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Association between Consumed Foods and Musculoskeletal Disorder in Office Workers

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ABSTRACT

Background: Musculoskeletal disorder (MSD) is one of the important problems concerning the staffs' health and productivity in the workplace. Nutritional status and consumption of some foods are also among the determining factors of MSD. So, this study aimed to evaluate the correlation of diet and consumed food groups with MSD. Methods: This cross-sectional study was conducted on 100 office workers. The participants' anthropometric parameters and their dietary information were collected using a semi-quantitative food frequency questionnaire. The findings were categorized into nine levels. The total scores were calculated for all the items per food group and per person. Nordic musculoskeletal questionnaire was also administered to evaluate the MSD symptoms in nine parts of body. Results: The score of consumed food groups was compared between individuals "with pain" and "without pain" in nine parts of the body. The scores of fruit intake in individuals "with pain" and "without pain" were 2.94 \pm 1.27 vs. 3.29 \pm 1.16 and 2.81 \pm 1.10 vs. 3.49 \pm 1.38 in terms of neck and wrists, respectively. The difference between the two groups were significant (P < 0.05). Furthermore, the participants with pain in the neck consumed significantly lower amounts of cereals and nuts (P = 0.03, 0.04). In the case of the shoulder pain, consuming legumes and nuts in the "without pain" group was higher than the group of participants who had pain (P = 0.01, P = 0.03). Fat intake was higher in the patients who had pain in their hips (P = 0.02). Conclusion: Less pain was reported in the musculoskeletal system by higher consumption of fruits, nuts, and legumes. It seems that plant-based dietary pattern is more effective in musculoskeletal health.

Keywords: Musculoskeletal disorder; Staff; Food groups; Nordic questionnaire; Food frequency questionnaire

Introduction

Adult musculoskeletal disorders (MSD), a group of inconveniences, injuries, and pains,

are some of the most common health problems in the world (Madadizadeh et al., 2017, Soe et al.,

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2015). Musculoskeletal system, nerves, circulatory tissues of the body are involved in this disorder (Soe et al., 2015). This disorder is observed in the different parts of the body and has many types such as low bone density, osteoporosis, sarcopenia, carpal tunnel syndrome, connective disorders, chronic tissue types such osteoarthritis (OA) or chronic low back pain (LBP), and many other conditions (Craig et al., 2017, Grimes and Legg, 2004, Hurley et al., 2015, Madadizadeh et al., 2017). The prevalence of MSD is higher in women and rural places than men and urban areas (Tay et al., 2018).

The workplace conditions are among the important causes of MSD (Madadizadeh *et al.*, 2017). Work-related MSD are among the major working problems worldwide (Thetkathuek *et al.*, 2018).

The main risk factors with regard to work conditions vary from physical actions to repetitive body postures for long periods of time (Quemelo *et al.*, 2015). For example, sitting for a long time in a non-standard posture and working with computer for long hours lead to a high prevalence of MSD among the office staff. These disorders affect neck, shoulders, back, and upper limb more frequently (Madadizadeh *et al.*, 2017, Quemelo *et al.*, 2015). The MSD create a huge burden of time and cost for individuals and the society since such disorders affect the people's psychosocial well-being and quality of life by causing absence from work and low productivity (Arnetz *et al.*, 2003, Bohman *et al.*, 2014, Geha *et al.*, 2014, Hurley *et al.*, 2015).

In this regard, identifying the potentially modifiable factors associated with MSD is of great importance. Nutrition and dietary patterns are among the determining factors of MSD and many studies investigated the effect of diet and nutrition on the bone and muscle heath (Bárbara Pereira Costa *et al.*, 2016, Campbell, 2001, Høstmark *et al.*, 2014, Kim *et al.*, 2015, Liu *et al.*, 2015, McAlindon *et al.*, 1996, Perälä *et al.*, 2017, Pernow *et al.*, 2010). Nutrient deprivation affects the prevalence of MSD by decreasing the lean mass, integrity of joint, muscle strength, and bone mineral density (BMD) (Bárbara Pereira Costa *et*

al., 2016, De França et al., 2016, McAlindon et al., 1996, Wu et al., 2017). In addition, calcium plays a vital role in the strength and stiffness of the skeletal structure and many enzymes need magnesium for their special effects on bone heath (Campbell, 2001). Zinc and copper are among the necessary nutrients in bone growth and normal maturation of collagen, respectively (Sadeghi et al., 2014). Dietary protein is essential for muscles because it is considered as the building block for muscle-fiber synthesis (Mangano et al., 2017). However, nutrients are not taken separately in a regular diet; so, they have interactive and growing effects with other foods. Many studies investigated the relationship between food items or dietary patterns and MSD (De França et al., 2016, Han et al., 2017, Hejazi et al., 2009, Perry et al., 2010, Silva et al., 2017, Wang et al., 2007, Whittle et al., 2012, Wu et al., 2017).

With regard to MSD, consuming fruits and vegetables provides a potential benefit for improving human health. Several studies reported improved skeletal health (De França et al., 2016, Karamati et al., 2014), muscle strength (Neville et al., 2014), and BMD (Li et al., 2013, Prynne et al., 2006, Tucker et al., 2002), but reduced bone turnover (Macdonald et al., 2005), knee pain (Han et al., 2017), and MS pain/stiffness (Høstmark et al., 2014) after consuming fruits and vegetables. These beneficial effects were reported for dairy products in some investigations although the results varied depending on the kind of dairy product or participant's gender and age (Bener et al., 2007, McCabe et al., 2004, Sahni et al., 2014, Shin and Joung, 2013). Furthermore, the pattern of consumed oil including Omega-3/Omega-6 acid $(\omega 3/\omega 6)$ fatty ratio or synthetically hydrogenated oil is important and in correlation with the MSD (Høstmark et al., 2014, Troy et al., 2007).

To the best of our knowledge, no study has assessed the effect of food items on MSD among office workers. Regarding the prevalence of MSD among office workers and the important role of nutrition in the prevention and relief of MSD, the current study aimed to assess the relationship

between MS pain and consumed food.

Materials & Methods

This cross-sectional study was conducted over 100 volunteers (70 women and 30 men). Patients were randomly selected from the office worker in Iran University of Medical Sciences. Volunteers with diabetes mellitus, recent illnesses, injuries or surgery, conditions such as pregnancy and lactation, and those who were receiving anti-inflammation medications since the past six months were excluded.

Measurements: The participants' demographic details were collected and routine anthropometric examinations including height and weight were undertaken. Height was measured using a stadiometer with 0.1 cm precision and participants were weighted while they were wearing light indoor clothes without shoes by the Seca scale (Hamburg, Germany) to the nearest 0.5 kg. The demographic information questionnaire was also administered among the participants and included information about their age, gender, level of education, and working hours in day and week were obtained.

Usual dietary intake was assessed using a 168-item interviewer-administered semi-quantitative food frequency questionnaire (FFQ) (Asghari *et al.*, 2012). This questionnaire was used to obtain information about the dietary intake of the individuals in the preceding 12 months. The FFQ comprised a list of commonly consumed Iranian foods.

Each participant reported consumption of each food based on nine frequency categories. The frequency categories included: less than once a month, one to three times a month, once a week, two to four times a week, five to six times a week, one time per day, two to three times per day, three to five times per day, six times per day, and more than six times per day.

After the FFQ was completed as explained, the mean of daily frequencies of the consumed foods was computed that ranged from one to nine as the minimum and maximum levels, respectively. For example, when an item was consumed "less than

once a month", it was scored as "1" or when it was consumed "more than six times per day" it was scored "9". Each group consisted of several food items, so that the total score was calculated for all items in each food group and each person. Finally, the mean of these scores was calculated by dividing the total score by the number of items per group.

We classified food items into eight major groups including: 1. Vegetables, 2. Fruits, 3. Dairy product, 4. Cereals, 5. Meats, 6. Fats, 7. Junk foods, and 8. Sugar. As a result, food consumption was assessed in all groups in details and its related subgroups were determined.

Risk assessment methods for work posture: The participants filled out the Nordic Musculoskeletal Questionnaire to evaluate the MSD symptoms. In Nordic Questionnaire, nine body regions, including head/neck, shoulders, upper back, elbows, back, hips, wrists/hands. low knees. ankles/feet, are illustrated on an image of the body. To assess the presence of MSD symptoms (ache, pain or discomfort), related questions were asked about each area during the previous 12 months and last 7 days. The questions should be responded with "ves" or "no".

Ethical considerations: All participants were informed about the study purposes and asked to sign informed consent forms. The project was approved by the Ethical Board of Iran University of Medical Sciences (ethics code: 93-04-132-24951).

Data analysis: Kolmogorov-Smirnov test was run for assessing the normality of continuous variables. An independent t-test was applied to compare the difference between groups in normal distribution while the Mann-Whitney test was applied for asymmetric variables. The odds ratio was calculated using simple logistic regression. A P-value of less than 0.05 was considered as statistically significant.

Results

In the current study, three women and one man withdrew from the study, since they did not have interest and adequate time to fill the questionnaire. Finally, 97 participants (men: 28, women: 69) aged

 36.21 ± 7.97 years completed the data analysis. Other general features of the study population are presented in **Table 1**.

The scores of food groups consumption (Vegetables, Fruits, Dairy, Sugar, Junk foods, Cereals, Meats, and Fats) and pain in different areas of the body (Neck, Shoulders, Upper back, Elbows, Wrists/Hands, Low back, Hips/Thighs, Knees, and Ankles/Feet) are tabulated in Table 2. Intake of some food items was significantly different between the two groups of "with pain" and "without pain" in some assessing areas.

Patients who took less amounts of fruits reported higher level of pain in their neck (P=0.04). The score of cereal intake was significantly higher in participants who did not report pain (P=0.03). The difference of legumes consumption between the two groups was more than the cereal group and similar to the statistically significant levels (P=0.06). As shown in **Table 2**, nuts consumption in "without pain" group were more than "with pain" group and the difference between these groups was significant (P=0.04)

In the case of shoulder pain, consumption of legumes and nuts in the "without pain" group was more than the "with pain" group (P = 0.01 and P = 0.03, respectively). Consumption of other food items did not differ significantly between the two groups in the shoulder zone. In addition, pain in wrists was reported in groups with less consumption of fruits (P = 0.01)

Fat intake was higher in patients with pain in hips, but it was only significant in the "other fat" subgroup including monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) (P = 0.02). Junk foods were consumed more in "with hips pain" group than the "without pain" group (P = 0.01). Furthermore, staffs with hip pain reported more red meat and organ consumption compared to those who did not have pain but the difference was not significant (P = 0.07). No significant differences were observed in the consumption of food groups in other body zones (**Table 2**).

The odds ratio (OR) of food items and pain were calculated in different zone of the body (Table 3). Non-significant ORs are shown in Table 4. Probable factors that can affect OR were assessed and adjusted ORs were presented for confounders (gender, age, weight, education level, work hours per week, and work hours per day). Adjusted OR are represented using a star. Consumption of nuts had a protective effect on pain in neck and shoulders. Increase of nuts intake in each serving decreased the participants' pain in neck and shoulders by about 35% and 36% respectively, which was statistically significant. (OR: 0.64; CI: 0.42, 0.98 and OR: 0.65; CI: 0.42, 0.99). Fruit consumption caused a decrease in the risk of pain in wrists by 50% (OR: 0.52; CI: 0.38, 0.89). For each one-unit increase in junk foods consumption, the risk of hip pain increased by 120%, and other fat intake resulted in 68% elevation in hip pain; the difference was significant (OR: 2.21, CI: 1.12, 4.37 and OR: 1.68; CI: 1.04, 2.74).

Table 1. Demographic characteristic of participants.

Variables	(Mean ± SD)
Age (y)	36.21 ± 7.97
Weight (kg)	67.00 ± 13.96
Working hours (in day)	8.34 ± 1.08
Working hours (in week)	43.00 ± 9.86

Table 2. Comparison of food items scores between two "with pain" and "without pain" groups in different areas of the body.

	T 14		With pain		Without pain	D 1
Areas	Food items	N	Mean ± SD of score	N	Mean ± SD of score	P-value
Shoulder	Vegetables	54	2.63 ± 0.66	37	2.86 ± 0.88	0.11
	Fruits	53	2.94 ± 1.27	37	3.29 ± 1.16	0.04
	Dairy	53	2.71 ± 1.01	37	2.99 ± 1.21	0.23
	Sugar	51	2.34 ± 0.91	36	2.62 ± 1.14	0.21
	Junk foods	53	2.21 ± 0.77	37	2.27 ± 0.77	0.74
	Cereals	53	2.44 ± 0.6	37	2.74 ± 0.85	0.03
	Legumes	53	2.21 ± 0.95	36	2.62 ± 1.08	0.06
	Other	53	2.50 ± 0.67	37	2.76 ± 0.88	0.12
	Meat	53	2.40 ± 0.56	37	2.45 ± 0.67	0.40
	Processed	48	1.36 ± 0.68	34	1.50 ± 0.87	0.69^{a}
	Fish& Chicken	53	2.50 ± 0.69	36	2.57 ± 1.09	0.71
	Reds & organ	53	2.55 ± 0.65	37	2.57 ± 0.75	0.59^{a}
	Fat	53	2.30 ± 0.83	37	2.60 ± 0.99	0.12
	SFA	52	2.30 ± 0.83	37	2.15 ± 1.37	0.08
	Nuts	53	1.97 ± 0.84	36	2.43 ± 1.26	0.04
	Others	53	2.79 ± 1.13	37	2.77 ± 1.16	0.93
	Vegetables	55	2.70 ± 0.73	37	2.76 ± 0.82	0.70
	Fruits	54	3.04 ± 1.25	37	3.09 ± 1.25	0.85
	Dairy	54	2.82 ± 1.10	37	2.79 ± 1.13	0.85
	Sugar	52	2.31 ± 0.92	36	2.71 ± 1.22	0.08
	Junk foods	54	2.20 ± 0.70	37	2.29 ± 0.85	0.59
	Cereals	54	2.49 ± 0.75	37	2.66 ± 0.81	0.14
	Legumes	54	2.20 ± 0.98	36	2.61 ± 1.03	0.01
	Other	54	2.56 ± 0.74	37	2.67 ± 0.84	0.44
	Meat	54	2.40 ± 0.55	37	2.44 ± 0.70	0.91
	Processed	50	1.36 ± 0.69	33	1.53 ± 0.85	0.39^{a}
	Fish& Chicken	54	2.50 ± 0.05 2.50 ± 0.75	36	2.59 ± 1.07	0.86
	Reds & organ	54	2.55 ± 0.66	37	2.59 ± 1.07 2.54 ± 0.76	0.80
	Fat	54	2.33 ± 0.80 2.33 ± 0.80	37	2.54 ± 0.70 2.54 ± 1.05	0.35
	SFA	53	2.33 ± 0.80 2.13 ± 0.99	37	2.63 ± 1.67	0.33
	Nuts	54	1.96 ± 0.8	36	2.03 ± 1.07 2.43 ± 1.27	0.13
	Others	54	2.87 ± 1.17	37	2.43 ± 1.27 2.60 ± 1.09	0.03
Upper back	Others	34	2.07 ± 1.17	31	2.00 ± 1.09	0.20
Opper back	Vegetables	33	2.64 ± 0.81	55	2.76 ± 0.77	0.49
		33		55 55		
	Fruits	33	2.99 ± 1.08		3.11 ± 1.35	0.66
	Dairy		2.80 ± 0.98	55 52	2.83 ± 1.21	0.19
	Sugar Junk foods	33 33	2.31 ± 0.83	52 55	2.57 ± 1.21	0.28
			2.18 ± 0.54		2.29 ± 0.88	0.53
	Cereals	33	2.46 ± 0.69	55	2.66 ± 0.81	0.23
	Legumes	33	2.18 ± 0.78	54	2.52 ± 1.13	0.13
	Other	33	2.53 ± 0.72	55	2.69 ± 0.81	0.37
	Meat	33	2.37 ± 0.55	55	2.45 ± 0.66	0.59
	Processed	30	1.45 ± 0.80	50	1.43 ± 0.76	0.91
	Fish& Chicken	33	2.42 ± 0.66	54	2.60 ± 1.00	0.66
	Reds & organ	33	2.51 ± 0.67	55	2.58 ± 0.73	0.36 ^a
	Fat	33	2.34 ± 0.88	55	2.46 ± 0.95	0.55
	Saturated fatty acids	32	2.27 ± 1.70	55	2.39 ± 1.10	0.21
	Nuts	33	2.08 ± 0.91	54	2.19 ± 1.15	0.99
	Others	33	2.78 ± 0.98	55	2.79 ± 1.24	0.94
Elbow						

Table 2. Comparison of food items scores between two "with pain" and "without pain" groups in different areas of the body.

	T 14		With pain		Without pain	
Areas	Food items	N	Mean ± SD of score	N	Mean ± SD of score	P-value
	Vegetables	18	2.75±0.67	71	2.68±0.75	0.70
	Fruits	17	2.92 ± 0.95	71	3.08 ± 1.31	0.63
	Dairy	17	2.66 ± 1.02	71	2.86 ± 1.15	0.52
	Sugar	17	2.17 ± 0.71	68	2.54 ± 1.15	0.44^{a}
	Junk foods	17	2.13 ± 0.45	71	2.26 ± 0.83	0.54
	Cereals	17	2.39 ± 0.52	71	2.61 ± 0.82	0.40
	Legumes	17	2.18 ± 0.49	70	2.44 ± 1.11	0.79
	Other	17	2.45 ± 0.62	71	2.65 ± 0.82	0.41
	Meat	17	2.55 ± 0.60	71	2.38 ± 0.62	0.31
	Processed	16	1.21 ± 0.40	64	1.43 ± 0.74	0.39
	Fish& Chicken	17	2.58 ± 0.77	70	2.49 ± 0.89	0.07
	Reds & organ	17	2.71 ± 0.65	71	2.51 ± 0.71	0.34
	Fat	17	2.32 ± 0.68	71	2.43 ± 0.98	0.98
	Saturated fatty acids	16	2.23 ± 1.11	71	2.36 ± 1.40	0.97
	Nuts	17	2.03 ± 0.85	70	2.19 ± 1.10	0.84
	Others	17	2.77 ± 0.92	71	2.76 ± 1.20	0.96
Wrists	Others	17	2.17 ± 0.72	7.1	2.70 ± 1.20	0.70
***11515	Vegetables	32	2.77 ± 0.72	57	2.65 ± 0.74	0.44
	Fruits	31	2.81 ± 1.10	57	3.49 ± 1.38	0.01
	Dairy	31	2.94 ± 1.09	57	2.78 ± 1.14	0.53
	Sugar	30	2.46 ± 0.99	55	2.43 ± 1.07	0.91
	Junk foods	31	2.27±0.61	57	2.49 ± 1.07 2.20 ± 0.85	0.66
	Cereals	31	2.46 ± 0.59	57	2.62 ± 0.86	0.57
	Legumes	31	2.40 ± 0.59 2.11 ± 0.57	56	2.51 ± 1.18	0.14
	Other	31	2.55 ± 0.67	57	2.64 ± 0.84	0.71
	Meat	31	2.33 ± 0.07 2.42 ± 0.53	57	2.42 ± 0.66	0.71
	Processed	30	2.42 ± 0.33 1.41 ± 0.74	50	1.39 ± 0.66	0.75
	Fish& Chicken	31	1.41 ± 0.74 2.61 ± 0.60	56	1.39 ± 0.00 2.54 ± 1.00	0.73
		31	2.56 ± 0.63	57	2.54 ± 1.00 2.55 ± 0.73	0.22
	Reds & organ Fat	31		57 57	2.35 ± 0.75 2.45 ± 1.00	0.98
	SFA	30	2.34 ± 0.77	57		0.77
			2.20 ± 1.58		2.41 ± 1.22	
	Nuts	31	2.19 ± 0.87	56	2.15 ± 1.15	0.31
T 1 1	Others	31	2.70 ± 0.95	57	2.79 ± 1.26	0.30
Lower back	3 7 , 1.1	27	0.55 . 0.66	<i>5</i> 0	2.00 . 0.76	0.11
	Vegetables	37	2.55 ± 0.66	52	2.80 ± 0.76	0.11
	Fruits	36	2.79 ± 1.11	52	3.24 ± 1.31	0.09
	Dairy	36	2.66 ± 1.08	52	2.93 ± 1.15	0.26
	Sugar	35	2.49 ± 1.14	50	2.45 ± 1.05	0.91
	Junk foods	36	2.20 ± 0.64	52	2.26 ± 0.85	0.69
	Cereals	36	2.40 ± 0.67	52	2.69 ± 0.83	0.08
	Legumes	36	2.23 ± 0.84	51	2.50 ± 1.13	0.29
	Other	36	2.45 ± 0.67	52	2.73 ± 0.84	0.15
	Meat	36	2.32 ± 0.49	52	2.48 ± 0.69	0.24
	Processed	33	1.30 ± 0.54	47	1.45 ± 0.77	0.4 ^a
	Fish& Chicken	36	2.42 ± 0.58	51	2.66 ± 1.03	0.37
	Reds & organ	36	2.47 ± 0.62	52	2.61 ± 0.75	0.40
	Fat	36	2.33 ± 0.92	52	2.47 ± 0.93	0.44
	Saturated fatty acids	36	2.35 ± 1.61	51	2.33 ± 1.14	0.73
	Nuts	36	1.99 ± 0.96	51	2.28 ± 1.10	0.15
	Others	36	2.74 ± 0.98	52	2.78 ± 1.26	0.85
Hips						

Table 2. Comparison of food items scores between two "with pain" and "without pain" groups in different areas of the body.

			With pain		Without pain	
Areas	Food items	N	Mean ± SD of score	N	Mean ± SD of score	- P-value
	Vegetables	15	2.67 ± 0.68	75	2.73 ± 0.80	0.75
	Fruits	15	3.51 ± 1.29	75	2.95 ± 1.23	0.11
	Dairy	15	3.13 ± 1.20	75	2.73 ± 1.10	0.28
	Sugar	14	2.58 ± 1.22	73	2.45 ± 1.05	0.68
	Junk foods	15	2.69 ± 1.25	75	2.15 ± 0.60	0.01
	Cereals	15	2.84 ± 1.13	75	2.51 ± 0.68	0.49
	Legumes	15	2.77 ± 1.63	74	2.30 ± 0.83	0.11
	Other	15	2.86 ± 1.02	75	2.56 ± 0.72	0.40^{a}
	Meat	15	2.63 ± 0.73	75	2.37 ± 0.59	0.14
	Processed	14	1.53 ± 0.97	68	1.40 ± 0.72	0.70^{a}
	Fish& Chicken	15	2.51 ± 0.85	74	2.55 ± 0.90	0.76
	Reds & organ	15	2.85 ± 0.80	75	2.49 ± 0.67	0.07
	Fat	15	2.73 ± 1.27	75	2.34 ± 0.82	0.53
	Saturated fatty acids	14	2.41 ± 1.37	75	2.33 ± 1.34	0.95
	Nuts	15	2.31 ± 1.35	74	2.10 ± 0.99	0.90
	Others	15	3.38 ± 1.67	75	2.64 ± 0.97	0.02
knee						
	Vegetables	43	2.64 ± 0.66	48	2.74 ± 0.78	0.52
	Fruits	42	3.20 ± 1.45	48	2.91 ± 1.04	0.27
	Dairy	42	2.83 ± 1.10	48	2.80 ± 1.15	0.91
	Sugar	40	2.28 ± 0.99	47	2.65 ± 1.12	0.11
	Junk foods	42	2.25 ± 0.81	48	2.20 ± 0.73	0.99
	Cereals	42	2.59 ± 0.84	48	2.53 ± 0.72	0.92
	Legumes	42	2.29 ± 1.11	47	2.44 ± 0.93	0.16
	Other	42	2.67 ± 0.84	48	2.55 ± 0.73	0.70
	Meat	42	2.43 ± 0.60	48	2.39 ± 0.63	0.73
	Processed	39	1.44 ± 0.75	43	1.33 ± 0.61	0.48
	Fish& Chicken	42	2.52 ± 0.73	47	2.60 ± 0.98	0.92
	Reds & organ	42	2.59 ± 0.69	48	2.49 ± 0.70	0.43
	Fat	42	2.35 ± 0.92	48	2.45 ± 0.92	0.44^{a}
	Saturated fatty acids	41	2.04 ± 0.88	48	2.58 ± 1.59	0.56
	Nuts	42	2.15 ± 1.17	47	2.17 ± 0.95	0.54^{a}
	Others	42	2.87 ± 1.27	48	2.63 ± 1.02	0.33
Ankles						
	Vegetables	29	2.71 ± 0.78	61	2.72 ± 0.78	0.93
	Fruits	28	3.22 ± 1.43	61	2.97 ± 1.17	0.37
	Dairy	28	2.79 ± 0.95	61	2.82 ± 1.19	0.93
	Sugar	28	2.56 ± 1.12	58	2.43 ± 1.06	0.57^{a}
	Junk foods	28	2.35 ± 0.68	61	2.19 ± 0.80	0.14^{a}
	Cereals	28	2.56 ± 0.71	61	2.58 ± 0.81	0.93
	Legumes	28	2.20 ± 0.80	60	2.46 ± 1.11	0.26
	Other	28	2.67 ±0.76	61	2.60 ± 0.79	0.70
	Meat	28	2.44 ± 0.55	61	2.40 ± 0.65	0.79
	Processed	26	1.55 ± 0.99	55	1.37 ± 0.63	0.75
	Fish& Chicken	28	2.35 ± 0.67	60	2.60 ± 0.97	0.22
	Reds & organ	28	2.61 ± 0.67	61	2.50 ± 0.77 2.52 ± 0.72	0.56
	Fat	28	2.39 ± 0.90	61	2.32 ± 0.72 2.43 ± 0.93	0.93 ^a
	Saturated fatty acids	27	2.39 ± 0.90 2.32 ± 1.72	61	2.45 ± 0.95 2.35 ± 1.15	0.93
	Nuts	28	2.32 ± 1.72 2.02 ± 0.99	60	2.33 ± 1.13 2.20 ± 1.09	0.67
	Others	28	2.92 ± 0.99 2.92 ± 1.08	61	2.73 ± 1.17	0.46

P-value is based on between groups comparison by independent t-test; ^a: Shows using Mann Whitney.

Table 3. Association of some food items and pain risk in some area of body in staff workers.

Among	Food items	Odds	Confidence interval %95		
Areas	r ood Items	Odds	Lower limit	Upper limit	
Neck	Nuts	0.65	0.42	0.99	
Shoulder	Nuts	0.64	0.42	0.98	
Wrists	Fruits	0.52	0.38	0.89	
Hips	Junk	2.21	1.12	4.37	
<u>-</u>	Others	1.68	1.04	2.74	

Table 4. Odds ratio of food items and some area of body.

	T 1.4	0.11	95% confidence interval		
Area	Food items	Odds ratio	Lower limit	Upper limit	
Neck					
	Vegetables	0.688	0.392	1.209	
	Fruits	0.797	0.564	1.127	
	Dairy	0.793	0.539	1.165	
	Sugar	0.763	0.498	1.167	
	Junk	0.911	0.527	1.572	
	Cereals	0.595	0.333	1.064	
	Legumes	0.661	0.418	1.047	
	Meat	0.861	0.431	1.719	
	Processed	0.793	0.445	1.413	
	Fish& Chicken	0.919	0.567	1.489	
	Reds & organ	0.952	0.518	1.750	
	Fat	0.690	0.429	1.109	
	Saturated fats	1.183	0.812	1.601	
	Nuts	0.653	0.428	0.997	
Shoulder					
	Vegetables	0.899	0.523	1.546	
	Fruits	0.968	0692	1.354	
	Dairy	1.030	0.706	1.503	
	Sugar	0.699	0.464	1.055	
	Junk	0.861	0.499	1.486	
	Cereals	0.742	0.430	1.280	
	Legumes	0.659	0.417	1.042	
	Meat	0.906	0.460	1.786	
	Processed	0.747	0.418	1.334	
	Fish& Chicken	0.887	0.551	1.427	
	Reds & organ	1.029	0.565	1.874	
	Fat	0.767	0.483	1.217	
	Saturated fats	0.737	0.513	1.058	
	Nuts	0.647	0.424	0.987	
Upper back					
	Vegetables	0.869	0.489	1.544	
	Fruits	0.901	0.632	1.286	
	Dairy	1.028	0.687	1.538	
	Sugar	0.793	0.519	1.211	
	Junk	0.886	0.492	1.598	

Table 4. Odds ratio of food items and some area of body.

A	Food items	0.11 (1	95% confide	95% confidence interval		
Area		Odds ratio	Lower limit Upper lim			
	Cereals	0.725	0.393	1.337		
	Legumes	0.676	0.394	1.161		
	Meat	0.846	0.403	1.776		
	Processed	0.991	0.531	1.849		
	Fish& Chicken	0.803	0.458	1.407		
	Reds & organ	0.881	0.462	1.677		
	Fat	0.853	0.521	1.398		
	Saturated fats	0.959	0.686	1.341		
	Nuts	0.873	0.566	1.347		
Elbow						
	Vegetables	1.147	0.567	2.320		
	Fruits	0.897	0.574	1.400		
	Dairy	0.853	0.523	1.392		
	Sugar	0.699	0.397	1.230		
	Junk	0.793	0.376	1.673		
	Cereals	0.654	0.298	1.435		
	Legumes	0.741	0.393	1.397		
	Other	0.699	0.334	1.467		
	Meat	1.535	0.670	3.515		
	Processed	0.541	0.183	1.600		
	Fish& Chicken	1.517	0.856	2.689		
	Reds & organ	1.483	0.709	3.101		
	Fat	0.876	0.481	1.595		
	Saturated fats	0.923	0.593	1.437		
	Nuts	0.858	0.500	1.472		
Wrists*						
	Vegetables	1.483	0.780	2.818		
	Fruits	1.557	1.052	2.303		
	Dairy	1.241	0.812	1.897		
	Sugar	1.013	0.649	1.582		
	Junk	1.313	0.712	2.421		
	Cereals	0.807	0.438	1.487		
	Legumes	0.595	0.319	1.111		
	Meat	1.034	0.480	2.230		
	Processed	0.995	0.489	2.027		
	Fish& Chicken	1.180	0.690	2.016		
	Reds & organ	1.029	0.527	2.009		
	Fat	0.860	0.517	1.432		
	Saturated fats	0.912	0.639	1.302		
	Nuts	1.005	0.647	1.561		
Lower back		-	•	-		
	Vegetables	0.621	0.340	1.134		
	Fruits	0.731	0.502	1.065		
	Dairy	0.800	0.541	1.183		
	Sugar	1.035	0.695	1.543		
	Junk	0.894	0.510	1.565		
	Cereals	0.585	0.314	1.091		
	Legumes	0.748	0.466	1.200		
	Meat	0.654	0.318	1.346		
		0.001	0.010	1.0.0		
		0.704	0.347	1.428		
	Processed Fish& Chicken	0.704 0.712	0.347 0.416	1.428 1.219		

Table 4. Odds ratio of food items and some area of body.

		0.11	95% confidence interval		
Area	Food items	Odds ratio	Lower limit Upper limit		
	Fat	0.844	0.526	1.354	
	Saturated fats	1.011	0.737	1.387	
	Nuts	0.752	0.486	1.163	
Hips					
	Vegetables	0.891	0.432	1.841	
	Fruits	1.386	0.913	2.104	
	Dairy	1.353	0.835	2.191	
	Sugar	1.113	0.663	1.870	
	Junk	2.216	1.123	4.375	
	Cereals	1.643	0.853	3.167	
	Legumes	1.457	0.898	2.366	
	Meat	1.876	0.793	4.437	
	Processed	1.227	0.617	2.437	
	Fish& Chicken	0.940	0.493	1.790	
	Reds & organ	2.016	0.928	4.377	
	Fat	1.517	0.871	2.640	
	Saturated fats	1.053	0.703	1.577	
	Nuts	1.189	0.724	1.952	
Knee	11415	1.10)	0.721	1.732	
Tenee	Vegetables	0.830	0.469	1.471	
	Fruits	1.207	0.860	1.693	
	Dairy	1.029	0.710	1.491	
	Sugar	0.720	0.474	1.093	
	Junk	1.082	0.630	1.859	
	Cereals	1.097	0.643	1.874	
	Legumes	0.859	0.561	1.314	
	Meat	1.124	0.572	2.208	
	Processed	0.647	0.667	2.437	
	Fish& Chicken	0.891	0.548	1.449	
		1.235	0.679	2.224	
	Reds & organ				
	Fat Saturated fats	0.897 0.682	0.569 0.453	1.414 1.027	
		0.682			
A1.1	Nuts	0.979	0.659	1.457	
Ankles	V7 1. 1	0.007	0.557	1 740	
	Vegetables	0.987	0.557	1.748	
	Fruits	1.175	0.826	1.671	
	Dairy	0.976	0.653	1.459	
	Sugar	1.123	0.742	1.701	
	Junk	1.302	0.737	2.299	
	Cereals	0.975	0.547	1.738	
	Legumes	0.749	0.450	1.247	
	Meat	1.100	0.537	2.253	
	Processed	1.348	0.750	2.424	
	Fish& Chicken	0.699	0.394	1.241	
	Reds & organ	1.209	0.642	2.277	
	Fat	0.957	0.585	1.567	
	Saturated fats	0.987	0.701	1.389	
	Nuts	0.842	0.537	1.320	

Discussion

In the current study, consumption of the five major food groups was compared between the MSD patients ("with pain") and healthy persons ("without pain") in nine body areas. The findings of this study can provide insights with regard to differences in the consumption of some food items between the two groups.

In our study, it seems that fruits, type of cereals, and type of consumed fat had the highest correlation with pain in different parts of the body and in the assessed food groups. Furthermore, pain in the neck, shoulders, hips, wrists, and elbows had the highest relationship with food intake and kind of diet, respectively.

Moreover, participants with pain in the neck, wrists, and lower back consumed lower amount of fruits than the "without pain" group. Our findings were in line with those of several studies that reported the protective effect of fruits intake on the MS system (Han *et al.*, 2017, Macdonald *et al.*, 2005, Neville *et al.*, 2014, Wu *et al.*, 2017)

Neville et al. studied the effect of food and vegetable (FV) consumption in a cross-sectional analysis in Northern Ireland Young Hearts Project and found that a higher FV intake was positively associated with higher muscle power (Neville et al., 2014). Dai et al. integrated the results of two large cohort studies, i.e., Osteoarthritis Initiative (OAI) among 4796 participants and Framingham Offspring Osteoarthritis Study (Framingham) among 1268 persons. They found a negative relationship between fiber intake and symptomatic OA and knee pain among the elderly (Dai et al., 2017). Another study reported that consumption was independently associated with the knee pain in the elderly (Han et al., 2017). Hostmark et al. investigated the correlation between FV intake and MSD and found that MSD was associated with FV intake (Høstmark et al., 2014).

One of the probable mechanisms for this effect is that the fruits alkaline salt content could balance the excess acidity and calcium excretion (Macdonald *et al.*, 2005, Neville *et al.*, 2014). It is proposed that the fruits nitrate can progress the

muscle contraction as a second mechanism (Neville et al., 2014). The third one is that some of the nutrient contents of fruits such as vitamins C, D, K, magnesium, and fiber have an important role in MS health (Craig et al., 2017, Dai et al., 2017, Høstmark et al., 2014, Sanghi et al., 2015). Moreover, the food with antioxidant properties can reduce the pro-inflammatory condition and pain (Høstmark et al., 2014, Perry et al., 2010, Shen et al., 2012). In our study, the group "without pain" in neck reported significantly higher consumption of cereals. It seems that legumes have a more important role in this difference than other types of cereals and are closer to the significant level (P =Furthermore, intake of legumes in 0.06). participants without pain in the shoulders was significantly more than the patient group. According to the results of simple logistic regression, the pain decreased by approximately 34% in both areas for every one-unit increase in consumption of legumes. An inverse correlation was found between legumes consumption and pain in most of the assessed areas, but it did not reach significant levels. Since legumes were proposed as a rich source of fiber and part of a healthy diet, they could be effective in MS health (Dai et al., 2017, Wu et al., 2017). In our study, less consumption of saturated fatty acid (SFA) and more consumption of nuts were correlated with less neck pain. These amounts were statistically significant for nuts and close to significant levels for SFA.

In patients with pain in the neck and shoulders, intake of nuts was significantly lower than the painless group. It is worth noting that pain significantly decreased by approximately 35% in the neck and shoulders per increased unit of nuts consumption.

Furthermore, intake of MUFA and PUFA was correlated with the hips pain in our study (p=0.022). PUFA is divided into $\omega 3$ or $\omega 6$, but we cannot assess the content of $\omega 3$ or $\omega 6$ in consumed oil and participants' diet. Since sunflower oil is one of the main consumed oils in Iran, the dietary content of $\omega 6$ is probably at high levels. Evidence suggests the effects of $\omega 3$ on reducing

inflammation and pain. A low ratio of $\omega 3$ to $\omega 6$ (below ½) increases pain (Høstmark *et al.*, 2014, Ji *et al.*, 2011, Perry *et al.*, 2010). It seems that the type of consumed oil and fat is very important in MS health. Future studies are recommended to investigate the effect of dietary fatty acids in MSD. Consuming junk foods had a positive correlation with hip pain in our study. The junk foods caused inflammation in white and brown adipose tissues in the previous animal model study (Sampey *et al.*, 2011). However, in the current research, it seems that junk foods, as non-nutrient-dense foods, elevated the risk of hip pain by 120%.

It is well-established that the diet is an important factor for the MS (Craig et al., 2017). Our study examined the correlation between individual food items and MS health. A mixture of healthy foods may provide the synergistic and cumulative effects of following a healthy dietary pattern (Craig et al., 2017, De França et al., 2016, Silva et al., 2017, Wu et al., 2017). For example, a cohort cross-sectional analysis on 347 women examined the associations between dietary patterns and MS health. As a result, three patterns were assessed, which included healthy, highprotein and fat, and processed foods. The healthy pattern was considered as the positive control and the processed foods pattern was inversely associated with MS health (Wu et al., 2017). Another study conducted on 3938 men and 5056 women reported a correlation between low back pain and a healthy lifestyle including healthy diet (Bohman et al., 2014). High intake of nuts, whole grains, vegetables, fruits, fish, olive oil (the main source of dietary fat), and low intake of meat as the Mediterranean pattern (all together) trigger optimal MS health (Craig et al., 2017, Silva et al., 2017). However, we did not evaluate a special pattern or only one certain food group or nutrient in our investigation. Probably, synergistic effects of some food consumption in different groups affected our findings; later, we suggest assessing dietary pattern in this regard.

Researchers can benefit from the results of the present study because of investigating several

food groups and body areas. We identified the present gaps in this field. However, due to the limitation in assessing the correlation between dietary food patterns and pain in the MS system, it was not possible to investigate the cumulative and synergetic effects of foods, which is suggested for future studies. Second, we could not divide the data into different dietary pattern groups because of the low sample size and suggest other researchers to conduct studies with larger sample sizes. Third, the type of consumed PUFA was not assessed as an important part of the consumed oil in our study.

Conclusion

Generally, our findings show that higher consumption of fruits, nuts, and legumes is negatively correlated with pain in the MS. It seems that plant-based dietary pattern would be effective in MS health. Cohort or interventional studies are very helpful in this regard and among this population.

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Authors' contributions

Arjmand G participated in designing the study, conducting the research steps and sampling, as well as drafting the manuscript. Irandoost P participated in conducting the research steps, analyzing the data, as well as drafting the manuscript. Abbaszadeh M participated in conducting the research steps and sampling. Farshad A participated in designing the study, conducting the research steps. Salehi M participated in conducting the research steps and analyzing the data. Shidfar F participated in designing the study, conducting the research steps and sampling, as well as drafting the manuscript. All authors read the manuscript and verified it.

Conflict of interest

The authors declare that they have no competing interests.

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