

RESEARCH ARTICLE

Open Access



# Dietary habits of patients with coronary artery disease in a tertiary-care hospital of Bangladesh: a case-controlled study

Taslima Khatun<sup>1,2\*</sup> , Dilara Maqbool<sup>3</sup>, Ferdous Ara<sup>4</sup>, Manika Rani Sarker<sup>5</sup>, Kazi Selim Anwar<sup>6</sup> and Asirul Hoque<sup>7</sup>

## Abstract

**Background and objectives:** Globally, coronary artery disease (CAD) remains one of the leading causes of death, both in developed and less economically developed countries (LEDC) including Bangladesh. Diet plays a key role in the pathogenesis processes of atherosclerosis and coronary artery disease (CAD). The purpose of this study was to assess the dietary habit of heart disease cases that had CAD against matched controls.

**Methodology:** Complying Helsinki ethical norms, with written consent, this case-control study was performed among 210 subjects: 105 CAD-hospitalized patients (selected from Lab Aid Cardiac and Specialized Hospitals) and 105 healthy subjects from local urban communities having their body mass index (BMI: ranging between  $\geq 18.5$  and 27 socio-demographic status, detailed-dietary patterns and blood pressure levels were recorded, anthropometric indices measured, and serum biochemistry (complete lipid profile) tested/analyzed for both the cases and controls. All visually re-checked data were analyzed using appropriate statistical tools (*t* test/conditional-logistic regressions) on SPSS/Windows V.21.0.

**Result:** Almost half (45%) CAD patients had hypertriglyceridemia and higher levels of low-density lipoprotein, significantly higher BMA ( $p=0.001$ ), waist circumference, and waist to hip ratio in male patients ( $p=0.005$  and  $p=0.020$ , respectively) than their peer controls. Serum lipid profiles, sugar concentrations, and blood pressure levels of CAD patients revealed higher levels than clinically defined cut-off values as established risk factors for CAD. Odds ratios (CI 95%) as risk factors for consuming junk food {OR=5.49 (2.25–13.38)}, chicken {OR=4.54 (1.89–10.9)} was the most, followed by beef {OR=2.68 (1.19–4.98)}, eggs {OR=2.38 (1.14–10.92)}, fish {OR=2.81 (1.31–6.04)}, and vegetables {OR=.968 (0.510–1.839)}. However, fat-free milk, ghee/butter oil, curd/yogurt, and fruits had lower ORs revealing no or less risks for CAD.

**Conclusion:** Food habits of CAD patients (with higher BMI level and biochemical indicators of the blood) statistically revealed that consuming junk food, meat, and eggs being riskier, fruits, fat-free milk, yogurt, and vegetable remains have protective effects on CAD.

**Keywords:** Coronary arterial diseases, Dietary intake, CVD-risk factors, Bangladesh

\* Correspondence: [tasumoni11@yahoo.com](mailto:tasumoni11@yahoo.com)

<sup>1</sup>Department of Public Health, College of Medicine, National Cheng Kung University (NCKU), Taiwan City, Taiwan

<sup>2</sup>Department of Community Nutrition, Faculty of Public Health, Bangladesh University of Health Sciences (BUHS), 125/1, Darus Salam, Mirpur, Dhaka 1, Bangladesh

Full list of author information is available at the end of the article



© The Author(s). 2021, corrected publication 2021. **Open Access** This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated in a credit line to the data.

## Background

Coronary artery disease (CAD) is the leading cause of death, globally. It is one of the most common chronic illnesses in the developing world [1, 2]. According to the World Health Organization, the number of deaths due to ischemic heart disease (IHD) in 2001 was 24, 84, 000 in developing countries compared to 3, 512, 000 in the Less Economically Developed Country (LEDC). The focus for dietary recommendations in Bangladesh are as follows: a balanced diet, eat a variety of foods from each of the food groups, and improve dietary diversity and quality as well as wise food selection in planning meals [3].

The historical advice to reduce the consumption of saturated fat was challenged by recent studies, including meta-analyses of prospective studies [4, 5], which led the UK Scientific Advisory Committee on Nutrition (SACN) [6] and the WHO [7] to conclude, based on evidence from both randomized, controlled trials, and prospective cohort studies, that the saturated fat intake is not associated with cardiovascular disease-related mortality. Although most information on the nutritional risk factors CVD is derived (not clear) from the western reports, the prevalence of CVD is rapidly evolving towards epidemic proportions in the LEDCs with rapid changes in people's lifestyle and food consumption behavior over the past few years [8, 9]. However, a study in the USA did not find a significant association between dietary intake of eggs and all-cause and heart disease mortality among the US adults, whereas the total dietary cholesterol intake at high levels seemed to be associated with the higher risk of all-cause mortality [10].

Based on the aforementioned facts and data, one can logically postulate that the absolute risk assessment provides a more accurate estimate of overall, individualized CAD risk as well. There is no sufficient number of published reports on the relationship between the food intake patterns and the risk of developing CAD in Bangladesh; we thus undertook a study to assess the dietary habit of the people with heart diseases (CAD) against their age, sex, and socioeconomic matched controls.

## Methodology

### Enrollment of patients

This case-control study was conducted at the LabAid Cardiac Hospital and LabAid Specialized Hospital in Dhaka. Of the 210 subjects, 105 randomly selected CAD patients (53 males and 52 female) were studied against 105 ages (40–75 years) and sex-matched healthy controls (54 male and 51 females) that had a BMI ranging from  $\geq 18.5$  to 27.5. The subjects were given a prescheduled time for data collection. The cases were randomly selected from the OPD of the LabAid Cardiac Hospital and their medical record, identified as a CAD patient.

On the other hand, control patients were the matched healthy subjects from the same hospital who visited it for a routine check-up; they were identified as non-CAD patients.

### Data collection

With prior written consents of the subjects who agreed to take part in the study after explaining them the nature and purpose of the study, they were, however, clearly briefed the potential risks of all the procedures used in the study. Both the CAD patients and the healthy controls were interviewed using a pre-tested semi-structured questionnaire, and then, the I.V. blood samples were collected. Data and blood samples of the healthy controls were collected while they were at the residence. However, data and blood samples of the cases (CAD patients) were collected from the IPD of the two LabAID and Cardiac Hospitals. The non-response rate among the cases was 10% (11/105), and it was ~5% (5/105) among the control group.

### Anthropometric measurements

Body weights were measured in light clothing, without shoes to the nearest 0.1 kg using a digital balance. Heights were measured to the nearest 0.1 cm using the SECA balance with height attachment. Measurement of the waist circumference as a surrogate for visceral adipose tissue was performed in the horizontal plane above the iliac crest [9]. BMI cut-offs for Asians and Indians proposed by the International Obesity Task Force (IOTF-2000) were used for identifying over weight and obesity which were;  $< 18.49$  kg/m<sup>2</sup> for underweight, 18.5 to 22.9 kg/m<sup>2</sup> for normal weight, 23 to 27.49 kg/m<sup>2</sup> for overweight, and  $> 27.50$  kg/m<sup>2</sup> which indicates obese [11].

### Assessment of food habits

Nutritional evaluation was accomplished using a customized Harvard food-frequency questionnaire that includes 57 food items mainly consumed by individuals daily and weekly over the past 7 days [12]. The frequency of consumption was semi-quantified in terms of the number of each food items consumed in a day or week [13].

### Clinical assessment of CAD patients

Blood pressure of each patient was measured in the right arm (average of 3 measurements in the seated position while resting and not tired, over whelmed, or anxious). A blood pressure greater than or equal to 140/90 mmHg or on prescribed antihypertensive medication(s) was classified as hypertensive [14].

Interviews were conducted during the first 72 h of hospitalization for the case group. The past medical histories of individuals and their reports assisted us in

characterizing them as having hypertension, hypercholesterolemia, or diabetes.

#### Laboratory tests/methods (in short) and essential calculations

Serum glucose (FBS) was measured using glucose-oxidase method, and the fasting serum lipid profile (cholesterol, triglyceride, and HDL) was determined by enzymatic colorimetric method. Serum LDL was calculated using the formula of Friede wald [15]. Hypercholesterolemia and hypertriglyceridemia were defined as serum total cholesterol (TC) and triglycerides (TG) levels of >200 and 150 mg/dL, respectively, or if hypolipidemic treatment was administered. Diabetics were those with fasting blood glucose equal to or greater than 126 mg/dL for two times or those who were under diabetic diet or medications.

#### Statistical analysis

All the collected and visually and logically rechecked data were analyzed using the SPSS software (Windows.V.21.5) using appropriate statistical lines. Estimations on the effect of each food item were performed using odds ratio (OR) at 95% confidence intervals (95% CI) employing binary logistic regression analysis, adjusting for age, BMI, smoking, history of hypercholesterolemia, hypertension, or diabetes.  $t$  test also done to compare means among two groups. All the  $p$  values were taken from two-sided tests at a significant level of 5%.

#### Results

The mean age of the patients was  $51.5 \pm 9.0$  and of the controls was  $50.8 \pm 9.2$  years, revealing no significant difference ( $p > 0.43$ ), a like sex ( $p$  value for the male patients was  $> 0.49$  and the that of females was  $> 0.47$ ). Similarly, no differences were found in their basic nutritional characteristics between the cases and the controls: in terms of BMI ( $p < 0.001$ ), the WC for males was ( $p = 0.005$ ) and females ( $p = 0.558$ ) while the WHR was ( $p = 0.020$  and  $0.125$  for males and females, respectively) (Table 1). Contrarily, all of the comparative values in biochemical parameters of the cases differed significantly compared to those of the matched controls, except FBS ( $6.72 \pm 2.39$  vs.  $6.56 \pm 2.80$ ,  $p > 0.67$ ) and diastolic-BP ( $74.51 \pm 12.6$  vs.  $77.0 \pm 9.4$ ,  $p > 0.12$ ). Thus, the values of the total S. cholesterol among the CAD patients ( $203.5 \pm 58.2$ ) and those of the control patients ( $155.93 \pm 53.88$ ), differed significantly ( $p \leq 0.001$ ), alike LDL ( $132.15 \pm 49.72$  vs.  $95.25 \pm 32.44$  ( $p \leq 0.001$ ), triglyceride { $128.50$  ( $54-780$ ) vs.  $120.28 \pm 58.18$ } ( $p = 0.001$ ), HDL ( $38.23 \pm 7.46$  and  $44.7 \pm 8.41$ ) ( $p \leq 0.001$ ), and systolic blood pressure ( $118.55 \pm 17.64$  and  $127.71 \pm 11.96$ ) ( $p \leq 0.001$ ) (Table 2). Similarly, while assessing the important prefixed risk factors, hypercholesterolaemia and hypertriglyceridaemia were higher in the CAD patients than those in

**Table 1** Basic characteristics and anthropometric parameters of CAD patients and Controls ( $n=210$ )

Variables	CAD patients	Controls	$p$ value
Age (year) M $\pm$ SD	55.21 $\pm$ 8.94	56.20 $\pm$ 8.88	
Male (%)	53	54	0.487
Female (%)	52	51	0.468
BMI (kg/m <sup>2</sup> )	25.12 $\pm$ 2.18	24.22 $\pm$ 2.19	0.004
WC (cm, male)	92.06 $\pm$ 7.4	88.10 $\pm$ 6.3	0.005
WC (cm, female)	86.86 $\pm$ 8.32	85.79 $\pm$ 9.3	0.558
WHR (male)	0.96 $\pm$ 0.053	0.94 $\pm$ 0.035	0.020
WHR (female)	0.96 $\pm$ 0.082	0.94 $\pm$ 0.059	0.125

Results were expressed as number and mean  $\pm$  SD with  $t$  test performed for the analysis;  $p < 0.05$  is considered; BMI body mass index, WHR waist hip ratio, WC waist circumference

the controls with  $p \leq 0.001$  and  $p = 0.001$ , respectively. The total cholesterol (TC) and HDL were strongly significant ( $p \leq 0.001$ ) including LDL ( $p < 0.028$ ) in the CAD patients than in the controls. The lipid profiles among both the case and the controls had higher than its cut-off values for risk factors. Systolic blood pressure (0.022) was also significantly higher among the CAD patients (Table 3).

Binary logistic regression analysis was performed against consumption of different food items beef (>2 times/week), chicken (> 2 times/week), egg (> 2 times/week), fish (< 2 times/week), junk foods (burger, pizza, pastry, etc.) (> 2 times/week), fruits and vegetable (< 2 times/day) by adjusting for age, BMI, smoking, history of hypercholesterolemia, hypertension, and diabetes. Significant association was found for beef, chicken, egg, fish, junk foods, fruits, and vegetables [OR (95%CI) {2.68 (1.19–4.98),  $p = 0.017$ }, {4.54 (1.89–10.94),  $p = 0.001$ }, {2.38 (1.14–10.92)  $p = 0.021$ }, {2.81 (1.31–6.04),  $p = 0.008$ }, {5.49 (2.25–13.38),  $p \leq 0.001$ }, {0.580 (0.311–1.083),  $p = 0.087$ }, and {0.968 (0.510–1.839),  $p = 0.921$ }], respectively, with CAD patients and controls. No association was found between daily consumption of fat-free milk and weekly consumption of ghee/butter-oil and curd/yogurt with risk of CAD. In the unadjusted model, beef, chicken, egg, fish, junk foods, fruits, and vegetables were found significantly associated with the risk of CAD; [OR (95%CI) {0.386 (0.171–0.872),  $p = 0.022$ }, {0.269 (0.110–0.659),  $p = 0.004$ }, {0.476 (0.225–1.004),  $p = 0.051$ }, {0.312 (0.140–0.692),  $p = 0.004$ }, {0.189 (0.077–0.464),  $p \leq 0.001$ }, {0.428 (0.198–0.925),  $p = 0.031$ }, and {0.372 (0.174–0.795),  $p = 0.011$ }] (Table 4).

#### Discussion

Most cardiovascular disease (CVD) occurs in the presence of traditional risk factors, including hypertension and dyslipidemia, and these, in turn, are influenced by behavioral factors, such as dietary habit and lifestyle. According to the BMI levels as suggested by the WHO

**Table 2** Biochemical parameter of the study respondents (n=210)

Biochemical parameters	CAD patients (M±SD)	Controls (M±SD)	p value
Fasting blood sugar (mmol/l)	6.72±2.39	6.56±2.80	0.658
Total blood cholesterol (mg/dl)	203.45±58.15	155.93±53.88	<0.001
LDL (mg/dl)	132.15±49.72	95.25±32.44	<0.001
Triglyceride (mg/dl)	128.50 (54-780)	100.00 (50-350)	*0.001
HDL (mg/dl)	38.23±7.46	44.7±8.41	<0.001
Systolic blood pressure (mm hg)	118.55±17.64	127.71±11.96	<0.001
Diastolic blood pressure (mm hg)	74.51±12.56	77.00±9.43	0.115

Results were expressed as mean ± SD and median (range). Independent samples *t* test and \*Mann-Whitney test were performed as test of significance ( $p < 0.05$ ); LDL low-density lipoprotein, HDL high-density lipoprotein

[16], we observed that more CAD patients belonged to the high-risk groups ( $BMI > 27.5 \text{ kg/m}^2$ ) compared to their controls. Waist circumferences were also higher among the CAD patients than among their counterparts. It has been observed that BMI and WHR were significantly lower among the people with healthy food habit which might support the dietary recommendations for a healthy weight [16]. The dietary factors are, therefore, vital for the development of obesity and cardiovascular disease (CVD) [17]. In our study, we found that cardiovascular risk factors, such as total cholesterol, triglyceride, LDL, HDL, and high blood pressure were strongly related to CAD. Hypertriglyceridemia and high levels of LDL-C were prevalent most CHD patients (99%) while half of the control patients showed hypertriglyceridemia and one-fifth had high concentrations of LDL-C [18]. However, many issues remain unsettled, and we need additional knowledge on the optimal level of intake of nutrients and foods and how the intake varies between individuals. The intake of energy and a few nutrients at intervals has demonstrated a higher risk for developing angina pectoris, myocardial infarction [19], and CVD-related mortality [20]. Two prospective studies in (Framingham, Massachusetts and Baltimore, Maryland) found that the healthy food pattern is protective against overweight [21] and prevents the increase in both BMI and waist circumference [22] as a potential risk factor for

developing CAD. A significant association was found in the weekly and some daily consumption of foods with a risk of CAD.

Logistic regression analysis was performed against the confounding independent variables. On the other hand, no association was found between the weekly consumption of ghee and curd and the daily consumption of milk with the risk of CAD. Some studies reported that a healthier eating pattern is associated with consuming medically prescribed diet [19, 23], reporting changed food habits [24, 25]. According to a review by Giugliano et al. [25], many diets high in refined starch, sugar, and saturated and trans fat and low in  $n-3$  fatty acids and natural antioxidants and fiber from fruit, vegetables, and whole grains cause the inflammation associated with the metabolic syndrome by affecting the immune system. It has been reported that the consumption of fruits and vegetables three or more servings a day versus less than once a day is associated with a 27% reduction in cardiovascular disease risk [26]. Despite achieving a reduction in the total fat intake between the intervention and the control groups (28.8% vs. 37% of calories ( $p < 0.001$ ), respectively), no significant effects of the intervention on CHD, stroke, or CVD were observed during the 8-year follow-up [27]. Although fish has a number of important nutritive qualities, their major cardiovascular benefit likely derives from their content of the omega-3 fatty

**Table 3** Comparison of selected cardiovascular disease risk factors between CAD patients and controls

Variable	CAD patients (n=105)	Controls (n=105)	p value
TG > 150 mg/dl	45 (43)	23 (22)	0.001
TC > 200 mg/dl	59 (59)	31 (30)	<0.001
LDL-C > 100 mg/dl	71 (68)	40 (38)	0.028
HDL-C < 35 mg/dl	68 (65)	28 (27)	<0.001
FBS > 126 mg/dl	44 (42)	39 (37)	0.283
BP > 140/90 mm hg	52 (50)	35 (33)	0.022
BMI > 27.5 kg/m <sup>2</sup>	63 (60)	33 (31)	<0.001
Cigarette smoking habit	26 (25)	10 (10)	<0.001

Abbreviations: TG triglyceride, TC total cholesterol, FBS fasting blood sugar, BP blood pressure, LDL low-density lipoprotein, HDL high-density lipoprotein

**Table 4** Binary logistic regression analysis of dietary intake pattern with CAD patients and controls

Food groups	Consumption frequency	CAD patients n=105	Controls n=105	Adjusted values			Unadjusted values				
				Odds ratio	95% C.I.		p value	Odds ratio	95% C.I.		p value
				Lower	Upper			Lower	Upper		
Beef	> 2 times/week	35	15	2.681	1.192	4.980	0.017	0.386	0.171	0.872	0.022
Chicken	> 2 times/week	37	10	4.545	1.891	10.94	0.001	0.269	0.110	0.659	0.004
Egg	> 2 times/week	63	53	2.381	1.141	10.92	0.021	0.476	0.225	1.004	0.051
Fish	< 2 times/week	52	82	2.816	1.311	6.047	0.008	0.312	0.140	0.692	0.004
milk	< 2 times/week	65	59	1.632	0.612	3.457	0.224	1.370	0.657	2.856	0.401
Ghee	> 2 times/week	57	41	1.625	0.799	3.304	0.180	0.628	0.305	1.297	0.209
Curd	> 2 times/week	67	85	1.682	0.711	3.977	0.237	0.496	0.204	1.209	0.123
Junk food	> 2 times/week	37	10	5.496	2.257	13.381	<0.001	0.189	0.077	0.464	<0.001
Fruits	< 2 time/day	52	71	0.580	0.311	1.083	0.087	0.428	0.198	0.925	0.031
Vegetables	< 2 times/day	54	74	0.968	0.510	1.839	0.921	0.372	0.174	0.795	0.011

Results were expressed as number with odds ratio performed for the analysis;  $p < 0.05$  is considered as statistically significant and 95% confidence interval

acids, eicosapentaenoic acid (EPA), and docosahexanoic acid (DHA) [28]. This effect appears to be related to enrichment of membrane phospholipids with omega-3 fatty acids and a resulting reduction in risk for abnormal cardiac electrical conductivity [29]. Other properties of these fatty acids that may benefit from the risk for CAD include anti-platelet aggregation and anti-inflammatory effects and also reduction in plasma triglycerides at higher doses [30].

The prospective cohorts study found that there was associations between macronutrient intakes and health (mortality and CVD risk) are non-linear [31]. One of the largest studies was conducted among 177,000 people in 50 countries, and they did not find any significant association between egg intake and blood lipids, mortality, or major CVD events [32].

To summarize, our findings suggest that the consumption of healthy food develop better anthropometric feature, keeping blood pressure and maintaining blood lipid values within the normal limit compared to other unhealthy dietary patterns. The group of people with this healthy dietary pattern may be distinguished from the population in general by more frequent consumption of high-fiber cereals, low-fat milk products, fruits, vegetables, fish, and less frequent consumption of products rich in fat and sugar.

A probable limitation of this study is the lack of data on portion sizes in the FFQ. The participants' dietary intake was assessed using a questionnaire which did not take into account the intake grams of foods; resulting lack of adjustment for the confounding effect of  $r$  potential nutrients intake in association analyses between the dietary patterns and the dependent variables in our study.

## Conclusions

Anthropometric parameters, such as BMI, WC, and WHR, are significantly associated with the CAD risk.

Consumption of junk foods is associated with a significantly higher risk of coronary artery diseases. On the contrary, consumption of fish, fruits, fresh vegetables, and fat-free yogurt has the protective effects on CAD while beef and egg have a role to increase the risk of CAD. There is a great need to conduct more study is on dietary risk factors to explore the risk of cardiac diseases with consumption of different compositions of food and portion size. It is clear that nutrition-related cardiac risk factor should be emphasized for the prevention of coronary artery disease in our country.

## Acknowledgements

We express our gratitude to Dr.A.P.M. Shohrabuzzaman, Chief Cardiologist. We express our gratitude to Dr. Khair (cardiologist); Dr. Najmul Islam (cardiologist); Nutrition Consultants Qamrun Ahmed, Farzana Ahmed, Salma Parveen; and my entire staff at the LabAid Hospital. We remain extremely grateful to Dr. Zahir Uddin Ahmed for assisting us with data collection. We wish to express our sincere thanks to Dr. Shamim Ahmed, the Managing Director of LabAid Cardiac Hospital and the LabAid Specialized Hospital for his kind support and inspiration that made this study successful. We remain indebted to all the study participants who were kind enough to spend their valuable time and energy in providing us with required information from time to time.

## Authors' contributions

Taslima Khatun: Conceptualized, designed, and developed the study tools, data analysis, and drafting and review of the manuscript. Dilara Maqbool: data collection, data entry, and drafting of the manuscript. Ferdous Ara: Drafting and review of the manuscript. Manika Rani Sarker: Drafting and review of the manuscript. Dr. Kazi Selim Anwar: Drafting and review of the manuscript. Asirul Hoque: Overall supervision of the research work and review of the manuscript. All authors accept the final responsibility for the paper. The authors read and approved the final manuscript.

## Funding

The authors did not receive any specific grant for this research work; only some amount was arranged by one of the supervisors from the Diabetic Association of Bangladesh to conduct the research as part of an academic degree (MPH).

## Availability of data and materials

Please contact author for data requests.

**Ethics approval and consent to participate**

All the participants were informed about the aims of study, and they gave their consent to provide their personal information in a consent form. The Ethical Committee of BADAS was followed according to the laid down guideline of the Bangladesh Diabetic Somiti (BADAS) ethical review compliances which is based on Helsinki guideline.

**Consent for publication**

Not applicable.

**Competing interests**

The authors declare that they have no competing interests.

**Author details**

<sup>1</sup>Department of Public Health, College of Medicine, National Cheng Kung University (NCKU), Taiwan City, Taiwan. <sup>2</sup>Department of Community Nutrition, Faculty of Public Health, Bangladesh University of Health Sciences (BUHS), 125/1, Darus Salam, Mirpur, Dhaka 1, Bangladesh. <sup>3</sup>Nutrition Officer, LabAid Cardiac Hospital, Dhaka 1205, Bangladesh. <sup>4</sup>Department of Food and Nutrition, Akij College of Home Economics, Road 9/A (New), House 118, Dhanmondi, Dhaka 1209, Bangladesh. <sup>5</sup>Department of Community Nutrition, Faculty of Public Health, Bangladesh University of Health Sciences (BUHS), 125/1, Darus Salam, Mirpur, Dhaka 1, Bangladesh. <sup>6</sup>Infectious Diseases Department, International University of Health & Welfare (IUHW), Narita, Japan. <sup>7</sup>Department of Community Nutrition, Faculty of Public Health, Bangladesh University of Health Sciences (BUHS), 125/1, Darus Salam, Mirpur, Dhaka 1, Bangladesh.

Received: 21 October 2018 Accepted: 14 February 2021

Published online: 01 March 2021

**References**

- Lichtenstein AH, Appel LJ, Brands M, et al. Diet and lifestyle recommendations revision. A scientific statement from the American Heart Association Nutrition Committee. *Circulation*. 2006;114:82.
- Krishnan MN. Coronary heart disease and risk factors in India—on the brink of an epidemic? *Indian Heart J*. 2012;64(4):364–7.
- Dietary Guidelines for Bangladesh. Nahar Q, Choudhury S, Sultana S S S, Siddiquee Ali M. National Food Policy Capacity Strengthening Programme, FAO; 2013. A-as880e.pdf (fao.org).
- Siri-Tarino PW, Sun Q, Hu FB, Krauss RM. Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. *Am J Clin Nutr*. 2010;91:535–46. <https://doi.org/10.3945/ajcn.2009.27725>.
- de Souza RJ, Mente A, Maroleanu A. Intake of saturated and trans unsaturated fatty acids and risk of all cause mortality, cardiovascular disease, and type 2 diabetes: systematic review and meta-analysis of observational studies. *BMJ*. 2015;351:h3978. <https://doi.org/10.1136/bmj.h3978>.
- SACN. Saturated fats and health London: Public Health England, 2019.
- WHO. Draft WHO Guidelines: saturated fatty acid and trans-fatty intake for adults and children. WHO; 2018.
- Maruthur NM, Wang NY, Appel LJ. Lifestyle interventions reduce coronary heart disease risk: results from the PREMIER Trial. *Circulation*. 2009;119(15):2026–31.
- O'Keefe JH, Carter MD, Lavie CJ. Primary and secondary prevention of cardiovascular diseases: a practical evidence-based approach. *Mayo Clin Proc*. 2009;84(8):741–57.
- Xia Fei P, Pan Fei P, Chen C, Yi W, Yi Y, An Pan P. Dietary intakes of eggs and cholesterol in relation to all-cause and heart disease mortality: a prospective cohort study. *J Am Heart Assoc*. 2020;9:e015743. <https://doi.org/10.1161/JAHA.119.015743>.
- Nishida C. Appropriate body mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004;363:157–63.
- Willett WC, Sampson L, Stampfer MJ, Rosner B, Bain C, Witschi J, Hennekens CH, Speizer FE. Reproducibility and validity of a semi quantitative food frequency questionnaire. *Am J Epidemiol*. 1985;122(1):51–65 [PubMed].
- Ferdous Ara, Kazi Selim Anwar and Taslima Khatun. Metabolic syndrome among postmenopausal women in a selected rural area of northern Bangladesh. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews* (in press; accepted in September 2018)
- Kotchen T. Hypertensive cardiovascular disease. In: Fauci A BE, Kasper D, editors. *Harrison's principals of internal medicine*. 17 edition. New York: Mac Graw Hill; 2008. p. 1405–10.
- Saiedullah M, Sarkar A, et al. Friedewald's Formula is applicable up to serum triacylglycerol to total cholesterol ratio of two in Bangladeshi population. *AKMMC J*. 2011;2(2):21–5.
- Berg CM, Lappas G, Strandhagen E, et al. Food patterns and cardiovascular disease risk factors: the Swedish INTERGENE Res Program *Am J Clin Nutr*. 2008;88:289–97.
- Hu FB, Willett WC. Optimal diets for prevention of coronary heart disease. *JAMA*. 2002;288:2569.
- Amani R, Noorizadeh M, Rahmania S, Afzali N, Haghhighizadeh Mohammad H. Nutritional related cardiovascular risk factors in patients with coronary artery disease in IRAN: a case control study. *Nutr J*. 2010;9:70.
- Diehr P, Beresford SA. The relation of dietary patterns to future survival, health, and cardiovascular events in older adults. *J Clin Epidemiol*. 2003;56:1224–35.
- Tomkins A, et al. *Br J Nutr*. 2001;85(Suppl. 2):S93–9.
- Quatromoni PA, Copenhafer DL, D'Agostino RB, Millen BE. Dietary patterns predict the development of overweight in women: the Framingham Nutrition Studies. *J Am Diet Assoc*. 2002;102:1239–46.
- Newby PK, Muller D, Hallfrisch J, Qiao N, Andres R, Tucker KL. Dietary patterns and changes in body mass index and waist circumference in adults. *Am J Clin Nutr*. 2003;77:1417–25.
- Muga MA, Owili PO, Hsu CY, Rau HH, Chao JC-J. Association between dietary patterns and cardiovascular risk factors among middle-aged and elderly adults in Taiwan: a population-based study from 2003 to 2012. *PLoSOne*. 2016;11(7):e0157745.
- Wirfalt E, Mattisson I, Gullberg B, Berglund G. Food patterns defined by cluster analysis and their utility as dietary exposure variables: are port from the Malmo Diet and Cancer Study. *Public Health Nutr*. 2000;3:159–73.
- Giugliano D, Ceriello A, Esposito K. The effects of diet on inflammation: emphasis on the metabolic syndrome. *J Am Coll Cardiol*. 2006;48:677–85.
- Panagotakos D, Ptasavos C, Kokkinos P. Consumption of fruits and vegetables in relation to the risk of developing acute coronary syndromes; the CARDIO2000 case-control study. *Nutr J*. 2003;2:2.
- Howard BV, VanHorn L, Hsia J, Manson JE, Stefanick ML, Wassertheil-Smoller S, et al. Low-fat dietary pattern and risk of cardiovascular disease: the Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA*. 2006;295(6):655.
- Albert CM, Campos H, Stampfer MJ, Ridker PM, Manson JE, Willett WC, Ma J. Blood levels of long-chain n-3 fatty acids and the risk of sudden death. *N Engl J Med*. 2002;346(15):1113–8.
- Iscovick DS, Raghunathan T, King I, Weinmann S, Bovbjerg VE, Kushi L, Cobb LA, Copass MK, Psaty BM, Lemaitre R, Retzlaff B, Knopp RH. Dietary intake of long-chain. n-3 polyunsaturated fatty acids and the risk of primary cardiac arrest. *Am J Clin Nutr*. 2000;71(1 Suppl):208S–12S.
- Massaro M, Scoditti E, Carluccio MA, De Caterina R: Basic mechanisms behind the effects of n-3 fatty acids on cardiovascular disease. *Prostaglandins Leukot Essent Fatty Acids* 2008;79(3-5):109–115.
- Ho KF, Gray RS, Welsh P, Rocha PF, Foster H, Waddell H, Anderson J, Lyall D, Sattar N, Gill MRJ, Mathers CJ, Pell PJ, Morales CC. Associations of fat and carbohydrate intake with cardiovascular disease and mortality: prospective cohort study of UK Biobank participants. *BMJ*. 2020;368:m688. <https://doi.org/10.1136/bmj.m688>.
- Mahshid Dehghan M, Andrew Mente A, Rangarajan S, et al. Association of egg intake with blood lipids, cardiovascular disease, and mortality in 177,000 people in 50 countries. *Am J Clin Nutr*. 2020;111:795–803.

**Publisher's Note**

Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.