Research Square

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Depressive and Anxiety symptoms are linked to self-reported hypertension among African women: evidence from Mozambique

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Abstract

Background

Mental health disorders and hypertension are increasingly recognised as major global public health concerns. Women of reproductive age may be particularly vulnerable to these conditions due to hormonal fluctuations, pregnancy-related disorders, gendered social expectations, and exposure to intimate partner violence. However, evidence on the relationship between mental health symptoms and hypertension among women of reproductive age in sub-Saharan Africa remains scarce, particularly in Mozambique. This study examined the association between depressive and anxiety symptoms and self-reported hypertension among Mozambican women aged 15–49 years.

Methods

We analysed nationally representative data from the 2022–2023 Mozambique Demographic and Health Survey. A weighted sample of 6,678 women aged 15–49 years who had ever had their blood pressure measured were included. Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9; range: 0–27) and anxiety symptoms using the Generalised Anxiety Disorder-7 scale (GAD-7; range: 0–21). The primary outcome was self-reported hypertension. Both PHQ-9 and GAD-7 scores were modelled as continuous variables. Modified Poisson regression models with robust variance estimates were fitted to estimate crude and adjusted prevalence ratios (aPRs) with 95% confidence intervals (CIs).

Results

The weighted prevalence of self-reported hypertension was 8.63% (95% CI: 7.74–9.62). The mean depressive symptom score was 3.31 (SD = 4.71; 95% CI: 3.08–3.54) and the mean anxiety symptom score was 3.43 (SD = 4.23; 95% CI: 3.22–3.63). In fully adjusted models, each one-unit increase in depression score was associated with a 3.2% higher prevalence of hypertension (aPR = 1.032, 95% CI: 1.001–1.064, p = 0.040). Similarly, each one-unit increase in anxiety score was associated with a 3.4% higher prevalence of hypertension (aPR = 1.034, 95% CI: 1.000–1.069, p = 0.047). Older age, higher education, greater household wealth, current employment, higher parity, non-hormonal contraceptive use, and substantial regional variations were significantly associated with higher hypertension prevalence.

Conclusions

Depressive and anxiety symptoms are independently associated with self-reported hypertension among reproductive-aged women in Mozambique. Integrating routine screening for depression and anxiety into hypertension care would be crucial for early detection, comprehensive management, and improving the health and overall wellbeing of women in Mozambique.

Background

Cardiovascular diseases, including hypertension, account for the highest proportion of non-communicable disease (NCD) -related deaths globally. These diseases contributed to approximately 19 million deaths in 2021 (WHO, 2024). As of 2024, an estimated 1.4 billion adults worldwide were living with hypertension, with two-thirds residing in low- and middle-income countries (LMICs) (WHO, 2024). In sub-Saharan Africa (SSA), the prevalence of hypertension is increasing rapidly. Between 2000 and 2010, the number of adults affected rose by 41% (93.2 million) to 66% (130.2 million), with projections estimating 216.8 million cases by 2030 (Adeloye & Basquill, 2014). A cross-sectional survey across four SSA countries reported a hypertension prevalence of 25.4% among participants aged 18 years and above, with approximately half on antihypertensive medication and only 47% of those achieving adequate blood pressure control (Odili et al., 2020).

Hypertension exerts particularly detrimental effects on women's reproductive health by reducing libido, causing genital pain, and increasing risks of pregnancy complications such as pre-eclampsia, haemorrhage, and maternal mortality (Navaneethabalakrishnan et al., 2020; Nobles et al., 2024). Moreover, maternal hypertension contributes to adverse foetal outcomes including growth restriction and long-term neurodevelopmental deficits (Mateus et al., 2019; Wang et al., 2021).

The risk factors for hypertension span across sociodemographic, lifestyle, and behavioural domains. Prior studies have established significant associations with older age, overweight or obesity, physical inactivity, high intake of salt and alcohol, and comorbid conditions such as diabetes and chronic kidney disease (Mills et al., 2020). Beyond these traditional risk factors, psychological disorders, particularly depression and anxiety, are gaining recognition as potential contributors to hypertension (Meng et al., 2012; Rubio-Guerra et al., 2013).

However, the evidence regarding the relationship between depression, anxiety, and hypertension remains inconsistent. Studies conducted predominantly in high-income countries have reported positive, inverse, or null associations (Licht et al., 2009; Meng et al., 2012). In SSA, only a limited number of studies have explored this relationship. For example, a health facility-based cross-sectional study in Nigeria found that depression increased the risk of uncontrolled hypertension after adjusting for demographic and lifestyle factors (Amaike et al., 2024). Additional studies in Ghana, Nigeria, and Ethiopia reported high prevalence of depression and anxiety among persons with hypertension but did not formally examine the strength or independence of these associations (Kretchy et al., 2014; Ademola et al., 2019).

In Mozambique, a prior analysis of the 2022–2023 DHS found that approximately 10% and 11% of women of reproductive age reported depressive and anxiety symptoms, respectively, with significant predictors including older age, skilled occupation, and pregnancy (Anaba et al., 2025). A related study revealed that Mozambican women were approximately twice as likely to report severe depression and anxiety compared to men (Antabe et al., 2025). Regarding hypertension, a multi-country study found that Mozambican women of reproductive age had the highest prevalence of hypertension among the countries examined after adjusting for sociodemographic factors (Porth et al., 2024). Women's

vulnerability to both hypertension and psychological disorders is further compounded by hormonal changes, increased risk of overweight and obesity, pregnancy-related complications, gendered social expectations, and exposure to intimate partner violence (Fisher et al., 2012; Leff-Gelman et al., 2024).

Despite the elevated risk of both psychological disorders and hypertension among Mozambican women, population-level, gender-sensitive analyses remain scarce. Understanding how mental health intersects with hypertension, particularly among women of reproductive age, has critical implications for maternal health and chronic disease prevention and management. Historically, these conditions have been managed separately within health systems, representing a missed opportunity for integrated care and early detection. Therefore, this study sought to assess the association between depressive and anxiety symptoms and self-reported hypertension among women of reproductive age in Mozambique. The rising burden of mental health disorders and chronic diseases, coupled with ongoing health system reforms in Mozambique, makes these findings both timely and relevant. The results have the potential to inform integrated care strategies and shape policy interventions aimed at improving the holistic health and wellbeing of women, contributing to achieving the Sustainable Development Goal targets related to health (SDG 3), gender equality (SDG 5), and reduced inequalities (SDG 10).

Materials and Methods

Data Source and Study Design

We analysed data from the 2022–2023 Mozambique Demographic and Health Survey (MDHS), a nationally representative, household-based, cross-sectional survey conducted across all 11 administrative provinces of Mozambique. Mozambique is a lower-middle-income country located along the Indian Ocean in Southeast Africa, with an estimated population exceeding 34.77 million, of whom approximately 17 million are female. The 2022–2023 MDHS collected comprehensive data on demographic and health indicators, including hypertension, depressive symptoms, and anxiety symptoms (INE & ICF, 2024).

Target Population and Sampling

This analysis focused on women of reproductive age (15–49 years) residing in both rural and urban areas. The MDHS employed a two-stage stratified cluster sampling design. In the first stage, 619 enumeration areas (clusters) were selected from a national sampling frame with probability proportional to size. In the second stage, a fixed number of households were systematically selected within each cluster. All women aged 15–49 years who were either permanent residents or visitors in selected households on the night preceding the survey were eligible for interview. A total of 13,183 women completed the individual women's questionnaire. This analysis was restricted to women who had ever had their blood pressure measured and who provided a valid response on self-reported hypertension

status, yielding a final weighted analytical sample of 6,678 women. Women with missing data on the outcome variable (n = 6,495) were excluded.

Outcome Variable

The primary outcome was self-reported hypertension, derived from two sequential survey questions. First, participants were asked whether they had ever had their blood pressure measured by a doctor or other healthcare workers (Yes/No/Don't know). Among those reporting a prior measurement, a follow-up question asked: "Have you ever been told that you have high blood pressure or hypertension?" (Yes = 1, No = 0). Responses were recoded as a binary variable (1 = ever diagnosed with hypertension; 0 = never diagnosed). It should be noted that the MDHS captures awareness-based (self-reported) hypertension prevalence rather than clinical prevalence based on blood pressure measurement and is therefore subject to potential recall and social desirability biases.

Exposure Variables

The primary exposure variables were depressive and anxiety symptom scores, measured using the Patient Health Questionnaire-9 (PHQ-9) and the Generalised Anxiety Disorder-7 (GAD-7) scale, respectively. The PHQ-9 comprises nine items with total scores ranging from 0 to 27, while the GAD-7 comprises seven items with total scores ranging from 0 to 21. Each item is scored on a four-point Likert scale (0 = never; 1 = rarely; 2 = often; 3 = always) based on symptom frequency over the preceding two weeks. Higher scores indicate greater severity of depressive or anxiety symptoms (Kroenke et al., 2001; Spitzer et al., 2006). Both PHQ-9 and GAD-7 scores were modelled as continuous variables in the regression analyses to preserve the full distribution of symptom severity and maximise statistical power.

Covariates

Covariates were selected a priori based on prior literature on the determinants of hypertension in SSA and theoretical frameworks linking sociodemographic, reproductive, and behavioural factors to cardiovascular outcomes (Mills et al., 2020; Adeloye & Basquill, 2014). Sociodemographic covariates included: age in 5-year groups (15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49); current marital status (married/cohabiting, divorced/widowed/separated, never married/single); region of residence (Niassa, Cabo Delgado, Nampula, Zambézia, Tete, Manica, Sofala, Inhambane, Gaza, Maputo province, Cidade de Maputo); highest educational level attained (no education, primary, secondary, higher); household wealth index quintile (poorest, poorer, middle, richer, richest); current employment status (yes/no); religion (Christianity, Islam, no religion/others); and type of place of residence (urban/rural). Reproductive health covariates included parity (no children, 1–4, 5–8, 9 or more children) and current contraceptive use (no method, hormonal, non-hormonal). Media exposure variables included frequency of reading newspapers or magazines, frequency of listening to radio, and frequency of watching television (each categorised as: not at all, less than once a week, at least once a week). These media

variables were included as proxies for health information access and hypertension awareness. Detailed variable descriptions are available in the MDHS final report (INE & ICF, 2024).

Statistical Analysis

All analyses were conducted using Stata/MP version 17.0 (StataCorp, College Station, TX, USA). The complex survey design, including clustering by primary sampling unit (PSU), stratification, and sampling weights, was accounted for throughout using the 'svyset' command and the 'svy' prefix in Stata. Descriptive statistics were computed for the total sample, including weighted frequencies, proportions, means, standard deviations (SDs), and 95% confidence intervals (CIs). The distribution of all participant characteristics was presented for the overall sample (Table 1). The proportion of women ever diagnosed with hypertension, along with proportions among non-hypertensive women, were estimated across all covariates with 95% CIs and design-based Pearson chi-squared p-values (Table 2). Mean depression and anxiety scores stratified by hypertension status were compared using adjusted Wald tests.

Modified Poisson regression with robust (sandwich) variance estimation was employed to estimate prevalence ratios (PRs), following the approach recommended by Zou (2004). This method was chosen because the prevalence of the outcome (~ 8.6%) was sufficiently high that logistic regression odds ratios would overestimate the true prevalence ratio. Two sequential models were fitted:

Model 1 (Crude/Unadjusted)

Each exposure variable and covariate was entered individually in separate Poisson regression models to estimate crude prevalence ratios (cPRs) with 95% CIs. This step identified the unadjusted magnitude and direction of each factor's association with self-reported hypertension.

Model 2 (Fully Adjusted): Both PHQ-9 and GAD-7 scores were entered simultaneously into a single Poisson regression model alongside all sociodemographic, reproductive, and media exposure covariates to estimate adjusted prevalence ratios (aPRs) with 95% CIs. The rationale for presenting both crude and adjusted models is to examine confounding: variables significant in crude models but attenuated in adjusted models indicate confounding, while variables that become significant only after adjustment indicate suppression (i.e., confounders were masking the true association).

Model diagnostics

Several diagnostic procedures were performed to ensure model robustness. First, potential multicollinearity between the PHQ-9 and GAD-7 scores, and among all covariates, was assessed using variance inflation factors (VIFs). The mean VIF across all covariates was 1.82, and no individual VIF exceeded 5, indicating acceptable collinearity levels. Although depressive and anxiety symptoms are correlated constructs, including both in the same model was justified by their distinct pathophysiological pathways to cardiovascular outcomes and the need to estimate independent effects. Second, overall model goodness-of-fit was evaluated using the F-statistic from the survey-adjusted Poisson model (F(42,

554) = 17.84, $p < 0.001$), indicating the model fitted the data significantly better than a null model. Third, the use of robust (sandwich) variance estimators inherently addresses potential overdispersion in Poisson models by providing consistent standard errors regardless of the true variance structure (Cameron & Trivedi, 2013). Fourth, influential observations were assessed through examination of deviance residuals and Cook's distance; no extreme outliers warranting exclusion were identified. All statistical tests were two-tailed, with statistical significance set at $p < 0.05$.

Handling of Missing Data

Of the 13,183 women who completed the individual women's questionnaire, 6,495 (49.3%) had missing data on the hypertension outcome variable, primarily because they had never had their blood pressure measured or responded, "Don't know." These women were excluded from the analytical sample. Among the remaining 6,688 women (6,678 weighted), there were no missing values on the exposure variables (PHQ-9 and GAD-7 scores) or any of the covariates included in the regression models. Thus, a complete-case analysis was performed on the final weighted sample of 6,678 women.

Ethical Considerations

The 2022–2023 MDHS protocol was reviewed and approved by the National Bioethics Committee for Health in Mozambique (CNBS) and the ICF Institutional Review Board. Written informed consent was obtained from all participants; for participants under 18 years of age, parental or guardian consent was obtained. Participation in the MDHS was voluntary. Ethical approval for this secondary analysis was not required, as the data are de-identified and publicly available. The dataset was accessed from the DHS Program website (https://dhsprogram.com) following official email authorisation.

Results

Participant Characteristics

Table 1 presents the weighted sociodemographic, reproductive, and media exposure characteristics of the analytical sample (N = 6,678). The largest age groups were 15–19 years (24.32%) and 20–24 years (19.67%), with the smallest proportion in the 45–49 age group (7.04%). Most women had attained primary (43.21%) or secondary (28.20%) education, while 26.02% had no formal education and 2.57% had higher education. The majority resided in rural areas (61.32%). Household wealth was distributed with the richest quintile comprising 25.33% and the poorest 17.35%. Approximately 30.85% of women were currently employed, and 64.31% were married or cohabiting; 22.45% had never married, and 13.24% were divorced, widowed, or separated. Christianity was the dominant religion (72.21%), followed by Islam (20.53%) and no religion or other affiliations (7.27%).

Regional distribution showed that Nampula (23.25%) and Zambézia (16.62%) accounted for the largest shares of respondents, while Inhambane (4.30%), Cabo Delgado (5.36%), Gaza (5.18%), and Cidade de Maputo (4.90%) contributed smaller proportions. Access to mass media was generally low: 91.51% never read newspapers, 66.89% never listened to the radio, and 63.11% never watched television. Only 17.72% listened to radio at least once a week and 28.78% watched television at least once a week. Regarding parity, 55.71% had 1–4 children, 23.93% were nulliparous, 18.51% had 5–8 children, and 1.86% had 9 or more. Nearly three-quarters (73.91%) reported using no contraceptive method, 20.10% used hormonal methods, and 5.99% used non-hormonal methods.

Table 1
Weighted characteristics of participants (N = 6,678)

Variables	Weighted n	Weighted %
Women's Age		
15–19	1,624	24.32
20–24	1,314	19.67
25–29	1,100	16.47
30–34	821	12.30
35–39	739	11.07
40–44	609	9.12
45–49	470	7.04
Educational Status		
No education	1,738	26.02
Primary	2,886	43.21
Secondary	1,883	28.20
Higher	172	2.57
Residence		
Urban	2,583	38.68
Rural	4,095	61.32
Household Wealth Status		
Poorest	1,159	17.35
Poorer	1,260	18.86
Middle	1,165	17.44
Richer	1,403	21.01
Richest	1,692	25.33
Currently Working		
No	4,618	69.15
Yes	2,060	30.85
Current Marital Status		
Married/Cohabiting	4,295	64.31

Variables	Weighted n	Weighted %
Women's Age		
Divorced/Widowed/Separated	884	13.24
Never married/Single	1,499	22.45
Religion		
Christianity	4,822	72.21
Islam	1,371	20.53
No religion/Others	485	7.27
Region		
Niassa	427	6.40
Cabo Delgado	358	5.36
Nampula	1,553	23.25
Zambézia	1,110	16.62
Tete	662	9.91
Manica	471	7.05
Sofala	449	6.72
Inhambane	287	4.30
Gaza	346	5.18
Maputo Province	689	10.31
Cidade de Maputo	327	4.90
Frequency of Reading Newspaper		
Not at all	6,111	91.51
Less than once a week	341	5.11
At least once a week	226	3.38
Frequency of Listening to Radio		
Not at all	4,467	66.89
Less than once a week	1,028	15.39
At least once a week	1,183	17.72
Frequency of Watching Television		

Variables	Weighted n	Weighted %
Women's Age		
Not at all	4,215	63.11
Less than once a week	541	8.11
At least once a week	1,922	28.78
Parity		
No children	1,598	23.93
1–4 children	3,720	55.71
5–8 children	1,236	18.51
9 or more children	124	1.86
Current Contraceptive Use		
No method	4,936	73.91
Hormonal	1,342	20.10
Non-hormonal	400	5.99

N = weighted frequency; % = weighted percentage. Source: 2022–2023 Mozambique DHS.

Prevalence of Self-Reported Hypertension and Mental Health Symptom Scores

Table 2 presents the distribution of all participant characteristics stratified by hypertension status, including proportions among both hypertensive and non-hypertensive women, with 95% CIs and design-based chi-squared p-values for each variable.

The weighted prevalence of self-reported hypertension was 8.63% (95% CI: 7.74–9.62), with 91.37% of women reporting no prior hypertension diagnosis. The mean PHQ-9 (depressive symptom) score for the overall sample was 3.31 (SD = 4.71; 95% CI: 3.08–3.54), and the mean GAD-7 (anxiety symptom) score was 3.43 (SD = 4.23; 95% CI: 3.22–3.63). Women with self-reported hypertension had a marginally higher mean depressive symptom score (3.65, SD = 5.00) compared to non-hypertensive women (3.28, SD = 4.67), although this difference was not statistically significant (p = 0.125). In contrast, anxiety symptom scores were significantly higher among hypertensive women (3.93, SD = 4.85) compared to non-hypertensive women (3.38, SD = 4.16; p = 0.016).

Table 2
Distribution of self-reported hypertension across participant characteristics (N = 6,678)

Variables	No HTN (%)	HTN (%)	95% CI (HTN)	P-value
Depression (Mean ± SD)	3.28 ± 4.67	3.65 ± 5.00	3.24, 4.05	0.125
Anxiety (Mean ± SD)	3.38 ± 4.16	3.93 ± 4.85	3.52, 4.35	0.016
Current Contraceptive Use				
No method	76.15	50.20	45.88, 54.52	< 0.001
Hormonal	18.52	36.82	33.05, 40.76	
Non-hormonal	5.33	12.98	10.28, 16.26	
Parity				
No children	25.48	7.55	5.68, 9.95	< 0.001
1–4 children	54.87	64.57	60.50, 68.44	
5–8 children	17.78	26.20	22.74, 29.98	
9 or more children	1.87	1.69	0.88, 3.20	
Current Marital Status				
Married/Cohabiting	63.94	68.23	63.85, 72.30	< 0.001
Divorced/Widowed/Separated	12.46	21.51	17.95, 25.56	
Never married/Single	23.60	10.26	8.14, 12.86	
Religion				
Christianity	70.78	87.30	83.58, 90.27	< 0.001
Islam	21.65	8.68	6.09, 12.22	
No religion/Others	7.57	4.03	2.81, 5.75	
Household Wealth Status				
Poorest	18.50	5.18	3.19, 8.31	< 0.001
Poorer	20.09	5.86	3.34, 10.10	
Middle	18.16	9.81	7.44, 12.84	
Richer	20.66	24.80	21.09, 28.91	
Richest	22.59	54.35	49.31, 59.29	
Currently Working				
No	72.13	37.62	33.42, 42.01	< 0.001

Variables	No HTN (%)	HTN (%)	95% CI (HTN)	P-value
Yes	27.87	62.38	57.99, 66.58	
Region				
Niassa	6.96	0.50	0.44, 0.56	< 0.001
Cabo Delgado	5.70	1.71	1.08, 2.68	
Nampula	24.77	7.21	5.66, 9.14	
Zambézia	17.50	7.28	5.85, 9.02	
Tete	9.95	9.45	6.57, 13.41	
Manica	6.96	8.00	6.51, 9.79	
Sofala	6.52	8.89	6.90, 11.37	
Inhambane	3.79	9.75	8.38, 11.32	
Gaza	4.65	10.82	9.00, 12.96	
Maputo Province	8.88	25.46	21.80, 29.51	
Cidade de Maputo	4.33	10.93	9.28, 12.82	
Residence				
Urban	36.62	60.53	56.76, 64.17	< 0.001
Rural	63.38	39.47	35.83, 43.24	
Educational Status				
No education	27.25	12.99	9.95, 16.79	< 0.001
Primary	43.59	39.21	34.92, 43.67	
Secondary	27.08	40.00	35.64, 44.52	
Higher	2.08	7.81	5.85, 10.36	
Frequency of Reading Newspaper				
Not at all	92.55	80.51	77.28, 83.39	< 0.001
Less than once a week	4.30	13.71	11.25, 16.61	
At least once a week	3.15	5.77	4.13, 8.02	
Frequency of Listening to Radio				
Not at all	68.01	55.02	50.56, 59.40	< 0.001
Less than once a week	15.01	19.45	16.35, 22.98	

Variables	No HTN (%)	HTN (%)	95% CI (HTN)	P-value
At least once a week	16.98	25.53	21.90, 29.54	
Frequency of Watching Television				
Not at all	65.53	37.56	32.98, 42.37	< 0.001
Less than once a week	7.79	11.46	8.53, 15.24	
At least once a week	26.69	50.98	46.14, 55.79	
Women's Age				
15–19	26.29	3.52	2.33, 5.28	< 0.001
20–24	20.53	10.65	8.24, 13.67	
25–29	16.59	15.23	11.95, 19.20	
30–34	11.90	16.55	13.75, 19.80	
35–39	10.01	22.30	18.39, 26.78	
40–44	8.38	16.91	13.93, 20.36	
45–49	6.31	14.83	12.02, 18.17	

HTN = hypertension. Column percentages are weighted. P-values from design-based Pearson chi-squared tests. Mental health rows show Mean ± SD; p-values from adjusted Wald tests of mean differences.

Bivariable Factors Associated with Self-Reported Hypertension

Table 3 presents crude prevalence ratios (cPRs) from separate unadjusted Poisson regression models for each exposure variable and covariate. Depressive symptoms were not significantly associated with hypertension in the unadjusted model (cPR = 1.014, 95% CI: 0.997–1.032, p = 0.115). However, anxiety symptoms showed a significant positive association (cPR = 1.027, 95% CI: 1.006–1.048, p = 0.012), indicating a 2.7% higher prevalence of hypertension for each one-unit increase in GAD-7 score. All sociodemographic, reproductive, and media exposure variables showed significant bivariate associations with self-reported hypertension (all $p < 0.05$), except for the comparison between the poorest and poorer wealth quintiles (p = 0.913).

Table 3
Crude prevalence ratios (cPR) from unadjusted Poisson regression models (N = 6,678)

Variables	cPR	95% CI Lower	95% CI Upper	P-value
Depression score (PHQ-9)	1.014	0.997	1.032	0.115
Anxiety score (GAD-7)	1.027	1.006	1.048	0.012
Women's Age (ref: 15–19)				
20–24	3.742	2.272	6.162	< 0.001
25–29	6.387	3.949	10.331	< 0.001
30–34	9.302	5.915	14.630	< 0.001
35–39	13.923	8.722	22.226	< 0.001
40–44	12.816	8.189	20.056	< 0.001
45–49	14.550	9.133	23.180	< 0.001
Educational Status (ref: No education)				
Primary	1.817	1.326	2.491	< 0.001
Secondary	2.841	2.067	3.905	< 0.001
Higher	6.085	4.153	8.916	< 0.001
Residence (ref: Urban)				
Rural	0.411	0.340	0.498	< 0.001
Household Wealth (ref: Poorest)				
Poorer	1.042	0.501	2.164	0.913
Middle	1.885	1.005	3.534	0.048
Richer	3.953	2.183	7.157	< 0.001
Richest	7.186	4.072	12.681	< 0.001
Currently Working (ref: No)				
Yes	3.717	3.116	4.434	< 0.001
Marital Status (ref: Married/Cohabiting)				
Divorced/Widowed/Separated	1.531	1.237	1.896	< 0.001
Never married/Single	0.431	0.330	0.563	< 0.001
Religion (ref: Christianity)				
Islam	0.350	0.237	0.515	< 0.001

Variables	cPR	95% CI Lower	95% CI Upper	P-value
No religion/Others	0.459	0.312	0.674	< 0.001
Region (ref: Niassa)				
Cabo Delgado	4.098	1.281	13.111	0.018
Nampula	3.987	1.332	11.929	0.013
Zambézia	5.630	1.890	16.772	0.002
Tete	12.260	4.228	35.548	< 0.001
Manica	14.585	5.248	40.537	< 0.001
Sofala	16.991	5.988	48.208	< 0.001
Inhambane	29.125	10.632	79.782	< 0.001
Gaza	26.841	9.753	73.867	< 0.001
Maputo Province	31.734	11.601	86.808	< 0.001
Cidade de Maputo	28.669	10.493	78.332	< 0.001
Reading Newspaper (ref: Not at all)				
Less than once a week	3.050	2.493	3.731	< 0.001
At least once a week	1.940	1.365	2.759	< 0.001
Listening to Radio (ref: Not at all)				
Less than once a week	1.536	1.238	1.907	< 0.001
At least once a week	1.752	1.430	2.147	< 0.001
Watching Television (ref: Not at all)				
Less than once a week	2.377	1.731	3.263	< 0.001
At least once a week	2.976	2.444	3.624	< 0.001
Parity (ref: No children)				
1–4 children	3.676	2.737	4.936	< 0.001
5–8 children	4.489	3.238	6.221	< 0.001
9 or more children	2.881	1.468	5.656	0.002
Contraceptive Use (ref: No method)				
Hormonal	2.698	2.271	3.205	< 0.001
Non-hormonal	3.189	2.456	4.142	< 0.001

cPR = crude prevalence ratio from separate unadjusted survey-weighted Poisson regression models. Each variable was modelled individually. Depression and anxiety scores modelled as continuous variables. 95% CI = 95% confidence interval.

Multivariable Association between Mental Health Symptoms and Self-Reported Hypertension

Table 4 presents adjusted prevalence ratios (aPRs) from the fully adjusted Poisson regression model. This model simultaneously included PHQ-9 and GAD-7 scores alongside all sociodemographic, reproductive, and media exposure covariates. The overall model was statistically significant ($F(42, 554) = 17.84$, $p < 0.001$).

Each one-unit increase in PHQ-9 (depression) score was associated with a 3.2% higher prevalence of self-reported hypertension (aPR = 1.032, 95% CI: 1.001–1.064, p = 0.040), and each one-unit increase in GAD-7 (anxiety) score was associated with a 3.4% higher prevalence (aPR = 1.034, 95% CI: 1.000–1.069, p = 0.047), independent of each other and all covariates. Notably, while depression was not significant in the unadjusted model (p = 0.115), it became significant after adjustment (p = 0.040), suggesting suppression by confounders that had masked the true positive association in the crude model.

Age demonstrated a strong graded association: compared to women aged 15–19, those aged 20–24 had nearly three times the prevalence (aPR = 2.900), rising progressively to ninefold higher among women aged 45–49 (aPR = 9.137, 95% CI: 5.179–16.122, p < 0.001). Women with secondary education (aPR = 1.676, p = 0.004) and higher education (aPR = 1.644, p = 0.032) had significantly elevated prevalence compared to those with no education, while primary education showed no significant difference (p = 0.104). Household wealth showed a positive gradient: women from the richer (aPR = 1.941, p = 0.029) and richest quintiles (aPR = 2.437, p = 0.006) had significantly higher prevalence. Currently employed women had 49.4% higher prevalence (aPR = 1.494, p < 0.001).

Marital status was not significantly associated with hypertension after adjustment (divorced/widowed/separated: aPR = 1.030, p = 0.766; never married: aPR = 1.051, p = 0.764). Among religious groups, women with no religion/other affiliations had significantly lower prevalence compared to Christians (aPR = 0.652, p = 0.028), while Islam showed no significant association (aPR = 1.134, p = 0.598). Residence (urban vs. rural) was not significant after adjustment (aPR = 0.938, p = 0.518).

Marked regional disparities persisted after adjustment. Compared to Niassa, all other provinces had significantly higher hypertension prevalence. The highest adjusted prevalence ratios were observed in Inhambane (aPR = 18.257, 95% CI: 6.482–51.424, p < 0.001), Gaza (aPR = 17.534, 95% CI: 6.183–49.726, p < 0.001), Maputo Province (aPR = 12.523, 95% CI: 4.391–35.711, p < 0.001), and Manica (aPR = 12.209, 95% CI: 4.302–34.651, p < 0.001).

Regarding media exposure, only infrequent newspaper reading (less than once a week) was significantly associated with higher hypertension prevalence (aPR = 1.369, p = 0.002). Frequent newspaper reading,

radio listening, and television watching were not significant after adjustment. Higher parity was associated with greater prevalence: women with 1–4 children (aPR = 1.697, p = 0.009) and 5–8 children (aPR = 1.966, p = 0.005) had significantly elevated risk compared to nulliparous women, while those with 9 or more children showed a borderline non-significant elevation (aPR = 2.061, p = 0.058). Non-hormonal contraceptive use was significantly associated with higher prevalence (aPR = 1.360, p = 0.018), while hormonal methods were not significant (aPR = 1.127, p = 0.186).

Table 4
Adjusted prevalence ratios (aPR) from the fully adjusted Poisson regression model (N = 6,678)

Variables	aPR	95% CI Lower	95% CI Upper	P-value
Depression score (PHQ-9)	1.032	1.001	1.064	0.040
Anxiety score (GAD-7)	1.034	1.000	1.069	0.047
Women's Age (ref: 15–19)				
20–24	2.900	1.710	4.918	< 0.001
25–29	4.232	2.485	7.205	< 0.001
30–34	5.720	3.401	9.619	< 0.001
35–39	7.164	4.130	12.427	< 0.001
40–44	6.968	3.980	12.199	< 0.001
45–49	9.137	5.179	16.122	< 0.001
Educational Status (ref: No education)				
Primary	1.298	0.948	1.778	0.104
Secondary	1.676	1.179	2.382	0.004
Higher	1.644	1.044	2.590	0.032
Residence (ref: Urban)				
Rural	0.938	0.774	1.138	0.518
Household Wealth (ref: Poorest)				
Poorer	0.937	0.462	1.899	0.856
Middle	1.153	0.611	2.173	0.660
Richer	1.941	1.071	3.517	0.029
Richest	2.437	1.287	4.614	0.006
Currently Working (ref: No)				
Yes	1.494	1.229	1.816	< 0.001
Marital Status (ref: Married/Cohabiting)				
Divorced/Widowed/Separated	1.030	0.845	1.256	0.766
Never married/Single	1.051	0.759	1.456	0.764
Religion (ref: Christianity)				

Variables	aPR	95% CI Lower	95% CI Upper	P-value
Islam	1.134	0.710	1.811	0.598
No religion/Others	0.652	0.446	0.954	0.028
Region (ref: Niassa)				
Cabo Delgado	3.265	1.031	10.342	0.044
Nampula	3.209	1.100	9.359	0.033
Zambézia	6.638	2.178	20.234	0.001
Tete	10.883	3.656	32.396	< 0.001
Manica	12.209	4.302	34.651	< 0.001
Sofala	10.592	3.725	30.121	< 0.001
Inhambane	18.257	6.482	51.425	< 0.001
Gaza	17.534	6.183	49.726	< 0.001
Maputo Province	12.523	4.391	35.711	< 0.001
Cidade de Maputo	10.449	3.682	29.655	< 0.001
Reading Newspaper (ref: Not at all)				
Less than once a week	1.369	1.123	1.668	0.002
At least once a week	0.935	0.622	1.405	0.746
Listening to Radio (ref: Not at all)				
Less than once a week	0.989	0.820	1.194	0.910
At least once a week	1.085	0.892	1.320	0.415
Watching Television (ref: Not at all)				
Less than once a week	0.978	0.732	1.307	0.880
At least once a week	0.927	0.741	1.159	0.506
Parity (ref: No children)				
1–4 children	1.697	1.144	2.518	0.009
5–8 children	1.966	1.224	3.156	0.005
9 or more children	2.061	0.976	4.352	0.058
Contraceptive Use (ref: No method)				
Hormonal	1.127	0.944	1.345	0.186

Variables	aPR	95% CI Lower	95% CI Upper	P-value
Non-hormonal	1.360	1.054	1.753	0.018

aPR = adjusted prevalence ratio. All variables entered simultaneously into a single survey-weighted modified Poisson regression model with robust variance estimation. Depression and anxiety scores modelled as continuous variables. $F(42, 554) = 17.84$, $p < 0.001$. 95% CI = 95% confidence interval.

Discussion

This study examined the association between depressive and anxiety symptoms and self-reported hypertension among 6,678 reproductive-aged women in Mozambique. The weighted prevalence of self-reported hypertension was 8.63%. The mean depressive symptom score was 3.31 and the mean anxiety symptom score was 3.43. The central finding was that both depressive and anxiety symptoms were independently and positively associated with self-reported hypertension after adjusting for a comprehensive set of sociodemographic, reproductive, and behavioural covariates. Although the per-unit effect sizes are modest (3%), their population-level significance is considerable given the high background prevalence of depressive and anxiety symptoms among Mozambican women, where approximately 10–11% report significant symptoms (Anaba et al., 2025).

The observed prevalence of self-reported hypertension (8.63%) is broadly consistent with multi-country estimates from SSA using self-report measures, which range from 5% to 15% (Porth et al., 2024). This figure is lower than clinical prevalence estimates, which typically exceed 25% in population-based studies employing blood pressure measurement (Odili et al., 2020), reflecting the well-documented gap between hypertension prevalence and awareness in low- and middle- income countries.

The independent positive associations between depressive and anxiety symptoms and hypertension corroborate a growing body of evidence. For instance, a meta-analysis by Meng et al. (2012) found that depression was associated with a 42% increased risk of incident hypertension. Similarly, studies from high-income settings have reported significant relationships between anxiety severity and hypertension risk (Rubio-Guerra et al., 2013; Pan et al., 2015). Furthermore, the findings in this study have been corroborated by similar studies in SSA. A facility-based study by Amaike et al. (2024) in Nigeria found that depression was associated with uncontrolled hypertension. However, the study focused on treatment outcomes rather than population-level prevalence. Studies in Ghana and Ethiopia reported high comorbidity between depression and hypertension (Kretchy et al., 2014; Ademola et al., 2019). Our study extends this literature by providing the first population-based evidence from Mozambique using nationally representative data and standardised screening instruments.

An important methodological finding was that depression was not significant in crude models but became significant after adjustment. This pattern indicates suppression by confounders—specifically, variables such as age, education, and wealth that are positively associated with both hypertension awareness and healthcare-seeking but may be inversely related to depressive symptom reporting. By

including these variables in the adjusted model, the suppression was removed, revealing the true positive association between depressive symptoms and hypertension. By contrast, anxiety was significant in both crude and adjusted models, suggesting a more robust bivariate signal that is less susceptible to confounding.

The biological plausibility of the depression–anxiety–hypertension link is well-established. Chronic psychological distress activates the hypothalamic–pituitary–adrenal (HPA) axis and the sympathetic nervous system, leading to sustained elevations in cortisol, catecholamines, heart rate, and peripheral vascular resistance (Walther & Wirtz, 2023). This neuroendocrine dysregulation promotes systemic inflammation, endothelial dysfunction, and arterial stiffness—all established pathways to hypertension (Meng et al., 2012). Furthermore, depression and anxiety frequently co-occur with behavioural risk factors such as physical inactivity, poor sleep quality, unhealthy diet, and tobacco or alcohol use, which independently contribute to elevated blood pressure (Bodnaruc et al., 2024; Goel et al., 2021).

In resource-constrained healthcare setting like Mozambique, this relationship is particularly concerning. Mental health challenges not only increase physiological susceptibility to hypertension but also impair health-seeking behaviours, medication adherence and engagement in health preventive behaviours (Salles & Barros, 2009). Because hypertension in this study was self-reported, the observed associations may partly reflect detection bias: women with psychological distress may be more likely to present to healthcare facilities with somatic complaints, thereby increasing the probability of blood pressure measurement and hypertension detection (Arias et al., 2022; Sweetland et al., 2014). Regardless of the directionality, however, the evidence reveals a strong and clinically meaningful interdependence between psychological and cardiovascular health.

Age emerged as the strongest covariate predictor of hypertension, with prevalence rising steeply from adolescence to late reproductive age. Women aged 45–49 had over nine times the prevalence of those aged 15–19. This gradient reflects the natural progression of vascular ageing and cumulative exposure to cardiovascular risk factors (Lopez et al., 2006). As women age, vascular elasticity declines, and repeated physiological stressors, including pregnancy, weight gain, and hormonal transitions associated with perimenopause, amplify cardiovascular strain (Nobles et al., 2018).

Reproductive history further shaped risk. Multiparous women (1–4 and 5–8 children) showed significantly higher prevalence compared to nulliparous women. Repeated pregnancies impose substantial haemodynamic demands, including volume overload and endothelial stress, that may precipitate lasting vascular changes, particularly among women who experienced hypertensive disorders of pregnancy such as pre-eclampsia (Mateus et al., 2019; Wang et al., 2021). This finding highlights the need for life-course approaches to women's health that emphasise cardiovascular risk screening after childbirth.

The finding that non-hormonal contraceptive users had higher hypertension prevalence likely reflects channelling bias in clinical decision-making rather than a causal effect: healthcare providers in Mozambique typically recommend non-hormonal methods to women already identified as having

elevated cardiovascular risk. Future research should collect data on contraceptive duration, clinical indication, and baseline blood pressure to disentangle this association.

Contrary to the inverse socioeconomic gradient observed in many high-income countries, hypertension prevalence in Mozambique was higher among women with secondary or higher education, those in wealthier households, and those currently employed. This positive gradient is consistent with early stages of the epidemiological transition, where affluence is associated with lifestyle-related risk factors such as energy-dense diets, sedentary behaviour, and urbanisation-related psychosocial stress, before the burden eventually shifts to lower socioeconomic groups as risk factor exposure democratises (Lopez et al., 2006). Simultaneously, higher socioeconomic status likely improves healthcare access and diagnosis awareness, contributing to detection bias (Mohseni et al., 2023). Employment was associated with 49% higher hypertension prevalence, highlighting the psychosocial strain of balancing occupational demands and domestic responsibilities, particularly in Mozambique's gendered labour context where employed women, especially those heading households, may face chronic stress that elevates cardiovascular risk (Audet et al., 2018).

The marked geographic disparities observed are notable. After full adjustment, all provinces showed significantly higher hypertension prevalence compared to Niassa, with the strongest effects in Inhambane (aPR = 18.257), Gaza (aPR = 17.534), and Maputo Province (aPR = 12.523). These disparities likely reflect a combination of urbanisation, dietary transitions toward processed and high-sodium foods, socioeconomic differences, and uneven healthcare infrastructure. Southern provinces, particularly those surrounding the capital Maputo, have higher levels of urbanisation and economic development, which may accelerate the epidemiological transition. Northern regions such as Cabo Delgado, while showing lower prevalence, face compounded burdens from armed conflict and population displacement, where trauma-related stress may simultaneously elevate both mental health and cardiovascular risks (Haenlein et al., 2025).

Among media exposure variables, only infrequent newspaper reading was significantly associated with hypertension after adjustment. Women who read newspapers less than once per week had 37% higher prevalence (aPR = 1.369, p = 0.002). This finding is difficult to interpret causally but may reflect a proxy for a particular socioeconomic or urban profile associated with hypertension risk. Frequent newspaper reading, radio listening, and television watching were not significantly associated with hypertension in the adjusted model, suggesting that after accounting for education, wealth, residence, and other sociodemographic factors, media exposure per se does not independently predict hypertension.

Religious affiliation showed mixed effects. Women reporting no religion or other affiliations had significantly lower hypertension prevalence compared to Christians (aPR = 0.652, p = 0.028), while Islam showed no significant association. These patterns may reflect residual confounding by geographic region, dietary practices, or lifestyle factors associated with religious communities in Mozambique. Marital status, which was strongly associated with hypertension in crude models (divorced/widowed

women at higher risk; never married at lower risk), was not significant after adjustment, suggesting that the crude associations were confounded by age, parity, and socioeconomic factors.

Recommendations for Policy, Practice, and Future Research

These findings carry several actionable implications. For health policy, they underscore the urgent need for integrated health interventions that jointly address mental health and cardiovascular risk among women of reproductive age. Routine screening for depressive and anxiety symptoms should be embedded within maternal health, primary care, and NCD platforms. The observation that both depression and anxiety independently predict hypertension strengthens the case for dual screening protocols.

For clinical practice, healthcare providers managing hypertension should assess comorbid psychological distress, and vice versa, as part of comprehensive patient care. The finding that depression was masked in unadjusted analyses but emerged as significant after adjustment highlights the importance of considering the broader clinical and social context when evaluating mental health–cardiovascular relationships.

For public health, messaging on cardiovascular prevention should incorporate mental wellbeing components. Targeted outreach should prioritise older women, those in urban and wealthier households, and women in southern provinces where both hypertension prevalence and healthcare access are highest. The marked regional disparities also suggest that decentralised, context-specific intervention strategies are needed.

For future research, longitudinal and cohort studies with clinical blood pressure measurements and diagnostic psychiatric assessments are needed to establish temporal and causal pathways. Studies should examine biological mediators (e.g., cortisol, inflammatory markers), behavioural mediators (e.g., diet, physical activity, substance use), and social mediators (e.g., intimate partner violence, social support) of the mental health–hypertension relationship in African contexts. Additionally, research should explore the impact of hypertension diagnosis itself on subsequent mental health trajectories, addressing the possibility of reverse causation.

Strengths and Limitations

This study has several notable strengths. First, it uses a large, nationally representative dataset with appropriate complex survey design adjustments (clustering, stratification, and sampling weights), enhancing both internal validity and generalisability to Mozambican women of reproductive age. Second, depressive and anxiety symptoms were measured using internationally validated, standardised instruments (PHQ-9 and GAD-7), facilitating cross-study comparisons. Also, both exposure variables were modelled as continuous scores, preserving the full distribution of symptom severity and avoiding the information loss inherent in arbitrary categorisation.

Several limitations should be acknowledged. Hypertension was self-reported rather than clinically measured, introducing potential misclassification bias. Undiagnosed hypertension would not be captured, likely leading to underestimation of true prevalence and potentially biasing associations if women with mental health symptoms have differential healthcare contact (detection bias). Second, although the PHQ-9 and GAD-7 are validated screening instruments, they measure symptom severity rather than clinical diagnoses; the observed associations should be interpreted as reflecting depressive and anxiety symptom burden rather than diagnosed psychiatric disorders. However, the cross-sectional design precludes causal inference. Reverse causality cannot be ruled out, as receiving a hypertension diagnosis may itself provoke anxiety or depressive symptoms. Nonetheless, residual confounding from unmeasured behavioural and biological risk factors, including diet, physical activity, body mass index, salt intake, family history of hypertension, and substance use, may persist. Additionaslly, 49.3% of the original sample (n = 6,495) was excluded due to missing data on the outcome variable (women who had never had their blood pressure measured or responded “Don’t know”). These excluded women may differ systematically from those included (e.g., in terms of healthcare access, socioeconomic status, or rural residence), potentially introducing selection bias and limiting the generalisability of findings to women who have engaged with the health system.

Conclusions

Depressive and anxiety symptoms were independently associated with self-reported hypertension among reproductive-aged women in Mozambique, with hypertension risk further shaped by age, educational attainment, employment status, household wealth, parity, geographic region, and contraceptive use. These findings underscore the interconnectedness of mental and cardiovascular health among women and highlight the need for integrated, multisectoral health interventions. Scaling up early detection and co-management of psychological distress and hypertension can reduce dual disease burdens, improve women’s health trajectories, and contribute to more equitable health outcomes across Mozambique. Future research should employ longitudinal designs with clinical assessments to establish causal pathways and elucidate the biological, behavioural, and social mechanisms linking depression, anxiety, and hypertension across diverse African populations.

Abbreviations

aPR
Adjusted Prevalence Ratio
CI
Confidence Interval
cPR
Crude Prevalence Ratio
DHS
Demographic and Health Survey
GAD

7–Generalised Anxiety Disorder–7
HPA
Hypothalamic–Pituitary–Adrenal
HTN
Hypertension
INE
Instituto Nacional de Estatística (National Institute of Statistics)
LMICs
Low–and Middle–Income Countries
MDHS
Mozambique Demographic and Health Survey
NCD
Non–Communicable Disease
PHQ
9–Patient Health Questionnaire–9
PR
Prevalence Ratio
PSU
Primary Sampling Unit
SD
Standard Deviation
SDG
Sustainable Development Goal
SSA
Sub–Saharan Africa
VIF
Variance Inflation Factor
WHO
World Health Organization.

Declarations

Ethical Approval and Consent to Participate

The authors confirm that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2013. The 2022–2023 MDHS protocol was reviewed and approved by the National Bioethics Committee for Health in Mozambique (CNBS) and the ICF Institutional Review Board. Written informed consent was obtained from all participants; for participants under 18 years of age, parental or guardian consent was obtained. Ethical approval for this secondary analysis was not

required, as the data are de-identified and publicly available. The dataset was accessed from the DHS Program website following official email authorisation.

Consent for Publication

Not applicable.

Competing Interests

The authors declare that they have no competing interests.

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Author Contribution

EAA, SA and YS conceived and designed the study. EAA, FA, SKA, and YS drafted the manuscript and conducted statistical analyses and interpretation of results. FA, SA, EAA and YS contributed to the interpretation of findings and critical revision of the manuscript. EAA, YS, FA and SKA proofread the manuscript. All authors contributed to the discussion, read, and approved the final version.

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Data Availability

The dataset analysed during this study is publicly available from the Demographic and Health Surveys (DHS) Program at https://dhsprogram.com upon registration and approval of a data access request.

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