

Association between psychosocial distress and a history of cardiovascular events among adults with hypertension in the SAVA Region, Madagascar : a multicenter cross-sectional study

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Abstract

Background

In the SAVA Region, data on the association between psychosocial factors and cardiovascular events among adults with hypertension remain limited, despite a potentially unfavorable health and socioeconomic context. This study aimed to identify psychosocial factors associated with a history of cardiovascular events and to determine whether these associations persisted independently of major traditional cardiovascular risk factors.

Methods

This secondary analysis used data from a multicenter cross-sectional study conducted between December 2024 and February 2025 among adults with hypertension recruited from four referral hospitals in the SAVA Region, Madagascar. Socioeconomic characteristics and history of cardiovascular events were collected using the World Health Organization STEPwise questionnaire. Psychosocial factors were assessed using validated instruments, including the 10-item Perceived Stress Scale (PSS-10), the Hospital Anxiety and Depression Scale (HADS), the 6-item Lubben Social Network Scale (LSNS-6), the 6-item De Jong Gierveld Loneliness Scale, and the 6-item Social Support Questionnaire (SSQ6). Bivariate analyses and multivariable logistic regression were performed using SPSS version 25.0. Statistical significance was set at $p < 0.05$.

Results

A total of 394 adults with hypertension were included. The mean age was 53.03 ± 14.3 years, and 57.6% were women. Overall, 31.47% reported a history of cardiovascular events. In bivariate analyses, perceived stress, anxiety, depression, anxiety-depressive disorders, social isolation, and social support were significantly associated with a history of cardiovascular events. After adjustment for potential confounders, perceived stress, anxiety, and anxiety-depressive disorders remained significantly associated with a history of cardiovascular events.

Conclusions

Perceived stress, anxiety, and anxiety-depressive disorders remained associated with a history of cardiovascular events after adjustment for major cardiovascular risk factors. These findings support the potential value of incorporating psychosocial assessment into the comprehensive care of adults with hypertension.

Background

Cardiovascular diseases are among the leading causes of morbidity and mortality worldwide, and hypertension remains one of their most important modifiable risk factors [1, 2]. In low- and middle-income countries, the epidemiological transition is accompanied by a progressive increase in noncommunicable diseases, while access to healthcare often remains limited [3, 4]. In sub-Saharan Africa, hypertension represents a major public health challenge because of its high prevalence, frequent late diagnosis, and substantial contribution to stroke, ischemic heart disease, and heart failure [5, 6]. Beyond traditional cardiovascular risk factors, psychosocial factors are increasingly recognized as important determinants of cardiovascular health. Chronic stress, anxiety, depression, and anxiety-depressive disorders may contribute to cardiovascular vulnerability through neuroendocrine, inflammatory, and behavioral mechanisms [7–10]. Similarly, social isolation, loneliness, and low social support have been associated with an increased risk of coronary heart disease, stroke, and cardiovascular mortality [11, 12]. Social factors, such as low educational attainment, limited income, employment insecurity, and certain marital circumstances, may also influence exposure to stress and adverse health behaviors [13–15]. In Africa, several studies have reported a high prevalence of anxiety and depressive symptoms among patients with hypertension, with greater vulnerability among those with comorbidities, low social support, or unfavorable socioeconomic conditions [16, 17]. However, findings from available African studies are heterogeneous and difficult to compare directly, and studies simultaneously examining psychological, social, and cardiovascular dimensions remain limited. In Madagascar, data on the relationships between psychological factors, social vulnerability, and cardiovascular events remain scarce, particularly in the SAVA Region, where socioeconomic constraints, distance from healthcare facilities, dependence on the vanilla economy, income instability, and exposure to environmental stressors may increase the vulnerability of patients with hypertension [18–20]. In this context, psychosocial factors may act as additional determinants of cardiovascular risk in interaction with traditional biological and behavioral factors. The present study was based on the hypothesis that adverse psychosocial factors are associated with a history of cardiovascular events among adults with hypertension in the SAVA Region, independently of major traditional cardiovascular risk factors. The objectives were to identify psychosocial factors associated with a history of cardiovascular events in the study population and to assess whether these associations persisted independently of major traditional cardiovascular risk factors.

Methods

Study design and population

This study was a secondary analysis of data from a multicenter cross-sectional study conducted from 1 December 2024 to 28 February 2025 in the internal medicine departments of the four District Referral Hospitals in the SAVA Region of Madagascar, namely Sambava, Antalaha, Vohémar, and Andapa. Although this dataset had previously been used in a publication examining psychosocial factors associated with overall cardiovascular risk [21], the present study involved a distinct analysis specifically focused on the association between psychosocial distress and a history of cardiovascular events. The study population consisted of adults with hypertension who were either attending outpatient

consultations or hospitalized in one of these four facilities. Patients with previously known hypertension or hypertension diagnosed at the time of consultation according to World Health Organization (WHO) criteria were eligible, with or without a history of cardiovascular events. The primary outcome was a history of cardiovascular events, defined as a previous coronary or cerebrovascular event. **Inclusion criteria** Participants were eligible if they were aged 18 years or older, had resided in the SAVA Region for at least 24 months, were attending outpatient consultations or hospitalized in one of the four District Referral Hospitals of Sambava, Antalaha, Vohémar, or Andapa, and had either known hypertension or hypertension diagnosed during the consultation according to WHO criteria, with or without a history of cardiovascular events. **Exclusion criteria** Patients with missing essential data that prevented analysis of the variables required for the study were excluded.

Data collection instruments Data were collected using a survey form developed from the WHO STEPwise approach to noncommunicable disease risk factor surveillance. Information collected included sociodemographic characteristics, substance use and dietary habits, physical activity, personal and family medical history, and clinical and laboratory parameters. Psychosocial factors were assessed using five standardized questionnaires. Assistance was provided to participants with low educational attainment to facilitate understanding of the items and completion of the questionnaires. Perceived stress was assessed using the 10-item Perceived Stress Scale (PSS-10), adapted from Cohen and Williamson [22]. A score greater than 27 indicated a high level of perceived stress. Anxiety and depression were assessed using the Hospital Anxiety and Depression Scale (HADS) developed by Zigmond and Snaith [23]. This scale consists of 14 items divided into two 7-item subscales, one assessing anxiety and the other depression. A score greater than 11 on either subscale indicated a clinically significant anxiety or depressive disorder, respectively. According to the interpretation proposed by Ibbotson [24], the total HADS score ranges from 0 to 42, and a score greater than 15 indicates the presence of anxiety-depressive symptoms. Social network was assessed using the 6-item Lubben Social Network Scale (LSNS-6) [25, 26]. A score below 12 indicated a limited social network. Loneliness was assessed using the 6-item De Jong Gierveld Loneliness Scale [27–29], which includes three items on emotional loneliness and three on social loneliness. A score of 5 or higher indicated a high level of loneliness. Perceived social support was assessed using the 6-item Social Support Questionnaire (SSQ6) developed by Irwin G. Sarason [30, 31]. Higher scores indicated greater perceived availability of social support and greater satisfaction with the support received. The questionnaires were translated into Malagasy and the local dialect and were subsequently pretested. Their reliability was assessed using Cronbach's alpha. **Statistical analysis** Data were entered and analyzed using SPSS version 25.0. Associations between psychosocial factors and a history of cardiovascular events were initially examined using bivariate analyses with the chi-square test. Variables showing a statistically significant association in bivariate analysis were subsequently included in multivariable analysis. To identify psychosocial factors independently associated with a history of cardiovascular events, binary logistic regression models were fitted. Because of conceptual overlap among the psychosocial factors, a separate model was constructed for each selected psychosocial variable rather than including all psychosocial variables simultaneously in a single model. Each model was adjusted for sex, age, duration

of known hypertension, diabetes, hypercholesterolemia, obesity, physical inactivity, smoking, and alcohol consumption. These adjustment variables were selected based on their clinical and epidemiological relevance as potential cardiovascular confounders. Before multivariable analysis, multicollinearity among explanatory variables was assessed using tolerance values and the variance inflation factor (VIF). Results were reported as adjusted odds ratios (aORs) with 95% confidence intervals (CIs). Statistical significance was set at $p < 0.05$. **Ethical considerations** The study received ethical approval from the Biomedical Research Ethics Committee (CERBM) of the Ministry of Public Health of Madagascar on 11 November 2024. Written informed consent was obtained from all participants before inclusion in the study. Confidentiality, anonymity, and data protection were maintained throughout the study.

Results

General characteristics and psychosocial profile of adults with hypertension A total of 394 adults with hypertension, aged 20 to 95 years, who were attending outpatient consultations or hospitalized in the four District Referral Hospitals of the SAVA Region were included in the analysis. The mean age was 53.03 ± 14.3 years, and women accounted for 57.6% of the study population. Overall, 36.8% were unmarried, 52.5% had a low educational level, 49.0% were in precarious employment, and 70.8% had a monthly income below 400,000 ariary. The sociodemographic and psychosocial characteristics of the participants by sex are presented in Table 1. Psychosocial assessment showed a substantial burden of psychological and social vulnerability: 66.0% of participants had moderate perceived stress and 18.8% had high perceived stress; 37.6% had a clinically significant anxiety disorder, 32.0% had a clinically significant depressive disorder, and 76.6% had anxiety-depressive symptoms. Regarding social relationships, 34.0% had social isolation, 45.4% reported high levels of loneliness, and 24.6% reported low social support.

Table 1
Sociodemographic and psychosocial characteristics of adults with hypertension by sex

Characteristic	Men n (%)	Women n (%)	Total n (%)
Unmarried	50 (12.8)	95 (24.1)	145 (36.8)
Low educational level	90 (22.8)	117 (29.7)	207 (52.5)
Precarious employment	74 (18.8)	119 (30.2)	193 (49.0)
Unemployed	23 (5.82)	46 (11.66)	69 (17.48)
Monthly income < 400,000 Ar	111 (28.2)	168 (42.6)	279 (70.8)
High perceived stress	39 (9.9)	35 (8.88)	74 (18.78)
Clinically significant anxiety disorder	64 (16.24)	84 (21.32)	148 (37.56)
Clinically significant depressive disorder	63 (15.99)	63 (15.99)	126 (31.98)
Anxiety-depressive symptoms	141 (35.79)	161 (40.86)	302 (76.65)
Social isolation	51 (12.94)	83 (21.07)	134 (34.01)
Low social support	47 (11.9)	50 (12.7)	97 (24.6)
High loneliness	75 (19.04)	104 (26.4)	179 (45.43)

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ariary. Percentages were calculated using the total study population as the denominator (N = 394). Psychosocial categories were defined according to the cut-off values of the standardized scales used in the study.

History of cardiovascular events Among the 394 adults with hypertension included in the study, 124 (31.47%) had a history of at least one cardiovascular event. Cerebrovascular events were reported in 16.8% of participants and coronary events in 14.7%. These proportions were broadly similar in men and women. The most frequently reported events were angina pectoris and transient ischemic attack (TIA), each occurring in 10.91% of participants. Stroke was reported in 5.84% of participants, whereas myocardial infarction was reported in 3.81%. The distribution of coronary and cerebrovascular events by sex is presented in Table 2.

Table 2
Distribution of cerebrovascular and coronary events by sex

Event	Men n (%)	Women n (%)	Total n (%)
Cerebrovascular events	32 (8.10)	34 (8.60)	66 (16.80)
Stroke	7 (1.78)	16 (4.06)	23 (5.84)
Transient ischemic attack (TIA)	25 (6.35)	18 (4.57)	43 (10.91)
Coronary events	28 (7.10)	30 (7.60)	58 (14.70)
Myocardial infarction	6 (1.52)	9 (2.28)	15 (3.81)
Angina pectoris	22 (5.58)	21 (5.33)	43 (10.91)

Percentages were calculated using the total study population as the denominator (N = 394).

Bivariate analysis of psychosocial factors associated with a history of cardiovascular events In bivariate analysis, a history of cardiovascular events was significantly associated with several psychosocial dimensions. The proportion of participants with a history of cardiovascular events increased with perceived stress level, from 11.7% among those with low stress to 37.8% among those with high stress ($p = 0.001$). A similar pattern was observed for anxiety, with 43.2% of participants with clinically significant anxiety reporting a history of cardiovascular events, compared with 22.7% of those without anxiety symptoms ($p < 0.001$). A history of cardiovascular events was also more frequent among participants with clinically significant depressive symptoms (40.5%; $p = 0.023$) and among those with anxiety-depressive symptoms (35.1%; $p = 0.005$). Social isolation was also significantly associated with a history of cardiovascular events, which was reported in 40.3% of socially isolated participants compared with 26.9% of those without social isolation ($p = 0.007$). Social support was also significantly associated with a history of cardiovascular events ($p = 0.042$). In contrast, no statistically significant associations were found with loneliness, marital status, educational level, employment status, or monthly income. The results of the bivariate analyses are presented in Tables 3 and 4.

Table 3

Bivariate analysis of psychological factors associated with a history of cardiovascular events

Variable	No history of CV event n (%)	History of CV event n (%)	Crude OR (95% CI)	Overall p-value
Perceived stress				0.001
Low stress	53 (88.3)	7 (11.7)	1.00 (Ref.)	
Moderate stress	171 (65.8)	89 (34.2)	3.94 (1.72–9.03)	
High stress	46 (62.2)	28 (37.8)	4.61 (1.84–11.54)	
Anxiety status				< 0.001
No anxiety symptoms	102 (77.3)	30 (22.7)	1.00 (Ref.)	
Mild anxiety symptoms	84 (73.7)	30 (26.3)	1.21 (0.68–2.18)	
Clinically significant anxiety	84 (56.8)	64 (43.2)	2.59 (1.54–4.36)	
Depressive status				0.023
No depressive symptoms	91 (75.2)	30 (24.8)	1.00 (Ref.)	
Mild depressive symptoms	104 (70.7)	43 (29.3)	1.25 (0.73–2.16)	
Clinically significant depressive symptoms	75 (59.5)	51 (40.5)	2.06 (1.20–3.56)	
Anxiety-depressive status				0.005
No anxiety-depressive symptoms	74 (80.4)	18 (19.6)	1.00 (Ref.)	
Anxiety-depressive symptoms	196 (64.9)	106 (35.1)	2.22 (1.26–3.92)	

Table 4

Bivariate analysis of social and sociodemographic factors associated with a history of cardiovascular events

Variable	No history of CV event n (%)	History of CV event n (%)	Crude OR (95% CI)	Overall p-value
Social isolation				0.007
No social isolation	190 (73.1)	70 (26.9)	1.00 (Ref.)	
Social isolation	80 (59.7)	54 (40.3)	1.83 (1.18–2.85)	
Social support				0.042
High social support	95 (64.6)	52 (35.4)	1.00 (Ref.)	
Moderate social support	114 (76.0)	36 (24.0)	0.58 (0.35–0.96)	
Low social support	61 (62.9)	36 (37.1)	1.08 (0.63–1.84)	
Loneliness				0.098
No loneliness	28 (70.0)	12 (30.0)	1.00 (Ref.)	
Moderate loneliness	129 (73.7)	46 (26.3)	0.83 (0.39–1.77)	
High loneliness	113 (63.1)	66 (36.9)	1.36 (0.65–2.86)	
Marital status				0.227
Stable relationship	176 (70.7)	73 (29.3)	1.00 (Ref.)	
Unmarried	94 (64.8)	51 (35.2)	1.31 (0.85–2.02)	
Educational level				0.574
High	27 (71.1)	11 (28.9)	1.00 (Ref.)	
Intermediate	106 (71.1)	43 (28.9)	1.00 (0.45–2.18)	
Low	137 (66.2)	70 (33.8)	1.25 (0.59–2.68)	
Employment status				0.281
Stable employment	88 (66.7)	44 (33.3)	1.00 (Ref.)	
Precarious employment	139 (72.0)	54 (28.0)	0.78 (0.48–1.26)	

Variable	No history of CV event n (%)	History of CV event n (%)	Crude OR (95% CI)	Overall p-value
Social isolation				0.007
Unemployed	43 (62.3)	26 (37.7)	1.21 (0.66–2.22)	
Monthly income				0.503
≥ 400,000 Ar	76 (66.1)	39 (33.9)	1.00 (Ref.)	
< 400,000 Ar	194 (69.5)	85 (30.5)	0.85 (0.54–1.36)	

Crude OR: unadjusted odds ratio; **95% CI:** 95% confidence interval; **Ref.:** reference category. The reported ORs are crude odds ratios. The overall p-value corresponds to the chi-square test assessing the association between each variable and a history of cardiovascular events. A p-value < 0.05 was considered statistically significant.

Multivariable binary logistic regression analysis of psychosocial factors associated with a history of cardiovascular events

The assessment of multicollinearity performed before the multivariable analysis did not identify any substantial collinearity among the explanatory variables. Tolerance values ranged from 0.392 to 0.868, and variance inflation factor (VIF) values ranged from 1.152 to 2.548, indicating no major instability in the regression coefficients. In the multivariable analysis, several psychosocial dimensions remained associated with a history of cardiovascular events. The results are presented in Table 5.

Table 5

Binary logistic regression analysis of psychosocial factors associated with a history of cardiovascular events

Psychosocial factor	Comparison	Adjusted OR	95% CI	p-value	Overall p-value
Perceived stress	Low stress vs high perceived stress	0.261	0.097–0.702	0.008	0.009
	Moderate stress vs high perceived stress	1.016	0.559–1.846	0.959	
Anxiety status	No anxiety symptoms vs clinically significant anxiety	0.404	0.229–0.712	0.002	0.005
	Mild anxiety symptoms vs clinically significant anxiety	0.549	0.309–0.974	0.040	
Depressive status	No depressive symptoms vs clinically significant depressive symptoms	0.608	0.334–1.106	0.103	0.245
	Mild depressive symptoms vs clinically significant depressive symptoms	0.728	0.418–1.267	0.261	
Anxiety-depressive status	No anxiety-depressive symptoms vs anxiety-depressive symptoms	0.483	0.261–0.892	0.020	0.020
Social support	Low social support vs high social support	1.313	0.718–2.402	0.377	0.094
	Moderate social support vs high social support	0.675	0.390–1.170	0.162	
Social isolation	No social isolation vs social isolation	0.695	0.426–1.133	0.144	0.144

aOR: adjusted odds ratio; **95% CI**: 95% confidence interval; **p-value**: statistical significance associated with each comparison; **overall p-value**: overall statistical significance of the psychosocial factor in the logistic regression model.

Each psychosocial factor was analyzed in a separate model adjusted for sex, age, duration of known hypertension, diabetes, hypercholesterolemia, obesity, physical inactivity, smoking, and alcohol consumption. Reference categories corresponded to the most unfavorable or clinically relevant categories according to the SPSS coding scheme. A p-value < 0.05 was considered statistically significant.

Perceived stress remained significantly associated with a history of cardiovascular events after adjustment (overall p = 0.009). Compared with participants with high perceived stress, those with low perceived stress had significantly lower odds of having a history of cardiovascular events (aOR = 0.261;

95% CI: 0.097–0.702; $p = 0.008$). In contrast, no statistically significant difference was observed between participants with moderate perceived stress and those with high perceived stress (aOR = 1.016; 95% CI: 0.559–1.846; $p = 0.959$). Anxiety also remained significantly associated with a history of cardiovascular events in the adjusted model (overall $p = 0.005$). Compared with participants with clinically significant anxiety, those without anxiety symptoms had significantly lower odds of having a history of cardiovascular events (aOR = 0.404; 95% CI: 0.229–0.712; $p = 0.002$). A similar association was observed among participants with mild anxiety symptoms (aOR = 0.549; 95% CI: 0.309–0.974; $p = 0.040$). Anxiety-depressive symptoms also remained significantly associated with a history of cardiovascular events (overall $p = 0.020$). Participants without anxiety-depressive symptoms had significantly lower odds of having a history of cardiovascular events compared with those with anxiety-depressive symptoms (aOR = 0.483; 95% CI: 0.261–0.892; $p = 0.020$). Depressive symptoms (overall $p = 0.245$), social support (overall $p = 0.094$), and social isolation (overall $p = 0.144$) were no longer significantly associated with a history of cardiovascular events after adjustment.

Discussion

History of cardiovascular events In this study, nearly one-third of participants had a history of cardiovascular events, indicating a substantial cardiovascular burden in this population. This high proportion is consistent with the major role of hypertension in the development of stroke, ischemic heart disease, and other cardiovascular complications [1, 2]. The World Health Organization has emphasized that hypertension is a major contributor to myocardial infarction, stroke, and premature mortality. Angina pectoris and transient ischemic attack (TIA) were the most frequently reported events, followed by stroke and myocardial infarction. This distribution indicates that both coronary and cerebrovascular events were represented in the study population. The relatively high proportion of participants reporting a history of TIA may reflect the presence of early cerebrovascular manifestations that can be underrecognized but remain clinically important because of their association with subsequent, more severe vascular events.

Factors associated with a history of cardiovascular events in the study population In bivariate analysis, a history of cardiovascular events was more frequent among participants with greater psychosocial vulnerability. These findings suggest that psychological and relational dimensions may be more closely associated with a history of cardiovascular events than structural social determinants considered in isolation. The observed association between perceived stress and a history of cardiovascular events is consistent with international evidence. The INTERHEART study showed that psychosocial factors were associated with the risk of myocardial infarction across several regions of the world [7]. More recent studies also suggest that chronic stress may contribute to cardiovascular disease through neuroendocrine activation, sympathetic hyperactivity, inflammation, blood pressure dysregulation, and adverse health behaviors [32]. In the SAVA Region, this association may be interpreted in light of the local context, characterized by economic vulnerability, income instability linked to the vanilla economy, and exposure to climatic shocks, all of which may contribute to chronic stress among adults with hypertension [18, 20]. Anxiety, depression, and anxiety-depressive symptoms were also associated with

a history of cardiovascular events. This finding is consistent with international meta-analyses showing that anxiety and depression are associated with an increased risk of coronary heart disease and stroke [8, 9, 33]. An African systematic review reported a high burden of depressive disorders among people living with hypertension, while a multicenter study conducted in Ethiopia found a high prevalence of anxiety and depression among patients with hypertension attending outpatient care [16, 17]. In our context, these findings support the hypothesis that psychological distress may represent an important component of cardiovascular vulnerability among adults with hypertension. Regarding social relationships, social isolation and social support were significantly associated with a history of cardiovascular events. This finding is consistent with previous studies showing that social isolation, loneliness, and low social support are associated with an increased risk of coronary heart disease and stroke [11, 12]. Low social support may influence cardiovascular vulnerability through several pathways, including poorer treatment adherence, delayed healthcare-seeking, chronic stress, and adverse health behaviors. In Madagascar, socioeconomic disadvantage may also contribute to greater social vulnerability among people living with chronic diseases. However, this interpretation should remain cautious because the present study was not designed to directly assess the mechanisms linking socioeconomic conditions and social networks. The absence of a statistically significant association with loneliness should be interpreted in light of its subjective nature, which differs from objective social isolation. Loneliness depends on the perceived quality of social relationships, cultural norms, and individual expectations. Thus, an individual may have a limited social network without feeling lonely, or may experience loneliness despite the presence of close relationships. Previous studies have shown that loneliness is associated with cardiovascular risk, although the magnitude of this association varies across populations, measurement instruments, and sociocultural contexts [11, 12]. The high prevalence of moderate or high loneliness observed in this study may have reduced the ability of this variable to discriminate between participants with and without a history of cardiovascular events. Finally, marital status, educational level, employment status, and monthly income were not significantly associated with a history of cardiovascular events in bivariate analysis. This finding does not necessarily indicate the absence of an effect of socioeconomic determinants. International studies have shown that low educational attainment and limited income are associated with adverse cardiovascular outcomes, although these associations may operate indirectly through access to healthcare, health behaviors, blood pressure control, exposure to stress, and comorbidities [13]. Similarly, marital status has been associated with cardiovascular risk in several studies, but this relationship may vary according to sex, age, cultural context, and the quality of spousal support [14]. In the SAVA Region, the relative socioeconomic homogeneity of the hospital-based study population, the simplified categorization of social variables, and the potential influence of psychological factors may have contributed to the absence of statistically significant associations.

Factors independently associated with a history of cardiovascular events in the study population After adjustment, perceived stress, anxiety, and anxiety-depressive symptoms remained associated with a history of cardiovascular events. These findings suggest that these psychological dimensions may be associated with cardiovascular vulnerability independently of major traditional cardiovascular risk

factors. The observed association between perceived stress and a history of cardiovascular events is consistent with the findings of the INTERHEART study, which demonstrated an association between psychosocial factors and myocardial infarction across diverse geographical and socioeconomic settings [7]. More recent studies suggest that chronic stress may contribute to cardiovascular vulnerability through several neurobiological mechanisms, including neuroendocrine activation, sympathetic hyperactivity, inflammation, and blood pressure dysregulation [32]. Behavioral factors may also contribute, including poorer treatment adherence, reduced physical activity, smoking, unhealthy dietary habits, and delayed healthcare-seeking, all of which may increase cardiovascular risk among adults with hypertension. In the SAVA Region, this association may be interpreted in the context of socioeconomic vulnerability, income instability, dependence on the vanilla economy, and exposure to climatic shocks [18, 20]. These conditions may contribute to prolonged exposure to stress among adults with hypertension. Anxiety also remained associated with a history of cardiovascular events after adjustment. This finding is consistent with meta-analyses showing that anxiety is associated with cardiovascular disease and coronary events [8]. In Africa, anxiety and depressive symptoms are frequently reported among patients with hypertension and may be related to the chronic nature of the disease, comorbidities, difficulties in accessing healthcare, and the financial burden of medical follow-up [16, 17]. In our study, the persistent association with anxiety suggests that this dimension may represent an important marker of cardiovascular vulnerability among adults with hypertension. Anxiety-depressive symptoms also remained significantly associated with a history of cardiovascular events, whereas depressive symptoms alone were no longer independently associated after adjustment. This difference may be explained by the fact that the combined anxiety-depressive measure reflects a broader dimension of emotional distress encompassing both anxiety and depressive symptoms. The literature describes a complex and bidirectional relationship between hypertension, anxiety, depression, and cardiovascular disease. Psychological distress may influence treatment adherence, blood pressure control, and health behaviors, whereas a cardiovascular event may, in turn, increase anxiety or depressive symptoms [9, 16, 17, 34]. The possibility of reverse causality should therefore be considered when interpreting these findings. The observed associations do not allow us to determine whether psychosocial distress preceded the cardiovascular event or whether it was, at least in part, a consequence of the event. In contrast, social support and social isolation were no longer significantly associated with a history of cardiovascular events after adjustment. However, this attenuation does not exclude a potential influence, which may operate indirectly through psychological stress, health behaviors, treatment adherence, access to healthcare, or cardiometabolic factors. International longitudinal studies have also shown that social isolation and loneliness are associated with an increased risk of coronary heart disease and stroke [11, 12]. The magnitude of these associations may nevertheless vary across populations, sociocultural contexts, and methods used to assess social relationships. These findings support the potential value of an integrated approach to cardiovascular prevention among adults with hypertension in the SAVA Region. Beyond the management of traditional cardiometabolic risk factors, care may also include the identification of psychological distress and social vulnerabilities. In this context, strengthening awareness of the relationships between chronic stress, mental health, and cardiovascular health, particularly at the community level, may also be relevant. This

study contributes to addressing the limited evidence available in Madagascar on the relationship between psychosocial factors and a history of cardiovascular events among adults with hypertension. It provides original data on these associations in the SAVA Region. Further qualitative and multicenter longitudinal studies are needed to better clarify the independent, mediating, and prognostic roles of psychosocial factors in the cardiovascular trajectories of Malagasy adults with hypertension.

Strengths and limitations The main strengths of this study include its multicenter design, its originality in a context where evidence from Madagascar remains limited, the use of standardized assessment tools, and the evaluation of multiple psychosocial dimensions among adults with hypertension. The main limitations relate to the cross-sectional design, which precludes establishing causal relationships or determining the temporal direction between psychosocial distress and cardiovascular events, and to the hospital-based recruitment, which may limit the generalizability of the findings to the broader population of adults with hypertension in the SAVA Region. Reporting and recall biases cannot be excluded, particularly with regard to the history of cardiovascular events and psychosocial variables. In addition, although the psychosocial assessment tools were translated, pretested, and subjected to reliability testing, potential linguistic and sociocultural differences in the interpretation of individual items may remain. These differences may have influenced the assessment of subjective dimensions such as perceived stress, loneliness, and social support.

Conclusion

This study identified a substantial prevalence of a history of cardiovascular events among adults with hypertension. Coronary and cerebrovascular events represented an important burden in this population, highlighting the cardiovascular impact of hypertension. Several psychosocial dimensions, particularly perceived stress, anxiety, and anxiety-depressive symptoms, remained associated with a history of cardiovascular events after adjustment. These findings suggest that psychological distress, especially stress and anxiety, may represent an important marker of cardiovascular vulnerability among adults with hypertension. In the SAVA Region, where socioeconomic constraints, limited access to healthcare, and chronic sources of stress may affect people living with hypertension, these findings support a more integrated approach to cardiovascular prevention. The management of adults with hypertension should therefore not be limited to the control of traditional cardiometabolic risk factors but may also benefit from the identification and assessment of psychosocial distress. However, given the cross-sectional design of this study, longitudinal, community-based, and multicenter studies are needed to better clarify the role of psychosocial factors in the development and progression of cardiovascular events among adults with hypertension in Madagascar.

Abbreviations

aOR

Adjusted Odds Ratio

AP

Angina Pectoris

CHRD

District Referral Hospital

CI

Confidence Interval

CVR

Cardiovascular Risk

EDNES

Doctoral School of Nutrition, Environment and Health

HADS

Hospital Anxiety and Depression Scale

HTN

Hypertension

IOSTM

Institute of Tropical Odonto-Stomatology of Madagascar

LabEBSP

Laboratory of Epidemiology and Biostatistics in Population Health

LSNS-6

6-item Lubben Social Network Scale

MI

Myocardial Infarction

OR

Odds Ratio

PSS-10

10-item Perceived Stress Scale

SPSS

Statistical Package for the Social Sciences

SSQ6

6-item Social Support Questionnaire

STEPwise

STEPwise Approach to Noncommunicable Disease Risk Factor Surveillance

TIA

Transient Ischemic Attack

VIF

Variance Inflation Factor

WHO

World Health Organization

Declarations

Ethics approval and consent to participate This study was conducted in accordance with the ethical principles of the Declaration of Helsinki and applicable national regulations. Ethical approval was obtained from the Biomedical Research Ethics Committee (CERBM) of the Ministry of Public Health of Madagascar on 11 November 2024 (Committee registration number: IORG00001212; Ethical approval reference: No. 158 MSANP/SG/AMM/CERBM). Written informed consent was obtained from all participants before their inclusion in the study. Confidentiality, anonymity, and protection of the collected data were maintained throughout the study.

Clinical trial registration Clinical trial number: not applicable.

Consent for publication Not applicable. This manuscript does not contain any identifiable personal data, images, videos, or information that could allow the identification of individual participants. **Availability of data and materials** The datasets supporting the conclusions of this article are not publicly available due to confidentiality requirements related to patient data. However, anonymised data may be obtained from the corresponding author upon reasonable request, subject to compliance with applicable ethical and institutional requirements. **Competing interests** The authors declare that they have no financial or non-financial competing interests related to this manuscript. **Funding** This research received no specific funding from any public, commercial, or non-profit organization. **Authors' contributions** **RJM** designed the study, developed the protocol, participated in data collection, performed the statistical analysis, interpreted the results, and drafted the different versions of the manuscript. **EHCC** contributed to data analysis and interpretation, provided scientific supervision, and critically revised the manuscript. **RN** supervised the scientific aspects of the study, provided doctoral research supervision, and critically reviewed the manuscript. All authors read and approved the final version of the manuscript and accept responsibility for the scientific integrity of the work. **Acknowledgements** We thank the administrative authorities and the staff of the four District Referral Hospitals in Sambava, Antalaha, Vohémar, and Andapa for their collaboration and contribution to the implementation of this study. We also thank all participants who agreed to take part in this research. Finally, we would like to express our gratitude to the Doctoral School of Nutrition, Environment and Health (EDNES) of the University of Mahajanga for its scientific support throughout this doctoral work.

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