Major Dietary Patterns in Relation to Chronic Low Back Pain; a Cross- sectional Study from RaNCD Cohort

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Research

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Abstract

Background

Chronic low back pain (LBP) is the most common musculoskeletal pain that affects a person's daily activities. This present study aimed at evaluating the relationship between major dietary pattern and Chronic LBP.

Methods

This cross- sectional study was applied using data from Ravansar non- communicable diseases (RaNCD) cohort study. Chronic LBP was diagnosed by the RaNCD cohort study physician. Dietary patterns were evaluated by principal component analysis. The three identified dietary patterns included: 1) vegetarian dietary pattern which included vegetables, whole grain, legumes, nuts, olive, vegetable oil, fruits, and fruit juice; 2) high protein diet related to higher adherence to red and white meat, legumes, nuts, and egg; and 3) unhealthy dietary pattern characterized with higher intake of salt, sweet, dessert, hydrogenated fat, soft drink, refined grain, tea, and coffee.

Results

22.5% of participants had chronic LBP Higher following high protein dietary pattern was associated with lower risk of chronic LBP in crude (OR: 0.79, 95% CI: 0.69–0.9) and adjusted model (for age, sex, smoking, drinking, diabetes, physical activity, and body mass index) (OR: 0.84, 95% CI: 0.72–0.97). In addition, after controlling for the mentioned potential confounders, participants in the highest category of unhealthy dietary pattern were higher at risk of chronic LBP compared with those in the lowest category (OR: 1.13, 95% CI: 1.01–1.32).

Conclusions

Higher adherence to high protein diet significantly the decreased risk of chronic LBP prevalence. In addition, we found that following unhealthy dietary pattern was associated with higher risk of chronic LBP.

Introduction

Low back pain (LBP) is the fifth most common cause among the reasons for referring to doctors; many adults experience it throughout their lives [1]. LBP is caused by problems related to the intervertebral discs, nerves, muscles, etc. in the lumbar and sacral vertebrae [2]. Most LBP patients (up to 90%) have non-specific pain without any clear cause [3]. LBP is classified into three categories based on the duration of symptoms. Acute LBP is often the result of actual or near tissue injury or sprain, which has been present for six weeks or less, and it tends to settle on its own with personal care. Sub-acute LBP has a six- to 12-week duration, and chronic LBP lasts longer than 12 weeks. According to this category, chronic LBP often persists even though the initial injury has healed. These cases are more likely to be referred for treatment than the more acute cases that linger untreated [4].

People with chronic LBP have difficulty in social and occupational activities, and even the resulting pain affects a person's mood and puts a heavy burden on the treatment system; overall, chronic LBP is the most common cause of disability in a person's daily activities [5]. It should be noted that many people may not see a doctor and consider a self-medication approach, so its prevalence is higher in communities [6]. Evidence suggests that stress, anxiety, sedentary lifestyle, hard work, obesity, and diet are involved in the etiology of chronic LBP [7].

Increased levels of pro- inflammatory mediators in the body can be involved in the pathogenesis of chronic LBP [8, 9]. Following an unhealthy diet pattern by producing pro-inflammatory mediators upsets the balance of these mediators in the body [10]. Higher adhere to Western diet, which is characterized by higher intake of refined grains, red meat, processed meat, high saturated fat, trans-fatty acids, sweet sugary foods, and caffeine, as an unhealthy diet is associated with the production of high levels of cytokines, interleukins, C-reactive protein (CRP) and tumor necrosis factor alpha (TNF-α) [2, 11]. On the other hand, a healthy diet pattern related to adequate and balanced intake of all food groups can moderate the inflammatory conditions of the body [12, 13].

According to the high prevalence of chronic LBP in the worldwide and the importance of proper diet in reducing inflammatory conditions, it seems necessary to conduct a study to determine the relationship between major dietary patterns and the risk of chronic LBP among in Kurdish adults participating in Ravansar non- communicable diseases (RaNCD) cohort study.

Material And Methods

Study design and participants

This cross-sectional study was conducted on data from recruitment phase of RaNCD cohort study. This population-based study was performed on Kurdish participants (4770 men and 5289 women) aged 35–65 years in Ravansar, Kermanshah province, Western Iran. This study was developed by the PERSIAN (Prospective Epidemiological Research Studies in Iran) mega cohort study and was approved by the Ethics Committees in the Ministry of Health and Medical Education, the Digestive Diseases Research Institute, Tehran University of Medical Sciences, Iran. The details of this study were in previous studies [14, 15]. This cohort study was approved by the Ethics Committee of Kermanshah University of Medical Sciences (No: KUMS.REC.1394.318).

Inclusion criteria for this study were participants who provided complete information for RaNCD cohort study. We also did not include participants with cardiovascular diseases (n = 1118), thyroid (n = 738), and cancer (n = 93) diseases due to possible dietary changes. Also, pregnant women (n = 134) were included to this study. After excluding these participants, the participants whose calories intake were not in the range of 800–4200 Kcal/day (n = 437), were not included in the study. Furthermore, 41 participants with missing data were excluded.

Data sources/ measurements

The necessary data were obtained from RaNCD cohort study including demographics, physical activity, dietary intake, anthropometric indices, and medical history of chronic LBP. Also, history of smoking and drinking was evaluated based on the history of smoking, being a passive smoker, and alcohol consumption of the participants [14].

Anthropometry

The weight of participants was measured with InBody 770 device (Inbody Co, Seoul, Korea) with the least clothing and without shoes in the study site in Ravansar. The automatic stadiometer BSM 370 (Biospace Co., Seoul, Korea) was applied to measure their height in a standing position without shoes with a precision of 0.1 cm. Body mass index (BMI) was calculated by dividing weight in kg into height square in meter. Non-stretched and flexible tape was used to measure waist circumference in standing position at the level of the iliac crest three times, and the average was recorded.

Dietary pattern

Dietary intake of the studied participants was assessed using a validated semi- quantitative 130 items food frequency questionnaire developed by RaNCD cohort study. The details of this questionnaire were described in the previous studies [14, 16]. To determine dietary patterns, 130 food items were categorized into 31 food groups based on the similarity of nutrients (Table 1). Principal component analysis was used to identify the major dietary patterns. In the factor analysis, to create a simple and distinct matrix, the varimax rotation was applied, and the scree-plot was drawn to determine number of matrix components (the major dietary patterns). We selected the first three major dietary patterns with values greater than 1.5. Overall, each participant received a factor score for each dietary pattern based on the intake of weighed food groups by factor loading. To better display the associations, we trimmed three identified dietary patterns.

Table 1
Food groupings used in the dietary pattern analyses

Food groups	Dietary components
Leafy vegetables	Cauliflower, lettuce, cucumber, onion, green bean, mushroom, pepper, garlic, turnip, others
Fresh fruits	Melon, watermelon, honeydew melon, plums, prunes, apples, cherries, sour cherries, peaches, nectarine, pear, fig, date, grapes, kiwi, pomegranate, strawberry, banana, persimmon, berry, pineapple, oranges, others
Dried fruits	Dried apricots, Dried berries, raisins, and other type dried fruits
Dairy	Milk, yogurt, yogurt drink (doogh), cheese, chocolate milk, crud
Tomato	Tomato
Carotene-rich vegetables	Yellow squash, carrot
Condiments	Condiments
Pickles	Pickles
Legumes	All type beans, peas,lentils, mung bean, soy
Whole grain	Dark breads (Iranian), wheat, barley
Starchy vegetables	Corn, eggplant, green peas, green squash
Vegetable oil	Vegetable oil
Natural juices	All fruit juices
Butter	Butter, margarine, mayonnaise
Olive	Olive and olive oil
Organ meat	Heart, kidney, liver, tongue, brain, offal
Read meat	Beef, lamb, minced meat
Fish	All fish types
Processed meat	Hamburger, sausage, delicatessen meat, pizza
Soft drink	Soft drink
Nuts	Almond, peanut, walnut, pistachio, hazelnut, seeds
Egg	Egg
Poultry	Chicken
Snack	Corn puffs, potato chips, French fries
Sweets and desserts	Cookies, cakes, biscuit, muffins, pies, chocolates, ice, honey, jam, sugar cubes, sugar, candies, others
Tea and coffee	Tea and coffee
Hydrogenated fat	Hydrogenated fats, animal fats
Salt	Salt
Potato	Potato
Refined grain	White breads (lavash, baguettes), noodles, pasta, rice

Physical activity

Physical activity level of the RaNCD participants was assessed using the standard questionnaire designed by PERSIAN Cohort. The questionnaire included 22 questions about the amount of daily activities of the person. Their responses were reported based on the metabolic equivalent of task per hour per day (MET/h/day). Detail of this questionnaire was described in previous study [14].

Outcome measurement

All participants completed self-reports about chronic LBP and the pain area was surveyed based on the RaNCD cohort study physician opinion and participants' response to her questions as follows: 1) Do you experience LBP that lasted more than a few months and interfered with their daily activities? In addition, has it lasted so far? (Yes/ No); 2) Do you have a history of back stiffness for more than an hour in the morning? (Yes/ No); 3) Do you have a history of arthralgia? (Yes/ No); 4) Do you have a history of joint stiffness for more than an hour in the morning? (Yes/ No). These questions were administered by the PERSIAN mega cohort study to evaluate chronic diseases in all Iranian adults ages ≥ 35 years. Based on self-report and their medical history after physical examination by the physician, chronic LBP was diagnosed the presence of LBP for at a few months, which led to limit daily activities and had been sought for it's treatment, such as medication, medical consultation, or physiotherapy. Furthermore, the physician did not consider pain associated with malignancies, infections, and fractures as chronic LBP [17].

Statistical analysis

SPSS 20 (IBM Corp, Chicago, IL, USA) and Stata, version 14 (Stata Corp, College Station, TX) were applied for all statistical analysis. We reported quantitative variables by mean ± standard deviation (SD), and qualitative variables using frequency (%). Comparison of participants' baseline characteristics was evaluated using Chi-square and ANOVA test based on the tertiles of all three dietary patterns. Binary logistic regression in crude and adjusted odds ratios (OR) and 95% confidence intervals (CI) was used to determine the association between chronic LBP and categories of three dietary patterns. In adjusted model 1, age (continuous), sex (categorical), smoking (categorical), and drinking (categorical) were adjusted. In adjusted model 2, we controlled the variables in model 1, diabetes (categorical), physical activity (continuous), body mass index (continuous), energy intake (continuous), and treatment for chronic LBP (categorical). In all analyses, the first tertile of dietary patterns was considered as the reference category. In addition, to better illustrate this association, we considered figure of linear regression OR across increased three major dietary patterns with adjustment for the mentioned variables in logistic regression. P-values were considered significant at the level of < 0.05.

Results

In current study, 7686 of the RaNCD participants met the study inclusion criteria. 51.3% of them were male. We found that 22.5% of the participants had chronic LBP. The results of factor analysis introduced three dietary patterns with factor loading of food groups more than 0.2 (Table 2). The major dietary patterns were identified are as follows: 1) vegetarian dietary pattern which included vegetables, whole grain, legumes, nuts, olive, vegetable oil, fruits, and fruit juice; 2) high protein diet related to higher adherence to red and white meat, legumes, nuts, and egg; and 3) unhealthy dietary pattern characterized with higher intake of salt, sweet, dessert, hydrogenated fat, soft drink, refined grain, tea, and coffee. Table 2 shows the rotated component matrix of each of the food groups and the correlation coefficient between each food group and dietary patterns.

Table 2
Factor loading of food groups in all dietary patterns

Food groups	Vegetarian dietary pattern	High protein dietary pattern	Unhealthy dietary pattern
Leafy vegetables	.717	-	-
Fresh fruits	.630	.274	-
Dried fruits	.563	-	-
Dairy	.485	-	-
Tomato	.455	-	-
Carotene-rich vegetables	.439	.226	-
Condiments	.439	-	-
Pickles	.402	-	-
Legumes	.378	.345	-
Whole grain	.369	-	-
Starchy vegetables	.354	-	-
Vegetable oil	.330	-	− .248
Natural juices	.322	.239	-
Butter	.319	-	.276
Olive	.247	-	-
Organ meat	-	.611	-
Read meat	-	.578	-
Fish	-	.578	-
Processed meat	-	.516	-
Soft drink	-	.496	.295
Nuts	.360	.435	-
Egg	-	.330	.221
Poultry	-	.311	.209
Snack	-	.287	.206
Sweets and desserts	-	-	.738
Tea and coffee	-	-	.654
Hydrogenated fat	-	-	.500
Salt	-	-	.388
Potato	.251	-	.342
Refined grain	-	-	.331
Variance %	11.04	19.47	26.67
Values < 0.2 have been removed for clarity			

The mean of BMI and WC in the highest tertiles of high protein and unhealthy diets were significantly lower than their lowest tertiles ($P < 0.001$), while higher adherence to vegetarian dietary pattern was significantly related to higher BMI and WC ($P < 0.001$) (Table 3).

Table 3
Baseline characteristics of studied participants

Variables	Total (n = 7686)	Vegetarian dietary pattern			P**	High protein dietary pattern			P**	Unhealthy dietary pattern			P**
		T1 (n = 2562)	T2 (n = 2562)	T3 (n = 2562)		T1 (n = 2562)	T2 (n = 2562)	T3 (n = 2562)		T1 (n = 2562)	T2 (n = 2562)	T3 (n = 2562)	
Age (year)	47.28 ± 7.99*	47.56 ± 8.19	47.31 ± 8.04	46.98 ± 7.74	0.032	48.97 ± 8.11	47.04 ± 7.92	45.84 ± 7.63	< 0.001	47.45 ± 8.13	47.49 ± 7.98	46.91 ± 7.86	0.015
Weight (kg)	72.77 ± 13.69	70.24 ± 13.44	72.86 ± 13.6	75.23 ± 13.59	< 0.001	70.75 ± 13.44	72.16 ± 13.50	75.41 ± 13.72	< 0.001	72.33 ± 12.97	72.30 ± 13.47	73.69 ± 14.55	< 0.001
BMI (kg/m^2)	27.28 ± 5.19	26.48 ± 4.51	27.33 ± 6.08	28.03 ± 4.72	< 0.001	27.66 ± 4.83	27.19 ± 6.10	26.98 ± 4.47	< 0.001	27.70 ± 6.01	27.13 ± 4.47	27 ± 4.94	< 0.001
WC (cm)	96.73 ± 10.67	95.42 ± 11.01	97.10 ± 10.37	97.66 ± 10.5	< 0.001	97.45 ± 11.16	96.46 ± 10.46	96.27 ± 10.35	< 0.001	97.44 ± 10.30	96.74 ± 10.21	96 ± 11.42	< 0.001
PA (MET hour/ day(	41.27 ± 8.38	41.46 ± 8.29	41.27 ± 8.49	41.06 ± 8.36	0.243	40.83 ± 7.46	40.99 ± 7.88	41.98 ± 9.60	< 0.001	39.36 ± 6.68	41.21 ± 8.12	43.23 ± 9.63	< 0.001
Sex, male, %	51.3	51.2	52.3	50.9	0.589	32.1	49.7	72.6	< 0.001	41	49.7	63.7	< 0.001
Drinking, %	6.6	6.7	6.9	6.3	0.689	2.3	5.7	12	< 0.001	4.5	5.7	9.8	< 0.001
Smoking, %	20.4	22.7	20.6	18.2	< 0.001	16.3	18.7	26.6	< 0.001	11.5	19.3	30.6	< 0.001
Diabetes, %	6.5	4.8	6.6	8.2	< 0.001	8.7	5.7	5.3	< 0.001	9.3	6.2	4.1	< 0.001
Chronic LBP, %	22.5	22.9	22.1	22.9	0.709	25.3	21.6	21.1	< 0.001	21.8	22	24.1	0.101

BMI: Body mass index; WC: Waist circumference; PA: Physical activity; LBP: low back pain.

*Mean ± SD **P-values were obtained ANOVA and Chi square test.

Our results showed that the mean of PA in all participants was 41.27 ± 8.38, in which in the third tertiles of high protein and unhealthy dietary pattern, the mean of PA was significantly higher than their first tertiles (P < 0.001) (Table 3). According to this table, the prevalence of diabetes was 6.5% among these participants. In this study, the prevalence of chronic LBP decreased significantly with higher adherence to high protein dietary pattern (P < 0.001). However, this prevalence was not significantly different with higher following the two other major dietary patterns (vegetarian and unhealthy dietary pattern). Other characteristics of studied participants are presented in Table 3.

Multivariable-adjusted odds ratios and 95% confidence intervals for chronic LBP across categories of three dietary patterns are indicated in Table 4. Compared with participants in the lowest tertile of high protein dietary pattern, those with higher adherence to this pattern were associated with lower risk of chronic LBP (OR: 0.79, 95% CI: 0.69–0.9); such that after controlling for age, sex, smoking, drinking, diabetes, physical activity, body mass index, energy intake and treatment this association remained (OR: 0.84, 95% CI: 0.72–0.97).

Table 4
Multivariable-adjusted odds ratios and 95% confidence intervals for chronic low back pain across categories of three dietary patterns

Major dietary pattern	Categories	Crude	Model 1*	Model 2*
Vegetarian dietary pattern	T1	1	1	1
	T2	0.95 (0.83–1.08)	0.96 (0.84–1.09)	0.94 (0.82–1.07)
	T3	0.99 (0.87–1.13)	1.01 (0.89–1.16)	0.96 (0.84–1.11)
P- trend		0.965	0.798	0.633
High protein dietary pattern	T1	1	1	1
	T2	0.81 (0.71–0.93)	0.86 (0.75–0.98)	0.85 (0.75–0.98)
	T3	0.79 (0.69-0.0.9)	0.88 (0.76–1.01)	0.84 (0.72–0.97)
P- trend		< 0.001	0.069	0.019
Unhealthy dietary pattern	T1	1	1	1
	T2	1 (0.88–1.15)	1.1 (0.88–1.15)	1 (0.87–1.14)
	T3	1.13 (0.99–1.29)	1.16 (1.01–1.33)	1.13 (1.01–1.32)
P- trend		0.055	0.026	0.05
*Model 1 adjusted for age, sex, smoking, and drinking.				
**Model 2 adjusted for variables in model 1, diabetes, physical activity, body mass index, energy intake, treatment.				

In addition, after controlling for the mentioned potential confounders, participants in the highest category of unhealthy dietary pattern were higher at risk of chronic LBP compared with those in the lowest category (OR: 1.13, 95% CI: 1.01–1.32). Figure 1 shows odds ratios and 95% confidence intervals for chronic LBP across categories of high protein and unhealthy dietary pattern.

However, no significant association was found between adherence to vegetarian dietary pattern and chronic LBP either before or after adjusting the confounders (Table 4).

Discussion

According to our hypothesis, we found that higher adherence to high protein dietary pattern was associated with lower risk of chronic LBP; while risk of chronic LBP was increased with higher adherence to unhealthy dietary pattern. LBP is one of the pains that many people experience during adulthood and it is believed that nutrition can affect the formation and severity of chronic LBP [18, 19]. To the best our knowledge, the current study evaluated the relationship between major dietary pattern and risk of chronic LBP.

In current study, the prevalence of chronic LBP was significantly deccreased with higher adherance to high protein dietary pattern. There was a significant association between high protein dietary pattern and risk of chronic LBP. After controlling for potential confounders, participants who were in third tertile of high protein dietary pattern were 12% lower at risk of chronic LBP compared to participants in the lowest group. A randomized clinical trial by Kirk et al. [20] showed that dietary protein supplementation significantly improved skeletal muscle function. Another clinical trial by Shell et al.[21] showed that administration of amino acids precursors could improve chronic LBP and decrease level of IL-6 and CRP. Nutritional mechanisms in the development of chronic LBP include affecting brain-gut axis neurotransmitters and changes in gut derived neurotransmitters such as glutamate, which also affect the brain system and induce chronic pain [22]. Essential and semi-essential amino acids deficiency interfere with the production of neurotransmitter precursors that can affect pain sensation [21, 23]. Other factors worsening chronic LBP include decreased muscle mass and some degree of sarcopenia [24, 25]. Skeletal muscle strength begins to decline in middle age in both men and women [26]. Adequate of protein intake is one of the main factors in maintaining this muscle strength [27]. The type and amount of protein determines the effect on muscle mass [28, 29]. In this study, high protein diet related to higher adherence to red and white meat, legumes, nuts, and egg involving protein with high biological value and essential micronutrients (e.g., calcium, iron, zinc, choline, vitamin B_{12}) that are important for growth and development, developing of neurotransmitters, improving of skeletal muscle mass and strength [30, 31].

Our study also found that adherence to unhealthy diet was positively associated with chronic LBP. After adjusting the potential confounders, participants who were in third tertile of unhealthy dietary pattern were 15% higher at risk of chronic LBP compared to participants in the lowest.

The components of unhealthy diet in our study is most similar to the Western diet involving higher intake of refined grains, red meat, processed meat, high saturated fat, trans-fatty acids, sweet sugary foods, and caffeine [11]. Following this dietary pattern was associated with increased level of inflammatory markers such as IL-6 and CRP, which can lead to a decrease in pain threshold in chronic LBP [32–34]. Song et al.[35] reported that in animal model high fat diet was related to increased chronic LBP. Another study was showed that higher adherance to sugary foods was decreased muscle strength (OR: 1.06 CI 95%: 1.01–1.12) [36]. Other studies also found that low-protein, high-sugar, high-fat diets were associated with more chronic LBP and higher CRP levels [37–40]. Therefore, unhealthy diet in current study was characterized by intake of salt, sweet, dessert, hydrogenated fat, soft drink, refined grain, tea, and coffee in which these dietary components can increase inflammation and consequence chronic LBP.

In this study, no significant relationship was found between the vegetarian diet and chronic LBP. Although we controlled potential confounders, we did not observe any association between the vegetarian diet and chronic LBP. In fact, this dietary pattern contains high level of important antioxidants such as vitamin C, vitamin E, vitamin A, and all carotenoids [41, 42]. These antioxidants have anti-inflammatory effects and can reduce the pain threshold in these patients [43]. On the other hand, vegetable-based diets produce short-chain fatty acids that stabilize the beneficial intestinal microbiome, and substances derived from this microbiome environment can affect the brain- gut system and reduce systemic and central inflammation [44]. Furthermore, this vegetable diet can relieve musculoskeletal pain [45]. In the present study, vegetarian dietary pattern was related to the intake of vegetables, whole grain, legumes, nuts, olive, vegetable oil, fruits, and fruit juice. The intake of these food groups in participants with and without chronic LBP seems to be the same and we could not find any association.

Limitations

This is the first study to evaluate the relationship between major dietary pattern and chronic LBP among Kurdish population; however, this study suffered from some limitations. Firstly, this is a cross- sectional study and the cause-and-effect relationship was not clear. Second, dietary intake was assessed by FFQ, and the error of recalling food intake should not be ignored. However, the questionnaire was presented by trained nutritionists. In addition, the degree and severity of chronic LBP in the RaNCD cohort study were not measured. Therefore, further studies are recommended without these limitations.

Conclusions

According to the findings of this study, higher adherence to high protein diet had protective effects on chronic LBP prevalence. In addition, we found that following unhealthy dietary pattern was associated with higher risk of chronic LBP. Therefore, it is recommended that people prone to chronic LBP consider a high biological value protein in their daily diet, and they reduce intake of salt, sweet, dessert, hydrogenated fat, soft drink, refined grain, tea, and coffee.

Abbreviations

Low back pain (LBP); C- reaction protein (CRP); tumor necrosis factor alpha (TNF-α); Ravansar non- communicable diseases (RaNCD); Body mass index (BMI); odds ratios (OR); confidence intervals (CI)

Declarations

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Ethics approval and consent to participate: All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later

amendments or comparable ethical standards. This study was approved by the Ethics Committee of Kermanshah University of Medical Sciences (ethics approval number: KUMS.REC.1394.318).

Informed consent: Written informed consent was obtained from each studied subject after explaining the purpose of the study. The right of subjects to withdraw from the study at any time and subject's information is reserved and will not be published.

Consent for publication: Not applicable

Availability of data and materials: Data will be available upon request from the corresponding author.

Competing interests: All authors have no conflict of interest.

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Authors' contributions: SM and YP equally contributed to the conception and design of the research; FN, BH, and YP contributed to data collection; SM, YP and MM contributed to the acquisition and analysis of the data; SM, SK and AM contributed to the interpretation of the data; and SM, SK, AM and YP contributed to draft the manuscript. All authors are in agreement with the manuscript and declare that the content has not been published elsewhere.

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Figures

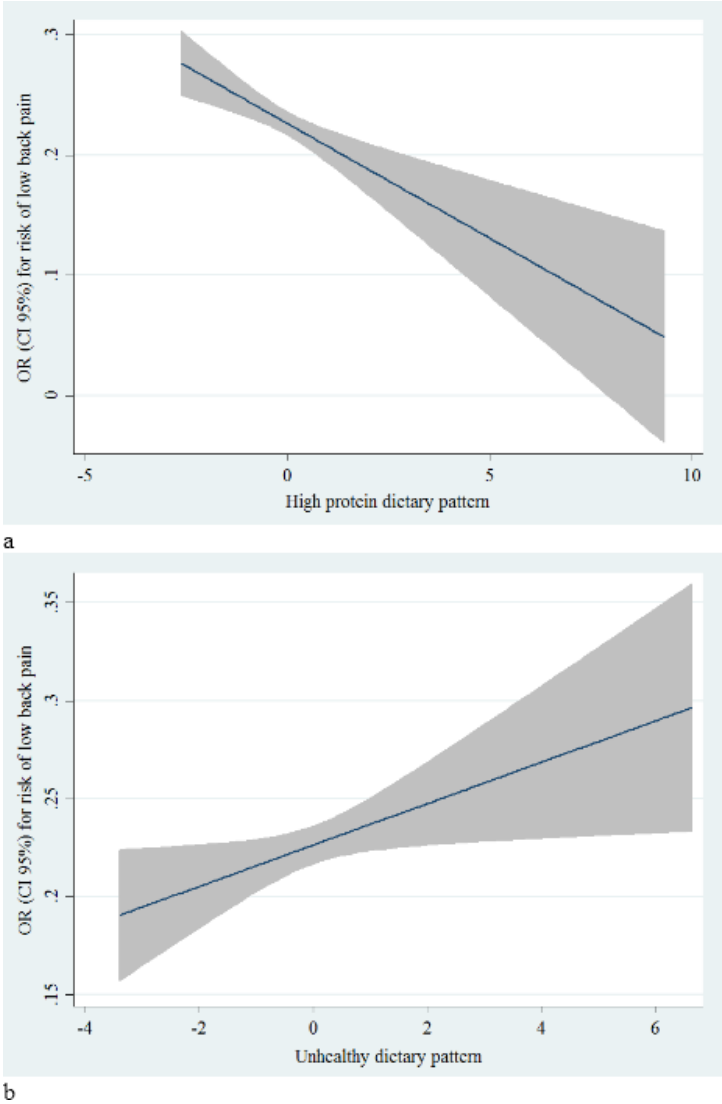

Figure 1

Liner regression odds ratios and 95% confidence intervals for chronic low back pain across categories of high protein (a) and unhealthy dietary pattern (b)