Is there any association between rice consumption and some of the cardiovascular diseases risk factors? A systematic review

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Review Article

Abstract

BACKGROUND: White rice is considered as a staple food in most population in the world, and there may be an association between rice intake and cardiovascular disease (CVD) risks. The present article was reviewed the correlation between rice intake and CVD and some of its risk factors.

METHODS: We searched in PubMed, Google scholar, and SCOPUS to February 2015 by using several keywords such as low and high density lipoprotein, triglyceride, total cholesterol, fasting blood glucose, CVD or risks, metabolic syndrome, diabetes, obesity, lipid profile, and refined grains or rice and white rice. Finally, 14 studies were included in our systematic review.

RESULTS: There was found a positive association between white rice intake and risk factors of CVD including metabolic syndrome and type 2 diabetes. Furthermore, it seems that there is no any significant correlation between white rice consumption and incidence of CVD and its mortality.

CONCLUSION: Finding from available data suggested the important roles of higher white rice consumption on CVD risk factors.

Keywords: White Rice, Refined Grains, Cardiovascular Disease, Metabolic Syndrome, Type 2 Diabetes

Introduction

Cardiovascular disease (CVD) is one of the main causes of mortality among the several population.[1] The incidence of CVD can be occurred results of many chronic problems including obesity, type 2 diabetes, and metabolic syndrome.[2] The mortality rate of CVD is rising not only in developed countries, but also in developing countries.[1] CVD mortality among men and women were 43% and 55% in developed countries, respectively.[1] Recent evidence suggested several risk factors contributing CVD including smoking, less physical activity, obesity, high blood pressure, and dyslipidemia.[3,4] Lifestyle related factors including dietary components are associated with the incidence of CVD. It seems that high-quality diet consumption is associated with lower risks of overweight and obesity which have the important role on CVD incidence.[5] High consumption of total carbohydrates is positively related to CVD risk factors.[6] Furthermore, as the refined grains (like white rice) increase, the serum glucose and lipid levels (risk factors of CVD) elevate.[7]

White rice is the most important sources of carbohydrate which is considered as the staple food in Asian people.[8,9] For example, white rice is one of the most predominant sources of energy and carbohydrate in Iranian population.[10] In additional, Koreans consume 37.9% of their total energy from rice.[11] Rice provides 43% of carbohydrate consumption in Japan.[6] Furthermore, the consumption of rice is reached to 6-8.5 serving per day in some countries.[12] In contrast, whole grains are the major components of healthy pattern and could able to prevent systemic inflammation and CVD, which are less consumed in these countries.[13] In contrast, whole grains are rich in many nutrients including dietary fiber, magnesium, vitamins, and phytoestrogen.[1,14] But white rice because of refining process and separation outer layer of bran, only contains the starch (endosperm) which may have unfavorable impacts on cardio-metabolic risk factors.[1]

Several studies have emphasized the role of energy density of foods on obesity, metabolic syndrome, and CVD risk.[15-18] The amount of dietary

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fiber is the main determinant of dietary energy density. Since white rice is poor in fiber and mineral because of the polishing process, could mention as the high energy-dense food.[5,8] In addition, quality of carbohydrate i.e. glycemic index (GI) and glycemic load (GL) have emerged as an important factor for development of chronic diseases like CVD.[19-21] The mean GI of white rice is approximately 64 which can be diverse according to the degree of processing, amylose content, and cooking time.[22] Several studies were searched into the correlation between refined rice and risk of CVD in different kinds of population Asian and western, but their results are inconsistent.[1,6,8-11,13,14,23-30] Consumption of refined rice was associated to lower risk of CVD mortality.[6] Furthermore, several investigations have not shown any significant association between rice intake and risk of coronary heart disease and total CVD.[31,32] Furthermore, there was no relation between refined rice and risk factors of CVD such as fasting blood glucose and serum lipid profile.[1] Whereas higher consumption of refined rice have led to metabolic syndrome, type 2 diabetes, and CVD.[8,9,23] Given the high prevalence of CVD and its components in the world and also importance of rice as the staple foods for many people in several countries especially in Asia and the probable correlation in this regard, we aimed to focus on available data regarding the association between white rice consumption and cardiovascular risk factors.

Materials and Methods

In order to investigate the association between white rice consumption and CVD and some of the risk factors of CVD, we searched in PubMed, Google scholar, and SCOPUS search engines from 1970 to February 2015, using the following key words for the topic: CVD or risks, metabolic syndrome, diabetes, obesity, overweight, dyslipidemia, lipid profile in combination with refined grains or rice and white rice.

Articles were screened by their title, and abstract and/or full texts were read when needed. Any human cross-sectional, clinical trial and prospective studies investigating the correlation between white rice and CVD risks were included in this systematic review. Studies and articles with an investigation of any type of rice such as brown rice and whole grains were not included. We settled to exclude studies which have examined the relation between white rice and some of the CVD risk factors.

We extracted data on publication (the first author's last name and year of publication), study design, gender, age, name of country that study were conducted, duration of study, number of participants, aim of study and results. Studies that investigated among association between white rice consumption and CVD risk factors are observed in table 1.

Results

Totally, our search retrieved 298 related papers. We found 25 papers as the duplicated papers. From 273 papers, 14 studies were included in our systematic review and others were excluded because they did not meet our inclusion criteria (Figure 1).

Results from studies evaluated the association between white rice consumption and risk of metabolic syndrome has shown positive results.[8,24-26]

In a study of 1476 Iranian adults, aged 19-70 years, showed that consumption of rice (if consumed $\geq$ 25.6% of total energy) were significantly related to greater risks of metabolic syndrome.[8] One cross-sectional study conducted among 6845 Korean adults shown that white rice intake in women were associated to greater levels triglyceride and fasting blood glucose and lower level of high-density lipoprotein (HDL).[25] Results from one cross-sectional study among a population of Korean adolescents revealed the lower level of HDL-cholesterol in girls with white rice consumption. Furthermore, rice intake was substantially correlated to increase risks of insulin resistance and metabolic syndrome in girls.[24] Boys with high dietary GL also had a greater level of fasting blood sugar.[24] In addition, higher consumption of refined grains such as white rice was related to metabolic syndrome in 2042 Asian Indians.[26] Rice eating with beans or multi-grains was associated with reduction in metabolic syndrome risk factors particularly in postmenopausal women.[11]

Finding from several studies regarding the correlation between CVD and CVD mortality have reached contradictory results.[6,9,27] In one prospective cohort examination among 207556 US individuals from the Nurse's Health Study, consumption of refined rice was not significantly associated with CVD risk. Their results were largely similar between Whites and Asians.[9] Furthermore, in another study conducted among 91223 Japanese male and female with obesity, aged 40-69 years, authors did not find any substantial correlation between white rice consumption and risk of CVD

Table 1. Studies regarding the association between white rice consumption, diabetes, and metabolic syndrome as the cardiovascular disease (CVD) risk factors

Reference	Country	Participants/gender	Age	BMI	Design	Aim of study	Duration of study	OR/HR/Percent change	Results
Murak et al.[9]	US	207555 female 73228 male	31-64	20-30	Cohort	Effect of rice consumption on CVD	4393130 (person-year)	0.98 (0.8-1.14)	No significant association
Sun et al.[30]	US	157463 female 39765 male	26-87	20-25	Cohort	Effect of white rice on diabetes	3318196 (person-year)	1.17 (1.02-1.36)	Positive association
Eshak et al.[16]	Japan	64327 female 46465 male	40-79	-	Prospective	Effect of white rice on CVD mortality	14.1 (year)	0.82 (0.7-0.97) for men	Negative association in men
Bahadoran et al.[8]	Iran	1476 adults	19-70	-	Prospective	Effect of white rice on metabolic syndrome	3 (year)	1.66 (1.04-2.66)	Positive association (higher TG and S and DBP and lower HDL with rice consumption)
Khosravi-Boroujeni et al.[1]	Iran	3006 male	19-65	-	Cross-sectional	Association between white rice and CVD risk factors	-	1.25 (0.72-2.18) for metabolic syndrome 1.06 (0.47-2.43) for diabetes 0.96 (0.68-1.34) for hyperlipidemia	No significant association With rice intake and level of lipid profile, FBs, and blood pressure)
Ahn et al.[11]	Korea	26006 male	40-69	-	Cross-sectional	Association between rice-eating pattern and metabolic syndrome risks	-	0.85 (0.73-0.98) in women and 1.03 (0.89-1.19) in men in white rice with multi-grains group in comparison with white rice (OR = 1)	negative association with white rice consumption with beans and multi-grains and metabolic syndrome
Song et al.[24]	Korea	1164 boys 1045 girls	10-18	-	Cross-sectional	Association with white rice and metabolic syndrome risk factors	-	-	Rice intake reduced HDL-cholesterol levels in girls an increased risk of insulin resistance and the metabolic syndrome in girls but not in boys
Song et al.[25]	Korea	2631 male 4214 female	30-65	-	Cross-sectional	Association with white rice and metabolic syndrome risk factors	-	-	Triglyceride, high-density lipoprotein cholesterol, and fasting blood glucose levels were associated with the percentage of energy from carbohydrates in men and white rice intake in women
Zuniga et al.[29]	Singaporean Chinese	2728 male and female	24-92	-	Cross-sectional	Association with white rice and insulin resistance and hyperglycemia	-	1.67% (0.44-2.92) for FBS 6.17% (0.49-12.16) For HOMA-IR 9.17% (3.44-15.22) For TG	Positive association
Eshak et al.[27]	Japan	91223 male and female	40-69	-	Cohort	Association between white rice and CVD mortality	15-18 (year)	0.97 (0.84-1.13)	No significant association
Mohan et al.[28]	India	15	25-41	≥ 23	Randomized cross-over	Effect of white rice and other rice on blood glucose and insulin response	5 (day)	Fasting insulin 57% lower in brown rice in compared to white rice	Brown rice help reduce the insulin and FBS compared to white rice
Kolahdouzan et al.[10]	Iran	212 male and female	18-65	≥ 25	Cross-sectional	Association between white rice and central obesity	-	0.04 (−1.46-2.73) for BMI and −0.01 (−5.87-4.78) for waist circumference	No significant association
Nanri et al.[23]	Japan	33622 female 25666 male	45-75	21-27	Prospective	Association between rice intake and diabetes	5 (year)	1.65 (1.06-2.57)	Positive association
Villegas et al.[33]	China	64227 female	40-70	-	Cohort	Association between rice intake and diabetes	4.6 (year)	1.78 (1.48-2.15)	Positive association

BMI: Body mass index; OR: Odds ratio; HR: Hazard ratio; CVD: Cardiovascular disease; HDL: High-density lipoprotein; DBP: Diastolic blood pressure; FBS: Fasting blood sugar; HOMA-IR: Homeostasis model assessment-estimated insulin resistance; TG: Triglycerides
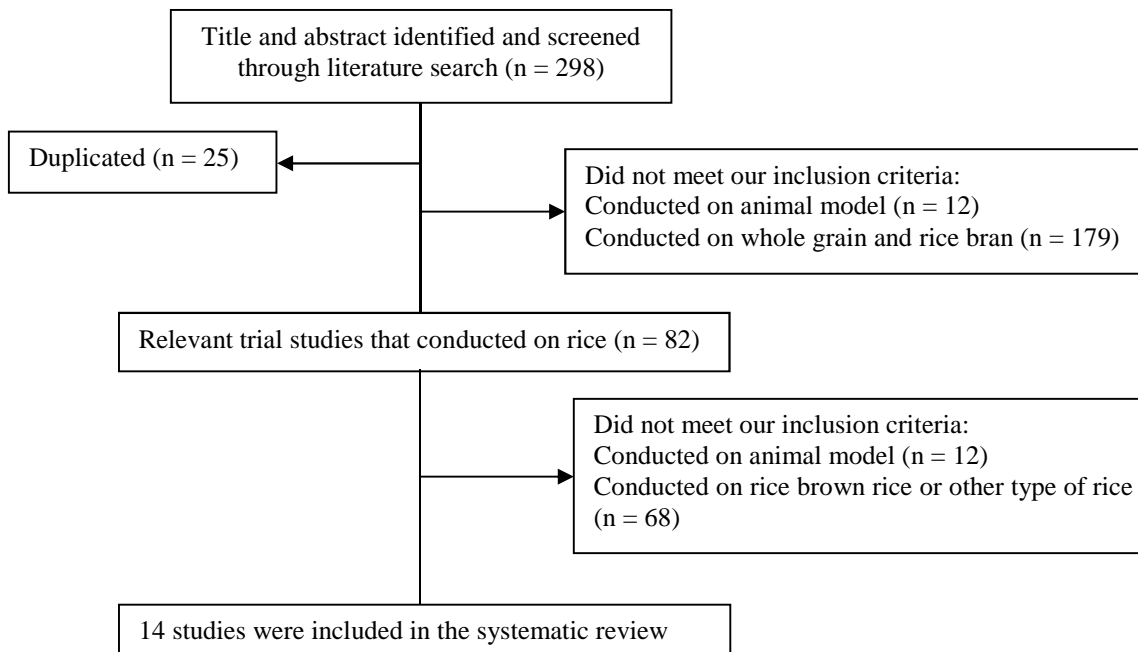
Figure 1: Flow diagram of study selection processes

morbidity and mortality.[27] These results were consistent with other study examining the relation between white rice consumption and CVD risk factors such as fasting blood glucose and lipid profile which conducted among 3006 samples of Iranian men.[1]

In contrast, in one prospective study among 83552 samples of Japanese men and women, consumption of rice was associated with reduced risk of CVD mortality in Japanese men.[6] But there was not find any substantial correlation between rice intake and risk of mortality from CVD in women after adjustment for potential confounders.[6]

Finding from several studies regarding the effect of white rice consumption on type 2 diabetes suggested the positive association in this regard.[14,28,29,33] One systematic review and meta-analysis published in 2012 by Hu et al., indicated that for each serving per day of rice consumption, the relative risk of diabetes was 1.11 (1.08-1.14, $T_{rend} < 0.001$).[14] They concluded that rice intake of was significantly correlated with augmentation risk of type 2 diabetes, especially in Japanese and Chinese population.[14] Furthermore, consumption of rice among 2728 Singaporean Chinese were substantially associated with hyperglycemia and insulin resistance according to one cross-sectional study.[29]

Discussion

Finding from several studies suggested the positive

relation between white rice consumption and diabetes and metabolic syndrome but not CVD mortality.[8,14,24,25] Studies regarding the association between rice consumption and risk of diabetes have reached consistent results.[23,29,33] Most of the studies conducted regarding the metabolic syndrome risk[8,11,24,25] and they showed the consistent results.

White rice is mentioned as the important source of carbohydrates for most people in the world especially in Asia. White rice is poor in nutrients including insoluble fiber, magnesium, vitamin E, folate, and other components.[34] The U.S. Preventive Services Task Force detected inadequate evidence on the favorable multivitamins to reduce the risk of CVD or cancer.[35] The consumption of rice in Asian people like Korea, Japan, Iran, etc., is more than 39% of their total energy from rice.[6,11,12] In contrast, the consumption of white rice in western countries is less than Asian people.[14] Phytoestrogens have the positive effects on regulating serum lipid metabolism, arterial vessels, cytokine levels, and coagulation/fibrinolysis system and may be used to prevent CVD.[36] Refined rice because of refining process is poor in fiber content and has high density of energy.[1]

Several studies suggested that fiber-rich carbohydrate diet such as whole grains and brown rice tend to a positive effect on prevention of diabetes and metabolic syndrome.[37,38] In one study, replacing of 50 g/day of white rice with brown rice and whole grains could reduce the risk for type 2

diabetes 16% and 36%, respectively.[30] Consumption of dietary fiber (≥ 14 g/1000 kcal) with white rice intake can attenuate the unfavorable impact of rice on metabolic syndrome.[8] But it seems that higher white rice intake may be related to weaker adherence to consumption of dairy products, nuts, vegetables, and fruits. In other hand, those with high consumption of refined rice may consume less of other these mentioned foods. The average intake of fruits and vegetables are less than guidelines recommendations in 90.9% of the population.[39]

Quality of carbohydrate i.e. GI and GL have considered as one of the major factors for development of chronic diseases like CVD.[19] The GI of white rice and brown rice are 64 ± 7 and 55 ± 5, respectively.[22] Furthermore, the GI of the various white rice varieties in the world may be different, and it depend on several factors including amylose content, other botanical structures, and processing method.[40] Foods with high GI and GL can cause a quick postprandial increase in serum glucose and insulin secretion.[1] People who consumed white rice as a staple food especially have a high GL and GI of meal time, and it can lead to CVD and related disorders.[41] Consumption of high GI foods could tend to insulin resistance and hyperglycemia through enhancement free fatty acid levels as soon as decline concentration of HDL cholesterol.[42]

One of the important factors contributed to the relation between white rice intake, and CVD risk factors are the amount of consumption. Consumption of white rice more than 25% of total energy intake/day can augment the risk of metabolic syndrome nearly up to 66% according to one study.[8] According to one other study conducted among Japanese women indicated that women who consumed ≥ 300 g/day of rice had 1.8 fold greater risk of diabetes than women with < 200 g/day rice consumption.[33] Results from recent cohort analysis suggested that intake of ≥ 5 serving/day of white rice is not significantly associated with CVD risks.[9] They did not support the report of Consumer Reports magazine regarding to limitation of white rice intake to 2 serving/weeks or less.[43] The average consumption of refined rice in India and China is 8.5 and 6 serving/day, respectively, and it may be related to diabetes and CVD epidemic especially in India.[12]

Obesity, as an important health problem in the world, leads to insulin resistance, dyslipidemia and metabolic syndrome, systemic inflammation, type 2 diabetes, and CVD.[44] Individuals with excess weight had greater risk of metabolic disorders if they consumed more refined rice based on one study.[8] One investigation indicated that individuals with normal BMI, who intake white rice may have a higher risk for diabetes. It seems that white rice consumption may tend to diabetes and risk of CVD independent of obesity.[45]

Physical activity is considered as one of the important factors contributed to the correlation between white rice and CVD risk factors. Physical activity may counterbalance the increased serum glucose because of white rice consumption and may diminish the adverse effect of white rice on CVD risk factor.[23] Sedentary life and less physical activity can affect the association between rice consumption and diabetes and CVD risk factors.[23]

Hence, we did not face to only white rice consumption as the contributing diet-related factor to incidence CVD and its related disorders. In other hand, beside the assessment of white rice intake, we should consider the status of physical activity, intake of dietary fiber available in fruits, vegetables, nuts and legumes, and the amounts of white rice in one day. Among the reasons for the discrepancies of the results of studies, we can mention the diverse consumption of the several types of white rice with different GI. Furthermore, dietary patterns in total such as amount consumption of the low-fat dairy product, legumes, fruits, and vegetables have the important role on CVD risk factors. Several investigations supported the positive effect of whole grains, as a major component of healthy pattern, on prevention against systemic inflammation and CVD because of its many nutrients including dietary fiber, magnesium, vitamins, and phytoestrogen.[13] It is suggested to examine more studies regarding the association between rice consumption and lipid profile, blood pressure and CVD.

Conclusion

In conclusion, we found the significant association between white rice consumption and several risk factors of CVD including type 2 diabetes and metabolic syndrome, but results regarding the correlation between refine rice intake and CVD mortality had not shown the consistent results. More studies are needed to clarify this association.

Acknowledgments

Conflict of Interests

Authors have no conflict of interests.

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