Journal of Zhejiang University-SCIENCE B (Biomedicine & Biotechnology) 2022 23(12):1057-1064
www.jzus.zju.edu.cn; www.springer.com/journal/11585
E-mail: jzus_b@zju.edu.cn

Report

https://doi.org/10.1631/jzus.B2200162

Prevalence and risk factors of cardiovascular diseases and psychological distress among female scientists and technicians

Lijun ZHANG[1], Yanping BAO[2,3], Guo LI[1], Shuhui TAO[1,4], Meiyan LIU[1]✉

[1]*Department of Psycho-Cardiology, Beijing Anzhen Hospital, Capital Medical University, Beijing 100029, China*
[2]*National Institute on Drug Dependence and Beijing Key Laboratory of Drug Dependence, Peking University, Beijing 100191, China*
[3]*School of Public Health, Peking University, Beijing 100191, China*
[4]*Henan Medical School, Henan University, Kaifeng 475001, China*

Abstract: This study aimed to explore the prevalence and risk factors of cardiovascular disease (CVD) and psychological distress among female scientists and technicians in China. Accordingly, we included scientists and technicians from representative research institutions, medical institutions, colleges, universities, and businesses in China, and the data were collected from July 1, 2019 to March 31, 2021 via online questionnaires. The parameters evaluated in this study included age, sex, marital status, educational background, monthly income, sleep hours, sleep problems, smoking, alcohol consumption, work-related stress, work burnout, cardiovascular symptoms, CVD, family history, and depressive and anxiety symptoms. A total of 14 530 scientists and technicians were included, comprising 7144 men and 7386 women. We found 34.9% men and 16.6% women with CVD, 35.1% men and 21.4% women with depressive symptoms, 28.7% men and 13.8% women with anxiety symptoms, and 22.0% men and 9.5% women with CVD combined with depressive or anxiety symptoms. This study focused on the details of women. Younger women (age⩽35 years) had the highest prevalence of depressive symptoms (24.9%), anxiety symptoms (16.2%), and comorbidity (11.2%). It was established that, despite traditional risk factors, unmanageable work burnout, depressive symptoms, and anxiety symptoms were associated with a higher risk of CVD in women; insomnia, overwhelming work stress, unmanageable work burnout, and CVD were linked to a higher risk of depressive symptoms and anxiety; insomnia, overwhelming work stress, and unmanageable work burnout were related to CVD combined with depressive or anxiety symptoms. A bidirectional relationship was noted between CVD and depression or anxiety in female scientists and technicians, and insomnia and overwhelming work stress were positively associated with comorbidity. It is suggested that effective measures should be taken to protect female scientists and technicians from CVD and psychological distress.

Key words: Female scientist and technician; Depressive symptom; Anxiety; Insomnia; Cardiovascular disease (CVD)

1 Introduction

According to the most recent Chinese cardiovascular disease (CVD) report, there are 330 million people suffering from CVD, which is responsible for 46.66% and 43.81% of rural and urban mortality in China, respectively (The Writing Committee of the Report on Cardiovascular Health and Diseases in China, 2021). CVD is a predominant risk factor of mortality in women worldwide (Vogel et al., 2021), which accounted for 35% of global mortality in women in 2019 (Global Burden of Disease Collaborative Network, 2020).

Moreover, it has been well recognized that CVD is commonly associated with depression or anxiety (Liu, 2021); 13% of patients present a high level of anxiety after acute myocardial infarction (AMI) (Hanssen et al., 2009). Depression elevates the risk of CVD (odds ratio (OR)=1.39; 95% confidence interval (CI)=1.22–1.58) (Li et al., 2019), and increases the risk of CVD mortality by 32% (Meng et al., 2020). The previous research data showed that women are suffering from both CVD and psychological distress (Smolderen et al., 2015). The Variation in Recovery: Role of Gender on Outcomes of Young AMI Patients (VIRGO) study reported that 39% of women present

✉ Meiyan LIU, liumeiyanaz@ccmu.edu.cn
Meiyan LIU, https://orcid.org/0000-0001-9114-9633

Received Mar. 30, 2022; Revision accepted Aug. 17, 2022; Crosschecked Nov. 3, 2022

with depressive symptoms after AMI, which is higher than that in men (22%) (Smolderen et al., 2015).

However, when compared with studies on men, there is still a lack of data on women's cardiovascular and psychological health, especially regarding those working under high stress, such as female scientists and technicians. Scientists and technicians are specialized in the scientific field, including engineers, agrotechnicians, scientific researchers, healthcare technicians, and natural science teaching staff. Considering all these categories, there are 40 million female scientists and technicians in China.

According to a recent psychological health investigation targeting scientists and technicians, approximately 25% of these skilled workers feel depressed, and over half of them feel anxious (Guo et al., 2020). The survey emphasized that there is serious psychological distress among scientists and technicians. However, there is lack of data on females in these professions. Moreover, no research has investigated the occurrence of both CVD and psychological distress in women.

Hence, we aimed to assess the prevalence and risk factors of CVD and psychological distress (depressive symptoms and anxiety) in Chinese female scientists and technicians.

2 Results

The survey response rate was 93.5%, including a total of 14 530 participants, with 7144 male and 7386 female scientists and technicians. The average age was (38.79±10.14) years. Among these participants, the prevalence of CVD was 25.6%, with 34.9% in men and 16.6% in women; the total prevalence of depressive symptoms was 28.1%, with 35.1% in men and 21.4% in women; the total prevalence of anxiety symptoms was 21.2%, with 28.7% in men and 13.8% in women; the total prevalence of CVD combined with depressive or anxiety symptoms was 15.7%, with 22.0% in men and 9.5% in women (Table S1).

2.1 Demographic characteristics of female scientists and technicians

Of all the female participants, 3481 (47.1%) were suffering from insomnia, 989 (13.4%) had potential sleep problems, and others (2916, 39.5%) slept normally. The data showed that 1236 (17.1%) of the participants were under overwhelming work stress, 929 (12.8%) were under manageable work stress, and others (5073, 70.1%) declared no work-related stress. Of the participants, 1332 (18.4%) complained of unmanageable work burnout, 955 (13.2%) reported manageable work burnout, and others (4935, 68.3%) perceived no work burnout. When exploring the history of diseases, there were 6163 (83.4%) participants without CVD and 1223 (16.6%) with CVD, including 473 (6.4%) with coronary artery disease (CAD), 287 (3.9%) with AMI, 868 (11.8%) with hypertension, 214 (2.9%) with atrial fibrillation (AF), 125 (1.7%) with heart failure (HF), 168 (2.3%) with supraventricular tachycardia/ventricular tachycardia (SVT/VT), and 194 (2.6%) with other kinds of CVD (Table S1).

2.2 Prevalence of depressive symptoms, anxiety, CVD, and CVD combined with depressive or anxiety symptoms

Of all the female scientists and technicians, older respondents had a higher prevalence of CVD (34.6% (≥50 years) vs. 12.9% (36–49 years) vs. 13.8% (≤35 years)), while younger respondents had higher prevalence of depressive symptoms (24.9% (≤35 years) vs. 18.3% (36–49 years) vs. 15.6% (≥50 years)), anxiety symptoms (16.2% (≤35 years) vs. 11.0% (36–49 years) vs. 11.2% (≥50 years)), and CVD combined with depressive or anxiety symptoms (11.2% (≤35 years) vs. 6.1% (36–49 years) vs. 10.7% (≥50 years)) (Table S2).

The participants with higher educational background (postgraduate) had lower rates of CVD (7.2% vs. 40.3%), depressive symptoms (13.6% vs. 35.4%), anxiety symptoms (8.0% vs. 28.7%), and CVD combined with depressive or anxiety symptoms (3.2% vs. 25.5%) than those with lower education background (technical secondary school or below) (Table S2).

The participants with CVD presented higher prevalence of depressive symptoms (56.7% vs. 14.4%) and anxiety symptoms (46.8% vs. 7.3%) than those without. The participants with depressive symptoms had higher prevalence of CVD (43.9% vs. 9.1%) than those without, and those with anxiety symptoms had higher prevalence of CVD (56.0% vs. 10.2%) (Table S2).

In addition, those with less than 5 h of sleep, insomnia, or overwhelming work stress, those with a history of diabetes mellitus, hyperuricemia, or cerebrovascular disease, and those with family history of

CVD or depression/anxiety, current smokers, or regular alcohol consumers had higher prevalence of CVD, depressive symptoms, anxiety symptoms, and CVD combined with depressive or anxiety symptoms. The details are shown in Table S2.

2.3 Associated risk factors of CVD, depressive symptoms, anxiety, and CVD combined with depressive or anxiety symptoms by multivariable logistic regression

The unadjusted logistic regression results are presented in Tables S3 and S4. We reported multivariable logistic regression results in this section. The younger participants had a lower risk of CVD (⩽35 years: OR=0.282, 95% CI=0.216–0.368; 36–49 years: OR=0.329, 95% CI=0.258–0.420). There were several factors associated with a higher risk of CVD among female scientists and technicians, including married (OR=1.892, 95% CI=1.362–2.626) or divorced status (OR=1.762, 95% CI=1.019–3.049), unmanageable work burnout (OR=1.706, 95% CI=1.139–2.556), current smoking (OR=12.413, 95% CI=7.872–19.575), regular drinking (OR=2.562, 95% CI=1.350–4.859), diabetes mellitus (OR=5.497, 95% CI=3.402–8.881), hyperlipidemia (OR=1.626, 95% CI=1.219–2.170), hyperuricemia (OR=2.115, 95% CI=1.284–3.483), cerebrovascular disease (OR=6.644, 95% CI=3.012–14.652), family history of CVD (OR=4.089, 95% CI=3.372–4.960), family history of depression or anxiety (OR=9.717, 95% CI=7.090–13.319), depressive symptoms (OR=1.907, 95% CI=1.434–2.537), and anxiety symptoms (OR=2.260, 95% CI=1.661–3.075) (Tables 1, S3, and S4).

There were several factors associated with a higher risk of depressive symptoms among female scientists and technicians, including younger age (⩽35 years: OR=2.659, 95% CI=2.024–3.495; 36–49 years: OR=1.926, 95% CI=1.466–2.532), fewer sleep hours (5–7 h: OR=1.407, 95% CI=1.150–1.720; <5 h: OR=3.077, 95% CI=2.251–4.205), insomnia (OR=6.259, 95% CI=5.082–7.707), overwhelming work stress (OR=2.727, 95% CI=1.893–3.929), unmanageable work burnout (OR=5.307, 95% CI=3.645–7.728), lower monthly income (5000–10000 CNY: OR=1.532, 95% CI=1.167–2.010; ⩽5000 CNY: OR=2.222, 95% CI=1.673–2.952), current smoking (OR=3.387, 95% CI=2.185–5.249), CVD (OR=2.739, 95% CI=2.190–3.427), and family history of depression or anxiety (OR=4.153, 95% CI=3.039–5.677) (Tables 1, S3, and S4).

There were several factors associated with higher risk of anxiety symptoms among female scientists and technicians, including younger age (⩽35 years: OR=

Table 1 Associated risk factors of CVD and psychological distress by multivariable logistic regression

Variable	CVD		Depressive symptoms		Anxiety symptoms		CVD combined with depressive or anxiety symptoms	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Age group (years)								
⩾50	1*		1		1		1	
36–49	0.329 (0.258, 0.420)	<0.001	1.926 (1.466, 2.532)	<0.001	1.603 (1.176, 2.184)	0.003	0.688 (0.468, 1.012)	0.058
⩽35	0.282 (0.216, 0.368)	<0.001	2.659 (2.024, 3.495)	<0.001	2.020 (1.482, 2.752)	<0.001	1.259 (0.860, 1.843)	0.237
Educational background								
Technical secondary school or below	1		1		1		1	
Junior college	0.628 (0.455, 0.867)	0.005	0.658 (0.478, 0.906)	0.010	0.649 (0.464, 0.907)	0.110	0.469 (0.309, 0.711)	<0.001
Undergraduate	0.338 (0.245, 0.465)	<0.001	0.520 (0.381, 0.711)	<0.001	0.434 (0.312, 0.603)	<0.001	0.170 (0.111, 0.259)	<0.001
Postgraduate	0.213 (0.136, 0.334)	<0.001	0.534 (0.363, 0.784)	0.001	0.516 (0.335, 0.795)	0.003	0.108 (0.056, 0.208)	<0.001

To be continued

Table 1 (continued)

Variable	CVD		Depressive symptoms		Anxiety symptoms		CVD combined with depressive or anxiety symptoms	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Marital status								
Unmarried	1		NA		1		1	
Married	1.892 (1.362, 2.626)	<0.001	NA	NA	0.906 (0.704, 1.167)	0.446	1.436 (0.967, 2.130)	0.073
Divorced	1.762 (1.019, 3.049)	0.043	NA	NA	0.762 (0.447, 1.297)	0.316	1.915 (0.957, 3.834)	0.066
Sleep time (h)								
⩾7	1		1		1		1	
5–7	1.108 (0.883, 1.390)	0.375	1.407 (1.150, 1.720)	0.001	1.355 (1.061, 1.730)	0.015	1.137 (0.805, 1.606)	0.467
<5	0.820 (0.554, 1.215)	0.322	3.077 (2.251, 4.205)	<0.001	2.244 (1.569, 3.210)	<0.001	1.379 (0.840, 2.262)	0.204
Sleep problems								
No	1		1		1		1	
Potential sleep problems	1.273 (0.944, 1.718)	0.113	1.467 (1.082, 1.989)	0.013	1.293 (0.895, 1.868)	0.170	2.537 (1.493, 4.311)	0.001
Insomnia	1.129 (0.897, 1.421)	0.301	6.259 (5.082, 7.707)	<0.001	4.047 (3.140, 5.214)	<0.001	5.635 (3.721, 8.532)	<0.001
Work stress								
No	1		1		1		1	
Manageable	0.811 (0.584, 1.125)	0.210	1.200 (0.874, 1.648)	0.260	1.194 (0.821, 1.735)	0.353	0.938 (0.557, 1.579)	0.809
Overwhelming	1.044 (0.697, 1.563)	0.836	2.727 (1.893, 3.929)	<0.001	3.054 (2.038, 4.577)	<0.001	2.449 (1.417, 4.233)	0.001
Work burnout								
No	1		1		1		1	
Manageable	1.141 (0.820, 1.587)	0.435	1.976 (1.416, 2.757)	<0.001	1.305 (0.892, 1.911)	0.171	1.701 (0.968, 2.990)	0.065
Unmanageable	1.706 (1.139, 2.556)	0.010	5.307 (3.645, 7.728)	<0.001	2.837 (1.878, 4.286)	<0.001	3.010 (1.661, 5.457)	<0.001
Monthly income (CNY)								
⩾10 000	1		1		1		1	
5000–10 000	1.054 (0.782, 1.421)	0.729	1.532 (1.167, 2.010)	0.002	1.361 (0.973, 1.905)	0.072	1.648 (0.977, 2.780)	0.061
⩽5000	0.905 (0.656, 1.249)	0.545	2.222 (1.673, 2.952)	<0.001	2.065 (1.458, 2.926)	<0.001	1.886 (1.100, 3.236)	0.021
Smoking								
None	1		1		1		1	
Current smoker	12.413 (7.872, 19.575)	<0.001	3.387 (2.185, 5.249)	<0.001	2.628 (1.802, 3.832)	<0.001	17.763 (11.413, 27.645)	<0.001
Former smoker	2.437 (1.153, 5.148)	0.020	3.144 (1.502, 6.578)	0.002	2.271 (1.077, 4.788)	0.031	6.047 (2.744, 13.330)	<0.001

To be continued

Table 1 (continued)

Variable	CVD		Depressive symptoms		Anxiety symptoms		CVD combined with depressive or anxiety symptoms	
	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*
Drinking								
None	1		1		1		1	
Drinking at times	1.327 (1.075, 1.640)	0.009	1.456 (1.223, 1.733)	<0.001	1.188 (0.963, 1.466)	0.108	1.400 (1.051, 1.865)	0.021
Regular drinker	2.562 (1.350, 4.859)	0.004	1.167 (0.651, 2.093)	0.603	1.482 (0.866, 2.535)	0.151	2.421 (1.241, 4.722)	0.009
Former drinker	0.328 (0.094, 1.140)	0.080	1.764 (0.763, 4.078)	0.185	2.565 (1.077, 6.110)	0.033	0.571 (0.148, 2.200)	0.415
CVD								
No	NA		1		1		NA	
Yes	NA	NA	2.739 (2.190, 3.427)	<0.001	3.302 (2.588, 4.212)	<0.001	NA	NA
Other diseases								
Diabetes mellitus								
No	1		1		1		1	
Yes	5.497 (3.402, 8.881)	<0.001	0.609 (0.367, 1.009)	0.054	0.815 (0.487, 1.366)	0.438	1.454 (0.792, 2.669)	0.227
Hyperlipidemia								
No	1		1		1		1	
Yes	1.626 (1.219, 2.170)	0.001	1.245 (0.936, 1.658)	0.132	1.085 (0.787, 1.494)	0.619	1.714 (1.168, 2.515)	0.006
Hyperuricemia								
No	1		1		1		1	
Yes	2.115 (1.284, 3.483)	0.003	1.432 (0.871, 2.357)	0.157	1.267 (0.780, 2.057)	0.340	2.239 (1.295, 3.871)	0.004
Cerebrovascular disease								
No	1		1		1		1	
Yes	6.644 (3.012, 14.652)	<0.001	1.265 (0.633, 2.531)	0.506	0.559 (0.297, 1.051)	0.071	2.930 (1.337, 6.424)	0.007
Family history of CVD								
No	1		1		1		1	
Yes	4.089 (3.372, 4.960)	<0.001	1.140 (0.945, 1.375)	0.171	1.049 (0.843, 1.304)	0.669	3.092 (2.354, 4.062)	<0.001
Family history of depression or anxiety								
No	1		1		1		1	
Yes	9.717 (7.090, 13.319)	<0.001	4.153 (3.039, 5.677)	<0.001	4.019 (3.004, 5.376)	<0.001	20.043 (14.674, 27.375)	<0.001
Psychological distress								
Depressive symptoms								
No	1		NA		NA		NA	
Yes	1.907 (1.434, 2.537)	<0.001	NA	NA	NA	NA	NA	NA
Anxiety symptoms								
No	1		NA		NA		NA	
Yes	2.260 (1.661, 3.075)	<0.001	NA	NA	NA	NA	NA	NA

*The reference for each parameter is set as 1. CVD: cardiovascular disease; OR: odds ratio; CI: confidence interval; NA: not available.

2.020, 95% CI=1.482–2.752; 36–49 years: OR=1.603, 95% CI=1.176–2.184), fewer sleep hours (5–7 h: OR=1.355, 95% CI=1.061–1.730; <5 h: OR=2.244, 95% CI=1.569–3.210), insomnia (OR=4.047, 95% CI=3.140–5.214), overwhelming work stress (OR=3.054, 95% CI=2.038–4.577), unmanageable work burnout (OR=2.837, 95% CI=1.878–4.286), ≤5000 CNY monthly income (OR=2.065, 95% CI=1.458–2.926), current smoking (OR=2.628, 95% CI=1.802–3.832), CVD (OR=3.302, 95% CI=2.588–4.212), and family history of depression or anxiety (OR=4.019, 95% CI=3.004–5.376) (Tables 1, S3, and S4).

There were several factors associated with higher risk of CVD combined with depressive or anxiety symptoms among female scientists and technicians, including insomnia (OR=5.635, 95% CI=3.721–8.532), overwhelming work stress (OR=2.449, 95% CI=1.417–4.233), unmanageable work burnout (OR=3.010, 95% CI=1.661–5.457), ≤5000 CNY monthly income (OR=1.886, 95% CI=1.100–3.236), current smoking (OR=17.763, 95% CI=11.413–27.645), regular drinking (OR=2.421, 95% CI=1.241–4.722), hyperlipidemia (OR=1.714, 95% CI=1.168–2.515), hyperuricemia (OR=2.239, 95% CI=1.295–3.871), cerebrovascular disease (OR=2.930, 95% CI=1.337–6.424), family history of CVD (OR=3.092, 95% CI=2.354–4.062), and family history of depression or anxiety (OR=20.043, 95% CI=14.674–27.375) (Tables 1, S3, and S4).

3 Discussion

In this work, we investigated the prevalence and risk factors of CVD, depression, anxiety, and CVD combined with depressive or anxiety symptoms among female scientists and technicians. Of all participants, 16.6% had CVD, 21.4% had depressive symptoms, 13.8% had anxiety, and 9.5% had CVD combined with depressive or anxiety symptoms. The results revealed that, except traditional risk factors, unmanageable work burnout and depressive and anxiety symptoms were associated with a higher risk of CVD; insomnia, overwhelming work stress, unmanageable work burnout, and CVD were associated with higher risk of depressive symptoms and anxiety; and insomnia, overwhelming work stress, and unmanageable work burnout were associated with CVD combined with depressive or anxiety symptoms.

Among the female scientists and technicians included in this survey, there were 16.6% participants with CVD. Although the situation of CVD is emergent, most women are negligent of it due to the atypical symptoms (Banks, 2008). Therefore, the awareness and recognition of CVD is important. Our study found that the participants with higher educational level had lower prevalence of CVD. In line with this observation, Tousoulis et al. (2020) demonstrated that better education, rather than finances, helps to improve behaviors and dietary habits, which benefits cardiovascular care. In this study, we identified that the prevalence of CVD was 23.4% among female scientists and technicians with insomnia, while no association between CVD and insomnia was established. However, some studies that did not focus on women reported different results. Bertisch et al. (2021) conducted a cohort study with 385 292 UK biobank participants and a 11.4-year follow-up, and then indicated that insomnia or poor sleep led to increased risk of incident CVD by 10%–40%. Additionally, Fan et al. (2020) proved that healthy sleeping could contribute to the reduction of CVD risk. Consistent with other published studies, depressive and anxiety symptoms were associated with CVD in female scientists and technicians. In a prospective cohort study including 860 women, depression was proved to be an independent risk factor of CVD after 18 years of follow-up (O'Neil et al., 2016). Similarly, anxiety also accounted for myocardial infarction or death in those with CVD (Shibeshi et al., 2007).

The prevalence of depressive and anxiety symptoms was 21.4% and 13.8% in female scientists and technicians, respectively. Younger women (≤35 years) had higher prevalence of depression and anxiety, and psychological distress in young women would accelerate the progression of atherosclerosis and lead to CVD (Vaccarino and Bremner, 2017). Similar to our findings, other studies also found that work stress could result in poorer psychosomatic health, and 10.5% of space scientists perceive high work-related and economic stress and long-term exhaustion (Li et al., 2019), which is the same proportion as that among information technologists (Wang et al., 2019). Among physicians, medical errors could lead to depression; conversely, depression could cause medical errors (Pereira-Lima et al., 2019). Female healthcare workers are reportedly more vulnerable to depression in the

Eastern Mediterranean Region (Abraham et al., 2021). During the coronavirus disease pandemic in Spain, female teachers experienced a higher level of stress, anxiety, and depression than male teachers (Santamaría et al., 2021). In addition, insomnia as a symptom of depression is considered to be a predictor and risk factor of depression.

Female scientists and technicians with CVD combined with depressive or anxiety symptoms comprised 9.5% of the study population. Insomnia, overwhelming work stress, and unmanageable work burnout were associated with higher risk of comorbidity. Our study implicates a bidirectional relationship between psychological distress and CVD in women scientists and technicians. This relationship may be relevant with covariables such as work burnout in our study. Gale et al. (2014) reported that psychological distress is associated with a higher prevalence of obesity and diabetes, which could contribute to CVD. We hypothesized that specific aspects of vascular function and inflammation could exert a significant role in the pathogenesis of CVD and psychological distress in women. It has been reported that factors of genetic "nature" together with factors of "nurture" contribute to gender differences through biological mechanisms, such as genes, brain anatomy and function, vascular anatomy, inflammation, hormones, and neurotransmitters (Perry et al., 2019).

The strengths of this study are as follows: first, it is the first study to explore the prevalence and risk factors of CVD and psychological distress among female scientists and technicians; second, we discovered that insomnia was not associated with CVD, but according to the strong relationship between insomnia and depressive or anxiety symptoms, we hypothesized that insomnia is indirectly associated with CVD by inducing depressive or anxiety symptoms; third, to our knowledge, this is the first study of its kind to identify the risk factors of CVD combined with depressive or anxiety symptoms.

The limitations of this study are as follows: first, it is a cross-sectional study without follow-up data, which is not sufficient to analyze the causal relationship between CVD and depression or anxiety; second, we did not collect information on the menopause period, and no subgroup analysis on non-menopause or menopause periods was conducted; third, the sample size in this study was relatively small, and it should be expanded in future work; finally, we did not collect blood samples from the participants, limiting further recognition of the findings in this study.

Our study revealed high prevalence of CVD, depression, anxiety, and CVD combined with depressive or anxiety symptoms in female scientists and technicians in China. Moreover, there was bidirectional relationship between CVD and depression or anxiety in female scientists and technicians, and insomnia and overwhelming work stress were positively associated with comorbidity. Therefore, effective measures should be taken to protect female scientists and technicians from CVD and psychological distress.

Methods and materials

Detailed methods are provided in the electronic supplementary materials of this paper.

Acknowledgments

This work was supported by the National Academy of Innovation Strategy of China (No. 2019ys1-4-4-8) and the China Women's Development Foundation (No. 2021573). We appreciated Mrs. Shuzhen GUO (Department of Psycho-Cardiology, Beijing Anzhen Hospital, Capital Medical University, Beijing, China), Mrs. Wen YU (Health Examination Center, Beijing Anzhen Hospital, Capital Medical University, Beijing, China), and Mrs. Ruoyu PAN (Department of Internal Medicine, School Hospital, Beijing Information Science and Technology University, Beijing, China) for helpful investigation.

Author contributions

Meiyan LIU designed and supervised the investigation, and revised the paper; Lijun ZHANG analyzed the data and wrote the draft; Yanping BAO directed the statistical analysis and revised the paper; Guo LI collected and analyzed the data; Shuhui TAO collected the data. All authors have read and approved the final manuscript, and therefore, have full access to all the data in the study and take responsibility for the integrity and security of the data.

Compliance with ethics guidelines

Lijun ZHANG, Yanping BAO, Guo LI, Shuhui TAO, and Meiyan LIU declare that they have no conflict of interest.

Our study received approval from the Medical Ethics Committee of the Ethics Committee of Beijing Anzhen Hospital, Capital Medical University (No. 2014017X), and all participants included agreed to finish the survey questionnaires. All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2008 (5). Informed consent was obtained from all patients for being included in the study.

Additional informed consent was obtained from all patients for which identifying information is included in this article.

References

Abraham A, Chaabna K, Doraiswamy S, et al., 2021. Depression among healthcare workers in the Eastern Mediterranean Region: a systematic review and meta-analysis. *Hum Resour Health*, 19:81. https://doi.org/10.1186/s12960-021-00628-6

Banks AD, 2008. Women and heart disease: missed opportunities. *J Midwifery Women's Health*, 53(5):430-439. https://doi.org/10.1016/j.jmwh.2008.04.008

Bertisch SM, Reid M, Lutsey PL, et al., 2021. Gender differences in the association of insomnia symptoms and coronary artery calcification in the multi-ethnic study of atherosclerosis. *Sleep*, 44(10):zsab116. https://doi.org/10.1093/sleep/zsab116

Fan MY, Sun DJY, Zhou T, et al., 2020. Sleep patterns, genetic susceptibility, and incident cardiovascular disease: a prospective study of 385 292 UK biobank participants. *Eur Heart J*, 41(11):1182-1189. https://doi.org/10.1093/eurheartj/ehz849

Gale CR, Batty GD, Osborn DPJ, et al., 2014. Mental disorders across the adult life course and future coronary heart disease: evidence for general susceptibility. *Circulation*, 129(2):186-193. https://doi.org/10.1161/circulationaha.113.002065

Global Burden of Disease Collaborative Network, 2020. Global Burden of Disease Study 2019 (GBD 2019) results. Institute for Health Metrics and Evaluation, Seattle, WA, USA. http://ghdx.healthdata.org/gbd-results-tool

Guo F, Wang YX, Liu YN, et al., 2020. Mental health status and the risk/protective factors of Chinese scientific and technological professionals. *Sci Technol Rev*, 38(10):90-102 (in Chinese). https://doi.org/10.3981/j.issn.1000-7857.2020.10.026

Hanssen TA, Nordrehaug JE, Eide GE, et al., 2009. Anxiety and depression after acute myocardial infarction: an 18-month follow-up study with repeated measures and comparison with a reference population. *Eur J Cardiovasc Prev Rehabil*, 16(6):651-659. https://doi.org/10.1097/HJR.0b013e32832e4206

Li HB, Zheng DQ, Li ZW, et al., 2019. Association of depressive symptoms with incident cardiovascular diseases in middle-aged and older Chinese adults. *JAMA Netw Open*, 2(12):e1916591. https://doi.org/10.1001/jamanetworkopen.2019.16591

Liu MY, 2021. Spotlight on the relationship between heart disease and mental stress. *Heart Mind*, 5(1):1-3. https://doi.org/10.4103/hm.hm_12_21

Meng RW, Yu CQ, Liu N, et al., 2020. Association of depression with all-cause and cardiovascular disease mortality among adults in China. *JAMA Netw Open*, 3(2):e1921043. https://doi.org/10.1001/jamanetworkopen.2019.21043

O'Neil A, Fisher AJ, Kibbey KJ, et al., 2016. Depression is a risk factor for incident coronary heart disease in women: an 18-year longitudinal study. *J Affect Disord*, 196:117-124. https://doi.org/10.1016/j.jad.2016.02.029

Pereira-Lima K, Mata DA, Loureiro SR, et al., 2019. Association between physician depressive symptoms and medical errors: a systematic review and meta-analysis. *JAMA Netw Open*, 2(11):e1916097. https://doi.org/10.1001/jamanetworkopen.2019.16097

Perry SW, Licinio J, Wong ML, 2019. The depressed heart. *Heart Mind*, 3(2):35-46. https://doi.org/10.4103/hm.hm_13_19

Santamaría MD, Mondragon NI, Santxo NB, et al., 2021. Teacher stress, anxiety and depression at the beginning of the academic year during the COVID-19 pandemic. *Glob Ment Health (Camb)*, 8:e14. https://doi.org/10.1017/gmh.2021.14

Shibeshi WA, Young-Xu Y, Blatt CM, 2007. Anxiety worsens prognosis in patients with coronary artery disease. *J Am Coll Cardiol*, 49(20):2021-2027. https://doi.org/10.1016/j.jacc.2007.03.007

Smolderen KG, Strait KM, Dreyer RP, et al., 2015. Depressive symptoms in younger women and men with acute myocardial infarction: insights from the VIRGO study. *J Am Heart Assoc*, 4:e001424. https://doi.org/10.1161/jaha.114.001424

The Writing Committee of the Report on Cardiovascular Health and Diseases in China, 2021. Report on cardiovascular health and diseases burden in China: an updated summary of 2020. *Chin Circul J*, 36(6):521-545 (in Chinese). https://doi.org/10.3969/j.issn.1000-3614.2021.06.001

Tousoulis D, Oikonomou E, Vogiatzi G, et al., 2020. Cardiovascular disease and socioeconomic status: it is mainly education that counts and not wealth! *Eur Heart J*, 41(34):3213-3214. https://doi.org/10.1093/eurheartj/ehaa405

Vaccarino V, Bremner JD, 2017. Behavioral, emotional and neurobiological determinants of coronary heart disease risk in women. *Neurosci Biobehav Rev*, 74(Part B):297-309. https://doi.org/10.1016/j.neubiorev.2016.04.023

Vogel B, Acevedo M, Appelman Y, et al., 2021. The *Lancet* women and cardiovascular disease Commission: reducing the global burden by 2030. *Lancet*, 397(10292):2385-2438. https://doi.org/10.1016/s0140-6736(21)00684-x

Wang Y, Li XP, Xiao ZY, 2019. Mental health of IT employees. *Sci Technol Rev*, 37(11):45-52 (in Chinese). https://doi.org/10.3981/j.issn.1000-7857.2019.11.006

Supplementary information

Materials and methods; Tables S1−S4