# Review Article

## Cardiovascular health in women: The role of diet

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**Abstract**

The prevalence of cardiovascular diseases (CVDs) has been increasing over the years and is one of the leading causes of deaths in the Indian population. While women may have a lower risk of CVD, as compared to men, during the early phases of life, it has been determined that in the later stages of life, more number of women suffer from CVD as compared to men. Moreover, women might also experience disproportionately high mortality due to CVD. Obesity is among one of the most important reasons underlying greater burden of CVD in women. The problem of obesity is continuously growing even in developing countries like India and is more common in females and urban populations. Females are particularly prone to weight gain because of certain bodily changes which they have to go through during their life span. Obesity is associated with several risk factors such as type 2 diabetes, hypertension, dyslipidemia, which increase the risk of CVD. Additionally, obesity also leads to various other health problems such as uterine cancer, gallbladder disease, osteoarthritis, and breast cancer. Accordingly, prevention and management of obesity is an important health goal and diet plays an integral role in this. Diets rich in foods with high glycemic index (GI), high sodium content and low fruit and vegetable intake have been correlated with greater risk of CVD. Therefore, foods with low GI should be incorporated in the diets. In general, diets rich in dietary fiber have been associated with lower plasma cholesterol levels. Adequate intake of dietary fiber, phytochemicals, and antioxidants such as polyphenols, isothiocyanates, carotenoids, flavonoids, ascorbic acid and folates in the form of fresh fruits and vegetables offer cardioprotective benefits.

**Key Words:** *Antioxidants, cardiovascular diseases, glycemic index, phytochemicals, postprandial blood glucose*

**Received:** September, 2016.
**Accepted:** October 2016.

### Introduction

In India, cardiovascular disease (CVD) has been gaining increasing importance because of the rising incidence of the disease over the years. It is now listed first among the top five causes of deaths in the Indian population.[1] According to the World Health Organization (WHO) estimates, in 2002, 16.7 million people in the world died because of CVD every year. This represents about 1/3 of all deaths worldwide. It is estimated that by 2020, heart disease and stroke will become the leading cause of both death and disability globally, with the number of fatalities estimated to increase to over 20 million a year and by 2030 to over 24 million a year.[2] Country wise statistics by the WHO on noncommunicable diseases (NCDs) show that NCDs account for 53% of the total deaths in India, out of which eight different forms of CVDs have a major share of 24%.[3]

### Prevalence of Cardiovascular Diseases in Women

CVD remains the number-one threat to women's health in the developing country. There is a significantly lower age-specific risk of coronary heart disease (CHD) in women than men with the risk of death due to CHD in women being roughly similar to that of men 10 years younger. However, despite their marked advantage in age-specific risk of CHD death, the greater likelihood of survival of women to advanced ages produces nearly equal numbers of actual deaths due to CHD in men

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**Access this article online**

Quick Response Code:

**Website:** www.jcpconline.org

**DOI:** 10.4103/2250-3528.196651



**How to cite this article:** Sharma S, Sharma V, Rawat R, Arya S. Cardiovascular health in women: The role of diet. J Clin Prev Cardiol 2017;6:18-23.

and women. In addition, cooccurrence with diabetes mellitus may erase, or substantially attenuate, the "female advantage" in the risk of CVD observed in nondiabetics, and having diabetes may be equivalent to aging by at least 15 years with regard to the clinical manifestations of CVD. Thus, it has been estimated that during the later stages of life, more number of women contribute to the CVD-inflicted population as compared to men.[4] A survey conducted during the early 1990s in Delhi documented the annual incidence of CHD at 1.73% among men and 2.1% among women.[5] Since then, the incidence of CVD in women has been increasing steadily. A more recent study has estimated that by 2040, women in the study countries (India, Brazil, Russia, China, South Africa) will represent a higher proportion of CVDs deaths than men.[6] In addition to increasing incidence of CVD, women also experience disproportionately high mortality from CVD. CVD is the largest single cause of mortality among women. An estimated 8.5 million deaths among women are annually caused by CVD, accounting for one-third of all deaths in women worldwide. In developing countries, half of all deaths in women over 50 are due to heart disease and stroke.[7]

## Obesity as a Risk Factor for Cardiovascular Disease

Obesity is defined as a body fat content of more than 30% in average adult female and more than 20% in average adult male according to their ideal body weight.[8] According to the WHO, obesity is one of the most common, yet among the most neglected, public health problems in both developed and developing countries.[9] Per the WHO World Health Statistics Report 2012, worldwide one in six adults was obese and nearly 2.8 million individuals died each year due to overweight or obesity.[10]

### *Defining obesity*

The initial step in the evaluation of obesity is calculation of body mass index (BMI). To measure BMI, the patient is weighed in underclothes and no shoes. Height is measured without shoes. BMI is calculated by dividing weight (in kg) by square height (in meters).[11,12] Based on BMI, obesity is defined and classified as below:

- <18.5 – underweight
- 18.5-24.9 – normal or healthy weight
- 25.0-29.9 – overweight
- 30.0 or above – obese.

For Asian Indians, lower cut off values have been proposed to define overweight (23.0–24.9 kg/m$^2$) and obesity (>25.0 kg/m$^2$).[13]

### *Role of body fat distribution*

Asian Indians have a greater predisposition to abdominal obesity and accumulation of visceral fat, and this has been termed as "Asian Indian Phenotype."[14,15] Abdominal obesity represented by the waist circumference or the waist-hip ratio, has been found to be a stronger predictor of CHD, independent of the general level of obesity, although the BMI also influences the CVD risk.[16] The risk imposed by central obesity is independent of BMI and has been shown to be an important factor in those who would not be classified as obese based on their BMI only. The correlation between increased abdominal adiposity and amplified levels of metabolic risk factors is strong and graded in South Asians and happens to explain a proportion of the augmented risk of ill health at lower BMI.[17,18]

Given these considerations, obesity can also be classified as given below which takes into account the presence or absence of abdominal obesity also:

- Overweight defined as a BMI ≥23 kg/m$^2$ but <25 kg/m$^2$ for both genders with or without abdominal obesity
- Generalized obesity defined as a BMI ≥25 kg/m$^2$ for both genders with or without abdominal obesity
- Abdominal obesity defined as a waist circumference ≥80 cm for women and ≥90 cm for men with or without generalized obesity
- Isolated generalized obesity defined as a BMI ≥25 kg/m$^2$ with waist circumference of <90 cm in men and <80 cm in women
- Isolated abdominal obesity-defined as a waist circumference of ≥90 cm in men or ≥80 cm in women with a BMI <25 kg/m$^2$.[19]

### *Prevalence of obesity in women*

A study reported that the problem of obesity is continuously growing even in developing regions like India and is more common in females and urban population.[20] National Family Health Surveys (NFHS) also reported a greater prevalence of obesity in Indian women as compared to men with an increasing trend in overweight and obesity.[21] Females are particularly vulnerable to weight gain because they experience certain life-changing experiences (i.e., pregnancy and childbirth) that directly impact bodyweight. Pregnancy and postdelivery period lead to significant amount of fat mass retention.[22] Obese women tend to have high prevalence of cardiometabolic risk factors, as has been reported in in various studies from different regions of the country.[23]

### *Relationship between abdominal fat and cardiovascular disease*

It is the distribution of fat which is more strongly related to heart health and not just the total weight. Generally, women have a pear shape body characterized by gynoid fat (fat located over the hips), or fat which is subcutaneous not shown to be related to heart disease.[24] However, men have an apple body shape characterized by android visceral fat generally which is associated with CVD.[25] Nevertheless, despite these differences, higher prevalence of obesity and other

cardiometabolic risk factors renders women at high risk for CVD.

### Risk associates of obesity

Risk factors for premature CHD and stroke have been studied in case–control INTERHEART and INTERSTROKE studies. As per these studies, nine standard risk factors explain more than 90% of CVDs. These include high apolipoprotein B, low apolipoprotein A1, high blood pressure, diabetes, high waist-hip ratio, smoking or tobacco use, sedentary lifestyle, psychosocial stress, poor quality diet, and alcohol.

All these risk factors are highly prevalent in Indian women. The second and third NFHS reported that smokeless tobacco use was particularly high in Indian women. Comparison of NFHS-2 and NFHS-3 showed that smoking was increasing among women, more among the illiterate and low educational and socioeconomic status.[26]

Obesity is also associated with increased prevalence of a number of diseases as listed in Table 1.[27]

## Role of Diet in Prevention of Cardiovascular Disease

Diet is an integral part of health. It is an important risk factor for CVD. Diets rich in foods of high glycemic index (GI), high sodium content and low fruit and vegetable intake have been correlated with greater risk of CVD.[28-34] According to a study conducted by Liu *et al.*, an inverse relationship was observed between fruit and vegetable intake and the risk of CVD. This relationship was more prominent in patients with a history of myocardial infarction and also among those not having any history of diabetes, hypercholesterolemia, and hypertension. According to Liu *et al.*, women with higher fruit intake had lowered risk of CVD. When compared with women consuming 1.5 servings of fruit daily, the women who consumed around 6.8 servings of fruit daily had 55% lower risk of developing cardiovascular complications. Besides, several studies have associated the dietary fiber present in fruits and vegetables with decreased risk of atherosclerosis and cardiovascular elasticity.[28]

**Table 1: Proportion of disease prevalence attributable to obesity Wolf *et al*, 1998**

| Disease | Prevalence (%) |
|---|---|
| Type 2 diabetes | 61 |
| Uterine cancer | 34 |
| Gallbladder disease | 30 |
| Osteoarthritis | 24 |
| Hypertension | 17 |
| Coronary heart disease | 17 |
| Breast cancer | 11 |
| Colon cancer | 11 |

Compared to populations in European and American regions, South Asians are found to have higher visceral fat and insulin resistance and generally develop metabolic syndrome at lower BMI. While this may be attributed to genetic predisposition of Asians, lifestyle factors such as diet also seem to play an important role. A study reported that[29] increased fat intake (around 40% of total energy intake) particularly in Delhi and Mumbai, indicated that components of the Indian diet may be responsible for a high-risk diet and health profile. The study observed trends such as consumption of sugary and high-fat foods which demonstrated a diet and nutrition transition. There are several additional factors which may also influence the relationship between diet and risk of chronic diseases. The method of cooking of vegetables (stir-frying, stewing, boiling, etc.) in traditional Indian dishes may change some of their preventive properties and also contribute substantially to added fat.

Diets which are rich in refined carbohydrates or saturated fats have been associated with increased risk of CVDs. Carbohydrates with higher glycemic load and higher animal fat intake have been associated with increased insulin demand.[30,33] Postprandial hyperglycemia has been identified as an independent risk factor for CVD. The biochemical mechanism which is thought to link the two is the oxidative stress caused by the presence of excess glucose in the blood stream.

In general, diets rich in dietary fiber have been correlated with lowered plasma cholesterol levels.[28] In a study conducted by Rastogi *et al.*,[35] a significant inverse relation was established between CHD risk and vegetable intake, especially green leafy vegetables. In another study by Shridhar *et al.*,[36] on urban south Indians, a correlation between high consumption of fruits, vegetables and legumes and reduced risk of CVD was observed. The cardioprotective effects of fruits and vegetable intake can be attributed to several factors, such as high fiber content, presence of phytochemicals and antioxidants such as polyphenols, isothiocyanates, carotenoids, flavonoids, ascorbic acid, and folates. The mechanism of action is attributable to their antioxidative effects and lowering of postprandial glucose levels.[30]

The Indian Migration Study[37] conducted in four Indian cities on urban migrants and their rural siblings observed that vegetarians had lowered cholesterol and sugar levels and lower incidence of hypertension. A cross-sectional study across North and South India has also indicated a significant correlation between consumption of meat snack and high cholesterol levels. The ratio of saturated and unsaturated fat in the diet plays an important role in determining the effectiveness of a vegetarian diet on plasma cholesterol levels. According to Rastogi *et al.*,[35] use of mustard oil for cooking was correlated with lowered risk of

heart disease. This was attributed to the presence of alpha-linolenic acid. Use of vanaspati was linked with increased risk of Coronary heart diseases due to the presence of trans-fatty acids. However, other studies which did not observe an association between vegetarian diets and lowered cardiac disease risk conjectured that the reasons for this could be greater intake of saturated fats among vegetarians.[36]

### GLYCEMIC INDEX: A DETERMINANT OF HARMFUL EFFECTS OF DIET

High intake of carbohydrates can result in elevated levels of blood fasting triacylglycerol, primarily by enhancing synthesis of very low-density lipoprotein in the liver and can also result in low levels of high-density lipoprotein (HDL), thus resulting in a deranged lipid profile.[38] GI is a quantitative assessment of foods based on postprandial blood glucose response. It is expressed as a percentage of the response to an equivalent carbohydrate portion of a reference food (white bread or glucose). When consumed in isoglucidic amounts, carbohydrate foods produce different glycemic responses depending on the nature of the food, their type and the extent of processing the food item has undergone [Table 2]. The principle is that the rate of rise of blood glucose is slower if the rate of carbohydrate absorption is slower and hence a lower GI value for such food item. Glucose, a monosaccharide, accelerates a large glycemic response and is generally used as the reference foods and has a GI of 100. Certain polysaccharides, like those present in instant potato, for example, may also result in large blood glucose responses when consumed in an amount containing 50 g available carbohydrate because of rapid and almost complete digestion and absorption in the small intestine.[39,40]

Several health benefits of taking a low GI diet have been reported in various studies.[29] Foods with high GI raise the overall blood glucose levels including blood fasting and postprandial blood glucose.[41] After consuming a low-GI diet for a month, patients with hyperlipidemia showed a significant reduction in blood low-density lipoprotein-cholesterol levels and triacylglycerol concentrations (in those with higher triacylglycerol levels), despite no major difference in body weight.[33,42,43] Two studies (one that used the third National Health and Nutrition Examination Survey database and the other a British study) showed a negative relation between HDL cholesterol and GI, suggesting that low-GI diets may maintain HDL cholesterol levels in the blood and thus have a positive effect in reducing CHD risk.[44] The dietary GI concept suggests a possible role for the rate of carbohydrate digestion in the prevention and cure of chronic diseases. It also underlies the hypothesis of use of dietary fiber in those patients with insulin resistance. Pharmacologic approaches to slow the rate of carbohydrate absorption, such as the use of α-glycoside hydrolase inhibitors, are now accepted in the management of diabetes.[45]

**Table 2: The average glycemic index of 62 common foods derived from multiple studies by different laboratories**

| | GI |
|---|---|
| High-carbohydrate foods | |
| White wheat bread* | 75±2 |
| Whole wheat/wholemeal bread | 74±2 |
| Specialty grain bread | 53±2 |
| Unleavened wheat bread | 70±5 |
| Wheat roti | 62±3 |
| Chapatti | 52±4 |
| Corn tortilla | 46±4 |
| White rice, boiled* | 73±4 |
| Brown rice, boiled | 68±4 |
| Barley | 28±2 |
| Sweet corn | 52±5 |
| Spaghetti, white | 49±2 |
| Spaghetti, whole meal | 48±5 |
| Rice noodles† | 53±7 |
| Udon noodles | 55±7 |
| Couscous† | 65±4 |
| Breakfast cereals | |
| Cornflakes | 81±6 |
| Wheat flake biscuits | 69±2 |
| Porridge, rolled oats | 55±2 |
| Instant oat porridge | 79±3 |
| Rice porridge/congee | 78±9 |
| Millet porridge | 67±5 |
| Muesli | 57±2 |
| Fruit and fruit products | |
| Apple, raw† | 36±2 |
| Orange, raw† | 43±3 |
| Banana, raw† | 51±3 |
| Pineapple, raw | 59±8 |
| Mango, raw† | 51±5 |
| Watermelon, raw | 76±4 |
| Dates, raw | 42±4 |
| Peaches, canned† | 43±5 |
| Strawberry jam/jelly | 49±3 |
| Apple juice | 41±2 |
| Orange juice | 50±2 |
| Vegetables | |
| Potato, boiled | 78±4 |
| Potato, instant mash | 87±3 |
| Potato, French fries | 63±5 |
| Carrots, boiled | 39±4 |
| Sweet potato, boiled | 63±6 |
| Pumpkin, boiled | 64±7 |
| Plantain/green banana | 55±6 |
| Taro, boiled | 53±2 |
| Vegetable soup | 48±5 |
| Dairy products and alternatives | |

*Contd...*

**Table 2: Contd..**

| | GI |
|---|---|
| Milk, full fat | 39±3 |
| Milk, skim | 37±4 |
| Ice cream | 51±3 |
| Yogurt, fruit | 41±2 |
| Soy milk | 34±4 |
| Rice milk | 86±7 |
| Legumes | |
| Chickpeas | 28±9 |
| Kidney beans | 24±4 |
| Lentils | 32±5 |
| Soybeans | 16±1 |
| Snack products | |
| Chocolate | 40±3 |
| Popcorn | 65±5 |
| Potato crisps | 56±3 |
| Soft drink/soda | 59±3 |
| Rice crackers/crisps | 87±2 |
| Sugars | |
| Fructose | 15±4 |
| Sucrose | 65±4 |
| Glucose | 103±3 |
| Honey | 61±3 |

Data are means±SEM. *Low GI varieties were also identified, †Average of all available data.[46] Atkinson *et al*, 2008. GI=Glycemic index, SEM=Standard error of mean

## Conclusions

Despite a lower age-specific CVD risk as compared to men, women tend to have high overall burden of CVD due to high prevalence of various CVD risk factors. Moreover, women also tend to have higher mortality with CVD as compared to men. Obesity is an important determinant of heightened CVD risk in women and therefore lifestyle modifications are of immense value in minimizing risk of CVD in women. Diet is an integral component of such lifestyle changes. Adherence to a healthy diet, in addition to regular physical activity, can significantly reduce the risk of CVD in women, much like in the general population.

### Financial support and sponsorship

Nil.

### Conflicts of interest

There are no conflicts of interest.

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