Research paper

Suicidal ideation is associated with cardiovascular disease in a large, urban cohort of adults in the Southern Cone of Latin America

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ABSTRACT

Introduction: To examine the relationship between suicidal ideation (SI) and cardiovascular disease (CVD) in the general adult population of four cities in the Southern Cone of Latin America (Argentina, Uruguay, Chile) and the role that depression, stressful life events (SLEs) and physical functional impairment may play in this association.

Methods: A population-based cross-sectional study was conducted among 7524 adults between 35 and 74 years old, randomly selected. History of CVD included acute myocardial infarction, stroke and central or peripheral revascularization. SI in the past two weeks was measured using the last item of the Patient Health Questionnaire (PHQ-9), quality of life was assessed with the 12-item Short Form Survey (SF-12), and having experience of a SLE was determined by asking participants whether they had experienced at least one of a list of events in the past year. Multiple logistic regression was used to examine the association between SI and CVD overall and by sex.

Results: The prevalence of SI was 8.3% (95% CI = 7.5, 9.0) and twice as high among women than men (11.1% vs. 5.1%). History of CVD was associated with almost twice the odds of SI (OR = 1.9, 95% CI = 1.5, 2.4). This association remained strong and significant after adjusting for potential confounders (OR = 1.8, 95% CI = 1.2, 2.7). Three additional models were tested to further adjust for depression severity, functional impairment, and SLEs separately. Adjustment for depression severity yielded no association between CVD and SI (OR = 1.1, 95% CI = 0.6, 1.7), adjustment for functional impairment yielded a marginal statistically significant association (OR = 1.5; 95% CI = 1.0, 2.4) and adjustment for SLE didn't modify either the magnitude or the statistical significance of the association.

Conclusions: There is a significant association between SI and CVD, particularly among women, which may be driven, at least in part, by depression and physical functional impairment.

1. Introduction

Suicide and suicidal behaviors (e.g., suicidal ideation, suicide plans, and suicide attempts) are common causes of death and injury worldwide. Approximately 800,000 people worldwide die from suicide each year, resulting in an annual global age-standardized suicide rate of 10.7 per 100,000 persons [1]. However, completed suicide is far less common than other suicidal behaviors. It has been estimated that for every completed suicide there are 8 to 25 times more individuals who attempt suicide [2], and the cross-national lifetime prevalence of suicidal ideation (SI), plans, and attempts is 9.2%, 3.1%, and 2.7%, respectively [3]. Taken together, this indicates that both suicide and non-fatal suicidal behaviors are prevalent problems that need to be addressed.

In order to develop suicide prevention strategies, identifying groups that are at high risk is crucial. To this end, SI has been identified as a strong predictor of more serious and potentially fatal suicidal behavior [4], and thus identification of individuals who endorse SI presents an important opportunity to intervene. In addition to mental disorder, chronic physical illness has been identified as a risk factor for SI [5,6]. The reason for this association is not completely understood. Because chronic physical illnesses have been also associated with depression and depression associated with suicidal behavior, depression may be a mediator in the relationship between SI and chronic physical illness [7]. However, some studies have reported an association between SI and chronic physical illness independent of depressive symptoms [7,8],

suggesting that there may be alternative mechanisms.

Although several types of chronic physical illness have been linked to suicidal behaviors, not all illnesses have been associated with SI and the evidence for some illnesses is stronger than for others. A recent systematic review of 65 studies identified physical conditions consistently associated with SI including malignant diseases, neurological disorders, pain, male genital disorders, arthritis, chronic obstructive pulmonary disease (COPD), and liver diseases [9]. Given that some illnesses are more consistently associated with SI than others, there may be condition-specific characteristics that account for this relationship. For example, functional disability induced by the chronic physical illness may, at least in part, explain this association, since it can lead to loss of autonomy and dignity, perception of lack of usefulness, isolation and increased burden on social networks. Other possible explanations that have been proposed in the literature are pain and burden of managing a chronic illness [8–13], which may be more present in some chronic illnesses (e.g., cancer, arthritis) than others.

Some studies have demonstrated an increased risk of SI among individuals with cardiovascular diseases (CVD) in general, but this evidence is less consistent [9]. Studies have linked stroke [14–16], myocardial infarction [16], heart disease [17], and coronary artery disease [18] to suicidal behavior. The relationship between SI and CVD is not completely understood. However, CVD may be associated with SI due to depression and physical impairment as described above. Furthermore, stressful life events (SLEs) have been also associated with CVD [19] and with suicide behavior [20], thus, this is an important variable that has not been previously explored in studies of the relationship between CVD and SI.

Most epidemiological studies of SI and chronic illnesses have been conducted in North America or Western Europe, and evidence from developing regions such as South America is scarce. Taking into account the large and growing public health importance of CVD in South America and worldwide [21,22], as well as the relatively high suicide rate (9.6 per 100,000) in several South American countries [1], there is a need for population-based epidemiological studies to further explore the association between CVD and SI. The present study seeks to reduce this knowledge gap and provide data that can help inform the development of suicide prevention strategies and improve overall well-being in this population. It examined the relationship between SI and CVD in the general adult population of four cities in the Southern Cone of Latin America, which includes Argentina, Uruguay and Chile; and evaluated the role of severity of depressive symptoms, stressful life events (SLEs) and physical functional impairment in this association.

2. Materials and methods

2.1. Study participants

The details of the study design and sampling methods of the CESCAS I study have been published previously [23]. Briefly, 7524 women and men aged 35 to 74 years old were recruited between February 2010 and December 2011 from randomly-selected samples in four mid-sized cities in the Southern Cone of Latin America: two cities located in Argentina (Bariloche and Marcos Paz), one in Chile (Temuco), and one in Uruguay (Pando-Barros Blancos). Marcos Paz and Pando-Barros Blancos are small cities with 54,000 and 58,000 residents, respectively, according to the latest census data [24]. Bariloche (Argentina) and Temuco (Chile) are larger cities with 134,000 and 245,000 residents, respectively, according to the latest census data as well [24]. Only urban populations were included from these sites. These study locations were selected based on population characteristics reflecting country averages. In addition, all four locations have demonstrated stable populations with migration rates below 10% over the past 10 years. A four-stage stratified sampling method was used to select a representative sample from these geographic areas [25]. In the first stage, census radii were randomly selected from each of the four locations,

stratified by socio-economic level. In the second stage, a number of blocks proportional to the radius size were randomly selected. In the third stage, households within each block were selected by systematic random sampling. All members between the ages of 35 and 74 in the selected households were listed to create the study sampling frame. In the final stage of sampling, one listed member per household was randomly selected to be included in the study.

Of the 10,254 individuals randomly selected, 550 were never found at their homes and 1394 refused to participate. Of those 8310 who completed the home surveys, 786 did not attend the clinical examination. Thus, the final sample for this analysis includes 7524 participants (3165 men and 4359 women). The overall response rate was 73.4%, and the response rates were similar in men and women and across different locations.

The study complies with the Declaration of Helsinki. The study protocol was approved by institutional review boards in all participating institutions in Argentina, Chile, Uruguay and the US, and written informed consent was obtained from all study participants.

2.2. Data collection

Study data were collected during a home visit and a clinical visit. Depression was measured during the home visits, using the Patient Health Questionnaire (PHQ-9), which is a nine-item self-reported scale, developed to screen for Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) major depressive episode, as well as to assess the severity of depressive symptoms during the two weeks prior to data collection in primary care settings and the community [26]. The PHQ-9 has been validated and calibrated in Argentina [27]. Suicidal ideation (SI) was measured using the last item on the PHQ-9: "*Did you ever have a period of at least 2 weeks during which you were bothered by thoughts that you would be better off dead, or of hurting yourself?*" This measures the presence or absence of SI during the two weeks prior to the evaluation and has been validated and used previously [28–30]. History of CVD was obtained through the self-report of any of the following conditions diagnosed by a physician: acute myocardial infarction, stroke or coronary or peripheral revascularization.

During the home survey, other information on sociodemographic characteristics, including age, sex, education, occupation, and lifestyle risk factors, including cigarette smoking, alcohol consumption, and physical activity was obtained using standard questionnaires. Religious practice was defined as attending religious services at least once a week. Health insurance included social security or private insurance. Alcohol abuse was defined as consuming ≥15 drinks per week in men and ≥8 drinks per week in women. Low physical activity was defined as completing < 600 metabolic equivalent (MET)-minutes of physical activity per week. Experience of a stressful life event (SLEs) was determined by asking participants whether they had experienced at least one of the following events in the past year: marital separation or divorce, loss of job or retirement, loss of crop or business failure, violence, major intra-family conflict, death or major illness of a close family member, death of a spouse, or other major stress [31,32]. Major personal injury or illness was excluded from the SLEs, as this information may be captured by the history of cardiovascular disease (CVD) question. Depressive symptom severity was measured using the PHQ-8, which excludes the last item of the PHQ-9 on suicidal ideation, given that this was the dependent variable of interest. The PHQ-8 is also a validated measure of depression [33]. Symptom severity was measured by summing the scores from each item in terms of frequency of that symptom (0 = "not at all" to 3 = "nearly every day") in the last two weeks. Scores could range from 0 to 24, with higher scores indicating greater symptom severity. Quality of life was assessed with the locally validated version of the 12-item Short Form Survey (SF-12) [34]. The SF-12 survey contains categorical questions (e.g., yes/no) that assess limitations in role functioning as a result of physical and emotional health. The measure is made of two components, a physical component

summary (PCS) and a mental component summary (MCS), with higher scores indicating better health status. PCS score was used as a measure of functional disability.

During the clinical examination, blood pressure (BP) and anthropometric measurements were obtained by trained and certified observers using the standard protocols and techniques described previously [35]. Hypertension was defined as mean systolic BP ≥ 140 mm Hg, and/or diastolic BP ≥ 90 mm Hg, and/or current use of antihypertensive medications [36]. Obesity was defined as a body-mass index (BMI) ≥ 30 kg/m², and overweight as BMI ≥ 25 kg/m² [37]. Diabetes was defined as fasting glucose ≥ 126 mg/dL or self- reported history of diabetes [12].

2.3. Statistical analysis

All calculations were weighted to represent the general adult population aged 35–74 years in the study sites, according to the study sampling design. Prevalence of SI was calculated for the overall population and by sex, with accompanying 95% confidence intervals (CI). Taylor series linearization was used to calculate standard errors to account for the complex sampling design [23,38]. Comparisons between two groups were analyzed using Rao-Scott chi-squared test for categorical variables and one-way ANOVA for continuous variables. Odds ratios (OR) and 95% CI for the association between SI and CVD were obtained using multivariable logistic regression models in the overall sample and stratified by sex. Covariates in adjusted models (age, sex, education, employment, health insurance status, living alone, smoking status, diabetes, depression, physical impairment, and SLEs) were selected because they were associated with both CVD and SI in this sample or they have been identified as potentially important confounders of the association of interest in the literature. The role of depression [7,9,39] and physical impairment [9,40,41] in the relationship of chronic physical illness and SI has been previously established. The selection of SLEs as a covariate was based on theory, since it has been demonstrated that SLEs are involved on CVD [19] and SLEs are also involved in suicide behavior [20]. Covariates in adjusted models (age, sex, education, employment, health insurance status, living alone, smoking status, diabetes, depression, physical impairment, and SLEs) were selected because they were associated with both CVD and SI in this sample or they have been identified as potentially important confounders of the association of interest in the literature. The role of depression [7,9,39] and physical impairment [9,40,41] in the relationship of chronic psychical illness and SI has been previously established. The selection of SLEs as a covariate was based on theory, since it has been demonstrated that SLEs are involved on CVD [19] and SLEs are also involved in suicide behavior [20]. Effect modification of the association between SI and CVD by sex was assessed by adding an interaction term to the regression model. All data analyses were conducted using SAS version 9.3 (SAS Institute, Cary NC).

3. Results

3.1. Participant characteristics

Demographic, clinical and behavioral risk factors in the study population are shown in Table 1. Of the 7524 total participants, 3165 (42.1%) were men and 4359 (57.9%) women. The proportion of individuals with history of CVD was 3.8% (95% CI: 3.3, 4.2). The mean score for the PHQ-8 was 3.2 (95% CI: 3.1, 3.4), and approximately 46.3% reported at least one SLE in the year previous to the assessment. The mean value of the PCSc score derived from the SF-12 was 48.2 (95% CI: 47.9, 49.1), while the mean MCSc score was 51.8 (95% CI: 51.5, 52.2). Mean PHQ-8 score, as well as the percentage of subjects with at least one SLE were higher in women than in men. Women also presented lower mean values for both subscales of the SF-12.

3.2. Prevalence of and factors associated with SI

Prevalence of SI was compared by various demographic, behavioral and clinical factors in Table 2. The overall prevalence of SI in adults aged 35–74 years in the Southern Cone was 8.3% (95% CI: 7.5, 9.0) and was more than twice as high in women than in men (11.1% vs. 5.1%, p < 0.0001). History of CVD, the exposure of interest in this study, was associated with SI, with a SI prevalence of 13.6% (95% CI: 9.4, 17.9) among those with history of CVD compared to 8.0% (95% CI: 7.3, 8.8) among those without CVD. A similar pattern was found for both men and women. As reported in Table 2, the prevalence of SI was higher in adults with lower vs. higher educational level, those who were unemployed vs. employed, those without health insurance vs. those with insurance, in those reporting a SLE vs. no SLE, and among those who lived alone vs. living with others. No differences in SI prevalence were observed related to smoking status, alcohol abuse, low physical activity or regular religious practice. Cardio-metabolic risk factors (e.g., hypertension, diabetes) were not associated with elevated SI prevalence. Higher scores in the PCSc and MCSc composite of the SF-12 and on the PHQ-8 were observed among those with SI compared to those without SI. These patterns were similar for men and women.

Unadjusted and adjusted ORs for the association between SI and CVD, sociodemographic characteristics, behavioral factors and health status are presented in Tables 3 and 4. In unadjusted models, the odds of SI were more than double in women compared to men (OR = 2.3; 95% CI: 1.8, 2.9) and no difference was observed by age group. Having history of CVD was associated with almost twice the odds of SI compared to not having history of CVD (OR = 1.9, 95% CI: 1.5, 2.4). In adjusted models, the association between SI and CVD remained strong and significant after adjusting for sex, age, education, employment, health insurance status, living alone, smoking and other chronic diseases (OR = 1.8, 95% CI: 1.2, 2.7). Further adjustment for physical impairment based on PCS score yielded a marginal but statistically significant association (OR = 1.5; 95% CI: 1.0, 2.4). Adding SLE to the model did not modify magnitude or the statistical significance of the association between SI and history of CVD. However, adjusting for depression severity yielded no association between CVD and SI (OR = 1.1, 95% CI: 0.6, 1.7). Among women, a similar pattern emerged. Among men, the association between CVD and SI was weaker and did not meet statistical significance in adjusted models. The interaction term between sex and CVD was not significant (p = 0.6).

4. Discussion

The CESCAS I study provided a unique opportunity to examine SI and its relationship with CVD in a large, urban, population-based cohort in the Southern Cone of Latin America. The major findings of the study were the relatively high prevalence of current SI in this cohort and elevated prevalence of SI among those with CVD vs. those without CVD, particularly among women. Additionally, the current study provided evidence that the association between SI and CVD may be explained, at least in part, by depression symptom severity and physical functional impairment.

Data regarding the prevalence of SI in the general population of the Southern Cone is scarce; however, we are able to compare findings from this study to other countries in Latin America, which can be considered culturally similar to the Southern Cone. This study also reported a relatively high prevalence of SI in this population (8.3%) and higher prevalence of SI among women (11.1%) compared to men (5.1%), consistent with previous studies in the region. In a large, cross-national study of suicidal behavior, 12.4% of adults in Colombia and 8.1% in Mexico reported SI [3]. The higher prevalence of SI in the Colombian study compared to the present study may be due to difference in the timing of SI between studies (lifetime SI in the Colombian study and current SI in the present study). In another population-based study in Colombia, a greater proportion of women (7.6%) reported SI compared

Table 1
General characteristics of the study population in the Southern Cone of Latin America.

	Overall % (95% CI)	Sex		p-Values*
		Women % (95% CI)	Men % (95% CI)	
Number of study participants	7524	4359	3165	
Age	50.9 (50.7, 51.2)	51.3 (50.9, 51.6)	50.6 (50.2, 51.0)	0.0141
Less than high school	52.3 (50.9, 53.7)	52.2 (50.4, 54.1)	52.4 (50.3, 54.5)	0.9256
Unemployed	6.0 (5.3, 6.7)	6.8 (5.7, 7.8)	5.1 (4.2, 6.1)	0.0269
No health insurance	56.2 (54.8, 57.6)	57.4 (55.6, 59.3)	54.8 (52.7, 56.8)	0.0598
Living alone	30.2 (28.9, 31.5)	37.5 (35.7, 39.3)	22.1 (20.3, 23.8)	< 0.0001
Current smoker	29.7 (28.4, 31.0)	26.5 (24.8, 28.3)	33.3 (31.3, 35.3)	< 0.0001
Alcohol abuse	4.2 (3.6, 4.7)	2.3 (1.8, 2.8)	6.2 (5.3, 7.2)	< 0.0001
Low physical activity	35.2 (33.8, 36.5)	41.3 (39.4, 43.1)	28.3 (26.4, 30.2)	< 0.0001
Regular religious practice	30.1 (28.8, 31.4)	35.5 (33.7, 37.3)	24.0 (22.2, 25.9)	< 0.0001
Experienced stressful life event	46.3 (44.9, 47.7)	48.2 (46.4, 50.1)	44.2 (42.1, 46.3)	0.0046
Mean PCSc score	48.2 (47.9, 48.4)	47.3 (47.0, 47.7)	49.1 (48.8, 49.4)	< 0.0001
Mean MCSc score	51.8 (51.5, 52.2)	49.8 (49.3, 50.3)	54.1 (53.7, 54.6)	< 0.0001
Mean depression symptom severity	3.2 (3.1, 3.4)	4.0 (3.8, 4.1)	2.4 (2.3, 2.6)	< 0.0001
Hypertension	40.8 (39.4, 42.1)	37.3 (35.5, 39.0)	44.7 (42.6, 46.7)	< 0.0001
Diabetes	12.4 (11.5, 13.3)	14.0 (12.8, 15.3)	10.6 (9.4, 11.7)	< 0.0001
Obesity	35.7 (34.4, 37.0)	39.1 (37.3, 40.9)	31.9 (30.0, 33.8)	< 0.0001
History of cardiovascular disease	3.8 (3.3, 4.2)	3.2 (2.6, 3.7)	4.5 (3.7, 5.2)	0.0064

Data are weighted percentage or mean (95% confidence intervals [CI]). Health insurance included social security or private insurance; alcohol abuse: ≥15 drinks per week in men or ≥8 drinks per week in women; low physical activity: < 600 MET-minutes per week; regular religious practice was defined as ≥1 religious practices per week; stressful life events: at least one in the last year such as marital separation or divorce, loss of job or retirement, loss of crop or business failure, violence, major intra-family conflict, death or major illness of a close family member, death of a spouse, or other major stress; PCSc: Physical Health Composite Scale scores derived from the SF-12; MCSc: Mental Health Composite Scale scores derived from the SF-12; depression severity was measured as the sum of the response frequencies to the first eight items on the PHQ-9, which excludes the SI item; hypertension: systolic blood pressure ≥140 mm Hg and/or diastolic blood pressure ≥90 mm Hg and/or use of antihypertensive medication; diabetes: fasting glucose ≥126 mg/dL or self- reported history of diabetes; obesity: body-mass index ≥30 kg/m^2; history of cardiovascular disease: self-report any of the following conditions diagnosed by a physician: acute myocardial infarction, stroke or coronary or peripheral revascularization.

* p-Values from Rao-Scott Chi-Squared tests (categorical variables) and one-way ANOVA (continuous variables).

to men (5.5%) [42].

Data regarding the prevalence of SI in the general population of the Southern Cone is scarce; however, we are able to compare findings from this study to other countries in Latin America, which can be considered culturally similar to the Southern Cone. This study also reported a relatively high prevalence of SI in this population (8.3%) and higher prevalence of SI among women (11.1%) compared to men (5.1%), consistent with previous studies in the region. In a large, cross-national study of suicidal behavior, 12.4% of adults in Colombia and 8.1% in Mexico reported SI [3]. The higher prevalence of SI in the Colombian study compared to the present study may be due to difference in the timing of SI between studies (lifetime SI in the Colombian study and current SI in the present study). In another population-based study in Colombia, a greater proportion of women (7.6%) reported SI compared to men (5.5%) [42]. Results for men were similar to the present study; however, prevalence of SI among women was lower than what was reported here. Female sex has been associated with elevated prevalence of SI and other non-fatal suicidal behavior in most settings. Explanations include gender differences in reporting of suicidal ideation, psychopathology (greater depression – of which SI may be a symptom – in women, substance use disorder in men), and cultural expectations of suicidal behavior [43].

The present study also found that having a history of CVD was significantly associated with SI in four cities from Argentina, Chile and Uruguay, particularly among women. Although CVD has been less consistently linked to suicidal behavior than other chronic illnesses such as cancer and respiratory disease [9,44], these findings support results from previous studies that examined the relation between SI and various cardiovascular outcomes. For example, in a study of older adults in Taiwan, Chan et al. found that the odds of current suicidal ideation were 1.6 times greater among those with heart disease compared to those without heart disease [17]. Similar findings have been reported in a population based case-control study in which one type of

CVD, myocardial infraction, was associated with increased odds of suicide in persons with and without psychiatric illness [45]. Another type of suicidal behavior (lifetime history of a suicide attempt) has also been linked with other CVD, specifically coronary artery diseases (CAD) in a random sample of 1863 community-dwelling persons over 65 years [18].

The relationship between medical illnesses and SI is complex and may be gender-specific. In some studies, greater suicidal behaviors among people affected by coronary heart disease (CHD), stroke, COPD was explained by depression [46]. On the other hand, it was found physical conditions to be a risk factor for suicidal behavior independent of mental disorders in a large, population based cross-national sample of 37,915 men and women [39]. A possible explanation for this is that varying factors might lead to suicidality in different medical illnesses. In these sense, Chan et al. have shown that patients with CVD often develop psychiatric disorders including depression, which has been consistently implicated as an important risk factor for suicide [17]. This study also illustrates the potentially explanatory role of depressive symptom severity and physical disability in the relation between SI and CVD [17]. Living with pain has been hypothesized to explain greater suicidal behavior among those with other chronic illnesses such as cancer [11], but individuals experiencing CVD alone generally do not experience pain. It has been suggested that mental health conditions, particularly depression [7], and reduced functioning [11] may explain the link between chronic disease and suicidal behavior. The findings of the present study support this. The tendency of women to report symptoms of SI and depression more frequently than men may explain the stronger association between SI and CVD among women compared to men in this study. This is in contrast to other studies that have noted a stronger association between SI and chronic physical illness burden among men compared to women [8,47]. However, these studies did not focus on CVD but rather on cumulative chronic disease burden, which limits comparison of findings. It is possible that sex-specific findings in

Table 2

Estimated prevalence and 95% confidence intervals of the suicide ideation (SI) among study population in the Southern Cone of Latin America.

		n	Overall % (95% CI)	Women % (95% CI)	Men % (95% CI)	* P-values
Total		7524	8.3 (7.5, 9.0)	11.1 (9.9, 12.2)	5.1 (4.2, 6.0)	< 0.0001
Age groups, years	35-44	1714	7.4 (6.0, 8.9)	10.3 (8.0, 12.6)	4.4 (2.6, 6.1)	0.0001
	45-54	2067	8.6 (7.2, 10.0)	11.3 (9.2, 13.5)	5.5 (3.8, 7.2)	< 0.0001
	55-64	2108	9.4 (7.9, 10.8)	12.7 (10.4, 15.0)	5.6 (3.9, 7.2)	< 0.0001
	65-74	1618	8.1 (6.6, 9.6)	10.0 (7.8, 12.2)	5.7 (3.8, 7.6)	0.0043
Less than high school	No	2698	6.4 (5.2, 7.5)	8.4 (6.7, 10.1)	4.1 (2.7, 5.4)	0.0002
	Yes	4809	10.0 (8.9, 11.0)	13.5 (11.9, 15.1)	6.1 (4.8, 7.3)	< 0.0001
Unemployed	No	7116	7.9 (7.2, 8.7)	10.9 (9.7, 12.1)	4.7 (3.8, 5.6)	< 0.0001
	Yes	391	13.2 (8.9, 17.5)	13.6 (7.9, 19.4)	12.5 (6.1, 19.0)	0.7998
No health insurance	No	3443	6.4 (5.5, 7.3)	9.5 (8.0, 11.0)	3.1 (2.1, 4.0)	< 0.0001
	Yes	3913	9.8 (8.6, 11.0)	12.3 (10.6, 14.1)	6.8 (5.3, 8.4)	< 0.0001
Living alone	No	5120	7.2 (6.3, 8.0)	10.1 (8.6, 11.5)	4.6 (3.6, 5.6)	< 0.0001
	Yes	2382	10.8 (9.2, 12.3)	12.8 (10.8, 14.7)	6.9 (4.5, 9.3)	0.0011
Current smoker	No	5507	7.6 (6.8, 8.5)	10.1 (8.8, 11.4)	4.5 (3.5, 5.6)	< 0.0001
	Yes	2000	9.8 (8.2, 11.3)	13.6 (11.1, 16.2)	6.3 (4.4, 8.2)	< 0.0001
Alcohol abuse	No	7177	8.3 (7.5, 9.0)	11.1 (9.9, 12.3)	4.9 (4.0, 5.9)	< 0.0001
	Yes	317	8.4 (4.6, 12.2)	9.8 (3.7, 15.9)	7.9 (3.1, 12.6)	0.6211
Low physical activity	No	4957	7.7 (6.7, 8.6)	10.6 (9.1, 12.1)	5.0 (3.9, 6.1)	< 0.0001
	Yes	2550	9.3 (8.0, 10.7)	11.8 (9.9, 13.7)	5.3 (3.6, 7.1)	< 0.0001
Regular religious practice	No	5499	8.4 (7.5, 9.3)	12.1 (10.6, 13.6)	4.8 (3.8, 5.9)	< 0.0001
	Yes	2008	8.0 (6.6, 9.3)	9.1 (7.3, 11.0)	6.0 (3.9, 8.1)	0.0385
Stressful life events	No	4144	4.8 (3.9, 5.6)	6.7 (5.3, 8.0)	2.7 (1.8, 3.7)	< 0.0001
	Yes	3358	12.3 (11.0, 13.6)	15.7 (13.8, 17.7)	8.1 (6.4, 9.7)	< 0.0001
Mean PCSc score (mean, 95% CI)	Without SI	6815	48.4 (48.2, 48.7)	47.6 (47.3, 48.0)	49.3 (48.9, 49.6)	< 0.0001
	With SI	568	45.5 (44.5, 46.6)	45.0 (43.8, 46.3)	46.8 (44.8, 48.8)	0.1430
MCSc score (mean, 95% CI)	Without SI	6815	53.1 (52.8, 53.4)	51.4 (50.9, 51.9)	54.9 (54.5, 55.3)	< 0.0001
	With SI	568	37.7 (36.5, 39.0)	36.9 (35.4, 38.4)	39.6 (37.3, 42.0)	0.0575
Depressive symptom severity (mean, 95% CI)	Without SI	6897	2.7 (2.5, 2.8)	3.2 (3.0, 3.4)	2.1 (1.9, 2.2)	< 0.0001
	With SI	576	9.7 (9.2, 10.3)	10.1 (9.3, 10.8)	8.9 (8.0, 9.9)	0.0672
Hypertension	No	3929	8.2 (7.2, 9.2)	10.5 (8.9, 12.0)	5.3 (4.0, 6.7)	< 0.0001
	Yes	3574	8.3 (7.2, 9.4)	12.0 (10.2, 13.8)	4.9 (3.6, 6.1)	< 0.0001
Diabetes	No	6313	7.9 (7.1, 8.7)	10.7 (9.5, 12.0)	4.9 (3.9, 5.9)	< 0.0001
	Yes	1057	10.4 (8.1, 12.7)	12.4 (9.3, 15.6)	7.5 (4.1, 10.9)	0.0495
Obesity	No	4579	8.5 (7.5, 9.5)	11.6 (10.0, 13.2)	5.4 (4.2, 6.6)	< 0.0001
	Yes	2909	7.8 (6.6, 9.0)	10.2 (8.4, 11.9)	4.5 (3.0, 6.0)	< 0.0001
History of cardiovascular disease	No	7133	8.0 (7.3, 8.8)	10.8 (8.6, 11.9)	5.0 (4.0, 5.9)	< 0.0001
	Yes	374	13.6 (9.4, 17.9)	20.5 (13.4, 27.5)	8.2 (3.1, 13.4)	0.0093

PCSc: Physical Health Composite Scale scores derived from the SF-12; MCSc: Mental Health Composite Scale scores derived from the SF-12; CI: confidence interval.
 * P-values from Rao-Scott chi-squared tests (categorical variables) and one-way ANOVA (continuous variables).

Table 3

Unadjusted odds ratios (ORs) and 95% confidence intervals for the association of risk factors with suicide ideation among study population in the Southern Cone of Latin America.

		Overall OR (95% CI)	Women OR (95% CI)	Men OR (95% CI)
Women vs. men (reference)		2.3 (1.8, 2.9)	–	–
Age groups, years[a]	35–44	1.0	1.0	1.0
	45–54	1.2 (0.9, 1.5)	1.1 (0.8, 1.5)	1.3 (0.7, 2.2)
	55–64	1.3 (1.0, 1.7)	1.3 (0.9, 1.8)	1.3 (0.8, 2.2)
	65–74	1.1 (0.8, 1.5)	1.0 (0.7, 1.4)	1.3 (0.8, 2.3)
Less than high school[a]		1.6 (1.3, 2.0)	1.7 (1.3, 2.2)	1.5 (1.0, 2.3)
Unemployed[a]		1.8 (1.2, 2.6)	1.3 (0.8, 2.1)	2.9 (1.6, 5.4)
No health insurance[a]		1.6 (1.3, 2.0)	1.3 (1.1, 1.7)	2.3 (1.6, 3.5)
Living alone[a]		1.6 (1.3, 1.9)	1.3 (1.0, 1.7)	1.6 (1.0, 2.4)
Current smoker[a]		1.3 (1.1, 1.6)	1.4 (1.1, 1.8)	1.4 (1.0, 2.1)
Alcohol abuse		1.0 (0.6, 1.7)	0.9 (0.4, 1.8)	1.6 (0.8, 3.3)
Low physical activity		1.2 (1.0, 1.5)	1.1 (0.9, 1.4)	1.1 (0.7, 1.6)
Regular religious practice		1.0 (0.8, 1.2)	0.7 (0.6, 1.0)	1.3 (0.8, 2.0)
Stressful life events[a]		2.8 (2.2, 3.5)	2.6 (2.0, 3.4)	3.1 (2.0, 4.8)
PCSc (per 10 unit decrease)[a]		1.4 (1.2, 1.5)	1.3 (1.2, 1.5)	1.4 (1.1, 1.7)
MCSc (per 10 unit decrease)[a]		2.6 (2.4, 2.8)	2.5 (2.2, 2.7)	2.6 (2.3, 3.1)
Mean depressive symptom severity (per one point increase)[a]		1.28 (1.26, 1.31)	1.25 (1.22, 1.29)	1.33 (1.28, 1.39)
Hypertension		1.0 (0.8, 1.2)	1.2 (0.9, 1.5)	0.9 (0.6, 1.3)
Diabetes[a]		1.4 (1.0, 1.8)	1.2 (0.9, 1.6)	1.6 (0.9, 2.7)
Obesity		0.9 (0.7, 1.1)	0.9 (0.7, 1.1)	0.8 (0.5, 1.3)
History of cardiovascular disease		1.9 (1.5, 2.4)	1.7 (1.3, 2.3)	2.3 (1.5, 3.7)

PCSc: Physical Health Composite Scale scores derived from the SF-12; MCSc: Mental Health Composite Scale scores derived from the SF-12; CI: confidence interval.
 [a] Risk factor significantly associated with Suicide intention and History of cardiovascular disease.

Table 4

Adjusted odds ratios (aORs) and 95% confidence intervals for the association of CV Disease (CVD) with suicide ideation among study population in the Southern Cone of Latin America.

	1. Model including CVD and confounding factors aOR (95% CI)	2. Model including CVD, confounding factors and PCSs aOR (95% CI)	3. Model including CVD, confounding factors and PHQ8 score aOR (95% CI)	4. Model including CVD, confounding factors and stressful life events aOR (95% CI)
Overall	1.8 (1.2, 2.7)	1.5 (1.0, 2.4)	1.1 (0.6, 1.7)	1.8 (1.2, 2.8)
Women	2.0 (1.2, 3.2)	1.8 (1.1, 3.0)	1.4 (0.8, 2.4)	2.1 (1.3, 3.4)
Men	1.6 (0.7, 3.5)	1.2 (0.5, 2.9)	0.6 (0.2, 1.8)	1.5 (0.7, 3.6)

Confounding factors: sex, age, education, employment, health insurance status, living alone, smoking status, diabetes. PCSc: Physical Health Composite Scale scores derived from the SF-12; PHQ8: 8-item Patient Health Questionnaire; aOR: adjusted odds ratio; CI: confidence interval.

terms of the association between SI and chronic physical illness may be dependent on the specific chronic illness of interest. Additional studies to confirm the current study's findings are warranted.

This study benefited from a large population-based cohort from four urban areas in three different countries of South America, which helps further our understanding of the relation between SI and CVD in this population as a whole. The study included several key factors, measured using validated instruments, which might explain the relation between SI and CVD – namely, depression, physical disability and stressful life events – that may not be available in other studies and allowed for examination of the association between SI and CVD independently of these potentially explanatory factors. Despite these strengths, several limitations should be considered when interpreting our study results. First, SI was measured using the last item on the PHQ-9, as opposed to through a full scale such as the Beck Scale for Suicidal Ideation (BSSI) and the Columbia-Suicide Severity Rating Scale (C-SSRS). However, this single-item approach has been validated and used in several other studies [28–30]. Second, history of CVD was based on patient self-reporting of a diagnosis from a health professional and not confirmed through medical records. Although cardiovascular risk factors such as hypertension, diabetes and obesity were evaluated through physical examination, we were unable to provide CVD diagnoses. Relying on self-reporting may result in an underestimation of the prevalence of CVD in this sample. Self-reporting of some medical condition diagnoses has demonstrated good agreement with medical records, however, the level of agreement may vary by disease and other factors [48]; thus, studies that examine SI and incorporate clinical examination for CVD would be useful in confirming the results of the present study. Finally, the cross-sectional design of the study does not allow for establishment of a temporal relation between SI and CVD. It is possible that SI and depression preceded the onset of CVD in some cases. However, it is beyond the scope of this study to establish any causal relationship. Future prospective studies would be helpful to further explore this association. However, evidence of comorbidity between CVD and SI, regardless of the direction of the relationship, is important in its own right in that it reflects the need to address SI, in addition to other mental health conditions, among those with CVD. Finally, these results are representative of the selected cities included in the study. As such, extrapolation to the general populations of Argentina, Chile, and Uruguay and the Southern Cone as a whole should be done with caution.

5. Conclusions

The present study showed that CVD is also associated with SI among adults in the Southern Cone of Latin America. That individuals with CVD have elevated prevalence of SI, driven in large part by depressive symptom severity, highlights the importance of screening for depression and SI by providers of care for CVD. Given that SI is a strong risk factor for suicide and that CVD is increasing in this population, coupled with the finding that adults who commit suicide often consult their physicians within weeks prior to their death [49], incorporating approaches to address depression and SI among adults with CVD –

through screening, integrated care, or referral to mental health care – may be critical to preventing potentially fatal behavior.

Conflicts of interest

No author or immediate family member has financial relationships with commercial entities that might appear to represent a potential for conflicts of interest.

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