



**A cross-sectional study of the relationship between depression and self-reported sleep disorders in breast cancer populations based on the NHANES database**

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Keywords:	sleep disorders, depression, breast cancer, self-reported, NHANES
Abstract:	<p>Background: To explore the relationship between depression and self-reported sleep disorders in breast cancer populations.</p> <p>Methods: Multivariate logistic regression, restricted cubic spline, and trend analysis were used to explore the relationship between depression and self-reported sleep disorder. Variables related to self-reported sleep disorders were stratified and the relationship between depression and self-reported sleep disorders was explored using stratified analyses. Receiver Operating Characteristic curves and Decision Curve Analysis curves were used to assess the predictive performance and clinical benefit of depression in predicting self-reported sleep disorders. Random forest and Adaboost were used to rank the importance of features on factors influencing self-reported sleep disorders.</p> <p>Results: A total of 408 breast cancer patients were enrolled in this study. When setting depression as a continuous variable, there is a positive association between depression and self-reported sleep disorders [OR=1.006(1.017-1.119), P=0.008]. When setting depression as a binary variable, there was still a positive association between them [OR=1.981(1.038-3.829), P=0.039]. When setting depression as an ordered classification variable, it was found that moderate depression was associated with self-reported sleep disorder [OR=3.227(1.491-7.322), P=0.004]. There was a linear relationship between depression and self-reported sleep disorder. With the increase in depression, the risk of self-reported sleep disorder gradually increased.</p> <p>Conclusions: There is a positive association between depression and self-reported sleep disorders. Furthermore, with the increase in depression, the risk of self-reported sleep disorder gradually increased.</p>

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**A cross-sectional study of the relationship between depression and self-reported sleep disorders in breast cancer populations based on the NHANES database**

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**Abstract**

**Background:** To explore the relationship between depression and self-reported sleep disorders in breast cancer populations.

**Methods:** Multivariate logistic regression, restricted cubic spline, and trend analysis were used to explore the relationship between depression and self-reported sleep disorder. Variables related to self-reported sleep disorders were stratified and the relationship between depression and self-reported sleep disorders was explored using stratified analyses. Receiver Operating Characteristic curves and Decision Curve Analysis curves were used to assess the predictive performance and clinical benefit of depression in predicting self-reported sleep disorders. Random forest and Adaboost were used to rank the importance of features on factors influencing self-reported sleep disorders.

**Results:** A total of 408 breast cancer patients were enrolled in this study. When setting depression as a continuous variable, there is a positive association between depression and self-reported sleep disorders [OR=1.006(1.017-1.119), P=0.008]. When setting depression as a binary variable, there was still a positive association between them [OR=1.981(1.038-3.829), P=0.039]. When setting depression as an ordered classification variable, it was found that moderate depression was associated with self-reported sleep disorder [OR=3.227(1.491-7.322), P=0.004]. There was a linear relationship between depression and self-reported sleep disorder. With the increase in depression, the risk of self-reported sleep disorder gradually increased.

**Conclusions:** There is a positive association between depression and self-reported sleep disorders. Furthermore, with the increase in depression, the risk of self-reported sleep disorder gradually increased.

**Keywords:** sleep disorders; depression; breast cancer; self-reported; NHANES

## 1 Introduction

Breast cancer is one of the most common cancers in women, accounting for 30% of female cancers <sup>1</sup>. The World Health Organization has stated that the global burden of breast cancer is set to increase to more than 3 million new cases and 1 million deaths by the year 2040 if current trends persist <sup>2</sup>. Most breast cancer patients experience a wide range of severe symptoms caused by the cancer itself or by the treatment modalities (e.g., chemotherapy, radiation, endocrine therapy, etc.), such as nausea, vomiting, pain, fatigue, diarrhea, and hormonal disturbances, which cause significant physical and psychological stress <sup>3</sup>. Therefore, the physical and psychological problems of breast cancer patients deserve our attention.

Depression is a common psychological disorder that is characterized by persistent low mood and loss of interest <sup>4</sup>. Studies have found the prevalence of depression in breast cancer patients to be in the range of 4.5%-38% <sup>5</sup>, which is higher than the prevalence in populations of the adult population <sup>6</sup>. Results of a meta-analysis that included 47,424 breast cancer patients with co-morbid depression showed that the prevalence of depression among breast cancer patients worldwide was 32.2% <sup>7</sup>. In addition, sleep disorders are very common in patients with breast cancer <sup>8</sup>, and among tumor patients, sleep disorders are the most common in breast cancer patients and lung cancer patients <sup>9</sup>. Faiz et al. found that 75% of patients experienced poor sleep and 55% experienced daytime sleepiness <sup>10</sup>.

Sleep disorders have been found to be associated with depression in a lung cancer population <sup>11</sup>. However, in another study, sleep disorders in older cancer patients were found to be related only to fatigue and not to depression or pain <sup>12</sup>. The relationship between depression and self-reported sleep disorders has

not been fully clarified in cancer populations, and there is a lack of research in breast cancer populations; therefore, this study explores the relationship between depression and self-reported sleep disorders in breast cancer populations based on the National Health and Nutrition Examination Survey (NHANES) database.

**2 Methods**

**2.1 Data source**

Patient data for this study were obtained from the NHANES 2011-2012 cycles, 2013-2014 cycles, 2015-2016 cycles, and 2017-2020.3 cycles. These cycles of NHANES data are the most recent available for self-reported sleep disorders. The NHANES program began in the early 1960s as a survey of different populations or health topics, combining the National Nutritional Surveillance System with the National Health Survey System.

**2.2 Inclusion and exclusion criteria**

Inclusion criteria: (1) the patient's gender was female, (2) the patient has breast cancer.  
Exclusion criteria: (1) missing and refusing to answer in self-reported sleep disorder data, (2) unable to calculate depression scores.

**2.3 Grouping, variables, and define**

In this study, the subjects were categorized into the without self-reported sleep disorder group and the self-reported sleep disorder group based on the presence or absence of self-reported sleep disorder.

The variables included in this study were race (Hispanic, others), education (high school and below, others), marital status (married, others), asthma (yes, no), arthritis (yes, no), congestive heart failure (yes, no), coronary heart disease (yes, no), angina pectoris (yes, no), stroke (yes, no), thyroid disease (yes, no),

liver disease (yes, no), age, ratio of family income to poverty (PIR), albumin, creatinine, albumin creatinine ratio, white blood cell count, lymphocyte number, monocyte number, neutrophils number, eosinophils number, basophils number, red blood cell count, hemoglobin, hematocrit, mean cell volume, mean cell hemoglobin, red cell distribution width, platelet count, mean platelet volume, blood lead, blood cadmium, blood mercury, blood selenium, blood manganese, depression.

The diagnosis of breast cancer was when the patient answered “yes” to the question "Have you ever been held by a doctor or other health professional that you had cancer or a malignancy of any kind", and then answered “yes” to the question "What kind of cancer was it" <sup>13</sup>.

Self-reported sleep disorder was defined as the patient's response of “yes” to the question-“Ever told a doctor or other health professional that trouble sleeping?”<sup>14</sup>.

Depression was assessed according to the score of the PHQ-9 questionnaire. There are 9 questions in this questionnaire, and each question scores 0-3, with a total score of 27. If the score is greater than 9, it is judged as depression <sup>15</sup>. In this study, depression was also categorized into four categories, with a depression score of 0-4 as no depression, 5-9 as mild depression, 10-14 as moderate depression, and 15-27 as moderate depression <sup>16</sup>.

## 2.4 Statistical analysis

R language was used for data analysis. The quantitative data of non-normal distribution were described by median ( $P_{25}$ - $P_{75}$ ), and the Mann-Whitney U test was used for comparison between the two groups. The quantitative data was described by ratio, and the chi-square test was used for comparison between the two groups. Multivariate logistic regression was used to explore the relationship between depression (setting as a continuous variable, a binary variable, and an ordered classification variable) and self-reported sleep

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5 106 disorder. When setting depression as a continuous variable, Restricted cubic spline (RCS) analysis, was  
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8 107 used to explore whether there was a linear relationship between depression and self-reported sleep disorder  
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10 108 under the crude model and the adjusted model. When setting depression as an ordered classification variable,  
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13 109 trend analysis was employed to explore the relationship between depression and self-reported sleep disorder  
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15 110 under the crude model and the adjusted model. Variables related to self-reported sleep disorders were  
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18 111 stratified and the relationship between depression (setting as a continuous variable, a binary variable, and  
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20 112 an ordered classification variable) and self-reported sleep disorders was explored using stratified analyses.  
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23 113 Receiver Operating Characteristic (ROC) curves and Decision Curve Analysis (DCA) curves were used to  
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26 114 assess the predictive performance and clinical benefit of depression (setting as a continuous variable, a  
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28 115 binary variable, and an ordered classification variable) in predicting self-reported sleep disorders. Random  
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39 119 **3 Results**

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41 120 **3.1 Patient information**

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44 121 A total of 408 breast cancer patients were enrolled in this study, of which 252 had no self-reported  
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46 122 sleep disorders and 156 had self-reported sleep disorders. As shown in **Table 1**, there were differences  
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49 123 between the two groups in asthma, arthritis, and coronary heart disease (all  $P<0.05$ ). Compared with those  
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52 124 without self-reported sleep disorder, individuals with self-reported sleep disorder were more likely to suffer  
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54 125 from asthma, arthritis, and coronary heart disease. The prevalence of asthma in individuals with self-  
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57 126 reported sleep disorders was significantly higher than in those without self-reported sleep disorders, with a



ratio of 23.077% to 13.095%, respectively. 71.795% of people with self-reported sleep disorders have asthma, while only 52.800% of people without self-reported sleep disorders have asthma. In terms of coronary heart disease, 9.615% of people in the self-reported sleep disorder group suffered from the disease, while only 3.586% of people in the without self-reported sleep disorder group suffered from the disease.

**Table S1** showed that when setting depression as a continuous variable, the self-reported sleep disorder group had higher depression scores than that in the without self-reported sleep disorder group (3.000 VS 1.000,  $P=0.001$ ). When setting depression as a binary variable, 17.949% of people in the self-reported sleep disorder group had depression, while only 7.540% of people in the without self-reported sleep disorder group suffered from depression ( $P<0.001$ ). It also found differences between the without self-reported sleep disorder group and the self-reported sleep disorder group when setting depression as an ordered classification variable ( $P<0.001$ ).

### 3.2 Relationship between depression and self-reported sleep disorder

Next, we further explored the relationship between depression and self-reported sleep disorder using multivariate logistic regression. When setting depression as a continuous variable, there is a positive association between depression and self-reported sleep disorders [OR=1.006 (95%CI:1.017-1.119),  $P=0.008$ ] (**Table S2**). When setting depression as a binary variable, there was still a positive association between them [OR=1.981 (95%CI: 1.038-3.829),  $P=0.039$ ]. When setting depression as an ordered classification variable, it was found that moderate depression was associated with self-reported sleep disorder [OR=3.227(95%CI: 1.491-7.322),  $P=0.004$ ].

When setting depression as an ordered classification variable, trend analysis was also used to explore the relationship between them (**Table S2**). After adjusting for asthma, arthritis, and coronary heart disease,

it was also found that with the degree of depression increased, the risk of self-reported sleep disorder gradually increased [P for trend: OR=1.350(95%CI: 1.030-1.769), P=0.030].

We further explored whether there was a linear relationship between depression and self-reported sleep disorder when setting depression as a continuous variable. From **Figure 1 A-B**, in the crude model, there was a linear relationship between depression and self-reported sleep disorder (P for overall<0.001, P for nonlinear=0.053) (**Figure 1 A**). On the whole, with the increase in depression score, the risk of sleep disorder gradually increased. The same result was also found in the adjusted model (P for overall=0.006, P for nonlinear=0.063) (**Figure 1 B**). All three of these results suggested an association between depression and sleep disorders.

Since asthma, arthritis, and coronary heart disease were found to differ between the two groups at baseline information, we further stratified these factors to explore the relationship between depression and self-reported sleep disorders. When setting depression as a continuous variable, there was a positive association between depression and self-reported sleep disorders in the total population, in the population without asthma, in the population with arthritis, and in the population without coronary heart disease (**Table 2**). The same result was also obtained when setting depression as a binary variable or an ordered classification variable (**Table 2**).

**3.3 Clinical value of depression in predicting self-reported sleep disorders**

Based on these results, we further explored the predictive value of depression for sleep disorders. As can be seen in **Figure 2 A**, when depression was set as a continuous variable, the area under curve (AUC) for depression to predict self-reported sleep disorder was 0.631 (95%CI: 0.595-0.681). From **Figure 2 B**, when depression was set as a binary variable, the AUC for depression to predict self-reported sleep disorder

was 0.552 (95%CI: 0.524-0.585). When depression was set as an ordered classification variable, the AUC for depression to predict self-reported sleep disorder was 0.588 (95%CI: 0.548-0.638) (**Figure 2 C**). When the threshold was about 0.3-0.6, depression (setting as a continuous variable) achieved a greater clinical benefit for predicting self-reported sleep disorder than the treat-all and treat-none model (**Figure 2 D**). Furthermore, when the threshold was set at approximately 0.35-0.6, depression (defined as a binary variable) exhibited a heightened clinical efficacy in predicting self-reported sleep disorders, surpassing the performance of the treat-all and treat-none model (**Figure 2 E**). Similar results were found when setting depression as an ordered classification variable with thresholds of 0.35-0.55 (**Figure 2 F**).

The results of the above research showed that asthma, arthritis, coronary heart disease, and depression were all related to sleep disorders. This study further used different machine learning models (random forest and Adaboost) to explore which factor was the most important among the factors related to sleep disorders. When depression was set as a continuous variable or an ordered classification variable, the results from Random Forest showed that depression ranked first among the four factors (**Figure 3 A, E**). When depression was set as a binary variable, the results of the Random Forest showed arthritis ranked first, depression ranked second, coronary heart disease ranked third, and asthma ranked fourth (**Figure 3 C**). Adaboost's results suggested that regardless of whether depression was set as a continuous variable, a binary variable, or an ordered classification variable, depression was ranked first in importance among the four factors (**Figure 3 B, D, F**).

#### 4 Discussion

The aggressive nature of breast cancer disease, ongoing clinical treatment, and uncertain clinical

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190 outcomes lead to more somatic symptoms. They also lead to more and more complex psychiatric and  
191 psychological symptoms that greatly reduce the quality of life of breast cancer patients <sup>17</sup>. Sleep disorders  
192 and depression are highly prevalent in breast cancer patients <sup>18</sup>. This study explored the relationship  
193 between sleep disorders and depression based on the NHANES database and found that (1) there is a  
194 positive association between depression and self-reported sleep disorders, (2) with the increase in  
195 depression, the risk of self-reported sleep disorder gradually increased.

196       In this study, we found that asthma was associated with sleep disorders. A meta-analysis based on 23  
197 studies showed a positive association between sleep disorders and asthma <sup>19</sup>. Another study on Arab breast  
198 cancer survivors also found an association between sleep disorders and asthma <sup>20</sup>. Numerous studies have  
199 shown that the effects of asthma and sleep disorders are bidirectional interactions <sup>21-23</sup>. The relationship  
200 between asthma and sleep disorder may be related to gastroesophageal reflux (GERD) <sup>24</sup>. During an asthma  
201 attack, the lungs swell and the increased pressure in the stomach may cause the muscles that normally  
202 prevent acid reflux to relax, which allows the acid to flow back into the esophagus, causing GERD <sup>25</sup>.  
203 GERD symptoms such as pain behind the sternum, heartburn, and throat discomfort can worsen at night  
204 when lying flat on the back, interfering with the patient's sleep <sup>26</sup>. Conversely, sleep deprivation will  
205 increase the sensitivity of the esophagus to acid, which will aggravate the symptoms of GERD <sup>27</sup>. GERD  
206 will cause gastric contents to reflux into the esophagus and even reach the trachea and lungs. These stomach  
207 acids and digestive juices can stimulate the respiratory tract, cause bronchospasm, and thus lead to asthma  
208 symptoms <sup>28</sup>.

209       In addition to this, this study also found that arthritis and coronary heart disease were associated with  
210 sleep disorders. A case-control study found that sleep disorders were significantly associated with arthritis,

regardless of gender, age, and type of arthritis<sup>29</sup>. Sleep deprivation may lead to decreased regulation of the immune system, which may exacerbate the inflammatory response<sup>30</sup> and aggravate arthritis. Conversely, the pain and discomfort caused by arthritis can also affect the quality of sleep. Sleep disorders were also found to be significantly associated with coronary heart disease in a cross-sectional study<sup>31</sup>. Coronary heart disease can affect the production of the sleep hormone melatonin in the pineal gland, which will lead to sleep disorder<sup>32</sup>. On the contrary, sleep deprivation can activate the sympathetic-adrenal system, leading to increased heart rate and blood pressure, and increasing the risk of coronary heart disease<sup>33</sup>.

In the present study, we found a positive association between depression and self-reported sleep disorder, and with the increase in depression, the risk of self-reported sleep disorder gradually increased. Peters van Neijenhof et al. explored the correlates of sleep disorders in depressed older adults based on the Dutch Geriatric Depression Study and found a correlation between sleep disorders and the severity of depression<sup>34</sup>. Similar results were found in the youth population<sup>35</sup>. Previous studies have considered sleep disorders to be a symptom of depression, and as research has progressed, several studies have found sleep disorders to be a risk factor for depression<sup>36,37</sup>. Depression and sleep disorders have a bidirectional relationship, sleep disorders are not only a complication of depression but may also be a precursor to it<sup>38</sup>. The relationship between depression and sleep disorder may be related to inflammation. Yin et al. found that inflammatory markers (neutrophil-to-lymphocyte ratio and C-reactive protein levels) mediated the relationship between sleep disorders and depression<sup>39</sup>. In another study, interleukin 6 (IL-6) levels were found to be significantly elevated in patients with major depressive disorder, and IL-6 levels correlated with sleep disturbances<sup>40</sup>. Depression activates the body's immune response system, leading to an increase in the levels of various inflammatory factors<sup>41</sup>. The activation of IL-1, IL-6, and TNF can promote rapid eye

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232 movement, thus causing drowsiness symptoms, while the activation of IL-4 and IL-10 can inhibit non-rapid  
233 eye movement sleep, thus playing an anti-sleep effect <sup>42</sup>. Sleep disorder causes norepinephrine to enter  
234 primary and secondary lymphoid organs, stimulates adrenaline to enter systemic circulation, and increases  
235 the expression of inflammatory genes by stimulating adrenergic receptors of leukocytes and activating NF-  
236  $\kappa$ B, thus increasing the secretion of inflammatory cytokines. Inflammatory reaction can significantly  
237 regulate neuronal activity, affecting inflammatory reaction can significantly regulate neuronal activity, and  
238 affect the normal function of the hypothalamus-pituitary-adrenal axis, thus causing depressive symptoms  
239 <sup>38</sup>. The relationship between sleep disorder and depression is complex, and the mechanisms of their  
240 interaction remain worthy of further investigation. When carrying out treatment and intervention for  
241 patients with sleep disorders, we should not only pay attention to the improvement of sleep status but also  
242 pay attention to the problem of depression.

243 This study was the first to find a positive association between sleep disorders and depression in the  
244 breast cancer population. This study has some limitations, firstly, due to the database we were unable to  
245 identify the subtypes of breast cancer to further explore the relationship further in different subtypes, and  
246 secondly, due to the database, there were some factors associated with sleep disorders that have not been  
247 included in this study.

248  
249 **5 Conclusions**

250 There is a positive association between depression and self-reported sleep disorders. Furthermore, with  
251 the increase in depression, the risk of self-reported sleep disorder gradually increased. Our findings  
252 suggested that breast cancer patients with sleep disorders should be concerned about their depressive status.

253

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**256 Author contributions**

257 ZW contributed to the conception and design. ZW, ZCH and PFL contributed to the collection and assembly  
258 of data. ZW, ZLX and YO analyzed and interpreted the data. All authors wrote and approved the final  
259 manuscript.

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**262 Statements and Declarations**

263 **Ethical considerations:** The Ethics Committee of The First Hospital of Putian City deemed that this  
264 research is based on open-source data, so the need for ethics approval was waived.

265 **Consent to participate:** Not applicable.

266 **Consent for publication:** Not applicable.

267 **Declaration of conflicting interest:** The author(s) declared no potential conflicts of interest with respect  
268 to the research, authorship, and/or publication of this article.

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270 **Data availability:** The datasets generated during and/or analyzed during the current study are available  
271 from the corresponding author on reasonable request.

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**Figure legends**

**Figure 1** The linear relationship between depression and self-reported sleep disorder, (A) crude model, (2) adjusted model, adjusted asthma, arthritis, and coronary heart disease

**Figure 2** The clinical value of depression in predicting self-reported sleep disorders, (A) the ROC of depression in predicting self-reported sleep disorders when setting depression as a continuous variable, (B) the ROC of depression in predicting self-reported sleep disorders when setting depression as a binary variable, (C) the ROC of depression in predicting self-reported sleep disorders when setting depression as an ordered classification variable, (D) the ROC of depression in predicting self-reported sleep disorders when setting depression as a continuous variable, (E) the ROC of depression in predicting self-reported sleep disorders when setting depression as a binary variable, (F) the ROC of depression in predicting self-reported sleep disorders when setting depression as an ordered classification variable, model 1: depression,

**Figure 3** The feature importance assessment of factors influencing self-reported sleep disorders. (A) Random forests and (B) Adaboost algorithms when setting depression as a continuous variable. (C) Random forests and (D) Adaboost algorithms when setting depression as a binary variable. (E) Random forests and (F) Adaboost algorithms when setting depression as an ordered classification variable.

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**Table 1** Basic information on breast cancer patients

Variable		Without self-reported sleep disorder (n=252)	Self-reported sleep disorder (n=156)	P
Race	Hispanic	48 (19.048)	31 (19.872)	0.838
	Others	204 (80.952)	125 (80.128)	
Education	High school and below	46 (18.254)	28 (17.949)	0.938
	Others	206 (81.746)	128 (82.051)	
Marital status	Married	113 (44.841)	65 (41.667)	0.530
	Others	139 (55.159)	91 (58.333)	
Asthma	Yes	33 (13.095)	36 (23.077)	0.009
	No	219 (86.905)	120 (76.923)	
Arthritis	Yes	132 (52.800)	112 (71.795)	<0.001
	No	118 (47.200)	44 (28.205)	
Congestive heart failure	Yes	13 (5.159)	10 (6.536)	0.562
	No	239 (94.841)	143 (93.464)	
Coronary heart disease	Yes	9 (3.586)	15 (9.615)	0.012
	No	242 (96.414)	141 (90.385)	
Angina pectoris	Yes	10 (3.968)	8 (5.195)	0.560

	No	242 (96.032)	146 (94.805)	
Stroke	Yes	15 (5.976)	16 (10.390)	0.105
	No	236 (94.024)	138 (89.610)	
Thyroid disease	Yes	64 (25.397)	42 (27.097)	0.704
	No	188 (74.603)	113 (72.903)	
Liver disease	Yes	15 (5.952)	12 (7.742)	0.481
	No	237 (94.048)	143 (92.258)	
Age		69.000 [60.000,78.000]	68.000 [59.000,77.000]	0.707
PIR		2.660 [1.340,5.000]	1.980 [1.260,4.190]	0.107
Albumin (mg/L)		9.400 [4.500,22.800]	9.000 [4.400,24.900]	0.832
Creatinine (mg/dL)		75.000 [49.000,123.000]	84.000 [45.000,133.000]	0.514
Albumin creatinine ratio (mg/g)		10.660 [6.140,24.010]	10.730 [7.160,23.180]	0.670
White blood cell count (1000 cells/ $\mu$ L)		6.600 [5.500,8.100]	6.900 [5.700,8.400]	0.054
Lymphocyte number (1000 cells/ $\mu$ L)		1.800 [1.400,2.400]	2.000 [1.500,2.500]	0.060
Monocyte number (1000 cells/ $\mu$ L)		0.500 [0.400,0.700]	0.500 [0.400,0.700]	0.216
Neutrophils number (1000 cell/ $\mu$ L)		3.900 [3.000,5.000]	4.100 [3.200,5.000]	0.175
Eosinophils number (1000 cells/ $\mu$ L)		0.200 [0.100,0.300]	0.200 [0.100,0.200]	0.817
Basophils number (1000 cells/ $\mu$ L)		0.000 [0.000,0.100]	0.100 [0.000,0.100]	0.175
Red blood cell count (million cells/ $\mu$ L)		4.400 [4.180,4.680]	4.400 [4.100,4.640]	0.625
Hemoglobin (g/dL)		13.400 [12.600,14.100]	13.300 [12.500,13.900]	0.222

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Hematocrit (%)	40.000 [37.800,41.900]	39.300 [36.900,41.400]	0.132
Mean cell volume (fL)	90.400 [86.800,94.000]	90.300 [87.100,93.500]	0.449
Mean cell hemoglobin (pg)	30.400 [29.000,31.700]	30.100 [28.600,31.700]	0.547
Red cell distribution width (%)	13.500 [13.000,14.300]	13.700 [13.100,14.600]	0.095
Platelet count (1000 cells/uL)	225.000	225.000	0.349
	[196.000,262.000]	[197.000,285.000]	
Mean platelet volume (fL)	8.400 [7.700,9.000]	8.100 [7.600,8.900]	0.158
Blood lead (ug/dL)	1.180 [0.800,1.600]	1.225 [0.760,1.760]	0.937
Blood cadmium (ug/L)	0.380 [0.260,0.590]	0.380 [0.246,0.580]	0.942
Blood mercury (ug/L)	0.870 [0.450,1.710]	0.730 [0.450,1.410]	0.277
Blood selenium (ug/L)	185.640	189.540	0.649
	[174.520,200.340]	[170.010,206.010]	
Blood manganese (ug/L)	9.060 [7.580,11.330]	9.550 [7.740,11.850]	0.395

PIR: ratio of family income to poverty



**Table 2 Relationship between depression and self-reported sleep disorder by stratified analyses**

	Depression score		Depression status		Depression degree	
	OR [95%CI]	P	OR [95%CI]	P	OR [95%CI]	P
Total	1.093 [1.045,1.144]	<0.001	2.683 [1.441,4.993]	0.002	1.568 [1.213,2.027]	0.001
Asthma						
Yes	1.064 [0.977,1.158]	0.153	1.731 [0.550,5.447]	0.348	1.335 [0.837,2.129]	0.225
No	1.094 [1.036,1.155]	0.001	2.796 [1.319,5.931]	0.007	1.577 [1.151,2.161]	0.005
Arthritis						
Yes	1.074 [1.019,1.132]	0.008	2.127 [1.054,4.292]	0.035	1.442 [1.071,1.941]	0.016
No	1.083 [0.983,1.193]	0.107	2.850 [0.681,11.932]	0.152	1.413 [0.805,2.479]	0.229
Coronary heart disease						
Yes	0.993 [0.862,1.145]	0.928	1.273 [0.182,8.892]	0.808	1.023 [0.446,2.344]	0.958
No	1.099 [1.047,1.153]	<0.001	2.715 [1.403,5.254]	0.003	1.585 [1.208,2.081]	0.001

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For Peer Review

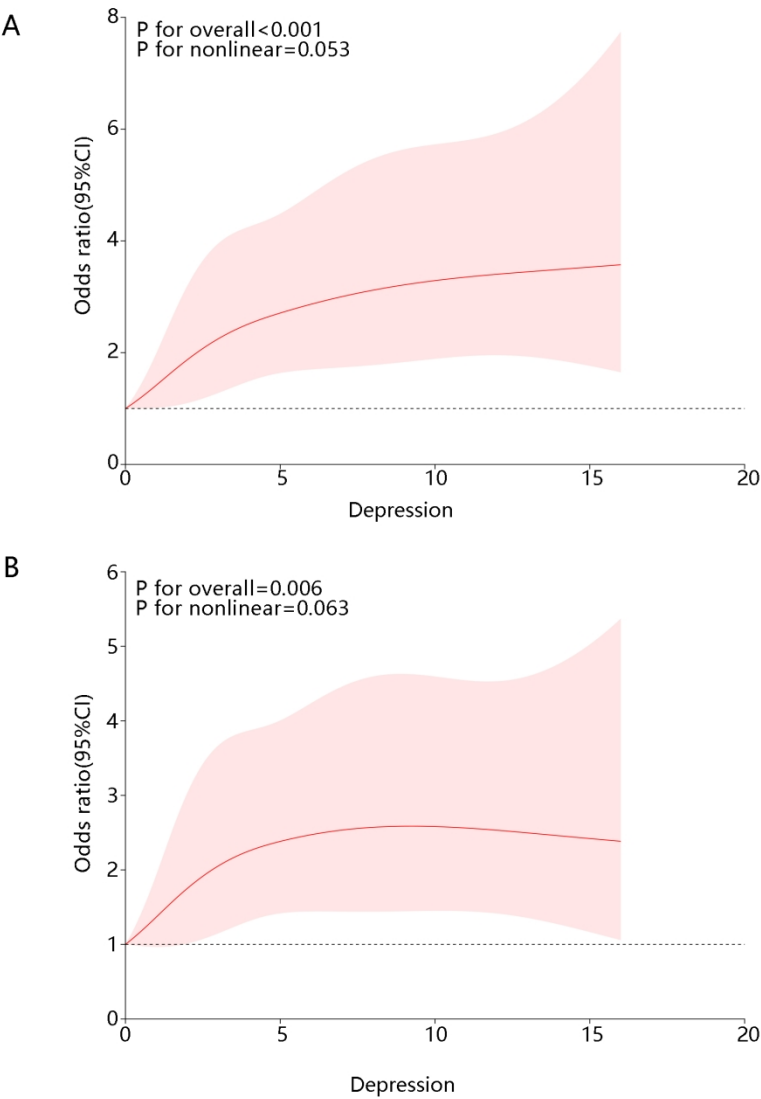


Figure 1

180x199mm (300 x 300 DPI)

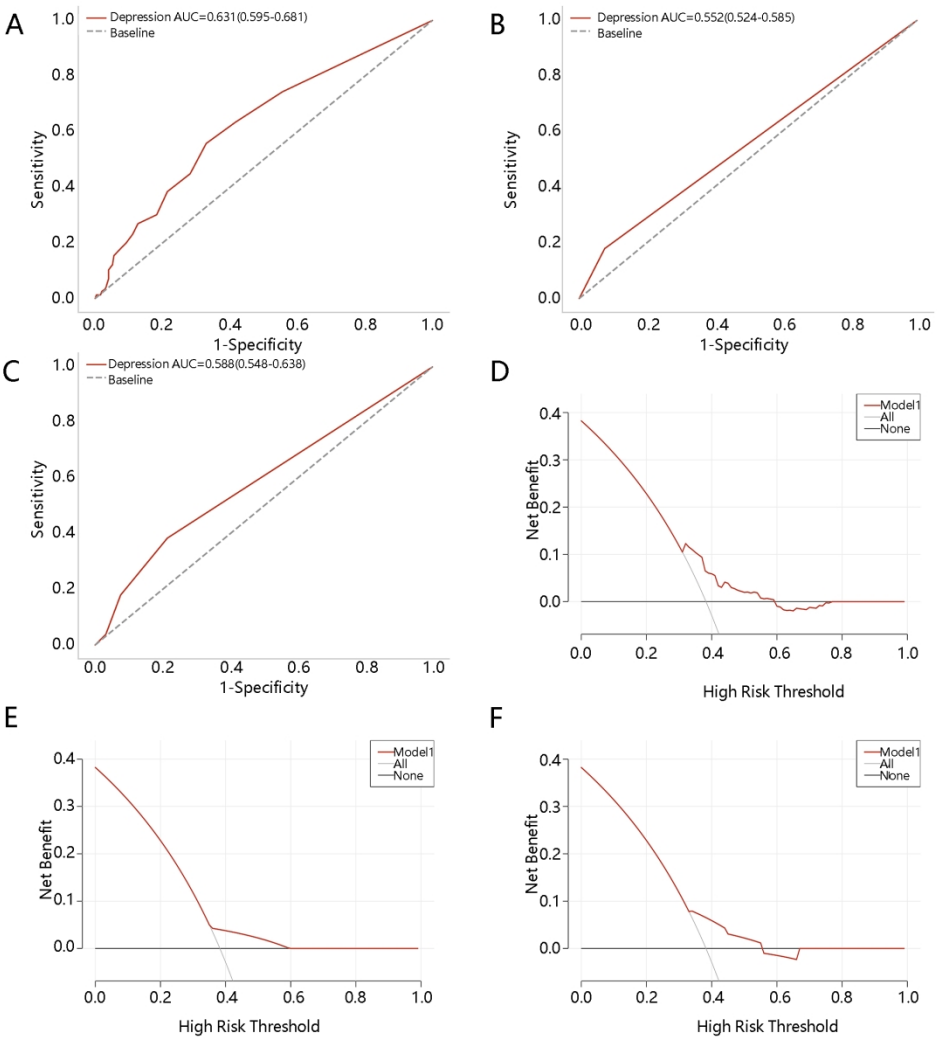


Figure 2

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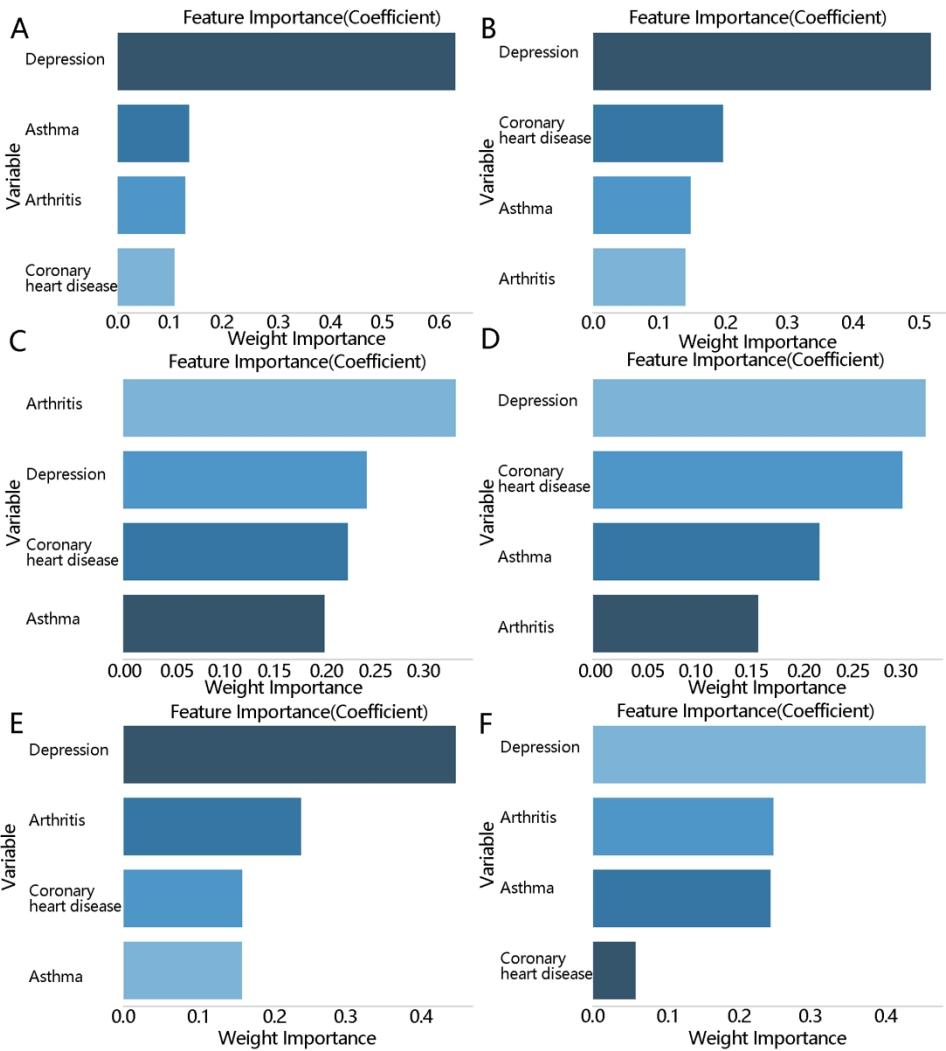


Figure 3

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**Table S1** Difference of depression between without self-reported sleep disorder group and self-reported sleep disorder group

Variable		Without self-reported sleep disorder(n=252)	Self-reported sleep disorder (n=156)	P
Depression status	No	233 (92.460)	128 (82.051)	0.001
	Yes	19 (7.540)	28 (17.949)	
Depression degree	No	198 (78.571)	96 (61.538)	<0.001
	Mild	35 (13.889)	32 (20.513)	
	Moderate	11 (4.365)	22 (14.103)	
	Severe	8 (3.175)	6 (3.846)	
Depression score		1.000 [0.000,4.000]	3.000 [0.000,7.000]	<0.001

**Table S2** Relationship between depression and self-reported sleep disorder

	Independent variable	Estimate	Z	P	Odds Ratio	Lower	Upper
Model 1	Depression score	0.064	2.635	0.008	1.066	1.017	1.119
Model 2	Depression (Yes VS No)	0.683	2.063	0.039	1.981	1.038	3.829
Model 3	Depression (Mild VS No)	0.471	1.664	0.096	1.601	0.916	2.787
	Depression (Moderate VS No)	1.172	2.912	0.004	3.227	1.491	7.322
	Depression (Severe VS No)	-0.099	-0.170	0.865	0.906	0.276	2.815
P for trend				0.030	1.350	1.030	1.769

Model 1, model 2, and model 3 all adjusted asthma, arthritis, and coronary heart disease, model 1 set depression as a continuous variable, model 2 set depression as a binary variable, and model 3 set depression as an ordered classification variable.