufficient cases to estimate the risk ratios are denoted as (-).

Previous diagnose of depression and a history of depression treatment showed association with depression in both sexes, particularly in the male group. Men diagnosed with depression in the past were

6.4-time more likely to show current depression and had 6.8 times higher likelihood to present depression when they had received treatment for depression than their counterparts.

Psychosocial variables associated with depression for women and men are presented in Table 4. In women, a higher likelihood of depression was found when informing regular and low perceived well-being than those who rated their well-being as good. Women who self-reported perception of stress most of the time had 11-time higher likelihood to present depression and it reached 26.5 times when they self-reported stress permanently. The same pattern was found for financial stress, that is, women who experienced high financial stress showed 4.3 more times to suffer from depression than those who did not. Difficulties for social participation were also related to depression in women, being 4.2 times higher for those who reported severe or extreme difficulties for social participation.

**Table 4:** Psychosocial variables associated with depression for women and men

	Women	<i>p</i>	Men	<i>p</i>
Self-rated health				
Good	1.00		1.00	
Regular	0.43 (0.26; 0.72)	0.01	1.88 (0.53; 6.69)	0.33
Bad	0.13 (0.064; 0.25)	<0.001	0.37 (0.11; 1.25)	0.11
Perceived well-being				
Good	1.00		1.00	
Regular	2.72 (1.61; 4.61)	<0.001	0.92 (0.33; 2.57)	0.87
Bad	4.94 (2.26; 10.79)	<0.001	3.72 (0.83; 16.57)	0.09
Perception of stress				
Never	1.00		1.00	
Sometimes	3.72 (1.84; 7.54)	<0.001	1.46 (0.51; 4.18)	0.48
Most of the time	10.94 (5.14; 23.27)	<0.001	13.82 (4.25; 44.90)	<0.001
Permanently	26.53 (13.70; 51.41)	<0.001	10.04 (2.57; 39.22)	<0.001
Financial stress				
None	1.00		1.00	
Moderate	1.56 (0.87; 2.81)	0.14	0.68 (0.21; 2.20)	0.52
High/Too much	4.29 (2.41; 7.61)	<0.01	5.11 (1.40; 18.64)	0.01
Social support				
Yes	1.00		1.00	
Sometimes	1.85 (0.94; 3.63)	0.08	0.34 (0.08; 1.43)	0.14
Rarely/Never	1.77 (1.01; 3.11)	0.05	1.31 (0.45; 3.80)	0.62
Instrumental social support				
Yes	1.00		1.00	
Sometimes	1.69 (0.72; 3.96)	0.23	0.69 (0.13; 3.68)	0.66
Rarely/Never	1.69 (0.95; 3.05)	0.08	1.14 (0.30; 4.33)	0.85

(Continued)

<b>Table 4 (continued)</b>				
	Women	<i>p</i>	Men	<i>p</i>
Difficulties for social participation				
Low	1.00		1.00	
Light	2.46 (1.31; 4.62)	<0.001	1.17 (0.29; 4.68)	0.83
Moderate	4.34 (2.20; 8.59)	<0.001	(–)	<0.001
Severe/extreme	4.17 (2.09; 8.32)	<0.001	8.07 (2.01; 32.4)	<0.001
Being a caregiver				
No	1.00		1.00	
I have full responsibility	1.84 (0.96; 3.56)	0.07	(–)	<0.001
I share this responsibility	0.88 (0.46; 1.65)	0.68	4.94 (1.47; 16.65)	<0.001

In men, a higher likelihood of depression was found for those who experienced perception of stress most of the time and permanently (13.8 and 10.0 times, respectively), financial stress, difficulties for social participation and those who were shared caregivers (Table 4).

#### 4 Discussion

This study identified factors associated with depression in the Chilean older population. There was a higher likelihood of depression in women than in men as well as some commonalities and sex differences. Common risk factors were to report diminished hours of sleep per day, severe chronic pain,  $\geq 2$  diseases and history of diagnosis and treatment for depression in the past. Psychosocial factors related to depression in both groups were the experience of stress, high financial stress and difficulties for social participation. Although these risk factors were for both sexes, there were some noticeable differences. In women, a high burden of disease, perception of stress and low self-rated well-being were related to depression. In men, instead, an incremented likelihood of depression was found for divorced and widowed men, for those with obesity and low-middle lifestyle score, men who reported asthma, financial stress, difficulties for social participation and those who were shared caregivers, in comparison to their counterparts.

##### 4.1 Socio-Demographic Factors Related to Depression

In terms of socio-demographic risk factors for depression, the main finding was the higher likelihood of depression in women compared to men, as it had previously established [17,18]. This differential risk has been widely analyzed, suggesting that it may primarily stem from biological sex differences, particularly the hormonal system [19]. Notwithstanding the above, there is evidence that the differences between men and women in depression's rates tend to be higher at earlier stages and become similar at later life [20]. However, our results suggest that, even later in life, women are more prone to depression than men. This agrees with existing evidence from other LMICs [21]. What might be contributing to this is that culturally, women are more open to asking for help from health providers, thus being subject to more diagnoses than men. Another proposal is that the exposure to gender-based inequalities in LMICs as well the general disadvantages and role burden across the life course in women could be associated with later depressive episodes [22,23].

Divorce and widowhood were associated with depression in men. The relationship between depressive symptoms and the loss of a spouse was previously stated [24,25]. Widowhood is one of the most important predictor of loneliness in old age and the experience of loneliness, isolation and lack of social support are

closely linked to depressive symptoms [26,27]. In our study, this relationship was founded only in men, which agrees with previous studies that informed a stronger association between depressive symptoms and loneliness among men than women [28–30]. A possible explanation is that older women have higher social contact participation and more extensive social networks than older men. Other studies also suggest that women can adapt over time to widowhood more successfully than men [31].

#### **4.2 Lifestyle Factors and Health Conditions Related to Depression**

The most important lifestyle risk factor for depression in both sexes was sleeping  $\leq 6$  h/day. A recent meta-analysis stated that self-reported sleep disturbances increase the risk of the onset of depression and raise the possibility of the recurrence and worsening of depression in older adults [32]. A longitudinal study showed that persistent sleep problems in older adults-with or without depression-during a year-long period predicted depression during the second year, emphasizing that identifying sleep disturbances may prevent late-life depression or its recurrence [33].

In terms of health conditions, chronic pain and multimorbidity were the main risk factors for depression in both groups. Regarding chronic pain, previous studies have already asserted its relationship with depression in different age groups [34], and there is evidence suggesting that people who experience a high level of pain have longer depressive episodes, late remission [35] and a higher risk of suicide [36]. Accordingly, the number of diseases informed was related to depression in the total sample, as it was previously reported [37–39]. A meta-analysis from 2017 highlighted that the risk of depression doubled in people with multimorbidity compared to people without multimorbidity, and tripled compared to people without any chronic physical disease. This meta-analysis also concluded that the likelihood of depression was incremented by 45% for each additional chronic condition [40]. Another international study—carried out in 43 middle-income countries—confirmed the above, establishing an estimated probable increase of 3.3% of depression due to multiple diseases [41].

The association between health conditions and depression can be attributable to the co-occurrence of depression with pain and inflammatory processes, as in the case of arthritis [42]. Also, it can be due to the functional impairment caused by the disease and the losses in quality of life and independence, which may also derive from social disconnectedness, feeling of loss and psychological distress [43].

Previous studies have reported a bidirectional association between physical conditions and mental health [41], stating that physical illness prompt depressive symptoms. People with depression are more likely to have a single or multiple physical illnesses than non-depressed [44]. A longitudinal study identified depression as a risk factor for chronic diseases, particularly those characterized by inflammation, pain and autonomic reactivity [45]. Also, depressive symptoms have been related to health risk behavior and lack of self-care practices, which can increase physical symptoms and interfere in health-seeking behavior, increasing mortality [41,46]. This close depression-diseases link sheds light on the importance of screening and treating both conditions.

In our study, the analysis of gender differences in lifestyle risk factors and health status indicated that obesity and low lifestyle score were related to depression in men. In Australia, the association between various measures of obesity and incident depression over 10 years was evaluated in a large cohort of community-based older men. The study concluded that men with a BMI  $\geq 30$  had a 31% increase in the risk of depression compared with nonobese men (BMI  $< 30$ ) and men with metabolic syndrome had a 137% increase in the adjusted risk of incident depression. Authors suggest that reducing the prevalence of obesity and metabolic syndrome could potentially lead to a decline in the prevalence and incidence of depression in men in later life [47].

In women, the presence of the frailty phenotype (pre-frail or frail), and chronic conditions, such as rheumatoid arthritis and hearing problems, were related to depression.

Regarding frailty phenotype, studies consistently show that at any given age, women have higher prevalence of frailty than males [48,49] and a recent meta-analysis reported that frail older adults showed increased odds of having depression and also, people with depression were at increased risk of having frailty [50]. Hearing problems may interfere drastically with daily life activities causing social isolation and exclusion [51]. In the case of asthma, a similar cross-sectional study in the USA found that older adults with asthma and depression had increased asthma episodes, urgent care visits for asthma and sleep disturbances due to asthma compared with older asthmatics without depression [52].

Our findings support the already robust evidence on the relationship between physical conditions and affective disorders [37,44,53]. However, in our study, this association shows a differential pattern by gender being women more vulnerable since they informed more medical conditions related to depression and stronger associations between them. Frailty phenotype, multimorbidity, chronic pain, and higher number of chronic diseases have been associated with depression in females, which suggests that the health domain is more critical for depression in females than males. One longitudinal study that investigated the gender differences in depression in older persons in a unique sample of unlike-sex twins indicated that physical functioning is one factor that explains the higher depressive symptoms in women than men in a 4-year follow-up [23]. Another study in Japan stated that health conditions and disability were the major risk factors for depressive symptoms among older women [54], different from what was found in men. More recently, other studies assert that the number of medical conditions was consistently related to depression in female older adults [39]. Women experienced more chronic conditions, demonstrating less ability to perform daily tasks, and subjectively reporting poor health. Hence, their health status was one of the main factors predicting the gender difference in depression in the elderly [55].

Among the main risk factors for late-life depression found in our study was to have had previous depression episodes and a history of depression treatment. This association was stronger in men than in women. Studies that have examined the course of depressive disorders in adults over 60 years informed that older persons clinically depressed at midlife showed recurrent episodes of depressive disorders later on in life. Also, the history of prior episodes is a prognostic risk factor for recurrence of depression [56]. Moreover, an unfavorable course of depression is associated with a younger age at depression onset, higher symptom severity [57] and untreated depression [58]. This evidence suggests that early recognition and treatment of depression are crucial to prevent its recurrence. The differential risk of a history of diagnosis and treatment of depression against men might be due to that since men demonstrate less help-seeking behavior due to traditional masculine values or the stigma of mental illness [59,60], those who timely recognize and ask for help are the ones that were in such a depressive condition that lead them to overcome prejudice and ask for treatment; and since depression is regarded as a chronic condition, they are more prone to exhibit depression at later stages.

### ***4.3 Psychosocial Factors Related to Depression***

The experience of permanent stress was closely associated with depression, given that general anxiety, prolonged and frequent worries, feeling tense or restless are specifiers of depressive disorders [61]. Financial stress was also a risk factor for depression in both sexes, with a stronger relationship in men than women. Longitudinal studies have asserted that economic stress increases older adults' vulnerability to physical health decline and mental distress [62,63]. A longitudinal study in older adults with cancer carried out in USA, reported that financial strain at the baseline predicted later depressive symptoms confirming the burden of the co-existence of physical conditions and financial stress, two common conditions in later life, that put older adults at higher risk of mood disorders [64]. A meta-analysis conducted in Chinese older adults also informed the role of poor self-perceived financial condition in depressive symptoms [65]. Studies have suggested that men are more prone to depression in particular socioeconomic circumstances [66] what might be related to the traditional social role of provider ascribed to males.

Our findings also confirmed that lack of social involvement and difficulties for social participation are associated with depression, being this relationship stronger in men than women. There is a vast amount of evidence regarding the role of social support on health and morbidity [67]. Moreover, research in older adults states the association between depression and social capital [68], social participation [69], social isolation [70] and loneliness [28], confirming the protective role of connectedness and the engagement in social activities for mental health. However, as people age, social connections might decrease due to the loss of family and friends, retirement or difficulties to initiate new networks, and it might be impaired due to health conditions, disabilities, or diminished functionality, making older people more prompt to loneliness and depressive symptoms.

We found gender differences regarding the importance of psychosocial risk for depression. Financial stress, difficulties for social participation and being a shared caregiver together with widowhood and divorce suggest that men might be more vulnerable than women to psychosocial-related stressors, or they are less able to cope with life transitions due to age.

#### ***4.4 Suggestions for the Clinical Practice***

Our results state the importance of recognizing older persons at risk of affective disorders and designing interventions with a gender perspective.

Health issues and social vulnerability are among the risk factors that should be used as screening and monitoring variables at old age and particularly to prevent and diagnose depression timely. Multimorbidity is one of the main factors associated with depression in both sexes. Existing evidence indicates a high prevalence of multimorbidity among older adults in high-income countries [71]-as well as in Chile, where 8.3% of women and 4.1% of men reported having >5 diseases [6]. Thus, since the probability of multimorbidity increase with age, it is essential to assess and treat depression as part of the management of chronic diseases because this co-occurrence has significant consequences for the self-care, help-seeking behavior, adherence to treatment as well as the course of the illnesses and their prognosis [53].

Health status or disability in women and social vulnerability in men are risk conditions that reinforce the importance to protect older people from the losses related to life transitions such as retirement and the loss of family and friends.

In both sexes, history of diagnosis and treatment for depression were closely related to current depression, which informs about the chronic condition of this disease. Unfortunately, late-life depression can be undetected or inadequately treated [72], maybe because many of its symptoms such as sleep disturbances, lack of energy and mood changes can be considered normal in late-life or might be confounded with other conditions distinctive from older adulthood.

#### ***4.5 Limitations***

This study is not without limitations. Firstly, the instrument CIDI-SF only informs suspected depression. Therefore, we cannot discard false positives due to, for example, a grieving process or depression caused by other psychiatric disorders. Secondly, the cross-sectional study design of this study does not exclude the possibility of reverse causation. Finally, self-reported measures are subject to different types of biases such as social desirability and recall bias.

An interesting issue that could not be addressed here is the relationship between depression and cognitive decline due to that participants with suspicious of cognitive impairment were excluded from the study. There is wide amount of evidence that assert that persons with a diagnosis of depression show a decrease in their cognitive functions. Moreover, longitudinal studies have concluded that depression symptoms are a prodromal feature of dementia and also, that both conditions can share common causes

[73–75]. Further studies should address the complex interplay between depression and cognitive impairment as two common comorbidities at late life.

## 5 Conclusion

Sociodemographic, biomedical and psychosocial risk factors for depression in Chilean older people were identified. Differences by gender were found: frailty phenotype, arthritis rheumatoid, hearing problems, insomnia, and low self-rated well-being, factors associated with depression in the female group. Divorce, widowhood, obesity and asthma were associated with depression in men. Both groups showed an increased probability of depression when reporting  $\leq 6$  h/day sleeping hours per day, health conditions such as chronic pain and multimorbidity, high perception of stress, financial stress and difficulties for social participation. In both groups, diagnosis and a history of depression treatment were closely related to current depression.

According to social and cultural contexts, ecological factors related to mental health are expected to differ. Thus, this research provides a country-specific perspective into the risk factors for depression in a developing country and suggest the need of implementing cultural and age-sensitive strategies to promote mental health in late life.

**Availability of Data and Materials:** Readers can access the data used in this study from: <http://epi.minsal.cl/bases-de-datos/>.

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