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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 ± 1.27 *vs.* 3.29 ± 1.16 and 2.81 ± 1.10 *vs.* 3.49 ± 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, and 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 tissue disorders, chronic types such as 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 (ω3/ω6) fatty acid 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

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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, wrists/hands, low back, hips, knees, and 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 "yes" 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

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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.

Areas	Food items	With pain		Without pain		P-value
		N	Mean ± SD of score	N	Mean ± SD of score	
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 ± 0.75	36	2.59 ± 1.07	0.86
	Reds & organ	54	2.55 ± 0.66	37	2.54 ± 0.76	0.92
	Fat	54	2.33 ± 0.80	37	2.54 ± 1.05	0.35
	SFA	53	2.13 ± 0.99	37	2.63 ± 1.67	0.13
	Nuts	54	1.96 ± 0.8	36	2.43 ± 1.27	0.03
	Others	54	2.87 ± 1.17	37	2.60 ± 1.09	0.26
Upper back						
	Vegetables	33	2.64 ± 0.81	55	2.76 ± 0.77	0.49
	Fruits	33	2.99 ± 1.08	55	3.11 ± 1.35	0.66
	Dairy	33	2.80 ± 0.98	55	2.83 ± 1.21	0.19
	Sugar	33	2.31 ± 0.83	52	2.57 ± 1.21	0.28
	Junk foods	33	2.18 ± 0.54	55	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.

Areas	Food items	With pain		Without pain		P-value
		N	Mean ± SD of score	N	Mean ± SD of score	
	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						
	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	2.20 ± 0.85	0.66
	Cereals	31	2.46 ± 0.59	57	2.62 ± 0.86	0.57
	Legumes	31	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	2.42 ± 0.53	57	2.42 ± 0.66	0.70
	Processed	30	1.41 ± 0.74	50	1.39 ± 0.66	0.75
	Fish& Chicken	31	2.61± 0.60	56	2.54 ± 1.00	0.22
	Reds & organ	31	2.56 ± 0.63	57	2.55 ± 0.73	0.98
	Fat	31	2.34 ± 0.77	57	2.45 ± 1.00	0.77
	SFA	30	2.20 ± 1.58	57	2.41 ± 1.22	0.30
	Nuts	31	2.19 ± 0.87	56	2.15 ± 1.15	0.31
	Others	31	2.70 ± 0.95	57	2.79 ± 1.26	0.30
Lower back						
	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.

Areas	Food items	With pain		Without pain		P-value
		N	Mean ± SD of score	N	Mean ± SD of score	
	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	0.31
	Fish& Chicken	28	2.35 ± 0.67	60	2.60 ± 0.97	0.22
	Reds & organ	28	2.61 ± 0.67	61	2.52 ± 0.72	0.56
	Fat	28	2.39 ± 0.90	61	2.43 ± 0.93	0.93[a]
	Saturated fatty acids	27	2.32 ± 1.72	61	2.35 ± 1.15	0.67
	Nuts	28	2.02 ± 0.99	60	2.20 ± 1.09	0.41
	Others	28	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.

Areas	Food items	Odds	Confidence interval %95	
			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
	Others	1.68	1.04	2.74

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

Area	Food items	Odds ratio	95% confidence interval	
			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

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

Area	Food items	Odds ratio	95% confidence interval	
			Lower limit	Upper limit
	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
	Processed	0.704	0.347	1.428
	Fish& Chicken	0.712	0.416	1.219
	Reds & organ	0.750	0.402	1.397

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

Area	Food items	Odds ratio	95% confidence interval	
			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				
	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
	Reds & organ	1.235	0.679	2.224
	Fat	0.897	0.569	1.414
	Saturated fats	0.682	0.453	1.027
	Nuts	0.979	0.659	1.457
Ankles				
	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

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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 FV 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 = 0.06). Furthermore, intake of legumes in 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 the 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 ω3 or ω6, but we cannot assess the content of ω3 or ω6 in consumed oil and participants' diet. Since sunflower oil is one of the main consumed oils in Iran, the dietary content of ω6 is probably at high levels. Evidence suggests the effects of ω3 on reducing

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inflammation and pain. A low ratio of ω3 to ω6 (below ¼) 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, high-protein 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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