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RELATIONSHIP BETWEEN PERCEIVED STRESS AND DIETARY INTAKES IN TYPE 2 DIABETIC PATIENTS

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ABSTRACT: ***As the major aspect of lifestyle, dietary patterns are concerned with health issues in all conditions including stress. Studies on the association between stress and food choices have resulted conflicting outcomes. This cross-sectional study was conducted on a sample of type 2 diabetic patients (n = 200) who met the inclusion criteria. A 14-item questionnaire was used to measure the perceived stress. Food recall was recorded by a trained dietitian for 24 hours over 2 regular days and 1 holiday. Liner regression results indicated that negative perceived stress had association with carbohydrate intake (B=0.246, P=0.04) which for the Positive perceived stress it was directly associated with mean protein (B=0.14, P=0.04) and fiber intakes (B=0.46, P=0.001). Based on the finding, there was a relationship between micronutrient intake and positive perceived stress. Positive perceived stress leads to healthy food choices while negative perceived stress leads to the unhealthy dietary patterns. A diet with adequate vitamin B complex, vitamin E and antioxidant minerals (selenium, zinc, copper, magnesium) may have positive effects in coping with stress and help positive interpretation of stressful events.***

KEY WORDS: Diet, Micronutrients, Perceived stress, Type 2 diabetes.

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INTRODUCTION

Type 2 diabetes is one of the most prevalent chronic diseases and is the 4th major cause of mortality in developed countries. The global prevalence of diabetes among adults was estimated 150 million in 1995, and this is projected to increase to 300 million by 2025 (Abubakari, 2008; Aliasgharzadeh et al., 2015). In Iran, approximately 7.7% of adults are reported as suffering from type 2 diabetes (Hadaegh et al., 2008). As genetic and lifestyle factors, such as lack of exercise and a poor diet, appear to account for the increased prevalence of type 2 diabetes (Hu et al., 2001; Ford et al., 2004), psychological factors such as stress, anxiety and depression have also been reported to be associated with type 2 diabetes as well as the metabolic syndrome (Timonen et al., 2007; Goldbacher et al., 2009). A growing body of evidence suggests that stress not only affects health through direct physiological processes but also through changes in health behaviors such as food choice and intake (Wallis et al., 2009). The relationship between stress and eating patterns is complex, but a number of animal and human studies recommend that stress is related to unhealthy changes in eating behaviors and food preferences such as increased fat intake (Ng et al., 2003; Hellerstedt et al., 1997; Wardle et al., 2000) and higher consumption of energy-dense and snack-type foods (Conner M et al., 1999; O'Connor DB et al, 2004). However, other studies showed no differences in intake by comparing the periods of high and low life stress (Bellisle et al., 1990; Pollard et al., 1995; Stone et al., 1994). In addition, some studies revealed that dietary composition had no effect on mood and behavior (Spring et al., 1987). In recent years, conflicting findings have drawn considerable interests among the researchers.

The effects of stress on eating are not uniform; for some people, stress may reduce energy intake whereas for others it can have the opposite effect. Therefore, it is important to investigate the relationship between stress and dietary intake. Psychological factors play a significant role in quality of life of diabetic patients. Regarding the significance of psychological and mental health in these patients, this cross-sectional study was conducted to test the relationship between perceived psychological stress and dietary intake in type 2 diabetics. To our knowledge, no previous studies have examined the relationship between perceived psychological stress and dietary intake in this population.

MATERIALS AND METHODS

This cross-sectional study was approved by the ethic committee of Tabriz University of Medical Sciences. Two hundred type 2 diabetic patients were recruited from the Iranian Diabetic Society and from endocrinology and metabolism clinics that were associated with Tabriz University of Medical Sciences. Inclusion criteria were defined as: age 30-65 years old, having type 2 DM for more than 6 months, currently having anti-diabetic treatment, having a stable diet and a body mass index (BMI)>25 kg/m^2 for the past 3 months. Subjects were excluded if they had a history of gastrointestinal, pancreatic, or cardiovascular disease, renal, thyroid or liver disturbance and if they were pregnant or lactating. An appointment time was set for each subject to provide study information, to complete their individual questionnaire, and to provide their written informed consent. Demographic data including age, medication, and diabetes duration (in years) were obtained using a questionnaire.

Stress measurement

The Perceived Stress Scale (PSS-14 items) which assesses the extent to which in which a respondent considers the life situations as being stressful was used for this study. The questions measure how unpredictable, uncontrollable, and overloaded respondents find their lives, using a 5-point Likert scale response format ('0=Never', '4=Very Often'). Scores for individual participants were obtained by summing their responses to all 14 items (Cohen et al., 1983). Employing the PSS scale in a population probability sample in Iran, Cohen and Williamson reported an internal reliability (Cronbach's alpha) of 0.78.

Assessment of dietary intake

The subjects' 24-hour food recalls (2 usual days and 1 holiday) were recorded by a well-trained dietitian for three days. All of the 24-hour food recalls were analyzed by Nutritionist IV (NIV) program, which also calculated their energy, macronutrient and micronutrient intake.

Statistical analysis

The analysis was conducted using SPSS 16, with statistical significance level set at $P<0.05$. Descriptive statistics were run on food consumption and perceived stress. Linear regression models were used for all analyses. Stress was the independent variable. Covariates included in all analyses were age, education, marital status, diabetes duration and income.

RESULTS

Sample characteristics

The characteristics of the subjects are presented in Table 1. All the participants were 35–60 year-old, type 2 diabetic women. Patients' mean weight and waist circumference were 81.11±19.64 kg and 103.22±16.35 cm, respectively. The mean ± SD scores of subjects' negative and positive perceived stress were 15.07±4.31 and 12.79±4.56, respectively.

TABLE 1. Demographic and clinical characteristics of patients (N=200). BMI, body mass index.

Characteristics	Mean ± SD
Age (yr)	47.38±9.47
Weight (kg)	81.11±19.64
Waist circumference (cm)	103.22±16.35
BMI (kg/m^2)	30.39±5.22
Systolic blood pressure (mm Hg)	127.35±14.31
Diastolic blood pressure (mm Hg)	84.05±10.85

Relationship between perceived stress and macronutrient intake

Table 2 Presents mean macronutrient intake of patients. The results of analyses relating perceived stress to macronutrients intakes were presented in Table 3. After adjustment for age, education, and marital status, diabetes duration and income,

TABLE 2. Mean macronutrient intake of patients (N=200). SFA, saturated fatty acid; PUFA, poly unsaturated fatty acid; MUFA, mono unsaturated fatty acid.

Dietary intake	Mean ± SD
Energy (kcal)	1998.3±645.75
Carbohydrate (g/day)	254.6±89.45
Protein (g/day)	68.26±30.89
Fat (g/day)	79.77±46.34
SFA (g/day)	23.20±19.03
PUFA (g/day)	23.03±15.33
MUFA (g/day)	25.76±17.76
Cholesterol (g/day)	239.94±15.56
Soluble fiber (g/day)	0.53±0.49
Insoluble fiber (g/day)	3.10±2.62
Dietary fiber (g/day)	13.15±5.99
Crude fiber (g/day)	3.40±1.82

TABLE 3. Regression Coefficients for positive and negative perceived Stress and macronutrient intakes (N=200). *Regression coefficients were controlled for age, education, and marital status, diabetes duration and income*

macronutrients intakes	Positive perceived stress			*negative* perceived stress		
	B	SE	**P**	B	SE	**P**
Carbohydrate	-0.008	0.005	0.14	0.246	0.021	0.042
Protein	0.14	0.301	0.04	-0.018	0.027	0.501
Fat	-0.024	0.022	0.65	0.011	0.046	0.871
Fiber	0.46	0.812	0.01	-0.12	0.741	0.136

weak but significant correlation was found between negative perceived stress and carbohydrate intake (B=0.246, P=.042). However, Positive perceived stress was directly associated with mean protein (B=0.14, P=0.04), fiber (B=0.46, P=0.001) There was a negligible and in/significant correlation between perceived stress and fat intake.

Relationship between perceived stress and micronutrient intake

As presented in Table 4, there were weak and significant association between micronutrient intake and positive perceived stress; however, negligible correlation was found between negative perceived stress and micronutrient intakes (data was not shown).

TABLE 4. Regression Coefficients for positive perceived Stress and micronutrient intakes (N=200). *Regression coefficients were controlled for age, education, and marital status, diabetes duration and income.*

Micronutrients intakes	Positive perceived stress		
	B	SE	**P**
Vitamin E	0.24	0.512	0.06
Vitamin B1	0.37	0.870	0.01
Vitamin B2	0.26	1.602	0.02
Vitamin B3	0.35	0.203	0.008
Vitamin B5	0.25	0.198	0.010
Vitamin B6	0.38	0.432	0.096
Magnesium	0.35	0.211	0.020
Selenium	0.28	0.071	0.011
Zinc	0.28	1.001	0.024
Copper	0.39	0.651	0.061

DISCUSSION

The aim of this study was to explore the relationship between dietary intake and perceived stress in type 2 diabetics. Most of the previous studies in this area evaluated the effect of food choice by using a food frequency questionnaire (FFQ); however, in the present study we used 24-hour food recall which can estimate mean energy and nutrient intake.

To the best of our knowledge, this study was the first to examine separately negative/positive perceived stress effect on dietary intake. As mentioned before, the relationship between stress and eating patterns is complex. There is growing evidence that food consumption has an influence on how we feel (Christensen et al., 2001). The effect of carbohydrate meals on mood is most frequently reported in this field. We found that subjects with high carbohydrate intake had higher negative perceived stress and it is unknown that carbohydrate intake deteriorated the mood and increased negative perceived stress which in turn caused selection of high carbohydrate foods.

Research results in psychology have shown that carbohydrate intake is associated with improved mood (Benton et al., 1999; Prasad 1998; Benton 2002). In a study, low carbohydrate/high protein breakfast for 3 weeks led to the reports of increased anger (Deijen, 1989). Epel et al reported that in women during and after stress consumption of palatable and dense foods like high fat/high carbohydrate foods was increased and this might have helped them to cope with the stressors (Epel et al., 2001). Consistent with our study, Mikolajczyk et al reported direct association between higher consumption of carbohydrate-rich foods (such as sweets, chocolate, cake, biscuits) and higher negative perceived stress levels (Mikolajczyk et al.,2009). Markus et al reported that high carbohydrate diet may inhibit deterioration of mood in individuals under stressful tasks (Markus et al., 1998). These findings were also supported by a recent study that found stressed college females with an increased appetite mainly choosing significantly more types of sweet foods and mixed dishes such as fast food (Kandiah et al., 2006). In contrast, it has also been observed that dietary composition had no effect on mood and behavior (Spring et al., 1987). These contradictory results have led to a debate regarding negative mood and carbohydrate consumption in the literature. Although there were conflicting results in the previous reports, a few studies have revealed that people increased carbohydrate intake in order to self-mediate against negative mood. According to the Wurtman hypothesis, carbohydrate could relieve depression. It was generally accepted that serotonin (5-hydroxytryptamine), an important neurotransmitter in the central nervous system, may play an important role in this respect and be involved in the modulation of various aspects of mood and behaviors including depression, anxiety, and aggression.

Tryptophan is the precursor of serotonin. Carbohydrate-rich foods may raise glucose and trigger insulin secretion, which facilitates the uptake of most large neutral amino acids (tyrosine, phenylalanine, leucine, isoleucine and valine), except tryptophan, into peripheral tissues. As a result, the plasma ratio of tryptophan to large neutral amino acid rises, which in turn gives tryptophan the advantage in its competition for accessing the brain. Thus, serotonin synthesis increases and the behavioral consequences of increased serotinergic activity

change (Anisman et al., 1992; Delbende et al., 1992; Maes et al., 1995; Markus et al., 2000). Moreover, stress appears to cause a loss of control that subjects usually exert to avoid eating what they perceived as fattening or unhealthy foods (Zellner et al., 2006). This could also contribute to interpretation why the subjects choose carbohydrate-rich and high-fat foods during stressful situations.

It is widely accepted that eating behavior in humans changes according to changes in their emotional feelings such as stress, anger, joy, depression and other moods (Patel et al., 2001; Canetti et al., 2002; Wallis et al., 2004). We found that women with positive perceived stress had higher dietary intake of protein and fiber. It seems logical to conclude that people with healthy food choices have positive perception in stressful events or high intake of fiber and protein causes elevated mood and increased positive perception of stress. It was demonstrated that weight gain in college female students was negatively associated with vegetable intake, less consumption of low cholesterol foods and being stress-free (Adams et al., 2007). Oliver and Wardle found that most "snack-type" foods, including sweets, chocolate, cake and biscuits, and savory snacks were eaten more under stress. Adversely, the "meal-type" foods such as fruit and vegetables, meat and fish were reported to be eaten less during stressful situation (Oliver and Wardle, 1999). This could be explained by the negative correlation between fruits/vegetables intake and perceived stress. Consistent with our findings, Liu et al reported that consumption level of fresh fruit was inversely correlated with perceived stress. There was a negligible correlation between perceived stress and fat intake in the present study (Liu et al., 2007). This finding is inconsistent with those of previous investigations which observed higher energy and fat intake under stressful situations (Oliver and Wardle, 1999; McCann et al.1990; Michaud et al.1990, Weidner et al., 1996). Potential explanation to this contrary conclusion is that subjects studied by one researcher may represent a different population than the ones described by another researcher.

The influence of stress on vitamin status and *vice versa* suggests numerous roles of vitamins in stress reactions and the ability to manage potentially harmful outcomes of stress (Schlebusch et al., 2000). Vitamin E, as the major component of antioxidant defense system in the body, has an important role in functional integrity of all biological membranes. Vitamin E deficiency in humans leads to the neuropathological changes such as peripheral neuropathy, decreased proprioception and vibration sense (Muller et al., 1983). It is reported that stressed individuals have higher oxidative stress and therefore lower levels of antioxidants (Tsaluchidu, 2008). According to these hypotheses, it is possible to explain the result of the present study that subjects with high vitamin E intake had positive perception of stress. On the other hand, diets rich in antioxidants, like vitamin E, improve body antioxidants defense system, help coping with stress and cause positive perception of stress (Karimi et al., 2015).

There is growing interest regarding possible effects of a number of essential micronutrients, especially B vitamins including B1, B6 and B12, and the essential mineral co-factor selenium on mood (Benton et al., 1999). However, despite the possibility that these nutrients can influence brain function, the evidence for their effects on mood via dietary intake remains ambiguous (Gibson et al., 2002; Ness et al., 2003). Our study showed that subjects with high vitamin B intake had positive perception of stress and this may declare the role of this vitamin in stressful situations. It has been recently indicated that stressful events increased the requirements for B-complex vitamins (Sanlier and Unusan, 2007). However, as we mentioned before high carbohydrate foods are mostly preferred in stressful situations and B-vitamins are necessary for carbohydrate metabolism; therefore, lack of these vitamins increases stress and decreases the ability to cope with stress. Deficiency of vitamin B1 results in problems like anxiety, depression and sleeplessness. Moreover, anxiety reactions could lead to vitamins B5 and B6 deficiency. Also, it is known that vitamin B6 deficiency decreases GABA, and increases central nervous system irritability (Bernstein, 1990).

In the present study selenium, copper, zinc and magnesium intakes were positively correlated with positive perceived stress. Huwang reported that zinc, thiamin, riboflavin, and folate intakes were lower in subjects with the highest stress scores (Hwang, and Lee, 2010). Our result confirmed that of a previous study which showed negative associations of zinc and copper intakes with stress levels (Oliver and Wardle, 1999). These minerals are part of an antioxidant defense system, which seems to cope better with stress when it receives adequate dietary intake. Mokhber et al reported that supplementation with selenium during pregnancy might be effective for the prevention of postpartum depression (Mokhber and Namjoo, 2011). However, low selenium levels were significantly associated with decreased performance in neurological tests of coordination among older adults (Shahar, 2010). In addition, magnesium supplementation has been beneficial in neuropsychiatric disorders (McLean, 1994) but genetic differences in magnesium utilization may be an explanation for differences in vulnerability to magnesium deficiency and differences in body response to stress (Seelig, 1994). In psychiatric patients, zinc deficiency may have an effect on emotionality and response to stress (McLaughlin et al., 1990; Katz et al., 1987). In the central nervous system, zinc is concentrated in the synaptic vesicles of specific glutaminergic neurons, which are found primarily in the forebrain and connect with other cerebral cortices and limbic structures. During synaptic events, zinc is released and passes into post synaptic neurons, serving as a neurotransmitter (Frederickson et al., 2000). Overall constituents in the multivitamin supplement that are known to have bearing on brain mechanisms in general may have contributed to the current findings. For example, antioxidants such as vitamin C, E, and flavonoids maintain a redox balance and can reduce oxidative stress (Glade, 2010), zinc has both antioxidant and anti-inflammatory characteristics (Bao et al., 2010), a-tocopherol and vitamin D are involved

with regulation of cellular proliferation, differentiation, and apoptosis (Singh et al.,2004; Holick, 2007) and the antioxidant and anti-inflammatory properties of multivitamins have been linked to increased telomere length of leukocyte DNA (Xu et al.,2009). Therefore, it seems that multivitamin supplementation may be useful in improving alertness and reducing negative mood symptoms and improving day-to-day functioning. One of the limitations of this study is that we did not measure serum levels of vitamins and minerals which can reflect the status of micronutrients and their association with stress better than dietary amounts.

In conclusion, positive perception of stress may lead to healthy food choices and negative perceived stress to the unhealthy dietary patterns. A diet with adequate vitamin B complex, vitamin E and antioxidant minerals (like selenium, zinc, copper, magnesium) may be a positive factor in coping with stress and help positive interpretation of stressful events. Further longitudinal studies are needed to determine which one (stress or dietary pattern) has priority in this relationship.

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Conflict of interest

The authors declare that there is no conflict of interest.

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