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The Associations between Meat Group Consumption and Acute Myocardial Infarction Risks in an Iranian Population: a Case-Control Study

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ABSTRACT

Acute myocardial infraction (AMI) is a highly frequent cause of mortality and disability around the world. The aim of the present study was to evaluate the associations between meat group intake levels and AMI risks in an adult Iranian population. This case-control study was conducted on 200 first AMI cases and 200 healthy individuals matched by age, sex, and body mass index. A Food Frequency Questionnaire validated for Iranian populations was used to assess usual dietary intake levels over the previous year. Data was extracted regarding the meat group—including meat (red and processed), fish, poultry, eggs, nuts, and legumes. The associations between meat group items and AMI were calculated by multivariable logistic regression. Red meat consumption was significantly positively associated with increased risk of AMI. After adjustment for potential confounders, a positive association was found between higher frequency of processed and red meat intake, and increased risk of AMI (processed meat consumption: odds ratio [OR], 1.71; 95% confidence interval [CI], 1.31–2.23 and red meat consumption: OR, 2.51; 95% CI, 1.84–5.11). In addition, the results indicated an inverse association between the frequency of nuts consumption and AMI (OR, 0.52; 95% CI, 0.31–0.92). There were no associations seen between poultry, fish, eggs and beans intake levels, and the odds of AMI. The current study suggested a direct association between the frequency of processed/red meat consumption and increased AMI risks. In addition, an inverse relation was observed between frequency of nuts consumption and the risks of AMI.

Keywords: Cardiovascular disease; Myocardial infarction; Meat; Diet; Case-control study

INTRODUCTION

Acute myocardial infarction (AMI) is a key component of the burden of cardiovascular disease, and is a very frequent cause of mortality and disability around the world [1]. It is defined by myocardial necrosis resulting from a dynamic process associated with inadequate

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coronary blood flow [2]. Almost 550,000 first episodes and 200,000 recurrent episodes of AMI occur every year, imposing large socio-economic burdens on healthcare systems [3]. The management of AMI has been improved over the past three decades, but remains a leading cause of death. Strategies are needed to prevent or decrease the progress of the disease [4]. Coronary atherosclerosis plays a pivotal part in the pathogenesis of AMI in many patients [5]. In this regard, many researchers have investigated and suggested that the following play major roles in the occurrence of atherosclerotic cardiovascular disease: diet, physical activity, smoking, or psychosocial stress [6-8]. This evidence implies that AMI might be largely preventable by adhering to specific diets [9], therefore gaining improved knowledge about the effects of each dietary component can be a critical step toward AMI prevention.

According to the food pyramid presented by the United States Department of Agriculture (USDA), the meat group (including red meat, poultry, fish, eggs, beans, and nuts) is the primary source of protein, and supplies substantial amounts of phosphorous, magnesium, iron, thiamine, niacin, vitamin B6, and vitamin B12 for daily needs [10]. The effect of each source of protein on cardiovascular health is different due to its ingredients [11]. Red and processed meat are sources of saturated fatty acid and cholesterol, which have been shown to be risk factors for atherosclerosis [12,13]. On the other hand, fish and nuts provide unsaturated fatty acid and minerals, which have been established as cardio-protective components [14,15]. The investigation into the relationships between dietary items and cardiovascular risk factors is not a new interest, with several studies on the subject from the United States [16-18], as well as European countries [19-21]. However, the available information reporting on these associations among Asian countries is low [22,23]. Also, there are many papers examining single-nutrient associations with the risk of atherosclerotic cardiovascular disease, although health recommendations can be more easily provided to patients when they are based on foods. Therefore, the present study was conducted to clarify the associations between the frequency of meat group item intakes on the manifestation of AMI in an adult Iranian population.

MATERIALS AND METHODS

This hospital-based case-control study was conducted in Heshmat Hospital in Guilan, Iran, in 2017. Two hundred coronary care unit patients who had suffered their first AMI, and 200 healthy individual without any history of heart disease or exertional chest pain were included in this study. Case and control groups were matched based on age (plus or minus 5 years), sex, and body mass index (BMI). Inclusion criteria for cases were cases of first myocardial infraction (diagnosed by physician), age > 30, and BMI between 25–30. The subjects were excluded if they were unable to respond to questions, were undergoing a systematic period of treatment by steroids, following a special dietary pattern, malnourished, of suffering from any other chronic disease including chronic liver cirrhosis, thyroid disease, gastrointestinal-related disease, renal failure, chronic inflammatory disease, cancer, pulmonary disease, and chronic infections such as human immunodeficiency viruses and hepatitis. Participants who did not respond to more than 35 food items in the food frequency questionnaire (FFQ), provided incomplete demographic data, or whose total amount of energy consumed lay outside the range of 800–4,200 kcal were also excluded. The same exclusion criteria for AMI cases were applied to the control group. Written informed consent was obtained from all recruited participants. This study was conducted according to the guidelines laid down in the Declaration of Helsinki and

all procedures involving human subjects/patients were approved by the ethics committee of Guilan University of Medical Sciences (Ethical approval No. IR.GUMS.REC.1396.399).

Questionnaires and interview

After explaining the purpose of the study to each participant and obtaining formal written consent, a structured questionnaire was completed by a researcher through a face-to-face interview. The questionnaire consisted of information on demographic data, anthropometric measurements, physical activity, and the FFQ. Each interview lasted nearly 30 minutes, in which the structured questionnaire was completed.

Assessment of demographic information

At the beginning of the interview, the researcher asked about the demographic and lifestyle characteristics of the subjects, including age, sex, education level (illiterate, elementary, high school, diploma, and university), marital status (single, married, widow, and divorced), occupational status (employed, unemployed, and retired), smoking status, alcohol consumption, opioid drug intake, body weight, and waist circumference measurements.

Assessment of physical activity

The physical activity of the participants was assessed by the short form of the International Physical Activity Questionnaire [24].

The daily physical activity of each subject was calculated based on metabolic equivalent for task, number of days per week, and amount of time in minutes per day.

Assessment of dietary intakes

An FFQ validated for Iranian populations was used to assess usual dietary intakes over the past year [25]. The FFQ was a semi-quantitative questionnaire consisting of a list of 168 food items from 6 food groups. All questionnaires were completed by a trained dietitian. Participants were asked to report their frequency of a given serving of each food item consumption according to intake per day, week, month, and year. All food items were categorized into main food groups based on the food pyramid suggested by the USDA's Food Guide Pyramid [26]. At the end, data of the meat group consumption (including meat [red and processed], fish, poultry, eggs, nuts, and legumes) was extracted.

Anthropometric measurements

Participants' body weight was measured to the nearest 0.1 kg by Seca scale (Seca, Hamburg, Germany), while participants were wearing light clothes and no shoes. The height of subjects was recorded using a tape in a normal position, based on standard protocols by the World Health Organization [27]. BMI was calculated by weight (kg) divided by height (m^2).

Statistical analysis

Data was analyzed by SPSS software version 21 (IBM Corp., Armonk, NY, USA). The Kolmogorov-Smirnov test was used to determine the normal distribution of variables. To detect the difference between general characteristics of case and control, Independent t-test and χ^2 test were applied for continuous and categorical variables, respectively. The associations between meat group items and AMI were calculated by multivariable logistic regression. These associations were determined in both the crude and adjusted models. The p value < 0.05 was considered to be statistically significant.

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RESULTS

Table 1 demonstrates the characteristics of the participants according to case-control status. A total of 400 participants with a mean age of 53 years old were recruited (200 with AMI and 200 healthy controls). There were no significant differences between the 2 groups in terms of age, sex, BMI (as this was the protocol of the study), waist circumstance, educational, marital and occupational status, while physical activity was significantly higher among patients with AMI than in the control group. In addition, cases reported having higher alcohol consumption, opioid drug intake and smoking habits, in contrast to the control group.

Based on the unadjusted results, no significant association was observed between the frequency of consumption of processed and white meat, fish, egg, nuts and beans, and the presence of AMI. However, the results showed a positive association between red meat intake and the risk of AMI. In particular, the frequency of red meat intake in the case group was marginally higher than in the control group (**Table 2**). The association between the frequency of meat group consumption and the risk of AMI are presented in 3 adjusted models in **Table 3**. In model 1, age, sex, and BMI were added. No significant association was found in adjusted model 1. After additional adjustment for physical activity, a significant association was observed between both processed and red meat consumption, and the risk of AMI (processed meat consumption: odds ratio [OR], 1.71; 95% confidence interval [CI], 1.31–2.23 and red meat consumption: OR, 2.51; 95% CI, 1.84–5.11). These associations were attenuated, and remained significant in further controlling for more confounders including opioid drug intake, alcohol consumption and smoking habit (processed meat consumption: OR, 2.87;

Table 1. Characteristics of patients with acute myocardial infraction and control subjects

Variables	Cases (n = 200)	Controls (n = 200)	p value[*]
Age	54.4 ± 10.8	52.8 ± 10.5	0.488
Sex (male/female)	169 (84.5)/31 (15.5)	169 (84.5)/31 (15.5)	1.000
Family history of cardiovascular disease	95 (47.5)	64 (32)	0.091
Education			0.070
Illiterate	46 (23)	29 (14.5)	
Elementary	34 (17)	29 (14.5)	
High school	64 (32)	60 (30)	
Diploma	40 (20)	58 (29)	
University	16 (8)	24 (12)	
BMI	26.2 ± 4.7	26.5 ± 3.4	0.488
Waist circumstance	89.8 ± 16.4	91.1 ± 14.6	0.498
Physical activity			< 0.001
Low	149 (74.5)	94 (47)	
Moderate	30 (15)	58 (29)	
High	21 (10.5)	48 (24)	
Marital status			0.944
Single	4 (2)	5 (2.5)	
Married	195 (97.5)	194 (97)	
Divorced	1 (0.5)	1 (0.5)	
Smoking	102 (51)	44 (22)	< 0.001
Occupational status			0.128
Employed	130 (65)	128 (64)	
Unemployed	29 (14.5)	42 (21)	
Retired	41 (20.5)	30 (15)	
Opioid drug intake	53 (26.5)	16 (8)	< 0.001
Alcohol consumption	25 (12.5)	10 (5)	0.006

Data are shown as mean ± standard deviation or number (%).
[*]The p values were calculated by independent t-test for continuous variables and χ^2 test for categorical variables.

95% CI, 2.00–3.95 and red meat consumption: OR, 2.81; 95% CI, 2.65–4.12). In addition, an inverse association between nuts intake and AMI risk was seen in the model 3 adjustment (nuts consumption: OR, 0.52; 95% CI, 0.31–0.92).

Table 2. Distribution of frequencies of meat group consumption between AMI patients and controls

Variables	AMI cases (n = 200)	Controls (n = 200)	p value*
Processed meat consumption			0.183
≤ 1 time/mon	143 (81.5)	168 (84)	
2–3 time/mon	20 (10)	21 (10.5)	
1–2 time/wk	12 (6)	9 (4.5)	
3–4 time/wk	5 (2.5)	1 (0.5)	
5–6 time/wk	0 (0.0)	1 (0.5)	
> 6 time/wk	0 (0.0)	0 (0.0)	
Red meat consumption			0.045
≤ 1 time/mon	34 (17)	26 (13)	
2–3 time/mon	43 (21.5)	65 (32.5)	
1–2 time/wk	79 (39.5)	75 (37.5)	
3–4 time/wk	32 (16)	30 (15)	
5–6 time/wk	6 (3)	2 (1)	
> 6 time/wk	6 (3)	2 (1)	
White meat consumption			0.892
≤ 1 time/mon	4 (2)	2 (1)	
2–3 time/mon	5 (2.5)	6 (3)	
1–2 time/wk	32 (16)	31 (15.5)	
3–4 time/wk	119 (59.5)	117 (58.5)	
5–6 time/wk	36 (18)	41 (20.5)	
> 6 time/wk	4 (2)	3 (1.5)	
Fish consumption			0.196
≤ 1 time/mon	36 (18)	22 (11)	
2–3 time/mon	50 (25)	48 (24)	
1–2 time/wk	55 (27.5)	73 (36.5)	
3–4 time/wk	52 (26)	52 (26)	
5–6 time/wk	4 (2)	5 (2.5)	
> 6 time/wk	3 (1.5)	0 (0.0)	
Eggs consumption			0.169
≤ 1 time/mon	4 (2)	4 (2)	
2–3 time/mon	15 (7.5)	18 (9)	
1–2 time/wk	44 (22)	37 (18.5)	
3–4 time/wk	80 (40)	102 (51)	
5–6 time/wk	29 (14.5)	28 (14)	
> 6 time/wk	28 (14)	11 (5.5)	
Nuts consumption			0.137
≤ 1 time/mon	32 (16)	19 (9.5)	
2–3 time/mon	47 (23.5)	38 (19)	
1–2 time/wk	46 (23)	48 (24)	
3–4 time/wk	39 (19.5)	43 (21.5)	
5–6 time/wk	19 (9.5)	18 (9)	
> 6 time/wk	17 (8.5)	34 (17)	
Beans consumption			0.217
≤ 1 time/mon	11 (5.5)	4 (2)	
2–3 time/mon	35 (17.5)	17 (8.5)	
1–2 time/wk	95 (47.5)	114 (57)	
3–4 time/wk	55 (27.5)	60 (30)	
5–6 time/wk	3 (1.5)	5 (2.5)	
> 6 time/wk	1 (0.5)	0 (0.0)	

Values are presented as number (%).
AMI = acute myocardial infraction.
*The p values were calculated using the χ^2 test.

Table 3. Results from multiple logistic regression models that were performed to assess the association of meat consumption with the risk of AMI

Consumption status (portion per month)	Risk of AMI		
	Model 1[*]	Model 2[†]	Model 3[‡]
Processed meat	1.30 (0.8–1.9)	1.71 (1.31–2.23)[§]	2.87 (2.00–3.95)[§]
Red meat	2.01 (0.9–4.3)	2.51 (1.84–5.11)[§]	2.81 (2.65–4.12)[§]
White meat	0.49 (0.04–5.53)	0.93 (0.77–5.23)	0.84 (0.63–6.18)
Fish	0.73 (0.33–1.59)	0.61 (0.37–1.83)	0.58 (0.41–2.94)
Eggs	1.00 (0.25–4.05)	0.9 (0.66–4.23)	0.73 (0.53–5.05)
Nuts	0.65 (0.33–1.3)	0.61 (0.5–1.0)	0.52 (0.31–0.92)[§]
Beans	0.59 (0.14–2.5)	0.8 (0.51–2.37)	0.7 (0.44–2.28)

Results are presented as OR and 95% CI and calculated by performing multiple logistic regressions.
AMI = acute myocardial infraction; BMI = body mass index; OR = odds ratio; CI = confidence interval.
[*]Adjusted for age, sex, and BMI; [†]Adjusted for age, sex, BMI, and physical activity; [‡]Adjusted for age, sex, BMI, physical activity, opioid drug intake, alcohol consumption and smoking habit; [§]p value < 0.05.

DISCUSSION

This case-control study was carried out to investigate the associations between the frequency of meat group items consumption and the risk of AMI, and demonstrated that red meat consumption might be associated with increased AMI risks. After controlling for potential confounding risk factors, the results indicated a positive association between processed and red meat intake, and risk of AMI. Furthermore, an inverse relationship was observed between frequency of nut intake and the odds of AMI.

This study's finding that processed and red meat intake are related with higher AMI risk is in line with several other studies [28]. Yang et al. [29] showed that high consumption of red meat can increase the risk of total and ischemic stroke. Another study suggested that an increase in consumption of processed meat for each one serving per day is associated with 15% increased risk of cardiovascular mortality [30]. Also, it was demonstrated that the risk of stroke increased by 11% and 13% for each 100 g/day increase in red meat and 50 g/day increase in processed meat consumption [31]. The key link for this association might be related to its high saturated fatty acid and cholesterol content [32]. Also, gut bacteria can metabolize L-carnitine, which is derived from red meat ingestion, and thus produce pro-atherosclerotic compounds [33]. In addition to the aforementioned constituents in red meat, processed meat contains 400% more sodium and 50% more nitrates, which can elevate blood pressure and stimulate peripheral vascular resistance that leads to arterial compliance impairment [28,34].

No association between poultry, fish, egg, and beans intakes and the risk of AMI was found. In contrast with our findings, growing evidence has indicated fish intake is associated with lower AMI incidence [35-37]. The reason underlying this inconsistency may be related to the species of fish which the participants consumed. One study suggested that fatty fish intake was associated with lower risk of AMI, whereas lean fish was not associated with AMI [38]. Generally, participants of the present study more often consumed Caspian Sea fish, which are categorized as lean fish. The cardio-protective effect of fish intake is proposed as relating to its unsaturated fatty acid content, including eicosapentaenoic acid and docosahexaenoic acid. These polyunsaturated acids can stimulate prostaglandin I_3, which acts as a vasodilator and reduces the formation of thromboxane A_2 in platelets, which leads to decreased platelet aggregation with no adverse effect on vasodilation [39,40]. In addition, fish oil can reduce blood pressure in hypertensive individuals via reducing plasma fibrinogen concentrations

[41]. Similar to the present study's results, previous studies did not detect any association between egg consumption and the risk of stroke [42-44]. Fish, beans and eggs are very common food items and are used as a main dietary constituent among people in the north of Iran. It seems that there is no direct connection between the incidence of AMI and the usual volume of fish, eggs, and beans consumption.

An inverse association was found between nuts intake and the risks of AMI, after adjusting for potential confounders. A previous study demonstrated that nuts intake of 3 or more times a week reduced the risk of atrial fibrillation by 18%, as well as the risk of heart failure [45]. Another study showed that individuals who consumed nuts more than 4 times per week had a 37% lower risk of coronary heart disease in comparison to non-consumers [46]. Increasing evidence has indicated that nuts consumption may confer cardiovascular protection through bioactive constituents, including unsaturated fatty acids, L-arginine, minerals, vitamin E, folate, phenolics, and phytosterols [47]. It can modify blood lipid levels [48], improve endothelial function [49] and reduce inflammation [50].

There are several limitations that should be considered when interpreting our findings. First, the assessment of dietary intakes by using self-administered FFQ might lead to misclassifications among the study participants. Second, it is possible that there was residual confounding—for example other food group components and stimulant drugs, which could not be detected or/and excluded, and may be confounders in the relationship between the frequency of meat group items intake and the risk of AMI, thus influencing the results. However, multivariable logistic regression was performed to adjust for a number of potential confounders. Third, the present study had a case-control design, so, similar to other observational studies, no causal inference between the frequency of meat group consumption and AMI can be drawn. In this case, it was not possible to clarify whether frequency of meat group items intake modifies the risk of AMI or whether AMI affects food preferences. Finally, due to its small sample size, these findings cannot be generalized to the general population.

CONCLUSION

In conclusion, the study findings suggested a positive association between AMI and processed and red meat consumption. In addition, the present study provides evidence for an inverse association between nuts intake and the risk of AMI. Although these findings imply promising associations which may provide a new approach to manage AMI, due to the nature of observational studies, they cannot be generalized to the wider population and cannot be used to determine causality. Long-term prospective cohort studies are recommended to provide more epidemiological evidence and to present detailed information about the associations between AMI and meat group items intake.

ACKNOWLEDGEMENTS

REFERENCES

1. Thygesen K, Alpert JS, Jaffe AS, Simoons ML, Chaitman BR, White HD, Thygesen K, Alpert JS, White HD, Jaffe AS, Katus HA, Apple FS, Lindahl B, Morrow DA, Chaitman BR, Clemmensen PM, Johanson P, Hod H, Underwood R, Bax JJ, Bonow JJ, Pinto F, Gibbons RJ, Fox KA, Atar D, Newby LK, Galvani M, Hamm CW, Uretsky BF, Steg PG, Wijns W, Bassand JP, Menasche P, Ravkilde J, Ohman EM, Antman EM, Wallentin LC, Armstrong PW, Simoons ML, Januzzi JL, Nieminen MS, Gheorghiade M, Filippatos G, Luepker RV, Fortmann SP, Rosamond WD, Levy D, Wood D, Smith SC, Hu D, Lopez-Sendon JL, Robertson RM, Weaver D, Tendera M, Bove AA, Parkhomenko AN, Vasilieva EJ, Mendis S, Bax JJ, Baumgartner H, Ceconi C, Dean V, Deaton C, Fagard R, Funck-Brentano C, Hasdai D, Hoes A, Kirchhof P, Knuuti J, Kolh P, McDonagh T, Moulin C, Popescu BA, Reiner Z, Sechtem U, Sirnes PA, Tendera M, Torbicki A, Vahanian A, Windecker S, Morais J, Aguiar C, Almahmeed W, Arnar DO, Barili F, Bloch KD, Bolger AF, Botker HE, Bozkurt B, Bugiardini R, Cannon C, de Lemos J, Eberli FR, Escobar E, Hlatky M, James S, Kern KB, Moliterno DJ, Mueller C, Neskovic AN, Pieske BM, Schulman SP, Storey RF, Taubert KA, Vranckx P, Wagner DR; Joint ESC/ACCF/AHA/WHF Task Force for Universal Definition of Myocardial Infarction; Authors/Task Force Members Chairpersons; Biomarker Subcommittee; ECG Subcommittee; Imaging Subcommittee; Classification Subcommittee; Intervention Subcommittee; Trials & Registries Subcommittee; Trials & Registries Subcommittee; Trials & Registries Subcommittee; Trials & Registries Subcommittee; ESC Committee for Practice Guidelines (CPG); Document Reviewers. Third universal definition of myocardial infarction. J Am Coll Cardiol 2012;60:1581-98.
   PUBMED | **CROSSREF**

2. Reed GW, Rossi JE, Cannon CP. Acute myocardial infarction. Lancet 2017;389:197-210.
   PUBMED | **CROSSREF**

3. Writing Group Members , Mozaffarian D, Benjamin EJ, Go AS, Arnett DK, Blaha MJ, Cushman M, Das SR, de Ferranti S, Després JP, Fullerton HJ, Howard VJ, Huffman MD, Isasi CR, Jiménez MC, Judd SE, Kissela BM, Lichtman JH, Lisabeth LD, Liu S, Mackey RH, Magid DJ, McGuire DK, Mohler ER 3rdMoy CS, Muntner P, Mussolino ME, Nasir K, Neumar RW, Nichol G, Palaniappan L, Pandey DK, Reeves MJ, Rodriguez CJ, Rosamond W, Sorlie PD, Stein J, Towfighi A, Turan TN, Virani SS, Woo D, Yeh RW, Turner MB; American Heart Association Statistics Committee; Stroke Statistics Subcommittee. Heart disease and stroke statistics-2016 update: a report from the American Heart Association. Circulation 2016;133:e38-360.
   PUBMED | **CROSSREF**

4. Anderson JL, Morrow DA. Acute myocardial infarction. N Engl J Med 2017;376:2053-64.
   PUBMED | **CROSSREF**

5. Boersma E, Mercado N, Poldermans D, Gardien M, Vos J, Simoons ML. Acute myocardial infarction. Lancet 2003;361:847-58.
   PUBMED | **CROSSREF**

6. Nordestgaard BG, Varbo A. Triglycerides and cardiovascular disease. Lancet 2014;384:626-35.
   PUBMED | **CROSSREF**

7. Tölle M, Reshetnik A, Schuchardt M, Höhne M, van der Giet M. Arteriosclerosis and vascular calcification: causes, clinical assessment and therapy. Eur J Clin Invest 2015;45:976-85.
   PUBMED | **CROSSREF**

8. Miraghajani M, Pourmasoumi M, Ghiasvand R. Dairy as a functional food in cardiovascular disease. In: Watson RR, Collier RJ, Preedy VR, editors. Nutrients in dairy and their implications on health and disease. London: Academic Press; 2017. p. 313-24.

9. Zyriax BC, Boeing H, Windler E. Nutrition is a powerful independent risk factor for coronary heart disease in women--the CORA study: a population-based case-control study. Eur J Clin Nutr 2005;59:1201-7.
   PUBMED | **CROSSREF**

10. Nagra V. Nutritional status of primary school children. New Delhi: EduPedia Publications; 2015.

11. Sasazuki S; Fukuoka Heart Study Group. Case-control study of nonfatal myocardial infarction in relation to selected foods in Japanese men and women. Jpn Circ J 2001;65:200-6.
    PUBMED | **CROSSREF**

12. Milićević D, Vranić D, Mašić Z, Parunović N, Trbović D, Nedeljković-Trailović J, Petrović Z. The role of total fats, saturated/unsaturated fatty acids and cholesterol content in chicken meat as cardiovascular risk factors. Lipids Health Dis 2014;13:42.
    PUBMED | **CROSSREF**

13. McNeill S, Van Elswyk ME. Red meat in global nutrition. Meat Sci 2012;92:166-73.
    PUBMED | **CROSSREF**

14. Ros E. Nuts and novel biomarkers of cardiovascular disease. Am J Clin Nutr 2009;89:1649S-56S.
    PUBMED | **CROSSREF**

15. Kris-Etherton PM, Harris WS, Appel LJ; American Heart Association. Nutrition Committee. Fish consumption, fish oil, omega-3 fatty acids, and cardiovascular disease. Circulation 2002;106:2747-57.
    PUBMED

16. Kerver JM, Yang EJ, Bianchi L, Song WO. Dietary patterns associated with risk factors for cardiovascular disease in healthy US adults. Am J Clin Nutr 2003;78:1103-10.
    PUBMED | CROSSREF

17. Fung TT, Rimm EB, Spiegelman D, Rifai N, Tofler GH, Willett WC, Hu FB. Association between dietary patterns and plasma biomarkers of obesity and cardiovascular disease risk. Am J Clin Nutr 2001;73:61-7.
    PUBMED | CROSSREF

18. Artinian NT, Schim SM, Vander Wal JS, Nies MA. Eating patterns and cardiovascular disease risk in a Detroit Mexican American population. Public Health Nurs 2004;21:425-34.
    PUBMED | CROSSREF

19. Panagiotakos D, Bountziouka V, Zeimbekis A, Vlachou I, Polychronopoulos E. Food pattern analysis and prevalence of cardiovascular disease risk factors among elderly people from Mediterranean islands. J Med Food 2007;10:615-21.
    PUBMED | CROSSREF

20. van Dam RM, Grievink L, Ocké MC, Feskens EJ. Patterns of food consumption and risk factors for cardiovascular disease in the general Dutch population. Am J Clin Nutr 2003;77:1156-63.
    PUBMED | CROSSREF

21. McNaughton SA, Mishra GD, Stephen AM, Wadsworth ME. Dietary patterns throughout adult life are associated with body mass index, waist circumference, blood pressure, and red cell folate. J Nutr 2007;137:99-105.
    PUBMED | CROSSREF

22. Shimazu T, Kuriyama S, Hozawa A, Ohmori K, Sato Y, Nakaya N, Nishino Y, Tsubono Y, Tsuji I. Dietary patterns and cardiovascular disease mortality in Japan: a prospective cohort study. Int J Epidemiol 2007;36:600-9.
    PUBMED | CROSSREF

23. Cai H, Shu XO, Gao YT, Li H, Yang G, Zheng W. A prospective study of dietary patterns and mortality in Chinese women. Epidemiology 2007;18:393-401.
    PUBMED | CROSSREF

24. Moghaddam MHB, Aghdam FB, Jafarabadi MA, Allahverdipour H, Nikookheslat SD, Safarpour S. The Iranian Version of International Physical Activity Questionnaire (IPAQ) in Iran: content and construct validity, factor structure, internal consistency and stability. World Appl Sci J 2012;18:1073-80.

25. Esmaillzadeh A, Mirmiran P, Azizi F. Whole-grain intake and the prevalence of hypertriglyceridemic waist phenotype in Tehranian adults. Am J Clin Nutr 2005;81:55-63.
    PUBMED | CROSSREF

26. United States Department of Agriculture. Human Nutrition Information Service. USDA's food guide pyramid. Hyattsville (MD): US Dept. of Agriculture; 1992.

27. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva: World Health Organization; 2000.

28. Micha R, Michas G, Mozaffarian D. Unprocessed red and processed meats and risk of coronary artery disease and type 2 diabetes--an updated review of the evidence. Curr Atheroscler Rep 2012;14:515-24.
    PUBMED | CROSSREF

29. Yang C, Pan L, Sun C, Xi Y, Wang L, Li D. Red meat consumption and the risk of stroke: a dose-response meta-analysis of prospective cohort studies. J Stroke Cerebrovasc Dis 2016;25:1177-86.
    PUBMED | CROSSREF

30. Wang X, Lin X, Ouyang YY, Liu J, Zhao G, Pan A, Hu FB. Red and processed meat consumption and mortality: dose-response meta-analysis of prospective cohort studies. Public Health Nutr 2016;19:893-905.
    PUBMED | CROSSREF

31. Chen GC, Lv DB, Pang Z, Liu QF. Red and processed meat consumption and risk of stroke: a meta-analysis of prospective cohort studies. Eur J Clin Nutr 2013;67:91-5.
    PUBMED | CROSSREF

32. Willett WC. Dietary fats and coronary heart disease. J Intern Med 2012;272:13-24.
    PUBMED | CROSSREF

33. Koeth RA, Wang Z, Levison BS, Buffa JA, Org E, Sheehy BT, Britt EB, Fu X, Wu Y, Li L, Smith JD, DiDonato JA, Chen J, Li H, Wu GD, Lewis JD, Warrier M, Brown JM, Krauss RM, Tang WH, Bushman FD, Lusis AJ, Hazen SL. Intestinal microbiota metabolism of L-carnitine, a nutrient in red meat, promotes atherosclerosis. Nat Med 2013;19:576-85.
    PUBMED | CROSSREF

34. Sacks FM, Campos H. Dietary therapy in hypertension. N Engl J Med 2010;362:2102-12.
    PUBMED | **CROSSREF**

35. Wallin A, Orsini N, Forouhi NG, Wolk A. Fish consumption in relation to myocardial infarction, stroke and mortality among women and men with type 2 diabetes: a prospective cohort study. Clin Nutr 2018;37:590-6.
    PUBMED | **CROSSREF**

36. Weitz D, Weintraub H, Fisher E, Schwartzbard AZ. Fish oil for the treatment of cardiovascular disease. Cardiol Rev 2010;18:258-63.
    PUBMED | **CROSSREF**

37. Wennberg M, Bergdahl IA, Hallmans G, Norberg M, Lundh T, Skerfving S, Strömberg U, Vessby B, Jansson JH. Fish consumption and myocardial infarction: a second prospective biomarker study from northern Sweden. Am J Clin Nutr 2011;93:27-36.
    PUBMED | **CROSSREF**

38. Gammelmark A, Nielsen MS, Bork CS, Lundbye-Christensen S, Tjønneland A, Overvad K, Schmidt EB. Association of fish consumption and dietary intake of marine n-3 PUFA with myocardial infarction in a prospective Danish cohort study. Br J Nutr 2016;116:167-77.
    PUBMED | **CROSSREF**

39. Dyerberg J, Bang HO, Stoffersen E, Moncada S, Vane JR. Eicosapentaenoic acid and prevention of thrombosis and atherosclerosis? Lancet 1978;2:117-9.
    PUBMED | **CROSSREF**

40. Terano T, Hirai A, Hamazaki T, Kobayashi S, Fujita T, Tamura Y, Kumagai A. Effect of oral administration of highly purified eicosapentaenoic acid on platelet function, blood viscosity and red cell deformability in healthy human subjects. Atherosclerosis 1983;46:321-31.
    PUBMED | **CROSSREF**

41. Iso H, Rexrode KM, Stampfer MJ, Manson JE, Colditz GA, Speizer FE, Hennekens CH, Willett WC. Intake of fish and omega-3 fatty acids and risk of stroke in women. JAMA 2001;285:304-12.
    PUBMED | **CROSSREF**

42. He K, Merchant A, Rimm EB, Rosner BA, Stampfer MJ, Willett WC, Ascherio A. Dietary fat intake and risk of stroke in male US healthcare professionals: 14 year prospective cohort study. BMJ 2003;327:777-82.
    PUBMED | **CROSSREF**

43. Qureshi AI, Suri FK, Ahmed S, Nasar A, Divani AA, Kirmani JF. Regular egg consumption does not increase the risk of stroke and cardiovascular diseases. Med Sci Monit 2007;13:CR1-8.
    PUBMED

44. Larsson SC, Åkesson A, Wolk A. Egg consumption and risk of heart failure, myocardial infarction, and stroke: results from 2 prospective cohorts. Am J Clin Nutr 2015;102:1007-13.
    PUBMED | **CROSSREF**

45. Larsson SC, Drca N, Björck M, Bäck M, Wolk A. Nut consumption and incidence of seven cardiovascular diseases. Heart 2018;104:1615-20.
    PUBMED | **CROSSREF**

46. Kelly JH Jr, Sabaté J. Nuts and coronary heart disease: an epidemiological perspective. Br J Nutr 2006;96 Suppl 2:S61-7.
    PUBMED | **CROSSREF**

47. Ros E. Health benefits of nut consumption. Nutrients 2010;2:652-82.
    PUBMED | **CROSSREF**

48. Del Gobbo LC, Falk MC, Feldman R, Lewis K, Mozaffarian D. Effects of tree nuts on blood lipids, apolipoproteins, and blood pressure: systematic review, meta-analysis, and dose-response of 61 controlled intervention trials. Am J Clin Nutr 2015;102:1347-56.
    PUBMED | **CROSSREF**

49. Xiao Y, Huang W, Peng C, Zhang J, Wong C, Kim JH, Yeoh EK, Su X. Effect of nut consumption on vascular endothelial function: a systematic review and meta-analysis of randomized controlled trials. Clin Nutr 2018;37:831-9.
    PUBMED | **CROSSREF**

50. Casas-Agustench P, Bulló M, Salas-Salvadó J. Nuts, inflammation and insulin resistance. Asia Pac J Clin Nutr 2010;19:124-30.
    PUBMED