〈Original Article〉

A knowledge about the relationship between dietary habits and sleep quality

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Summary To investigate the relationship between dietary habits and sleep quality, we calculated the total protein, tryptophan, total carbohydrate, total lipid, zinc, and sodium intakes based on the contents of all meals during 1 week, and evaluated their possible association with the Pittsburgh sleep quality index (PSQI) score. The possible association between the PSQI score and mood score or the derivatives-reactive oxygen metabolites (d-ROMs) was also evaluated. The subjects consisted of 10 healthy female volunteers in the same generation. There was a significant inverse correlation between the PSQI score and tryptophan as an essential amino acid and a significant positive correlation between the PSQI score and d-ROMs. The PSQI score were inversely associated with the zinc, total protein, sodium, and energy intakes and the vigor score.

Key words: Dietary habit, Sleep quality, Tryptophan, Oxidative stress

1. Introduction

The circadian rhythm is considered to be regulated by melatonin as a pineal hormone and MT_1 and MT_2 receptors that bind to melatonin as a ligand[1-2]. Melatonin is a metabolite in the serotonin pathway of tryptophan as an essential amino acid, and a decrease in the plasma tryptophan level is associated with central fatigue[3]. Therefore, deviated dietary habits may affect the melatonin level in the brain. Indeed, an increase in the melatonin level in the pineal body after tryptophan administration in rats has been reported[4]. On the other hand, since psychological stress occurring in many people in their normal lives affects gustation, people sometimes feel that meals are unappetizing, resulting in a deviated selection of meals[5-7]. Deviated dietary habits increase oxidative stress in the body[8], and resulting oxygen species further increase oxidative stress[9], forming a vicious cycle. When sleep with poor quality persists, people become susceptible to psychological stress, which has been reported to cause circadian rhythm disorders and insomnia[10]. These findings suggest that the relationship between dietary habits and psycholog-

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ical stress affects oxidative stress in the body and sleep quality. In this study, we evaluated the relationship between dietary habits and sleep quality based on the contents of all meals during a week.

2. Subjects and Methods

1) Subjects

The subjects consisted of 10 healthy female student volunteers (mean age: 21.3±0.9 years, mean BMI: 19.5±1.7) in our university. The subjects were limited to females in the same generation because the energy metabolic rate differs between males and females, and the energy requirement differs according to age.

2) Nutritional assessment

After informed consent was obtained, the 10 subjects entered the contents of all meals (including snacks between meals) during a week in a table. To prevent omissions, they were asked to take photos of all meals. Nutritional element analysis was performed using the Microsoft® Excel Add-In software "Excel Eiyo-kun Ver. 4.5"[11], and the intakes of the total energy, total protein, tryptophan, niacin, total carbohydrate, total lipid, arachidonic acid, α -linolenic acid, γ -linolenic acid, zinc, copper, iron, and sodium were calculated.

3) Evaluation of sleep

To evaluate sleep, the Pittsburgh Sleep Quality Index (PSQI) as a questionnaire made by Buysse DJ et al. widely used in the world was employed[12]. The PSQI allows scoring of the sleep quality (range, 1-21). PSQI scores above 5.5 as the cut-off score indicate a "poor sleep quality".

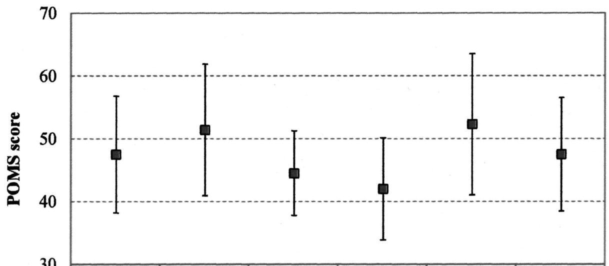
4) Measurement of oxidative stress

On the final day, blood was collected from the finger tip, and derivatives-reactive oxygen metabolites (d-ROMs) were measured as an index of oxidative stress[13], and compared with the results of the nutritional survey. As oxidative stress monitor including hydroperoxides, a precursor of the chain initiation of lipid hyperoxidation[14], the whole blood levels of d-ROMs were determined using a special measurement device (FRAS4, H&D Inc., Italy). In this method, 1 unit (Carratelli units: U. CARR) represents 0.08 mg/100 mL H_2O_2, equivalent to the concentration of hydroperoxides. The normal range of d-ROMs in whole blood is 250 to 300 U. CARR. Values outside this range indicate a modification of the prooxidant /antioxidant ratio[13].

5) Mood analysis

On the third day of the dietary survey, the Japanese Version of the Profile of Mood States (POMS), which is a questionnaire to assess mood states, was used. The POMS test is developed by McNair et al.[15] to assess mood changes in the following six categories: tension-anxiety, depression-dejection anger-hostility, vigor, fatigue and confusion.

6) Statistical analysis



	tension-anxiety	depression-dejection	anger-hostility	vigor	fatigue	confusion
■average	48	51	45	42	52	48

Fig. 1 The mean POMS score. Error bars indicate standard deviations.

Table 1　Each element intake in all meals during 1 week

Food element (unit)	Energy (kcal)	Total protein (g)	Tryptophan (mg)	Niacine (mg)	Carbohydrate (g)	Total lipid (g)	Arachidonic acid (mg)	α-linolenic acid (mg)	γ-linolenic acid (mg)	Zinc (mg)	Copper (mg)	Iron (mg)	Sodium (mg) (/week)
Subject													
A	22,917	904	9,071	197	3,486	600	1659	10,017	65	113.4	15.4	148.5	37,497
B	18,367	780	8,531	180	2,045	768	2266	14,226	15	90.0	8.5	74.0	31,449
C	14,943	521	5,322	105	2,263	379	1294	4,052	4	88.7	10.5	67.0	17,556
D	13,796	469	4,075	318	2,375	238	637	3,524	6	61.4	6.7	55.9	18,245
E	17,960	574	6,676	120	2,885	404	1336	9,875	65	80.0	11.3	63.1	21,795
F	14,765	625	3,872	216	2,002	293	843	6,969	8	87.8	27.0	207.9	14,169
G	20,011	604	5,482	106	3,275	467	1321	7,267	51	80.9	14.5	74.2	32,490
H	13,626	427	3,787	135	2,069	380	954	6,743	1	68.0	16.8	117.9	8,150
I	8,888	344	3,308	78	888	419	1631	6,267	2	37.0	4.4	39.1	15,421
J	16,598	654	6,405	164	2,116	576	2103	11,410	42	72.2	8.0	62.9	23,708

To calculate correlation coefficients between values, the Pearson product moment correlation coefficient of Microsoft Office Excel 2003 was used. This study was performed with the approval of the Ethical Committee, Fujita Health University (10-075).

3. Results

1) Nutritional assessment

The results of nutritional evaluation after the analysis (during 1 week) are shown in Table 1.

2) Sleep quality score

The mean PSQI score was 4.0±1.6, which was lower than the cut-off score (5.5).

3) Oxidative stress

The mean d-ROMs was 330±36 U. CARR, which was slightly higher than the upper limit (300 U. CARR) of the normal range[13].

4) Mood score

The mean POMS score is shown in Fig. 1. There were no abnormal values, but the vigor score was slightly low[15].

5) Relationship between the PSQI score and intake of each element

Table 2 shows the correlation coefficients between the PSQI score and intake of each element. There was a significant inverse correlation between the PSQI score and tryptophan. In addition a significant positive correlation between the PSQI score and d-ROMs (correlation coefficient, $r = 0.622$; $p<0.05$). Table 3 shows the correlation coefficients between the PSQI score and each mood subscale. The PSQI score was inversely associated with the zinc, total protein, sodium, energy, and carbohydrate intakes as well as the vigor score.

4. Discussion

There was an inverse correlation between the PSQI score and tryptophan as a melatonin derivative, showing better sleep quality with a higher trypto-

Table 2　Correlation coefficients between the PSQI score and each element (* indicates a significant correlation)

Food component	Total protein	Tryptophan	Niacine	Zinc	Copper	Iron	Sodium
correlation coefficient	-0.529	-0.613*	-0.359	-0.595	0.077	-0.111	-0.499
Food element	Total lipid	Arachidonic acid	α -linolenic acid	γ -linolenic acid		Carbohydrate	Energy
correlation coefficient	-0.225	-0.031	-0.040	-0.204		-0.488	-0.491

Table 3　Correlation coefficients between the PSQI score and each mood subscale

mood subscale	tension-anxiety	depression-dejection	anger-hostility	vigor	fatigue	confusion
correlation coefficient	0.000	-0.043	0.055	-0.505	0.053	-0.058

phan intake. We previously reported a positive correlation between the tryptophan or niacin intake and vigor in subjects with exercise habits[16]. This finding may be associated with better sleep quality in subjects with a high vigor score, which requires further evaluation. The blood zinc level is known to be decreased when body fatigue is more marked[17]. However, since a sex-related difference in its sensitivity has been reported[18], the subjects in this study were limited to females. In this study, since dietary zinc was measured, the obtained value did not represent the serum zinc level. Therefore, there was no association between the zinc intake and POMS score (data not shown). However, there was an inverse association between the PSQI score and zinc intake, suggesting better sleep quality with a higher zinc intake. In addition, with a higher intake of total protein, carbohydrate, sodium, or energy, the sleep quality was better. On the other hand, there was a positive correlation between the d-ROMs and PSQI score, suggesting that oxidative stress decreases sleep quality. This study showed that dietary habits without deviation, maintenance of low blood oxidative stress, and high vigor, i.e., being physically and psychologically healthy, are associated with the maintenance of good sleep quality.

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