Association between depressive symptoms and 25-hydroxyvitamin D in middle-aged and elderly Chinese

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ABSTRACT

Background: Vitamin D deficiency is recently speculated to play a role in the development of depression. Nevertheless, few studies have explored the association between blood 25-hydroxyvitamin D [25(OH)D] concentrations and depression in the general population. Therefore, we aimed to determine this association in middle-aged and elderly Chinese.

Methods: We conducted a population-based cross-sectional study in 2005 in Beijing and Shanghai, China. Participants included 3262 community residents aged 50–70. Depressive symptoms were defined as a Center for Epidemiological Studies of Depression Scale (CES-D) score of 16 or higher. Circulating 25(OH)D concentrations were measured by radioimmunoassay.

Results: The prevalence of depressive symptoms was lower in the top tertile of 25(OH)D concentrations compared to the lowest tertile (7.2% vs. 11.1%) in the study population (odds ratio, 0.62; 95% confidence interval, 0.46–0.83; P for trend=0.002). This association was substantially attenuated after controlling for various confounding factors, and disappeared after including geographic location in the model. Stratiﬁed analysis by location did not ﬁnd any association between depressive symptoms and 25(OH)D levels among participants from either Beijing or Shanghai.

Limitations: Due to the cross-sectional study design, causal relation remains unknown.

Conclusions: Depressive symptoms are not associated with 25(OH)D concentrations in middle-aged and elderly Chinese. Further prospective studies are required to determine whether they are correlated.

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1. Introduction

Major depression was the fourth leading cause of disease burden in 2000 and is projected to become the second by 2020 (Lopez and Murray, 1998). Vitamin D receptor and the vitamin D activating enzyme 1-alpha-hydroxylase are widely distributed in human brain, particularly hypothalamus, and it is speculated that 25-hydroxyvitamin D [25(OH)D] deﬁciency might increase the odds of suffering depression (Berk et al., 2007). Despite a growing interest in this area, few studies have evaluated the association between depression and blood 25(OH)D levels in the general population (Hoogendijk et al., 2008). We reported herein the results from the Nutrition and Health of Aging Population in China (NHAPC) project, a population-based cross-sectional study in middle-aged and elderly Chinese.

2. Subjects and methods

2.1. Participants

The study design of NHAPC project has been described in detail previously (Pan et al., 2008a,b). In brief, this study was...
simultaneously conducted in Beijing (north) and Shanghai (south) among non-institutionalized individuals of 50–70 years old in 2005. One rural county and two urban districts were selected in both cities. Individuals were excluded if they had one of the following conditions: self-care disabilities; psychological severe disorders; diagnosed with cancer, CVD, Alzheimer’s disease and dementia within the 6 month period before the start of the study; or currently diagnosed with tuberculosis, AIDS and other communicable diseases. In total, 3262 eligible participants with complete information of questionnaire, physical examination and 25(OH)D data were included in the analyses. The study was approved by the Institutional Review Board of the Institute for Nutritional Sciences, and informed consent was obtained from each participant.

2.2. Assessment of depressive symptoms

The self-reported 20-item Center for Epidemiologic Studies–Depression (CES-D) Scale (Radloff, 1977), validated in Chinese populations previously (Zhang and Norvilitis, 2002), was used to measure the presence of depressive symptoms experienced during the previous week. Binary categories of respondents were created using a generally accepted cutoff point of 16, which has a good validity for major depression (Radloff, 1977).

2.3. Plasma 25(OH)D measurement

Circulating 25(OH)D concentrations were measured by radioimmunoassay using acetonitrile extracts of the plasma (DiaSorin, Stillwater, MN).

2.4. Covariates

In-house, face-to-face interviews were conducted by trained research staff using a standardized questionnaire (Pan et al., 2008a,b). Socio-demographic variables included age, gender, geographic location (Beijing/Shanghai), residential region (urban/rural), marital status (having spouse or not), annual household income, and social activity level (active/inactive). Current smoking status (yes/no) also was assessed. The physical activity level for each individual was classified as low, moderate or high according to the International Physical Activity Questionnaire scoring protocol with minor modification (Craig et al., 2003). Information of the presence of the following chronic diseases was obtained: diabetes, dyslipidemia, hypertension, heart disease, cerebrovascular disease, chronic bronchitis, gastrointestinal ulcer, arthritis, rheumatic and rheumatoid arthritis, fracture, cataract, and glaucoma. Participants were categorized into three groups according to the number of reported chronic diseases (none, 1–2, and ≥3). Body height and weight of the participants were measured and body mass index was calculated as weight (kg)/height² (m²).

2.5. Statistical analyses

Multivariate logistic regression was used with depressive symptoms as the outcome and plasma 25(OH)D concentrations (tertiles) as a predictor, along with adjustment for potential confounders (age, sex, urban/rural, body mass index, physical activity level, smoking status, social activity level, marital status, household income, and number of chronic diseases). Geographic location (Beijing/Shanghai) was further included in the model to determine its influence, and stratified analysis by location was also performed. The natural-logarithm transformation was performed to approximate normality CES-D scores or 25(OH)D concentrations when necessary. All statistic tests were based on 2-sided probability using Stata 9.2 (StataCorp, College Station, Texas).

3. Results

The prevalence of depressive symptoms was lower in the top tertile of 25(OH)D compared to the lowest tertile (78 vs.

### Table 1

<table>
<thead>
<tr>
<th>25-hydroxyvitamin D categories (nmol/L)</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>P for trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total, continuous level</td>
<td>26.1±5.9</td>
<td>41.1±4.1</td>
<td>65.1±16.0</td>
<td></td>
</tr>
<tr>
<td>Cases/participants (%)</td>
<td>121/1087 (11.1)</td>
<td>113/1088 (10.4)</td>
<td>78/1087 (7.2)</td>
<td></td>
</tr>
<tr>
<td>Unadjusted association</td>
<td>1.00</td>
<td>0.93 (0.71–1.21)</td>
<td>0.62 (0.46–0.83)</td>
<td>0.002</td>
</tr>
<tr>
<td>Model 1 a</td>
<td>1.00</td>
<td>0.96 (0.72–1.27)</td>
<td>0.67 (0.49–0.92)</td>
<td>0.016</td>
</tr>
<tr>
<td>Model 2 b</td>
<td>1.00</td>
<td>1.11 (0.81–1.51)</td>
<td>0.75 (0.53–1.06)</td>
<td>0.122</td>
</tr>
<tr>
<td>Model 3 c</td>
<td>1.00</td>
<td>1.38 (1.00–1.90)</td>
<td>1.35 (0.94–1.96)</td>
<td>0.075</td>
</tr>
<tr>
<td>Beijing d, continuous level</td>
<td>23.4±4.9</td>
<td>35.6±3.02</td>
<td>54.7±13.6</td>
<td></td>
</tr>
<tr>
<td>Cases/participants (%)</td>
<td>84/540 (15.6)</td>
<td>79/541 (14.6)</td>
<td>81/541 (15.0)</td>
<td></td>
</tr>
<tr>
<td>Unadjusted association</td>
<td>1.00</td>
<td>0.93 (0.67–1.30)</td>
<td>0.96 (0.69–1.33)</td>
<td>0.789</td>
</tr>
<tr>
<td>Model 1 a</td>
<td>1.00</td>
<td>0.97 (0.69–1.36)</td>
<td>1.00 (0.77–1.53)</td>
<td>0.643</td>
</tr>
<tr>
<td>Model 2 b</td>
<td>1.00</td>
<td>1.25 (0.85–1.83)</td>
<td>1.24 (0.84–1.84)</td>
<td>0.271</td>
</tr>
<tr>
<td>Shanghai e, continuous level</td>
<td>30.6±7.2</td>
<td>47.7±4.4</td>
<td>72±16.4</td>
<td></td>
</tr>
<tr>
<td>Cases/participants (%)</td>
<td>21/546 (3.9)</td>
<td>27/547 (4.9)</td>
<td>20/547 (3.7)</td>
<td></td>
</tr>
<tr>
<td>Unadjusted association</td>
<td>1.00</td>
<td>1.30 (0.73–2.33)</td>
<td>0.95 (0.51–1.77)</td>
<td>0.875</td>
</tr>
<tr>
<td>Model 1 a</td>
<td>1.00</td>
<td>1.06 (0.57–1.96)</td>
<td>0.72 (0.36–1.44)</td>
<td>0.325</td>
</tr>
<tr>
<td>Model 2 b</td>
<td>1.00</td>
<td>1.20 (0.60–2.43)</td>
<td>0.88 (0.41–1.88)</td>
<td>0.668</td>
</tr>
</tbody>
</table>

Data are expressed as mean±standard deviation or odds ratio (95% confidence interval) unless specified.

- Model 1: adjusted for age, sex, and urban/rural.
- Model 2: further adjusted for body mass index, physical activity, smoking status, number of chronic diseases, social activity level, marital status, household income.
- Model 3: further adjusted for geographic location.
- Geographic location specific tertiles were calculated.

D status; however, autoimmune diseases, infectious diseases, and cardiovascular diseases (Holick, 2007). Recently, several small studies have provided preliminary evidence that vitamin D supplementation improves the symptoms of depression (Dumville et al., 2006; Jorde et al., 2008). Although there is ample biological evidence to support the idea that vitamin D may be the link between seasonality of mood and seasonal change in photoperiod (Berk et al., 2007), this has been supported by two small clinical pilot studies (Gloth et al., 1999; Landsdowne and Provost, 1998) with vitamin D supplementation improving the depression measures, but not in all studies (Dumville et al., 2006). However, in the present study we did not evaluate whether the depressive symptoms are seasonal as the survey was simultaneously conducted in both cities during April and June, thus reducing the seasonal influences. More studies are still needed to evaluate whether vitamin D is associated with seasonal affective disorders.

The main strength of our study is that we used data from a large population-based sample of both genders and from both northern and southern China, which is representative of populations of this age. Additionally, we controlled for various covariates known to be related to 25(OH)D levels and depressive symptoms in the analysis. Admittedly, we are aware of certain limitations in the present study. Firstly, the validity of the findings based on the self-reported measure of depression (CES-D), and we did not conduct the psychiatric diagnostic interview. However, the sensitivity of the CES-D to detect major depression is high (Radloff, 1977) and has been validated in Chinese populations (Zhang and Norvilitis, 2002), and diagnose of depression is not feasible to apply in large-scale epidemiological studies. Secondly, conclusions could not be made currently due to the cross-sectional nature of the present study.

In conclusion, we find no evidence that depressive symptoms are associated with 25(OH)D levels in the middle-aged and elderly Chinese in the present study. Further investigations (particularly prospective studies) are warranted to determine whether they are related.

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There were no conflicts of interest of the sponsors in study design, data collection, analysis and interpretation of data, and in the decision to submit the paper for publication.

**Conflict of Interest**

The authors have no conflicts of interest to declare.

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**References**


