The association between diet quality scores with sleep quality among employees: A cross-sectional study

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Abstract

Background: Various studies show that the quality of sleep, in employees can be effective in improving the quality and performance of their work. Numerous factors such as nutrition and diet can affect the quality of sleep of people, especially employees. This study was performed to investigate the relationship between food quality scores (HEI, DII and DASH score) and sleep quality in employees. Materials and methods: The present cross-sectional study was performed on 211 employees with a mean age of 38.75±11.31. Nutritional status of individuals was determined through the Food Frequency Questionnaire (FFQ) and to assess sleep quality, the Pittsburgh Sleep Quality Index (PSQI)was used which contains questions about delay, duration, sleep effectiveness, sleep disorders, sleeping pills and daily dysfunction. The quality of sleep decreases with increasing Pittsburgh index score. The calculated dietary quality scores include DASH Dietary Adherence Index, Healthy Nutrition Index (HEI) and Diet Inflammation Index (DII). Results: The results of this study after adjusting for confounding factors including age, sex, daily energy intake and BMI showed a significant positive relationship between DASH diet score and sleep duration ($p < 0.001$). There was a significant negative relationship between HEI score and total score of Pittsburgh Sleep Quality Index ($P = 0.003$). Also, HEI score had a significant positive relationship with sleep duration in the unmodified and modified models ($p < 0.001$), and a significant negative relationship was seen in unadjusted and modified model between DII score and sleep duration ($p < 0.001$). Conclusion: DASH and HEI score had a significant positive relationship with sleep duration and DII had a significant negative relationship with sleep duration. HEI also significantly improved sleep quality.

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Results: The results of this study after adjusting for confounding factors including age, sex, daily energy intake and BMI showed a significant positive relationship between DASH diet score and sleep duration (p <0.001). There was a significant negative relationship between HEI score and total score of Pittsburgh Sleep Quality Index (P = 0.003). Also, HEI score had a significant positive relationship with sleep duration in the unmodified and modified models (p <0.001), and a significant negative relationship was seen in unadjusted and modified model between DII score and sleep duration (p <0.001).

Conclusion: DASH and HEI score had a significant positive relationship with sleep duration and DII had a significant negative relationship with sleep duration. HEI also significantly improved sleep quality.

Keywords: sleep quality, DASH score, HEI index

What is already known about this topic?

Previous studies have examined the relationship between consumption of foods such as fish or food groups such as vegetables with sleep quality, and few studies have examined dietary quality indices with sleep quality. There was also no study examining the relationship between diet quality and employee sleep quality.

What does this article add?

Our study simultaneously examines the relationship between the three quality indices of diet, including Healthy Eating Index, Dietary Inflammatory Index and DASH score with sleep quality in employees.

Introduction:

Human health such as cardio-metabolic and mental health is related to sleeping habits, suggested by epidemiological evidence(1, 2). Most of evidence suggest that sleep duration and quality can influence on health of variety of systems in human body(3). Sleep is also very important for strengthening memory, improving vision, maintaining body temperature, maintaining and recovering energy(4), and restoration of the brain energy metabolism(5). Therefore, sleep disorders may significantly affect the occupational, physical, cognitive and social performance of people and impair their quality of life(6).

Hormonal disruption, metabolic impairment and inflammatory process can play a role in the relationship between sleep and health status(7, 8).

The quality of diet can affect sleep quality and health of individuals and for this reason, has recently been considered by researchers(9).

Studies have shown that diet plays an important role in causing or modulating inflammation in the body. Accordingly, it has been shown that following a Western diet increases inflammation, and following healthy diets such as the Mediterranean diet can be effective in reducing inflammation(10-12).

CRP, -glutamyl transferase (GGT), carotenoids, uric acid, vitamin C, and vitamin D, are several biomarkers of inflammation and antioxidants, that have been related to sleep quality parameters and duration(13).

Evidence shows that there is an association between diet quality and inflammation, and a healthy dietary pattern can result in lower CRP levels(14).

Various diet quality scores have been developed to assess adherence to desirable priori-defined diets and patterns comprehensively and to investigate the health effects of these diets(15).

The Dietary Inflammatory Index (DII®) is a literature-derived score that has been developed to evaluate the inflammatory potential of the diet and link diet to inflammation. It takes into account six inflammatory markers (i.e., CRP, IL-1beta, IL-4, IL-6, IL-10, and TNF-alpha). The DII has proven to be of value for its association with health status in the general population(16, 17).

Of the other priori-defined dietary patterns, the Dietary Approaches to Stop Hypertension (DASH) diet, which recommends higher intakes of whole grains, fruits, vegetables, nuts, seeds, legumes, and low-fat dairy, and lower intakes of processed meat, sodium, and sweetened beverages, was originally developed to manage high blood pressure(18). The other score for evaluating the dietary quality is HEI score. The HEI is designed to examine the overall quality of diets, its adaptation and compatibility and coordination with dietary guidelines and food pyramid in 1995. This index is designed to evaluate diet quality in different societies with different dietary patterns(19).

Technical-administrative employees at universities mainly perform office tasks, in some cases involving much responsibility and demanding high levels of concentration. As a result, this population of workers might be more exposed to situations which might interfere with the duration of sleep. Given that the role of nutrition in employees' sleep quality has not been investigated to date, this study aims to investigate the relationship between Dietary Inflammatory Score, HEI score and DASH score, and sleep quality in employees.

Materials and methods:

Participants :

Among 525 employees, 94 were not willing to participate, then 431 filled the consent form. Therefore, 275 of them had complete diet data, however after considering total energy intakes within the range of 800–4200 kcal, then 211 of participants was taken into the final analysis. cluster random sampling from different departments in university.

This descriptive-analytic study was conducted on 211 employees using cluster random sampling from different departments in Ahvaz Jundishapur University of Medical Sciences, aged between 18-50 who met the inclusion criteria. The inclusion criteria were willingness to participate in the study and age between 18-50 years. The exclusion criteria were reluctance to participate in the study, history of chronic disease, following vegan diet, pregnancy and lactation, taking certain medications.

Sample size:

The sample size was determined based on BMI (mean = 28.9 and SD = 4.5) as the primary outcome from a study conducted by Muscogiuri et al.(20);

The sample size was calculated using following formula:

N= [$(z_{1-\alpha/2})2 \times sd^2]/d^2$ ($\alpha = 0.05$, confidence level of 95% and d = 2%) as 162 subjects. Considering the withdrawal rate of 35%, 218 subjects were recruited.

Ethical approval:

The study protocols were fully explained to the participants. The study protocols were approved by the ethics committee of AJUMS (IR.AJUMS.REC.1399.717). Each subject was given an informed consent to sign.

Anthropometric and physical assessment:

Body weight and height was measured in the participants. Body weight was measured using a Seca scale, with an accuracy of 100 grams. Height was measured using a Seca stadiometer with an accuracy of 0.5cm. then BMI was calculated by dividing body weight by the height square.

Dietary assessments:

The used food intake was obtained from the participants, by trained dietitians, through a structured interview. To determine typical food intakes, a valid and reliable 147- item semi quantitative FFQ with standard servings was used(21). the intake frequency of each food item was asked on a daily, weekly or monthly basis during the past year, and converted to the gram. Total energy and nutrient intake were then calculated using Nutritionist IV software as modified for Iranian foods.

DII score:

For developing the latest DII, the relationship between food components or parameters and specific inflammatory markers was reviewed in the literature, published in 2010. Each article was assigned a positive or negative value, based on the effect of the food parameter on inflammatory markers (+1 = pro inflammatory relationship, 0= no significant relationship with inflammatory markers, -1 = anti-inflammatory relationship). Based on the number of pro-inflammatory and anti-inflammatory articles, an inflammatory effect score for each food parameter was calculated. First of all, each participant's dietary intake was linked to the global dataset, for calculating the DII score. Then the mean intake for each of the 45 food parameters was provided(12, 15).

HEI calculation:

By summing the sub scores in 13 categories, the total HEI score is calculated: (the score range in parentheses): total vegetables (0–5), greens and beans (0–5), total fruit (0–5), whole fruit (0–5), whole grains (0–10), total dairy (0–10), total protein (0–5), seafood and plant protein (0–5), fatty acids (0–10), sodium, refined grains (0–10), and "empty" calories from solid fats, alcohol, and added sugars (0–20). A better score, shows a better dietary quality(22).

DASH score calculation:

DASH score, reward points for high intakes of five food groups, such as fruits, vegetables, nuts and seeds and legumes, low-fat dairy products and whole grains, according to quantiles ranking (i.e., participants in the lowest quintiles receive 1 point, those in the 2nd, 3rd, and 4th quintiles receive 2, 3, and 4 points respectively, and the highest quintiles, 5 points). Intakes of sodium, sweetened beverages, red meat and processed meat had the lowest score (i.e., the lowest quintiles are assigned 5 points and the highest quintiles, 1 point)(23).

Sleep quality measurements:

To assess the sleep quality, The Pittsburg questionnaire (PSQI) was used. The Pittsburg questionnaire has 7 scales that include mental quality of sleep (ration of duration of useful sleep from time spent in bed), sleep disorders (waking up at night), dose of medicine measures sleep deprivation and dysfunction. The score of each scale is between 0-3 and the score of 3 in each scale determines the maximum negative. The overall score of this questionnaire is 0 to 21 and the overall score of 6 and above indicates the inadequacy of sleep quality.

Statistical analysis:

Distributions of demographic, lifestyle behaviors, and dietary characteristics were compared across sleep quality score and time in bed (hr/d). Hence, we used chi-square test for categorical variables and one-way ANOVA test for continues variables.

The Generalized Additive Models (GAM) procedure was applied to the dataset of 211 without any missing data by smoothening the effect of covariates into crud and adjusted models. Moreover, the adjusted Model include age, sex and total daily energy intake.

GAM uses a link function to establish a relationship between the mean of the response variable and a smoothed function of the explanatory variable(s).

We used SPSS version16 and R version 3.6.2 to perform the analyses. P values <0.05 were considered significant. The FFQ analysis and nutrients were estimated using NUT IV software (Nutritionist IV).

Results:

Table 1. shows the relationship between the baseline information of participants and the score of Sum sleep. Sum sleep score is divided in to two groups (<5 hours and >5 hours). None of the baseline characteristics had significant difference with sum sleep score.

Table 2. shows the association between the baseline information of participants and time in bed. time in bed is divided in to two groups (<6 hours and >6 hours). None of the baseline characteristics had significant difference with time in bed.

Table 3. shows the results and relationship between DASH score and sum sleep and time in bed. Our results showed that there was a negative relationship between DASH score and sum sleep, but the relationship was not significant. The data for DASH score were divided into quartiles, and the first quartile was considered as reference (anti-inflammatory quartile). Data were analyzed in two models, the first model was the non-adjusted model and the second one was adjusted for energy intake, age, BMI. In none adjusted model, there was not any significant relationship between any of the quartiles and sum sleep. But, the p-value for second quartile was 0.06 that showed the relationship could be strong. Also, the results showed that there is a strong positive association between DASH score and time in bed, in adjusted and none adjusted model ($P<0.001$).

Table 4 shows the association between HEI score and sum sleep and Time in bed, in adjusted and non-adjusted model. The negative relationship between HEI and sum sleep and time in bed, in adjusted and non-adjusted model was strongly significant ($P<0.001$). The data for HEI score were divided into quartiles, and the first quartile was considered as reference. There was not any significancy in the quartiles.

The relationship between DII score and time in bed and sum sleep is presented in Table5. The results showed that there is a strong negative relation between DII and time in bed and sum sleep, in adjusted and non-adjusted model ($P<0.001$). Like the other scores, DII scores were divided into quartiles, and the relationship between each quartile was examined, and no significancy was observed.

Discussion:

In the present study, the relationship between DASH, DII and HEI score with sum sleep and time in bed was assessed, in the employees.

The results of the present study showed that there is a positive association between DASH score and time in bed; also, there is a strong negative association between HEI score and sum sleep, and a strong positive association between HEI score and time in bed. But we noticed a positive association between DII score and sum sleep. It means that by increasing HEI and DASH score, sleep quality increases, but by increasing DII score, the sleep quality decreases.

There are several studies that have surveyed the relationship between sleep quality and diet quality.

Similar to our study, Liang et al. In a study of 3941 American adults found that following a dash diet could effectively improve sleep quality and sleep duration(24). Also, similar to our study, Mossavar-Rahmani in a study of 2,140 Spanish adults found that increasing the Healthy Eating Index effectively increased sleep duration and sleep efficiency(25). Also, another study conducted on 1500 adults in Spain, showed a lower variation in sleep duration, and lower sleep quality, in the individuals, adherent to the Mediterranean diet(26). Another study conducted by Jaussent et.al found a positive effect of Mediterranean pattern on specific aspects of sleeping(27). Consumption of fruits, legumes, nuts and fish is an important factor in the indication of Healthy Eating Index and following a DASH diet(22). Various studies have shown that these factors can be effective in improving sleep quality. Jyväkorpi et al. Showed that eating vegetables helps to sleep better(28). Hakkarainen et al. Also showed that people with insomnia eat less vegetables(29). Kurotani et al. And Cao Y et al. Showed that consumption of vegetables, fruits and legumes is associated with better sleep quality(30, 31). Liang et al. Also found that reduced consumption of vegetables, nuts, and legumes was associated with reduced sleep duration(24). Other studies also confirm that consumption of fruits and vegetables is directly related to sleep duration and sleep quality(26, 32).

In addition, Jyväkorpi et al. And del Brutto et al. Showed that fish consumption can be effective in improving sleep duration(33). Kurotani et al. Also showed that fish consumption can reduce the PQS (poor quality of sleep) score(30) and nutrition showed that fish is related to sleep timing(34).

Refined grains, Sodium, Added Sugars and Saturated Fats are factors that reduction of their consumption can increase the score of the Healthy Eating Index(22). Sodium is also important in determining the score of dash diet(35). Mossavar-Rahmani et al. showed that among the components of AHEI-2010, decreased sodium intake was most strongly associated with higher sleep efficiency (25). Grandne et al. Showed that sugar consumption was directly related to poor sleep quality(36). Kant et al. Also showed that consuming Sugars during sleep is also effective(37). Jyväkorpi et al. Also showed that consumption of Sugars and Saturated Fats are associated to poor sleep quality(28). Moreover, other animal and small human experimental studies have shown that high-saturated-fat diets may influence in circadian rhythms(38, 39). Other studies with results aligned to our study, showed that higher DII scores are negatively associated with sleep quality.

In a recent study by Lopes et al, it was shown that the DII score was only positively associated with daytime sleepiness as a component of PSQI(40). In the study by Godos et al, participants in the highest quartile of DII score were more likely to have poor sleep(41).

An interventional study also showed that an anti-inflammatory diet including increased intake of fruits, vegetables, lean protein, and reduced intake of added sugars and SFAs could improve sleep quality(42).

There are some possible explanations for the mechanisms underlying the inverse association between sleep quality and the healthy pattern, one of the explanations is that proteins include tryptophan that is a component of serotonin production and neurosecretory hormone melatonin. sleep cycle, either directly or indirectly, and brain function is controlled by Serotonin(43).

Generally, serotonin promotes wakefulness, also regulates sleep through changes in the concentration of melatonin(43, 44). Melatonin exerts a hypnotic effect through thermoregulatory mechanisms by lowering the core body temperature, reducing arousal and increasing sleep-propensity(44).

Also, vitamin B6, pyridoxine, is required for the synthesis of serotonin from tryptophan(45). The 5-Hydroxytryptophan is an intermediate in this process, and is converted to serotonin by a pyridoxal 5'-dependent enzyme(44, 45). In relation, dietary niacin is involved in leaving more tryptophan to be used for the synthesis of serotonin(46).

In addition, folate is involved in the metabolism of monoamines like serotonin in the brain(46). The N-3 fatty acids are required to convert serotonin to melatonin by the enzyme arylalkylamine-Nacetyltransferase(44).

Other nutrients such as Magnesium enhances the secretion of melatonin from the pineal gland by stimulating serotonin N-acetyltransferase activity, which is the key enzyme in melatonin synthesis(47). B12 also increases melatonin receptors in the brain(48).

In addition, oxidative stress can lead to insomnia(49). Diets with rich in antioxidant vitamins including vitamin C, have a high score of the healthy dietary pattern, which may decrease the levels of oxidative stress and prevent the development of DIS. Therefore, the above-mentioned nutrients or their combination might have a beneficial role in initiating sleep.

Increased HEI and DASH scores are associated with increased protein intake resulting in increased tryptophan. Diets with higher DASH and HEI score, contain more dark green vegetables, fruits, nuts and seeds(22, 23).

As a result, it increases the intake of magnesium, folate and vitamin C and other antioxidants from the diet, which are important factors in regulating effective hormones in sleep(30).

Diets with higher HEI and DASH scores have more variety of foods, and contain whole grains that are high in B vitamins, so they can help individuals with their sleep quality.

Increasing fish intake increases omega-3 and b12 fatty acids, which improve sleep quality(48). Fish also contains glycine, which studies show can improve sleep satisfaction(50).

Decreasing the DII score of a diet indicates the anti-inflammatory properties of the diet, which together with increasing the consumption of nutrients such as magnesium, niacin B6, B12, folate, vitamin C and omega 3, are effective in regulating melatonin(44).

Other anti-inflammatory agents that have been shown to be effective in improving quality and sleep time include potassium, fiber, and calcium(24, 30, 51).

Studies have also shown that some nutrients that have inflammatory properties in the DII index, play an important role in reducing sleep duration and sleep quality. These nutrients include total fat, SFA and cholesterol(52, 53).

One of the reasons that increased DII scores, results in decreased sleep quality, may be because of the increase in CRP levels, that is related to increased sleep apnea. Also, researchers have found that inflammation and inflammatory factors are positively linked to oxidative stress; these factors include advanced-glycation end products like erythrulose that decreases sleep quality.

One of the strengths of this study is that no such study has been conducted in the south of Iran, about dietary scores and sleep quality, also no study has been done to evaluate the food and nutrition of employees and that the results of this study provide conditions for other studies. But there are limitations to this study, too. We could not cover different ethnicities and our sample size was limited to Jundishapur University and other university centers in the province were not surveyed; also, the sample size of the study reduced the original sample size by excluding very high and low calories.

Conclusion:

The results from this study showed that there is a significant relationship between dietary health scores, such as HEI and DASH score and sleep quality derived from PQSI in staff of AJUMS. Also, the results showed that increasing DII score, which is caused by increasing the consumption of inflammatory foods, reduces the quality of sleep. From this article it can be concluded that one of the ways to improve the quality of sleep can be a change in diet, especially shifting to healthy eating patterns.

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Table 1. Characteristics, diet quality scores and food intakes according to sum sleep quality score

Variable	<5 sum score	[?]5 sum score	P-value[1]
Weight (kg)	75(12.17)	74.91(13.34)	0.96
Age (years)	39.25(6.54)	39.94(7.52)	0.57
Hight(cm)	157.84(43.84)	174.46(125.72)	0.38
BMI (kg/m2)	26.08(3.81)	26.01(3.69)	0.97
Sex (N) (%)			0.47
Male	23(22.3)	80(77.7)	
female	21(18.4)	93(83.7)	
Marital status (N) (%)			0.004
Married	32(19)	136(81)	
Single	7(16.3)	36(83.7)	
Divorced	4(100)	0	
Education status (N) (%)			0.14
<12 years	1(6.3)	15(93.5)	
>12 years	43(21.7)	155(78.3)	
Smoking status (N) (%)			0.76
Yes	3(23.1)	10(74.9)	
No	40(19.7)	163(80.3)	
Income status (N) (%)			0.93
strongly satisfied	3(21.4)	11(78.6)	
partially satisfied	22(21.8)	79(78.2)	
strongly unsatisfied	14(20.3)	55(79.7)	
partially unsatisfied	4(16)	21(84)	
DII score	0.29(2.40)	-0.02(2.10)	0.41

Variable	<5 sum score	[?]5 sum score	P-value[1]
DASH score	20.35(4.07)	20.65(3.92)	0.66
HEI score	62.83(7.16)	64.12(8.54)	0.37
Protein%	14.26(2.47)	13.94(2.07)	0.38
Carbohydrate%	62.09(7.23)	25.11(8.33)	0.68
Fat%	25.68(7.92)	25.11(8.33)	0.68
Energy (kcal/d)	2286.63(725.60)	2493.33(734.91)	0.06

Abbreviation : DII; dietary inflammatory index, DASH; Dietary Approaches to Stop Hypertension, HEI;Healthy Eating Index

[1] Based on chi-square test for categorical variables and one-way ANOVA test for continues variables.

Continuous variables are shown as means ± SDs, and categorical variables are shown as percentages. $p < 0.05$ was considered statistically significance

Variable	Time in bed <6 h	Time in bed [?]6 h	P-value[1]
Weight (kg)	74.82(13.18)	75.50(12.71)	0.77
Age (years)	39.99(7.20)	38.86(7.89)	0.39
Hight(cm)	172.79(124.22)	163.82(29.39)	0.66
BMI (kg/m2)	25.93(3.66)	26.46(3.97)	0.44
Sex (N) (%)			0.50
Male	85(82.5)	18(17.5)	
female	95(83.3)	19(16.7)	
Marital status (N) (%)			0.004
Married	146(86.9)	22(13.1)	
Single	31(72.1)	12(27.9)	
Divorced	2(50)	2(50)	
Education status (N) (%)			0.63
<12 years	14(87.5)	2(12.5)	
>12 years	164(82.8)	34(17.2)	
Smoking status (N) (%)			0.55
Yes	10(76.9)	3(23.1)	
No	169(83.3)	34(16.7)	
Income status (N) (%)			0.22
strongly satisfied	9 (64.3)	5 (35.7)	
partially satisfied	84 (83.2)	17 (16.8)	
strongly unsatisfied	60 (87)	9 (13)	
partially unsatisfied	20 (80)	5 (20)	
DII score	0.05(2.12)	-0.01(2.37)	0.86
DASH score	20.46(3.96)	21.21(3.87)	0.32
HEI score	63.65(8.11)	63.90(8.33)	0.87
Protein%	13.99(2.18)	14.08(2.04)	0.82
Carbohydrate%	62.92(8.26)	62.11(7.30)	0.58
Fat%	25.59(8.33)	25.91(7.83)	0.58
Energy (kcal/d)	2496.46(737.98)	2232.43(695.25)	0.04

Table 2. Characteristics, diet quality scores and food intakes according to Time in bed

Abbreviation : DII; dietary inflammatory index, DASH; Dietary Approaches to Stop Hypertension, HEI;Healthy Eating Index

[1] Based on chi-square test for categorical variables and one-way ANOVA test for continues variables.

Continuous variables are shown as means ± SDs, and categorical variables are shown as percentages. $p < 0.05$ was considered statistically significance

Table 3. The Generalized Additive Models associations between baseline Healthy Eating Index score, sum sleep and Time in bed.

	Model 0[a]	Model 0[a]	Model 0[a]	Model 0[a]	Model 1[b]	Model 1[b]	Model 1[b]	Model 1[b]
Sum sleep	β	SE	t-value	P-value	β	SE	t-value	P-value
HEI Score	-0.11	0.001	-32.07	<0.001	-0.09	0.03	-2.98	<0.05
Q2 HEI Score	0.48	0.83	0.57	0.56	7.68	8.58	0.89	0.37
Q3 HEI Score	-0.11	1.21	-0.09	0.92	1.76	1.23	0.14	0.88
Q4 HEI Score	0.48	1.78	0.27	0.78	8.30	1.82	0.45	0.65
Time in bed								
HEI Score	0.08	0.001	50.55	<0.001	0.08	0.01	5.55	<0.001
Q2 HEI Score	-0.23	0.48	-0.47	0.63	-0.35	0.47	-0.75	0.45
Q3 HEI Score	0.06	0.75	0.08	0.93	-0.16	0.73	-0.22	0.82
Q4 HEI Score	0.37	1.00	0.37	0.70	0.11	0.98	0.11	0.90

a. Model 0, GAM generalized additive model without adjustment; b. Model I, GAM generalized additive model with adjustment for energy intake, age, BMI

Abbreviation : HEI;Healthy Eating Index, Q; Quartile, SE;Standard error

Table 4. The Generalized Additive Models associations between baseline DASH score, sum sleep and Time in bed.

	Model 0[a]	Model 0[a]	Model 0[a]	Model 0[a]	Model 1[b]	Model 1[b]	Model 1[b]	Model 1[b]
Sum sleep	β	SE	t-value	P-value	β	SE	t-value	P-value
DASH Score	-0.05	0.06	-0.80	0.42	-5.59	7.03	-0.79	0.42
Q2 DASH Score	-1.82	1.15	-1.15	0.11	-1.37	7.27	-1.88	0.06
Q3 DASH Score	-2.37	1.68	-1.40	0.16	-7.16	8.57	-1.55	0.12
Q4 DASH Score	-2.11	2.29	-.91	0.36	-7.16	7.69	-0.93	0.35
Time in bed								
DASH Score	0.24	0.006	37.84	<0.001	2.05	5.703	3.61	<0.001
Q2 DASH Score	0.58	0.52	1.12	0.26	0.70	0.57	1.35	0.17
Q3 DASH Score	0.23	0.75	0.30	0.76	0.15	0.75	0.21	0.83
Q4 DASH Score	0.03	1.03	0.02	0.97	0.13	1.03	0.12	0.89

a. Model 0, GAM generalized additive model without adjustment; b. Model I, GAM generalized additive model with adjustment for energy intake, age, BMI

Abbreviation : DASH; Dietary Approaches to Stop Hypertension, Q; Quartile, SE;Standard error

Table 5. The Generalized Additive Models associations between baseline Dietary Inflammatory Index score, sum sleep and Time in bed.

	Model 0[a]	Model 0[a]	Model 0[a]	Model 0[a]	Model 1[b]	Model 1[b]	Model 1[b]	Model 1[b]
Sum sleep	β	SE	t-value	P-value	β	SE	t-value	P-value
DII Score	-0.10	0.12	-0.79	0.42	-1.02	1.30	-0.78	0.43
Q2 DII Score	0.02	1.37	0.01	0.98	5.04	8.22	0.61	0.54
Q3 DII Score	0.10	2.15	0.05	0.96	-1.393	8.02	-0.24	0.80
Q4 DII Score	0.82	2.79	0.29	0.76	-4.90	8.03	-0.61	0.54
Time in bed								
DII Score	-0.13	0.02	-5.46	<0.001	-1.35	0.23	-4.21	<0.001
Q2 DII Score	0.09	0.64	0.15	0.87	1.14	6.68	0.17	0.86
Q3 DII Score	-0.36	1.01	-0.35	0.72	-5.26	1.04	-0.50	0.61
Q4 DII Score	-0.63	1.29	-0.48	0.62	-7.43	1.31	-0.56	0.57

a. Model 0, GAM generalized additive model without adjustment; b. Model I, GAM generalized additive model with adjustment for energy intake, age, BMI

Abbreviation : HEI; Dietary Inflammatory Index, Q; Quartile, SE;Standard error