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Study on the correlation between dietary structure and sleep in patients with insomnia disorder

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Abstract. – OBJECTIVE: Insomnia disorder (ID) is a persistent difficulty sleeping, often accompanied by anxiety and depression, which seriously reduces a person's quality of life. Dietary changes in insomnia patients have been a concern. To explore the rationality of diet in patients with ID and its correlation with insomnia in ID patients.

PATIENTS AND METHODS: This study included 216 patients diagnosed with ID and 197 individuals as the healthy control (HC) group who attended the neurology outpatient clinic or sleep clinic at Henan Provincial People's Hospital between September 2018 and November 2019. Through the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), Hamilton Anxiety Scale (HAMA), and Hamilton Depression Scale (HAMD), sleep and mental conditions were assessed in the ID and HC groups. The dietary intake structure of both groups was observed using the food frequency table. Meanwhile, the relationship between dietary intake and sleep quality was analyzed based on the logistics regression.

RESULTS: Individuals in the ID group had significantly higher age, weight, and body mass index compared to the HC group ($p<0.01$). Individuals within the ID category demonstrated a heightened daily consumption of carbohydrates, grains, tubers, and legumes relative to the healthy control group. In contrast, the intake levels of vegetables, fruits, and nuts were diminished compared to the HC group, with this difference being statistically significant ($p<0.01$). A positive correlation was observed between the daily consumption of grains, tubers, and legumes and PSQI scores. Conversely, a negative association was found between daily consumption of vegetables and fruits.

CONCLUSIONS: ID patients exhibit an elevated intake of carbohydrates, whereas the consumption of vegetables, fruits, and nuts is deficient in comparison to the healthy cohort, implying that a distorted dietary structure might be a contributing factor to ID onset. Sensible and scientific dietary guidance is of considerable significance in preventing the onset of ID and facilitating its management. However, the derived conclusions warrant further extensive research.

Key Words:
Insomnia disorder, Dietary structure, Sleep quality.

Introduction

Insomnia disorder (ID) is clinically characterized by challenges in initiating sleep, sustaining sleep, and a lack of restorative energy post-sleep, paired with increased vigilance[1]. ID not only precipitates daytime dysfunction but also amplifies the prevalence of cardiovascular diseases, depression, anxiety, and dementia, thereby exerting a significant strain on both the national economy and public health[2]. Existing pharmacotherapies for ID are limited, potentially giving rise to a variety of side effects and fostering drug dependencies[3,4]. The 2015 China Sleep Index reported by the Chinese Medical Association delineates that approximately one-third of the Chinese population is experiencing severe insomnia disorder, a phenomenon that is escalating[3]. ID is a critical public health concern that detrimentally affects the well-being of Chinese inhabitants. Strategic health management of ID patients can reduce medical costs for society and is advantageous to a large segment of individuals grappling with ID[5].

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Management encompasses several facets, including dietary, physical, and psychological elements. Ogawa et al[6] indicated that a plethora of neurotransmitters secreted by the gut microbiota can cross the blood-brain barrier or convey feedback to the central nervous system through the vagus nerve, consequently influencing the physiological sleep-wake cycle. As a primary influencer of gut microbiota composition[7], dietary intake is closely related to sleep patterns. Regrettably, at this juncture, no study has elucidated the connection between dietary consumption and insomnia in the Chinese population. Therefore, this study sought to scrutinize the appropriateness of dietary structures in ID patients, offering a theoretical foundation for the inception of dietary advice for those affected by insomnia disorder.

Patients and Methods

Study Subjects

This study included 216 patients diagnosed with ID and 197 individuals in the healthy control (HC) group who attended the neurology outpatient clinic or sleep clinic at Henan Provincial People's Hospital between September 2018 and November 2019. The enrolment criteria for ID patients included: 1. adherence to the diagnostic guidelines for ID as detailed in the "Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition" and the "Chinese Classification and Diagnostic Criteria of Mental Disorders, Third Edition"; 2. the Pittsburgh Sleep Quality Index (PSQI) score ≥7; 3. age range of 18 to 60 years. The prerequisites for the HC group encompassed: 1. absence of primary complaints and clinical signs of insomnia disorder; 2. scores <7 on the PSQI, Hamilton Depression Rating Scale (HAMD), and Hamilton Anxiety Rating Scale (HAMA); 3. age range of 18 to 60 years. The exclusion criteria were as follows: insomnia attributed to sleep disorder-associated ailments such as obstructive sleep apnea syndrome or sleep-related periodic limb movement; acute suicidal thoughts or grave mental disorders; a past characterized by substance, tobacco, or alcohol misuse; pregnancy or lactation phase; previous psychiatric or neurological diseases; a history of cranial injuries; genetic familial diseases; previous surgeries conducted under general anesthesia; a history of major bodily diseases. This study was approved by the Ethical Review Committee of Henan Provincial People's Hospital, and all participants voluntarily participated in the survey and provided signed informed consent.

Methodology

Survey methods

Participants completed clinical scales under the cohesive guidance of expert neurologists, psychologists, and nutritionists. These scales included both screening and formal evaluation scales. Sociodemographic details encompassing attributes such as gender and age were gathered through a personal information questionnaire. Additionally, a daily lifestyle questionnaire was used to collect demographic and clinical data including educational background, medical history, primary insomnia complaints, living conditions, and smoking habits. The instruments used in the appraisal of sleep and mental conditions included the PSQI, Insomnia Severity Index (ISI), HAMA, and HAMD.

Dietary intake was examined using the Food Frequency Questionnaire, devised by the China Center for Disease Control and Prevention Nutrition and Health Institute, and modified to suit the goals of this research. This semi-quantitative questionnaire scrutinized the food consumption patterns of subjects over the preceding year, segregating 43 types of food items into classifications, such as tubers, grains, legumes, vegetables, fruits, poultry, fish, shellfish, nuts, and dairy products. Concurrently, the height and weight of the participants were recorded, and blood specimens were obtained to assess the concentrations of total cholesterol and high-density lipoprotein cholesterol (HDL).

Statistical Analysis

Data compilation involved dual entries using EpiData 3.1 (The Epidata Association, Odense, Denmark), and statistical analysis was performed using SPSS 23 software (IBM Corp., Armonk, NY, USA). Statistical synopsis encapsulated the demographic data, sleep conditions, and dietary consumption patterns of the study population. Counting metrics were portrayed through case counts and percentages, whereas measurement metrics were explained by means and standard deviations. Non-normally distributed data between the two groups were compared using the Wilcoxon rank-sum test, and the χ^2 test was used to compare counting data between the two groups. Logistic regression analysis was used to

examine the relationships between dietary habits and sleep parameters. In the unadjusted model, no modifications were instituted for variables, whereas Model I integrated adjustments for sex and age factors. Statistical significance was set at $p<0.05$.

Results

Basic Information of the Subjects

This study included 216 ID patients, comprising 89 males and 127 females, with a mean ID disease duration of 8.1 years. The HC group consisted of 197 individuals, 74 males and 123 females. Individuals in the ID group displayed an elevated age, weight, and body mass index when compared to those in the HC group, indicating a significant statistical discrepancy ($p<0.01$). Nevertheless, no notable statistical divergence was observed between the two cohorts in terms of sex distribution, education level, and smoking prevalence. The ID group manifested markedly augmented scores on the Pittsburgh Sleep Quality Index (PSQI), along with escalated depression and anxiety indices in comparison to the HC group; these differences were statistically significant. Detailed results are presented in Table I.

Daily Dietary Intake of the Subjects

Individuals within the ID category demonstrated a heightened daily consumption of carbohydrates, grains, tubers, and legumes relative to the healthy control group. In contrast, the intake levels of vegetables, fruits, and nuts were diminished compared to the HC group, with this difference being statistically significant ($p<0.01$). A comprehensive overview of the findings is presented in Table II.

Logistic Regression Analysis of Different Types of Dietary Intake and Sleep in the ID Group

According to the unadjusted model, a positive correlation was observed between the daily consumption of grains, tubers, and legumes and PSQI scores. Conversely, a negative association was found between daily consumption of vegetables, fruits, and nuts and the aforementioned index. This correlation was significant even after accounting for potential confounders, such as age and sex. Detailed results are presented in Table III.

Discussion

Sleep quality maintains a complex interrelationship with dietary habits, wherein the nutri-

Table I. Basic information of study participants in ID and HC groups.

Variables	HC group (n = 197)	ID group (n = 216)	t (χ^2)	p
Age (years)	34.71 ± 9.99	40.56 ± 13.13	-6.84	< 0.01
Gender [n (%)]				
Male	89 (45.1%)	74 (34.1%)	2.55	0.111
Female	108 (54.9%)	142 (65.9%)		
Educational level [n (%)]				
Junior high school	11 (5.6%)	12 (5.6%)	14.44	0.731
High school and vocational	11 (5.6%)	11 (5.1%)		
University and above	175 (88.7%)	193 (89.4%)		
Smoking status [n (%)]				
Non-smoker	186 (94.4%)	203 (94.0%)	0.58	1.000
Current or past smoker	11 (5.6%)	13 (6.0%)		
Weight (kg)	62.66 ± 10.73	65.54 ± 13.18	-6.50	< 0.01
Height (cm)	168.82 ± 7.82	164.61 ± 7.82	-5.88	< 0.01
Body mass index (kg/m²)	22.840 ± 3.29	23.05 ± 3.00	-3.93	< 0.01
Total cholesterol (mmol/l)	3.61 ± 1.21	3.39 ± 0.84	-4.76	0.27
HDL (mmol/l)	1.2 ± 0.38	1.3 ± 0.47	-3.95	0.36
PSQI	3.39 ± 2.92	14.87 ± 2.55	-7.38	< 0.01
ISI	2.13 ± 2.98	17.95 ± 4.68	-7.37	< 0.01
HAMA	3.13 ± 3.82	19.99 ± 10.50	-7.31	< 0.01
HAMD	4.00 ± 4.83	17.22 ± 8.50	-7.01	< 0.01

HDL: High-density Lipoprotein Cholesterol; PSQI: Pittsburgh Sleep Quality Index; ISI: Insomnia Severity Index; HAMA: Hamilton Anxiety Scale; HAMD: Hamilton Depression Scale.

Table II. Average daily intake of various foods and nutrients.

Foods and nutrients	HC group (n = 197)	ID group (n = 216)	t (χ^2)	p
Total energy (kcal/day)	2,793.32 ± 777.84	2,896.03 ± 823.12	3.79	< 0.05
Carbohydrates (g)	303.47 ± 94.09	344.29 ± 97.63	0.03	< 0.05
Proteins (g)	103.16 ± 28.39	105.41 ± 31.62	4.06	0.65
Fats (g)	122.52 ± 40.67	125.72 ± 43.45	6.12	0.62
Grains, tubers, and legumes (g)	201.95 ± 58.26	223.6 ± 57.2	0.32	< 0.05
Vegetables (g)	403.24 ± 89.66	289.4 ± 102.79	9.27	< 0.01
Fruits (g)	251.88 ± 33.50	197.7 ± 35.92	6.83	< 0.01
Poultry (g)	81.16 ± 36.37	78.06 ± 38.78	0.03	> 0.99
Fish and shellfish (g)	37.95 ± 28.79	41.22 ± 27.65	3.14	0.32
Nuts (g)	9.03 ± 3.18	7.47 ± 3.50	5.08	< 0.01
Dairy and dairy products (g)	221.32 ± 314.47	219.12 ± 325.01	7.09	0.97

Table III. Logistic regression analysis of different types of dietary intake and sleep.

Dietary intake	Unadjusted model		Adjusted model	
	OR (95% CI)	p	OR (95% CI)	p
Grains, tubers, and legumes	1.01 (0.59-1.42)	0.02	1.12 (0.73-1.61)	0.01
Vegetables	0.98 (0.37-1.43)	0.03	0.83 (0.41-1.22)	0.02
Fruits	0.98 (0.78-1.21)	0.04	0.91 (0.68-1.13)	0.03
Poultry	1.01 (0.69-1.38)	0.18	1.21 (0.86-1.77)	0.17
Fish and shellfish	1.01 (0.76-1.37)	0.25	1.04 (0.83-1.23)	0.25
Nuts	0.97 (0.62-1.45)	0.01	0.82 (0.61-1.27)	0.01
Dairy and dairy products	1.02 (0.58-1.52)	0.43	1.16 (0.82-1.47)	0.42

tional constituents of a diet can exert substantial effects on both physiological and psychological well-being. This study examined the association between daily dietary intake and ID using a cross-sectional survey. The results revealed a negative correlation between carbohydrate consumption and sleep index, while a positive relationship was noted with the ingestion of vegetables, fruits, and nuts.

Quality fatty acids such as polyunsaturated fatty acids function as crucial nutritional components and foster human health[8]. These compounds can modulate various immune cell functions and exert therapeutic effects in conditions such as diabetes and mental disorders[9]. Nutrient-dense foods are a considerable source of polyunsaturated fatty acids in human diets[10]. The existing literature suggests that a prolonged unbalanced diet and insufficient intake of polyunsaturated fatty acids can increase the incidence of ID[11], while dietary interventions encompassing an increased intake of quality fatty acids may diminish the emergence of ID[12,13]. Current research affirms that superior intake of polyunsaturated fatty acids can mitigate symptoms associated with depression and insomnia[14]. Consistent with previous investigations[12-14], our longitudinal analysis revealed that the daily consumption of nut foods is significantly reduced in ID patients compared with the healthy population.

Individuals with ID have an increased risk of metabolic syndrome. Andersen et al[15] have confirmed that ID can amplify the occurrence of cardiovascular ailments, diabetes, and mental disorders, thereby imposing both physiological and psychological distress on patients. Earlier observational analyses have elucidated a relationship between insomnia symptoms and dietary patterns[16]. Detrimental dietary practices, typified by reduced fiber, elevated saturated fatty acid, and sugar intake, might result in suboptimal sleep quality[17]. This study identified that the weight and body mass index of patients are notably greater than those of healthy individuals. Nevertheless, a conspicuous deficit exists in guiding ID patients towards health-promoting dietary habits within the present preventative and therapeutic strategies for ID, with a large proportion of patients lacking systematic dietary guidance or appreciation for the significance of a balanced diet[2]. Thus,

offering tailored and informed dietary advice could potentially aid patients with ID in diminishing or averting the onset of ID.

The current study ascertained a positive correlation between the daily consumption of grains, tubers, and legumes and Pittsburgh Sleep Quality Index scores. A study by Stern et al[18] found that postmenopausal women who consume high-calorie, poor-quality diets have shorter sleep durations. Consumption of particular nutritional elements, including caffeine, carbohydrates, and zinc, can modulate sleep cycles[19,20]. Given the high carbohydrate content in grains and tuber foods[21], this might potentially undermine sleep quality, thereby instigating ID. However, a harmonized and nutritious dietary structure can potentially enhance sleep quality. A cross-sectional analysis[22] indicated a reduced prevalence of sleep initiation difficulties in individuals adhering to a diet rich in vegetables, fungi, potatoes, seaweeds, legumes, and eggs. Another study by Spaeth et al[23] reported that an increased dietary fiber intake can prolong slow-wave sleep, suggesting that a balanced and nutritious diet can alleviate insomnia symptoms and corroborating the negative correlation identified in this study between daily consumption of vegetables, fruits, and nuts and the PSQI.

This investigation fundamentally scrutinizes and contrasts the unsound dietary aspects prevalent in patients with ID from a daily dietary intake standpoint, offering insights and foundational references for future preventative strategies and adjunctive treatments for ID. Nonetheless, the gender distribution in this study was imbalanced, thereby necessitating a larger sample population to draw more robust conclusions. Furthermore, dietary data rely on subjective self-reports, which introduces the possibility of recall bias. Moreover, given the cross-sectional nature of the study, it can only ascertain correlations between dietary habits and insomnia prevalence in patients with ID, without affirming a causative linkage. Hence, subsequent intervention and controlled quantitative research are required to explore the association between daily consumption of specific food groups, including vegetables, fruits, nuts, quality fats, and ID.

Conclusions

In conclusion, ID patients exhibit an elevated intake of carbohydrates, whereas the consumption of vegetables, fruits, and nuts is deficient in comparison to the healthy cohort, implying that a distorted dietary structure might be a contributing factor to ID onset. Sensible and scientific dietary guidance is of considerable significance in preventing the onset of ID and facilitating its management. However, the derived conclusions warrant further extensive research.

Conflict of Interest

The authors declare that they have no conflict of interests.

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Authors' Contribution

ZZ and LX conceived and designed the study. LL and QY performed the studies search and analyzed the data. ZZ wrote the manuscript. QL and JD edited the article and provided the necessary guidance. The article's submission and publishing were approved by all authors.

Informed Consent

Informed consent was obtained from all individual participants included in the study.

Ethics Approval

This study was approved by Henan Provincial People's Hospital (No. 2020168).

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Availability of Data and Materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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