

## Prevalence and Patterns of Insomnia Symptoms Among People Aged 65 and Above in Guangdong Province, China

### ABSTRACT

**Objective:** This survey investigated the prevalence, distribution, and correlative factors of insomnia symptoms among people aged 65 and above in Guangdong Province, China.

**Methods:** The Guangdong Mental Health Survey was conducted on the elderly in all 21 cities of Guangdong Province from September to December 2021. Multistage stratified cluster sampling was adopted, and 16 377 adult residents were interviewed face-to-face, from which 4001 elderly participants aged 65 and above were included for this study. Complex weighted adjustment methods were applied to weight the data. Multinomial logistic regression was applied to test the independent associations of clinical insomnia symptoms (CIS) and subthreshold insomnia symptoms (SIS) with the factors.

**Results:** The pooled estimate of insomnia symptoms was 13.44% [95% confidence interval (CI): 12.2 %-14.7%]. The 1-month weighted prevalence of SIS and CIS were 11.15% (95% CI: 10.05%-12.37%) and 2.28% (95%CI: 1.77%-2.94%), respectively. Multinomial logistic regression analysis revealed that urban residence, irregular diet, low body mass index, chronic disease, napping 3-4/week, early changes in dementia, symptoms of subthreshold depression, subthreshold generalized anxiety, and generalized anxiety disorder were positively associated with SIS. Additionally, living in urban areas, having chronic diseases, symptoms of subthreshold depression, major depressive disorder, subthreshold generalized anxiety, generalized anxiety disorder were positively associated with CIS.

**Conclusion:** Insomnia symptoms, including CIS and SIS, were prevalent among the elderly in Guangdong Province. Given the high burden of CIS and SIS, policymakers and healthcare professionals must explore and treat the related factors accordingly.

**Keywords:** Clinical insomnia symptoms, Guangdong province, insomnia, prevalence, subthreshold insomnia symptoms

### Introduction

Insomnia refers to the subjective experience of feeling dissatisfied with sleep time and/or quality despite having suitable sleep opportunities and sleep environment. It is mainly manifested in difficulty initiating sleep, sleep maintenance disorder, and early awakening.<sup>1,2</sup> Former studies have indicated an association between decreased sleep quality and cognitive decline.<sup>3</sup> Additionally, insufficient sleep has been correlated with innate and adaptive immune responses, contributing to an increased risk of chronic inflammation state, cardiovascular, cancer, autoimmune, and neurodegenerative diseases.<sup>4</sup> The estimates suggested that the prevalence of insomnia symptoms was 11.6% in the mid-aged and elderly.<sup>5</sup> According to a meta-analysis study, poor sleep quality in urban elderly varied widely, with prevalence rates ranging from about 10% to over 80%,<sup>6</sup> and the prevalence of insomnia was reported to be 14.84%,<sup>7</sup> which indicated that the sleep quality in the elderly was not optimistic. Besides, insomnia harms life and daily function,<sup>5</sup> and causes high medical costs and socioeconomic burdens.<sup>8</sup>

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Received: December 2, 2023

Revision Requested: January 2, 2024

Last Revision Received: February 8, 2024

Accepted: February 28, 2024

Publication Date: April 26, 2024

Cite this article as: Liao D, Hu J, Ding K, et al. Prevalence and patterns of insomnia symptoms among people aged 65 and above in Guangdong province, China. *Alpha Psychiatry*. 2024;25(2):233-242.



During the COVID-19 pandemic, older adults were considered a group at risk due to the high prevalence of chronic diseases and a weakened immune system. The psychological burden brought by the novel coronavirus, coupled with the loneliness brought by the lockdowns, affects the sleep quality of the elderly.<sup>9,10</sup> The prevalence of insomnia in the elderly during the epidemic period ranged from about 23% to 62%,<sup>11-13</sup> which was higher than that before the pandemic.<sup>7</sup> However, the subthreshold insomnia symptoms and clinical insomnia symptoms during the epidemic are underexplored. Subthreshold insomnia symptoms (SIS) refer to having daytime sleepiness or at least one insomnia symptom "several times a week" but do not cause clinically significant distress or functional impairment.<sup>14</sup> Clinical insomnia symptoms (CIS) refer to having a sleep disturbance that causes clinically significant distress or functional impairment.<sup>15</sup> A previous study showed that the prevalence of SIS and CIS among the elderly was 20.9% and 44.7%, respectively.<sup>16</sup> This indicates that the risk of developing insomnia symptoms among the elderly during this pandemic should concern the sleep medicine community.

According to the National Population Census of China in 2020, the number of older people over 65 years of age was approximately 10.81 million in Guangdong province, accounting for 8.58% of the total population in Guangdong. Consequently, the public health burden resulting from insomnia among the elderly was substantial. To our knowledge, a representative epidemiological study has not been reported in this elderly population. Therefore, we analyzed the current insomnia symptoms among the adult residents (over 65 years of age) included in the Guangdong Mental Health Survey (GDMHS) in 2021 to understand better the prevalence and correlates of insomnia in older adults.

## Material and Methods

### Participants and Study Setting

In this study, all data were acquired from GDMHS and set up from September to December 2021. The Guangdong Mental Health Survey is a provincial representative survey with a consistent methodology aimed at investigating the prevalence of mental disorders. A multistage stratified cluster random sampling method was applied. In the first stage, all the 21 administrative regions of Guangdong province were selected as the first stratification. In the second stage, probability proportional to size (PPS) sampling was used to select 3-5 districts or counties from each administrative region. In the third stage, based on the population size of each district or county, we chose 1-4 subdistricts or towns from each selected district or county.

### MAIN POINTS

- This survey investigated the prevalence, distribution, and correlative factors of insomnia symptoms among people aged 65 and above in Guangdong Province, China.
- The 1-month weighted prevalence rates of SIS and CIS among the elderly in south China were 11.15% and 2.28%, respectively.
- People with one or more chronic diseases were more likely to suffer from SIS and CIS.
- Living in urban areas, early changes in dementia, symptoms of subthreshold depression, symptoms of subthreshold generalized anxiety, generalized anxiety disorder, and chronic diseases were the common risk factors for SIS and CIS.

Subsequently, we chose 2-4 village councils or neighborhood committees from each subdistrict or town using probability proportional to the size, and 50 residents were selected from each neighborhood. Finally, 1 adult resident older than 18 years was randomly selected from each household in the selected village council or neighborhood committee.

The sample size was calculated based on the complex sampling using the formula:

$$n = deff \frac{Z_a^2 \times p(1-p)}{d^2}$$

We assigned the design effect (*deff*) as 3.0, the confidence level as 95% for both sides. According to the estimate of the 12-month prevalence of major depressive disorder during 2019 in China,<sup>17</sup> we assigned the *p* value as 3.6%, and the permissive error *d* as 0.1*p*. Based on the values of the above parameters, the calculated minimum sample size was 13373. Given that the estimated response rate was 80.0% and the super-proportional sampling for the elderly, a total sample size of 20680 community-dwelling individuals was planned. Eventually, 16377 respondents participated in the survey and provided effective data, giving a response rate of 79.2%. This study included 4001 residents aged 65 or over in Guangdong province. The definition of a resident was someone who had lived more than 6 months in prefecture-level cities in the past 12 months.

### Procedures and Measures

Participants were interviewed face-to-face by investigators who underwent uniform training, using an electronic structured questionnaire at local health service centers. The questionnaire included basic socio-demographics, lifestyle factors, sleep duration, napping, chronic disease history, mental health literacy, and mental health screening. Insomnia, depression, anxiety, and dementia were screened using Insomnia Severity Index (ISI), Patient Health Questionnaire-9 (PHQ-9), Generalized Anxiety Disorder-7 (GAD-7), and Alzheimer's Disease scale (AD-8), respectively.

Lifestyle factors included smoking, alcohol consumption, tea consumption, diet habits, and exercise frequency. A current smoker was defined as an adult who had smoked at least one cigarette per day in the past 6 months. Current drinkers referred to those who had consumed alcoholic beverages once or more per week in the past 6 months. Tea consumption referred to those who had consumed tea at least 4 times a week and for at least 12 months. Diet habits were divided into 4 groups: "regular three meals a day", "regular two meals a day", "regular multiple meals a day (more than three meals a day)", and "irregular meals". Irregular meals were defined as skipping any of the 2 or 3 meals. Physical exercise referred to conscious exercise, such as walking, running, etc., and exercise time was more than 10 minutes. Participants who did not or seldom (less than once per month) exercise were categorized as lacking in exercise.

Body mass index (BMI) was calculated by weight/height<sup>2</sup> (kg/m<sup>2</sup>). According to the guidelines on the prevention and control of overweight and obesity in Chinese adults, adults were classified as "underweight" (BMI < 18.5 kg/m<sup>2</sup>), "normal weight" (18.5 ≤ BMI < 24.0 kg/m<sup>2</sup>), and "overweight" (≥ 24.0 kg/m<sup>2</sup>). Educational level was defined as the highest educational qualification attained by respondents (excluding non-academic education).

Mental health literacy was assessed using the 2020 National Mental Health Literacy Questionnaire for Residents, including judgment, self-assessment, and case questions. To achieve standardized mental health literacy, each resident must meet 3 conditions simultaneously: judgment questions with total scores  $\geq 80$ , self-assessment questions with total scores  $\geq 24$ , and case questions with total scores  $\geq 28$ .

Somatic chronic diseases were confirmed by self-reporting measures and certificates of diagnosis from secondary medical institutions or above. In this survey, chronic diseases were classified according to the International Classification of Disease, 10th Revision (ICD-10).

Insomnia: Insomnia Severity Index (ISI) is a 7-item self-report questionnaire designed to measure the nature, severity, and effect of insomnia. Items are scored on a 5-point Likert scale ("0" = not at all to "4" extremely), yielding a total score from 0 to 28. Insomnia severity index had been validated as a screening tool for community adults and clinical insomnia patients, with an ISI score of 8 as the optimal cutoff value.<sup>18</sup> In this study, a total score of ISI  $\geq 8$  was considered as insomnia, 0-7 as the no insomnia group, 8-14 as the SIS group, and 15-28 as the CIS group.<sup>19</sup> Cronbach's alpha for ISI in this study was 0.89.

Depression: Patient Health Questionnaire-9 (PHQ-9) is a 9-item self-report questionnaire assessing the severity of depressive symptoms based on the Diagnostic and Statistical Manual of Mental Disorders-IV criteria (DSM-IV). Items are scored based on the frequency of symptoms using a 4-point scale ("0" = never to "3" = nearly every day), with higher scores reflecting more severe depression symptoms (0-27 score). The total score of PHQ-9 is 0-4 for no depression; 5-9 for mild depression; 10-14 for moderate depression; and  $\geq 15$  for severe depression.<sup>20</sup> Subthreshold depressive symptoms refer to those with a PHQ-9 total score of more than 5 and no diagnosis of major depressive disorder after double-checked by psychiatrists. The Chinese version of the PHQ-9 has demonstrated high reliability and validity.<sup>21</sup>

Anxiety: Generalized Anxiety Disorder-7 (GAD-7) is a 7-item self-report questionnaire for investigating the severity of generalized anxiety disorder. Items are scored based on the frequency of symptoms using a 4-point scale ("0" = never to "3" = nearly every day). The total score of GAD-7 is 0-4 for no anxiety; 5-9 for mild anxiety; 10-14 for moderate anxiety; and  $\geq 15$  for severe anxiety.<sup>22</sup> Subthreshold generalized anxiety symptoms was defined as obtaining a total score of GAD-7  $\geq 5$  without a diagnosis of generalized anxiety disorder after reconfirmed by psychiatrists.<sup>23</sup> The Chinese version of the GAD-7 has demonstrated high reliability and validity.<sup>24</sup>

Dementia: Alzheimer's Disease scale (AD-8) is an 8-item self-report questionnaire designed to screen the dementia. The AD-8 consists of eight "Yes/No/Don't know" questions, measuring memory, problem-solving, orientation, and judgment. A total score of AD-8  $\geq 2$  indicates cognitive impairment, with higher scores indicating greater impairment (score of 0-8). The Chinese version of the AD-8 has demonstrated high reliability and validity.<sup>25</sup>

### Ethical Approval

The study protocol was approved by the Research Ethics Committee of the Guangdong Provincial People's Hospital, Guangdong Academy of Medical Sciences (Approval Number: KY2020-268-01, Date: March 26, 2021). All participants provided electronic informed consent to participating in the survey.

### Statistical Analysis

Based on the complex survey design, a complex weighted adjustment method was used to analyze the data weighting by gender, age groups, administrative regions, and place of residents (urban/rural area) according to the Guangdong Province's population data obtained from the Seventh National Population Census in 2020. The analyses were conducted using the Statistical Package for the Social Sciences (SPSS) version 26.0 (IBM SPSS Corp.; Armonk, NY, USA). Comparisons between no insomnia participants, SIS participants, and CIS participants on socio-demographic characteristics, lifestyle factors, chronic diseases, psychological problems, and psychological service needs were performed using Rao-Scott  $\chi^2$  test. All factors with significant differences between groups using univariate analyses were included in the multinomial logistic regression model to examine their independent associations with CIS and SIS. Additionally, multinomial logistic regression was applied to test the independent associations of CIS and SIS with the various chronic diseases, respectively. The no-insomnia group was used as a reference category. The significance level was set at 0.05 (both sides).

### Results

The pooled estimate of insomnia symptoms (including SIS and CIS) was 13.44% (95% CI: 12.2%-14.7%). The 1-month weighted prevalence of SIS and CIS were 11.15% (95% CI: 10.05%-12.37%) and 2.28% (95% CI: 1.77%-2.94%), respectively.

Table 1 and Table 2 present the distributions of socio-demographics, lifestyle factors, BMI, psychological problems by total sample size, SIS, and CIS. Table 3 shows the distribution of the severity of insomnia symptoms. Table 4 shows the prevalence rates of SIS and CIS in a broad range of chronic diseases. Compared with normal populations, the prevalence of SIS is higher in people with the following chronic diseases: hypertension (14.75% and 3.01%), diabetes (14.84% and 4.73%), cardiovascular diseases (22.15% and 5.95%), cerebrovascular diseases (17.94% and 5.55%), chronic obstructive pulmonary disease (COPD) (23.29% and 8.62%), hyperlipidemia (20.91% and 28.73%), arthritis (17.67% and 5.42%), intervertebral disc disease (17.67% and 3.55%), chronic gastroenteritis/ulcer (21.13% and 7.52%), gallstone/cholecystitis (13.26% and 8.34%), urinary system diseases (24.26% and 5.24%), cataract/glaucoma (21.21% and 6.06%), gout (17.86% and 1.62%), Parkinson's diseases (40.10% and 11.56%), dementia (20.50% and 12.38%), anemia (23.60% and 6.93%), and multimorbidity (18.88% and 5.24%).

Table 5 shows the odds ratios of the associations of CIS and SIS with socio-demographics, and lifestyle factors. Multinomial logistic regression analysis revealed that lived in urban areas, chronic diseases, subthreshold depressive symptoms, major depressive disorder, subthreshold general anxiety symptoms, general anxiety disorder were positively associated with CIS. On the other hand, lived in urban areas, widowed, irregular diet, underweight, chronic diseases, nap 3-4/week, poor mental health, dementia screening had changed, subthreshold depressive symptoms, subthreshold general anxiety symptoms, general anxiety disorder were positively associated with SIS.

Table 6 shows the adjusted odds ratios of the associations between chronic diseases and different insomnia symptoms after adjusting for socio-demographics, life factors, psychological problems and psychological service needs. Compared to health controls, CIS

**Table 1.** Prevalence of Subthreshold Insomnia Symptoms and Clinical Insomnia Symptoms by Sociodemographic and Lifestyle Factors

Variable	Total (n=4001)		SIS (n=448)		CIS (n=89)		Statistics	
	n	Constituent Ratio (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)	$\chi^2$	P
Gender							16.14**	.007
Female	1979	49.46	248	12.61	62	2.81		
Male	2022	50.54	200	9.52	27	1.69		
Age (years)							19.08*	.013
65-69	1763	44.06	195	10.60	30	1.87		
70-74	1236	30.89	113	9.28	33	2.54		
75~	1002	25.04	140	14.51	26	2.69		
Residence							12.41*	.011
Rural	1698	42.44	161	9.48	34	1.66		
Urban	2303	57.56	287	12.23	55	2.68		
Level of education							12.04	.147
Primary school or below	2162	54.04	245	11.41	55	2.62		
Junior high school	1006	25.14	95	8.96	22	2.19		
Senior high school	646	16.15	83	13.41	9	1.48		
College or above	187	4.67	25	12.66	3	1.41		
Marital status							62.54***	<.001
Married/Cohabitation	3116	77.88	312	9.41	56	1.74		
Unmarried/Divorce/Separation	65	1.62	10	15.84	2	3.73		
Widowed	820	20.49	126	17.18	31	4.14		
Occupation							9.58	.149
Mental work	80	2.00	14	18.29	1	0.95		
Manual work	1578	39.44	172	10.28	37	1.87		
Others	2343	58.56	262	11.54	51	2.65		
Family income per capita (CNY)							12.85	.344
<3500	2401	60.01	256	10.41	56	2.31		
3500~	994	24.84	113	11.48	22	2.10		
6000~	326	8.15	45	13.85	4	1.58		
9000~	138	3.45	14	12.07	6	5.10		
12000~	142	3.55	20	17.06	1	2.03		
Smoking							6.42	.418
Never smoked	2777	69.41	309	11.12	73	2.40		
Current smoker	846	21.14	86	9.74	10	2.16		
Former smoker	378	9.45	53	14.50	6	1.62		
Alcohol consumption							6.94	.331
Never drunk	3370	84.23	386	11.34	77	2.32		
Current drinker	335	8.37	28	8.98	4	0.76		
Former drinker	296	7.40	34	11.27	8	3.51		
Tea consumption							16.51**	.007
No	2026	50.64	250	12.53	63	2.96		
Yes	1975	49.36	198	9.79	26	1.62		
Diet habit							23.55**	.007
Regular 3 meals a day	3776	94.38	413	10.84	81	2.18		
Regular 2 meals a day	61	1.52	5	8.87	2	2.16		
Regular multiple meals a day (>3)	125	3.12	19	15.99	5	4.46		
Unregular	39	0.97	11	32.57	1	4.98		
Exercise frequency							8.51	.689
Never/hardly exercise	786	19.65	97	11.81	27	3.24		
1-3/month	299	7.47	33	11.12	3	2.44		
1-2/week	335	8.37	39	11.01	9	3.06		
3-5/week	389	9.72	46	12.26	8	1.50		
Everyday or almost every day	2192	54.79	223	10.70	42	1.89		

(Continued)

**Table 1.** Prevalence of Subthreshold Insomnia Symptoms and Clinical Insomnia Symptoms by Sociodemographic and Lifestyle Factors (Continued)

Variable	Total (n=4001)		SIS (n=448)		CIS (n=89)		Statistics	
	n	Constituent Ratio (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)	$\chi^2$	P
Chronic disease							128.48***	<.001
No	1330	33.24	65	4.97	9	0.40		
Yes	2671	66.76	383	14.62	80	3.33		
Napping							37.31**	.001
No	643	16.07	71	10.53	20	3.04		
1-2/week	546	13.65	71	11.65	16	3.83		
3-4/week	540	13.50	89	17.17	11	1.93		
Almost every day	2272	56.79	217	9.66	42	1.75		

Numbers are unweighted, but percentages are weighted. \* means multiple Rao-Scott  $\chi^2$  tests were used with the health controls as the reference to examine the differences in the rates of insomnia symptoms in different groups.

Abbreviations: SIS= Subthreshold insomnia symptoms, CIS= Clinical insomnia symptoms.

\*\* indicates p<0.05, \*\*\* indicates p<0.01, \*\*\*\* indicates p<0.001.

**Table 2.** Prevalence of Subthreshold Insomnia Symptoms and Clinical Insomnia Symptoms by Body Mass Index, and Mental Health

Variable	Total (n=4001)		SIS (n=448)		CIS (n=89)		Statistics	
	n	Constituent Ratio (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)	$\chi^2$	P
BMI (kg/m <sup>2</sup> )							16.89*	.022
<18.5	307	7.67	55	16.04	12	3.80		
18.5-24.0	2196	54.89	224	10.11	52	2.51		
≥24.0	1498	37.44	169	11.67	25	1.65		
Mental health literacy							17.46**	.002
Unstandardized	3678	91.93	432	11.77	85	2.32		
Standardized	323	8.07	16	4.29	4	1.87		
AD-8 scale (n=3957)							106.20***	<.001
No change	3285	83.02	304	9.10	58	1.82		
Change	672	16.98	139	21.11	30	4.55		
Depression							455.40***	<.001
Healthy	3698	92.43	348	9.26	54	1.46		
Subthreshold depressive symptoms	227	5.67	75	36.99	16	7.45		
Major depressive disorder	76	1.90	25	29.48	19	27.39		
Anxiety							551.59***	<.001
Healthy	3703	92.55	340	8.96	49	1.36		
Subthreshold general anxiety symptoms	224	5.60	80	37.96	19	9.07		
General anxiety disorder	74	1.85	28	39.57	21	28.98		

Numbers are unweighted, but percentages are weighted. \* means multiple Rao-Scott  $\chi^2$  tests were used with the health controls as the reference to examine the differences in the rates of insomnia symptoms in different groups.

Abbreviations: BMI=body mass index, SIS= Subthreshold insomnia symptoms, CIS= Clinical insomnia symptoms.

\*\* indicates p<0.05, \*\*\* indicates p<0.01, \*\*\*\* indicates p<0.001.

**Table 3.** ISI Positive Detection Rate of Each Item in the Elderly

ISI entry	Mild		Moderate		Severe		Extremely Severe		Above Moderate Statistics	
	n	Prevalence Rate (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)
Difficulty initiating sleep	1008	25.34	245	6.45	57	1.30	2	0.04	304	7.79
Difficulty maintaining sleep	978	24.28	241	6.22	46	0.99	3	0.06	290	7.27
Early morning awakening	1105	26.71	237	6.09	55	1.32	3	0.12	295	7.53
Sleep satisfaction	1530	37.28	659	16.83	247	5.98	23	0.47	929	23.27
Decreased daytime function	752	18.58	226	5.75	40	1.18	15	0.26	281	7.20
Impact on the quality of life	737	18.31	213	5.44	38	1.02	11	0.19	262	6.65
Degree of insomnia problems	556	13.94	170	4.02	40	1.07	12	0.20	222	5.29

Numbers are unweighted, but percentages are weighted. Abbreviations: ISI= Insomnia Severity Index.



**Table 4.** Comparison of Chronic Diseases and Multimorbidity Among Three Groups by Insomnia

Variable	Total (n=4001)		SIS (n= 448)		CIS (n=89)		Statistics	
	n	Prevalence Rate (%)	n	Prevalence Rate (%)	n	Prevalence Rate (%)	$\chi^2$	P
Hypertension	1624	38.31	227	14.75	46	3.01	39.96***	<.001
Diabetes	541	12.92	78	14.84	23	4.73	25.40***	<.001
Cardiovascular diseases	333	7.63	69	22.15	17	5.95	63.60***	<.001
Cerebrovascular diseases	161	3.69	28	17.94	7	5.55	15.30**	.004
COPD	65	1.38	16	23.29	2	3.13	8.62*	.011
Hyperlipidemia	213	5.00	38	20.91	14	5.03	28.73***	<.001
Arthritis	488	11.90	86	17.67	23	5.42	49.68***	<.001
Intervertebral disc disease	336	8.21	59	17.67	24	7.55	62.87***	<.001
Chronic gastroenteritis/ulcer	200	4.82	38	21.13	12	7.52	47.80***	<.001
Gallstone/Cholecystitis	122	2.84	16	13.26	8	8.34	20.18**	.005
Urinary system diseases	124	2.66	28	24.26	6	5.24	24.24***	<.001
Cataract/Glaucoma	227	5.19	45	21.21	12	6.06	38.41***	<.001
Gout	201	4.65	34	17.86	4	1.62	9.05*	.013
Parkinson's disease	22	0.54	10	40.10	3	11.56	27.97***	<.001
Anemia	38	0.89	6	23.60	3	6.93	9.54*	.034
Dementia	20	0.60	4	20.50	2	12.38	13.67*	.019
Number of chronic diseases							192.18***	<.001
0	1380	37.31	77	5.67	13	0.72		
1	1375	33.49	154	10.53	18	1.44		
≥2 (multimorbidity)	1246	29.20	217	18.88	58	5.24		

Numbers are unweighted, but percentages are weighted. \* means multiple Rao-Scott  $\chi^2$  tests were used with the health controls as the reference. Abbreviations: SIS= Subthreshold insomnia symptoms, CIS= Clinical insomnia symptoms, COPD=chronic obstructive pulmonary disease. "\*" indicates  $p<0.05$ , "\*\*\*" indicates  $p<0.01$ , "\*\*\*\*" indicates  $p<0.001$ .

patients were likely to suffer from hypertension, diabetes, cardiovascular diseases, arthritis, intervertebral disc disease, chronic gastroenteritis/ulcer and multi-morbidity; people with SIS were more likely to have hypertension, cardiovascular diseases, COPD, arthritis, chronic gastroenteritis/ulcer, urinary system diseases and multi-morbidity. Multicollinearity between independent variables was checked and there was no collinearity [tolerations (Tol) > 0.1, variance inflation factor (VIF) < 10].

## Discussion

The results of this survey showed that the 1-month prevalence of insomnia among adults aged 65 years and older was 13.44% in Guangdong province, which was higher than in the general Chinese population before the COVID-19 epidemic (11.6%),<sup>5</sup> while lower than studies conducted in the early stages of the pandemic (18.4%-35.7%).<sup>26-28</sup> Compared with the other countries, the prevalence of insomnia was lower than that in the United States (59.8%),<sup>29</sup> in the UK (28%),<sup>30</sup> and in Japan (25.2%).<sup>29</sup> Firstly, it may be due to the significant differences between studies in design, sample size, sampling location, measurement methods, diagnostic criteria, and survey type. Secondly, participants and racial/ethnic differences may have influenced the results. Thirdly, the outcome variable of this study was self-reported insomnia symptoms, which were not diagnosed by psychiatrists. Therefore, there might be some subjective bias and tend to the underestimated. Furthermore, during the survey period, the COVID-19 epidemic in Guangdong was relatively stable, which might have led to decreased perceived stress. Therefore, insomnia's prevalence was likely lower than in the early stages of the COVID-19 pandemic.<sup>29</sup> Nevertheless, all the results reported above evidenced

that sleep quality in the elderly was not optimistic, while the occurrence of insomnia resulted from various factors.

Our study found that the elderly living in urban areas were more likely to suffer from insomnia than those living in rural areas. This may be because individuals living in urban areas tended to experience excessive nighttime light exposure,<sup>31</sup> higher levels of neighborhood, and traffic-noise annoyance.<sup>32</sup> In addition, people in urban areas generally have more stress,<sup>33</sup> lower levels of physical activity, and a lower age of retirement than those living in rural areas, leading to increased levels of insomnia.<sup>34</sup>

Also, we found that low BMI (BMI < 18.5 kg/m<sup>2</sup>) was associated with SIS. This might be due to individuals with insomnia having excessive hyperarousal throughout the day.<sup>35</sup> Moreover, overexcitability was associated with chronic stress responses, which might result in preventing weight gain.<sup>36</sup> At the same time, insomnia patients might try to maintain their sleep capacity by increasing exercise or reducing body weight,<sup>37,38</sup> leading to a lower BMI. The results were consistent with previous studies. Moreover, SIS was associated with taking naps 3-4 times per week. There was evidence that insomnia symptoms were reported as contributors to daytime napping in the elderly.<sup>39</sup> We speculated that erratic napping rhythm was associated with SIS. After controlling for confounding factors, the association between women and insomnia was not statistically significant. However, most previous studies have shown that older women were more likely to suffer from insomnia,<sup>6,40-42</sup> which could be related to menopause. In addition, irregular diet had an impact on insomnia. This suggested that lifestyle, place of residence, and chronic diseases may be responsible for the significant association, which was also in line with a previous study in Shanghai.<sup>43</sup>

**Table 5.** Odds Ratios and 95% CIs of Sociodemographic and Lifestyle Factors, and Multimorbidity in Relation to SIS and CIS

Variable	SIS vs. No insomnia			CIS vs. No depression		
	B (SE)	OR (95%CI)	P	B (SE)	OR (95%CI)	P
Female	0.01 (0.14)	1.01 (0.76-1.33)	.935	0.06 (0.39)	1.06 (0.49-2.28)	.873
Age (years)						
65-69	-0.07 (0.16)	0.92 (0.67-1.27)	.647	0.05 (0.40)	1.06 (0.47-2.36)	.885
70-74	-0.32 (0.17)	0.72 (0.50-1.01)	.063	0.17 (0.42)	1.19 (0.52-2.72)	.675
75~		1.00			1.00	
Urban	0.38 (0.13)	1.47 (1.12-1.92)	.005	0.91 (0.33)	2.48 (1.29-4.76)	.006
Marital status						
Married/Cohabitation		1.00			1.00	
Unmarried/Divorce/Separation	0.00 (0.49)	1.00 (0.37-2.65)	1.000	0.45 (0.77)	1.57 (0.34-7.13)	.554
Widowed	0.43 (0.16)	1.55 (1.12-2.13)	.007	0.65 (0.46)	1.92 (0.78-4.75)	.155
Tea consumption	-0.10 (0.13)	0.89 (0.68-1.16)	.417	-0.33 (0.28)	0.71 (0.40-1.26)	.247
Diet habit						
Regular 3 meals a day		1.00			1.00	
Regular 2 meals a day	-0.46 (0.61)	0.63 (0.19-2.08)	.450	-0.70 (0.84)	0.49 (0.09-2.57)	.401
Regular multiple meals a day (>3)	0.24 (0.30)	1.28 (0.69-2.33)	.422	0.61 (0.66)	1.84 (0.49-6.82)	.358
Unregular	1.17 (0.38)	3.23 (1.51-6.92)	.003	0.59 (1.27)	1.81 (0.15-22.01)	.639
BMI (kg/m <sup>2</sup> )						
<18.5	0.50 (0.21)	1.65 (1.07-2.52)	.021	0.40 (0.45)	1.50 (0.61-3.66)	.369
18.5-24		1.00			1.00	
≥24	0.03 (0.13)	1.03 (0.79-1.35)	.792	-0.57 (0.33)	0.56 (0.29-1.07)	.083
Chronic disease	0.97 (0.16)	2.64 (1.89-3.68)	<.001	1.92 (0.41)	6.87 (3.05-15.47)	<.001
Napping						
No	0.22 (0.18)	1.25 (0.87-1.80)	.224	0.62 (0.36)	1.87 (0.92-3.79)	.083
1-2/week	0.09 (0.17)	1.10 (0.77-1.56)	.591	0.69 (0.41)	1.99 (0.87-4.53)	.100
3-4/week	0.73 (0.17)	2.08 (1.47-2.94)	<.001	0.34 (0.51)	1.40 (0.51-3.86)	.509
Almost every day		1.00			1.00	
Poor mental health	0.63 (0.31)	1.89 (1.02-3.47)	.040	-0.24 (0.48)	0.78 (0.30-2.03)	.617
AD-8 scale positive (n=3957)	0.50 (0.15)	1.65 (1.22-2.23)	.001	0.09 (0.31)	1.09 (0.59-2.02)	.764
Depression						
Healthy		1.00			1.00	
Subthreshold depressive symptoms	1.13 (0.22)	3.11 (2.00-4.84)	<.001	1.16 (0.53)	3.18 (1.11-9.13)	.031
Major depressive disorder	0.66 (0.44)	1.95 (0.82-4.63)	.131	1.85 (0.55)	6.39 (2.15-18.97)	.001
Anxiety						
Healthy		1.00			1.00	
Subthreshold general anxiety symptoms	1.38 (0.21)	3.99 (2.61-6.11)	<.001	1.76 (0.52)	5.83 (2.07-16.41)	.001
General anxiety disorder	2.19 (0.41)	9.02 (3.97-20.48)	<.001	3.29 (0.51)	26.93 (9.77-74.24)	<.001

Complex weighted computation and multinomial logistic regression model were used in the statistical analysis. Socio-demographics, lifestyle factors, and mental health were adjusted for in the model. Pseudo  $R^2=0.17$ .

CIS, clinical insomnia symptoms; SIS, subthreshold insomnia symptoms; BMI, body mass index; CI, confidence interval; SE, standard error; AD-8, Alzheimer's disease scale.

In terms of mental illness, this study found that elders with cognitive changes were associated with SIS. The result coincided with prior studies and demonstrated the presence of extensive cognitive impairment and partial impairment of executive function in patients with chronic insomnia.<sup>44</sup> Furthermore, they often complained of subjective memory impairment.<sup>45</sup> Increasing evidence has shown the effect of insomnia on sustained worsening cognitive function.<sup>3</sup> Furthermore, clinical studies have found that the level of CSF amyloid- $\beta$ 42 in insomnia patients is significantly increased, which was significantly associated with sleep quality. This suggested that chronic insomnia could increase the risk of Alzheimer's disease by inducing brain amyloid- $\beta$ <sup>46</sup> and eventually compromised cognitive function.<sup>47</sup>

We found that depression and anxiety were risk factors for insomnia, which was consistent with previous studies. Western studies showed that individuals with affective and anxiety disorders had a 3.3 times and 2.6 times increased risk of insomnia, respectively.<sup>48</sup> And 90% of depressive patients had sleep disorders.<sup>49</sup> Meanwhile, studies in China also believed that depression and anxiety were closely related to the occurrence of sleep disorders in the community elderly.<sup>50</sup> Insomnia and excessive sleepiness were both among the most commonly reported symptoms of patients with depressive and anxiety disorders. It could even precede the onset of mental illness and worsen over time.<sup>51</sup> In addition, due to the stress and learned helplessness, chronic insomnia experiences could have a decisive impact on the development of relative mental disorders.<sup>35</sup>

**Table 6.** Adjusted Odds Ratios and 95% CIs of Specific Chronic Diseases in Relation to SIS and CIS

Variable	SIS vs. No insomnia			CIS vs. No insomnia		
	B (SE)	AOR (95% CI)	P	B (SE)	AOR (95% CI)	P
Hypertension	0.56 (0.13)	1.75 (1.35-2.28)	<.001	0.69 (0.27)	2.00 (1.18-3.41)	.010
Diabetes	0.33 (0.18)	1.39 (0.97-1.99)	.066	1.00 (0.32)	2.73 (1.44-5.17)	.002
Cardiovascular diseases	0.70 (0.19)	2.01 (1.38-2.96)	<.001	1.11 (0.35)	3.05 (1.53-6.06)	.001
Cerebrovascular diseases	0.42 (0.26)	1.52 (0.91-2.55)	.109	0.77 (0.50)	2.16 (0.80-5.87)	.128
COPD	0.91 (0.33)	2.49 (1.29-4.78)	.006	-0.19 (1.00)	0.82 (0.11-5.92)	.845
Hyperlipidemia	0.38 (0.24)	1.46 (0.90-2.38)	.120	0.34 (0.36)	1.41 (0.68-2.88)	.346
Arthritis	0.45 (0.17)	1.57 (1.11-2.23)	.010	0.84 (0.35)	2.33 (1.17-4.65)	.016
Intervertebral disc disease	0.43 (0.20)	1.54 (1.03-2.30)	.032	1.24 (0.33)	3.45 (1.79-6.65)	<.001
Chronic gastroenteritis/ulcer	0.66 (0.26)	1.94 (1.15-3.26)	.012	1.12 (0.43)	3.06 (1.31-7.12)	.009
Gallstone/Cholecystitis	-0.24 (0.32)	0.78 (0.41-1.48)	.455	0.58 (0.72)	1.78 (0.42-7.43)	.425
Urinary system diseases	0.97 (0.29)	2.64 (1.49-4.66)	.001	1.18 (0.62)	3.26 (0.95-11.14)	.059
Cataract/glaucoma	0.47 (0.23)	1.61 (1.01-2.56)	.044	0.85 (0.46)	2.34 (0.94-5.79)	.065
Gout	0.49 (0.26)	1.63 (0.98-2.72)	.059	-0.48 (0.61)	0.61 (0.18-2.05)	.430
Parkinson's disease	1.39 (0.59)	4.04 (1.26-12.95)	.019	1.45 (1.16)	4.26 (0.43-42.04)	.215
Dementia	0.22 (0.65)	1.25 (0.34-4.54)	.730	0.54 (1.03)	1.73 (0.22-13.13)	.596
Number of chronic diseases						
1	0.59 (0.17)	1.81 (1.28-2.57)	.001	0.84 (0.44)	2.32 (0.96-5.56)	.059
≥2 (multimorbidity)	1.17 (0.17)	3.22 (2.29-4.53)	<.001	1.99 (0.36)	7.37 (3.61-15.02)	<.001

Complex weighted computation and multinomial logistic regression models were used in the statistical analysis. Socio-demographics, lifestyle factors, and mental health were adjusted for in the models. Pseudo  $R^2 = 0.16$  (chronic diseases); Pseudo  $R^2 = 0.18$  (number of chronic disease). AOR, adjusted odds ratio; CIS, clinical insomnia symptoms; SIS, subthreshold insomnia symptoms; COPD, chronic obstructive pulmonary disease; CI, confidence interval; SE, standard error.

In terms of somatic disorders, we found that hypertension, cardiovascular diseases, COPD, arthritis, intervertebral disc disease, chronic gastroenteritis/ulcer, urinary system diseases, and multimorbidity were related to SIS. In contrast, hypertension, diabetes, cardiovascular diseases, arthritis, intervertebral disc disease, chronic gastroenteritis/ulcer, and multimorbidity were related to CIS. These results were aligned with previous studies.<sup>41,52-55</sup> In addition, multimorbidity was significantly associated with SIS and CIS, respectively. Patients with 2 or more health problems had a higher prevalence of insomnia.<sup>56</sup> A variety of physical diseases might exert a synergetic effect on insomnia progression, although a single chronic disease might not be significant for individuals from a clinical point of view.<sup>43</sup> Considering the negative effects of chronic disease on insomnia, community and village health service workers should regularly screen the elderly for common chronic diseases.

The main strengths of the study were using provincial representative sampling methods, a large sample size, employing internationally validated assessment scales to conduct face-to-face screening work, and the investigators trained in consistency. However, there were some limitations to the present study. Firstly, the cross-sectional study limited our ability to make causal inferences and obtain information about the evolution of insomnia in the subjects. Therefore, further research with longer follow-up periods was needed. Secondly, insomnia symptoms were assessed based on self-reported data from the respondents over the past month, which meant the recall bias could not be avoided. Additionally, the total score of the ISI questionnaire was used as the classification basis without psychiatrists reviewing the group results in the study, which might lead to the possibility of misclassification and inherently introduce a level of subjectivity in the process. Thirdly, we studied only community residents, which ignored patients

hospitalized and residents living in nursing homes. This may lead to an underestimation of the prevalence rate.

Insomnia symptoms, including both CIS and SIS, were prevalent among the elderly in Guangdong Province. Given the high burden of insomnia, policymakers and healthcare professionals need to explore the related factors and treat them accordingly.

**Availability of Data and Materials:** The data and materials that support the findings of this study are available from the corresponding author, upon reasonable request.

**Ethics Committee Approval:** This study was approved by the Ethics committee of the Guangdong Provincial People's Hospital, Guangdong Academy of Medical Sciences (Approval No: KY2020-268-01; Date: March 26, 2021).

**Informed Consent:** Informed consent was obtained from the participants who agreed to take part in the study.

**Peer-review:** Externally peer-reviewed.

**Author Contributions:** Concept – D.D.L., S.B.W., and F.J.J.; Design – D.D.L., K.R.D., C.L.H., S.B.W.; Supervision – C.L.H., F.J.J., S.B.W.; Resources – S.B.W. Materials – S.B.W.; Data Collection and/or Processing – D.D.L., W.Y.T., Y.F.K.; Analysis and/or Interpretation – D.D.L., J.H.H., K.R.D.; Literature Search – D.D.L.; Writing – D.D.L. and J.H.H.; Critical Review – J.H.H., K.R.D., C.L.H., W.Y.T., Y.F.K., F.J.J., and S.B.W.

**Declaration of Interests:** The authors have no conflicts of interest to declare.

**Funding:** This work was supported by the National Social Science Foundation of China (Grant No. 19ZDA360), Guangdong Key Disciplines Project (Grant No. 2022ZDJS139), Medical Scientific Research Foundation of Guangdong Province of China (Grant No. C2022010) and the Guangzhou Science and Technology Plan Project (Grant No. 202002030484).



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