

Review

Effects of Breakfast Skipping on The Risk of Cardiovascular Diseases and Diabetes Mellitus

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ABSTRACT: Epidemiological studies indicate that skipping breakfast as a universal behavior, may have adverse effects on cardiovascular diseases [CVDs] and metabolic diseases. However, eating breakfast regularly, may increase satiety, thereby reducing overeating later in the day which prevents weight gain. Recent studies indicate that skipping breakfast increases the risk of obesity, metabolic syndrome, hypertension, hypercholesterolemia, type 2 diabetes mellitus (T2DM), coronary artery disease (CAD), and cardiovascular mortality as well as all-cause mortality. However, many studies also reported that regular taking of breakfast decreases the risk of CVDs and T2DM and all-cause mortality. Previous studies reported that heavy breakfast, in particular eating western diet may increase circadian rhythm of CVDs and sudden cardiac death. It seems that those who do not eat breakfast, they tend to eat refined and sweetened products, possibly, more in the night resulting in to greater risk of CVDs and T2DM. Breakfast skipping and eating in the night, may be associated with circadian misalignment in the central and peripheral clocks, leading to oxidative stress and inflammation. Increased systemic inflammation damages the adipocytes, beta cells of pancreas, endothelial cells and smooth muscle cells as well as neurons, which may produce dysfunction in these cells resulting in to related diseases. The beneficial effects of breakfast, may also be, at least in part, due to nutrient dense foods rather than time of eating. Eating regular breakfast, in particular rich in Indo-Mediterranean foods; vegetables, whole grains, fruits, spices and nuts may be protective against circadian increase in oxidative stress in the morning, resulting in to significant decline in the risk of CVDs and T2DM.

Key Words. Breakfast consumption; mortality; coronary diseases; obesity

1. Introduction

About 12,000 years ago, all humans got their food by hunting, fishing and gathering. As foragers, they would fast until they found, caught or killed their food. There was no breakfast upon waking, or leftovers for lunch. For the majority of human history, people ate one or two meals per day. The evolutionary, Paleolithic diet is considered healthy for prevention of non-communicable diseases (<https://www.nationalgeographic.com/food-features/evolution-of-diet/>). It seems that food scarcity, possibly, was not the immediate cause of death. Eat breakfast like a king, lunch like a prince and dinner like a pauper" (Adelle Davis, 1904–1974) is a concept that appears to align with some contemporary experience, but it is not always correct because energy and nutrient metabolism appear to be highly complex.

There is evidence that skipping breakfast as a universal behavior, may have adverse effects on health [1,2]. However, eating breakfast regularly, may increase satiety, thereby reducing overeating later in the day to restrict weight gain [4]. Recent studies indicate that skipping breakfast increases the risk of cardiovascular diseases (CVDs) [1-3], obesity [4]

hypertension, [5] hypercholesterolemia (HC),[6] type 2 diabetes mellitus (T2DM),[7] metabolic syndrome,[8] coronary artery disease (CAD),[9] and cardiovascular mortality (CVM).[10] However, some studies also reported that regular taking of breakfast decreases the risk of cardiovascular diseases (CVDs) and type 2 diabetes mellitus (T2DM) and all-cause mortality [10,11]. There is consistent evidence on association of skipping breakfast with increased risk CVD and all-cause mortality, but some of which continue to be controversial [10-12]. American heart Association guidelines emphasize that eating breakfast regularly may promote cardiovascular health and decrease all-cause mortality [1]. The skipping of breakfast has been considered to be associated with weight gain, in particular among younger subjects. However, a few studies involving middle-aged population considering sex did not find same results [3] This article aims to highlight the role of breakfast skipping on risk of CVDs and T2DM.

2. Effects of Eating Patterns on Health and Risk Of Diseases

There are variations in eating pattern among various people and populations and in the same family, community and country [1-3]. The consumption of typical breakfast, lunch, and dinner meals are difficult to identify due to missing of meals and snacking which are more prevalent [1]. Moreover, food quality and patterns of physical activity can also influence eating patterns [1,12]. The intake of breakfast, appears to be an important meal of the day. However, in many communities and social groups, it is being ignored by the people due to acceleration of the pace of modern lifestyle [13]. The causes for skipping breakfast may be; office and hospital workers, may not have enough time to eat breakfast, students may also lack a good habit of eating breakfast due to hurry and worry [1-3]. Most obese patients, may have a poor appetite or want to limit their energy intake, hence do not like to eat breakfast. It is possible that those who do not take breakfast, may be eating refined food snacks more so in the night, which may have increased the risk of CVDs among these subjects. Such eating patterns may influence markers of CVDs and T2DM. Thus, irregular eating patterns may have adverse effects in achieving a healthy profile of cardio-metabolic status. There is an unmet need to develop guidelines for eating methods and patterns with mindful attention to the traditional diet and traditional eating patterns, with emphasis on frequency of eating as well as timing of eating which may lead to healthier lifestyle and health promotion.

3. Effects of Breakfast Skipping In Health And Diseases

In several previous studies, the relationship between skipping breakfast and risk of CVDs and T2DM has been reported but, most of them were cross-sectional studies [1]. It is not clear how breakfast skipping influences other cardio-metabolic diseases such as obesity, metabolic syndrome, hypertension, strokes, hypercholesterolemia and mortality due to CVDs. Chen et al conducted a meta-analysis including seven cohort studies concerning a total of 221,732 subjects [2]. The findings showed that skipping breakfast was associated with increased risk of CVDs with the relative risk(RR) 1.22, 95% confidence interval 1.10–1.35) and all cause mortality (RR 1.25, 95% confidence interval 1.11–1.40) compared with participants who were eating breakfast regularly. It is clear that breakfast skipping enhances the risk of CVDs and all cause mortality. Eating breakfast regularly may promote cardiovascular health and decrease all cause mortality. Figure 1.

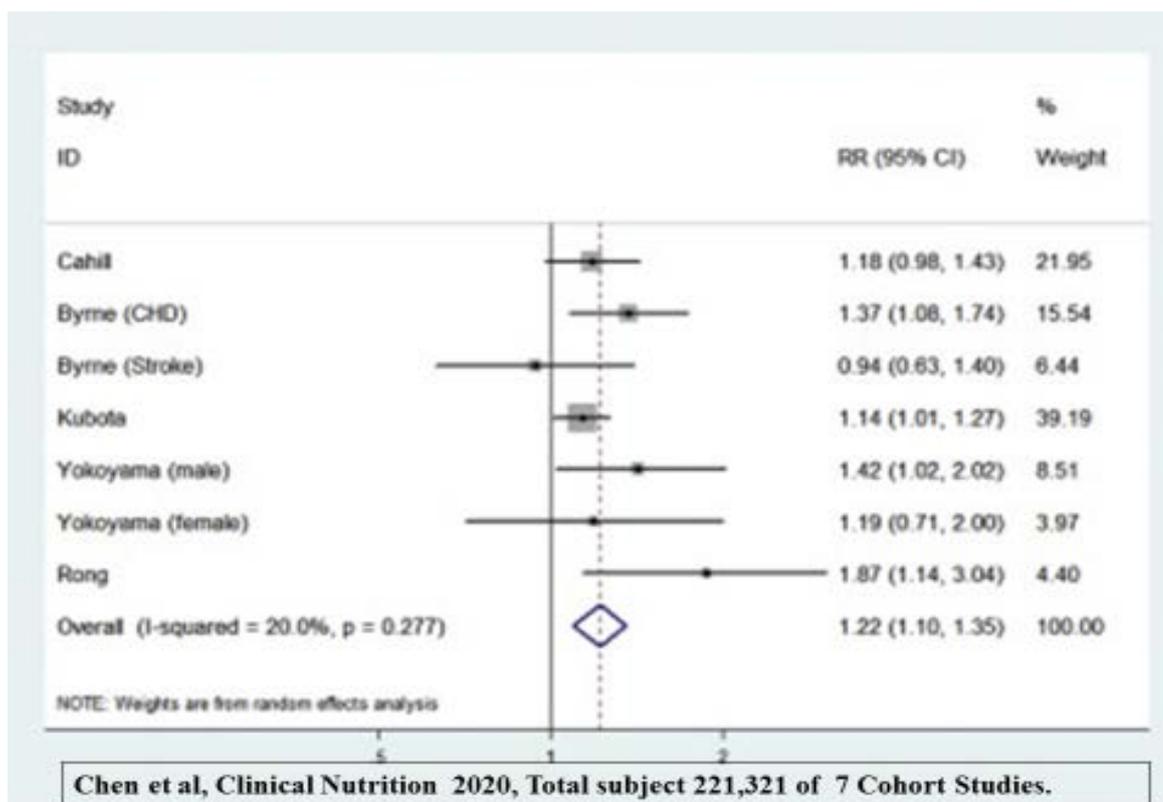


Figure 1. Effects of breakfast skipping on risk of cardiovascular diseases (Adapted from Chen et al, reference 2).

Skipping breakfast is common among adult populations of USA. There is only limited evidence indicating the association of breakfast skipping with atherosclerosis and CVDs. Therefore, Rong et al, conducted a prospective cohort study in the United States, including a representative sample of 6,550 adults, aged 40 to 75 years, from the National Health and Nutrition Examination Survey III 1988 to 1994 [10]. Interestingly, of 6,550 subjects (mean age 53.2 years; 48.0% male) 5.1% never consumed breakfast, 10.9% rarely consumed breakfast, 25.0% consumed breakfast some days. There were only 59.0% of subjects who took breakfast daily. After 112,148 person-years of follow-up, there were total 2,318 deaths including 619 victims dying from CVDs. Those subjects, who never consumed breakfast compared with those consuming breakfast daily, revealed; had hazard ratios of 1.87 (95% confidence interval: 1.14 to 3.04) for mortality due to CVDs and 1.19 (95% confidence interval: 0.99 to 1.42) for all-cause mortality [10]. It is clear that in a randomly selected sample from USA, cohort with 17 to 23 years of follow-up, breakfast skipping was associated with a significantly increased risk of deaths from CVDs, which indicates the benefits of eating breakfast in promoting cardiovascular health. Figure 2.

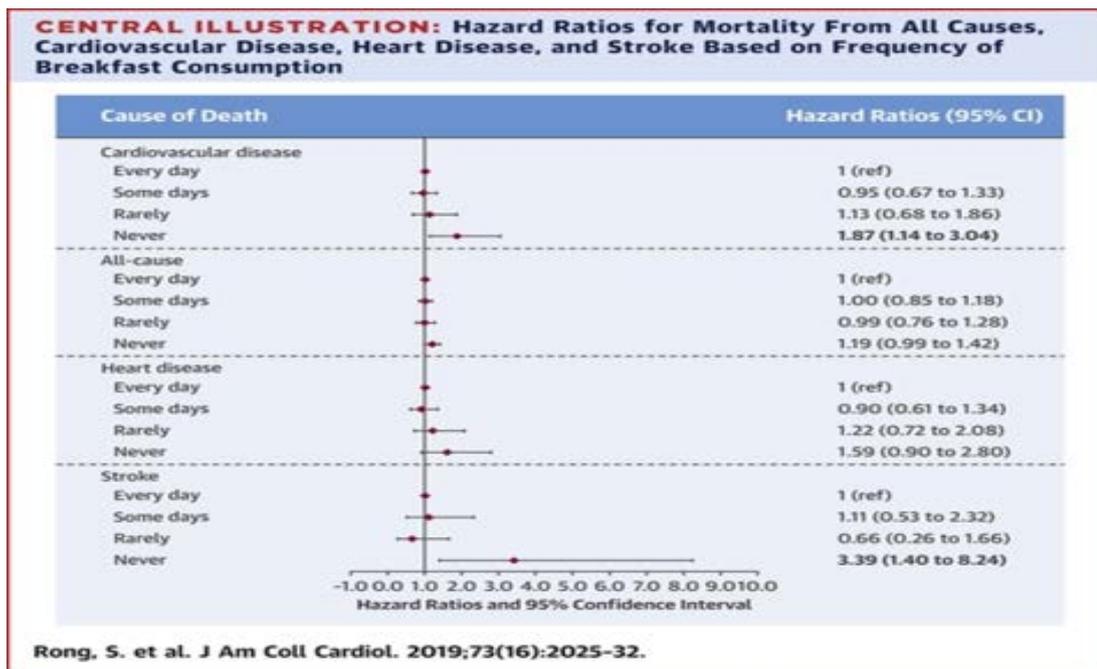


Figure 2. Effects of breakfast skipping on cardiovascular and all cause mortality. (Adapted from Rong S et al, reference 10).

The Health Professionals Follow-up Study in USA, examined eating habits, including breakfast eating, were assessed in 1992 in 26 902 American men 45 to 82 years of age from who were free of cardiovascular disease and cancer [9]. After a follow up of 16 years, 1527 incident cases of CAD were diagnosed. Cox proportional hazards models used to estimate relative risks and 95% confidence intervals for CAD revealed that men who skipped breakfast had a 27% higher risk of CAD compared with men who did not (relative risk, 1.27; 95% confidence interval, 1.06-1.53). Compared with men who did not eat late at night, those who ate late at night had a 55% higher risk of CAD (relative risk, 1.55; 95% confidence interval, 1.05-2.29). It is clear that eating breakfast was associated with significantly lower risk of CAD in this cohort of male health professionals.

Breakfast skipping can also increase the risk of T2DM. A meta-analysis included 6 studies, involving 96,175 subjects and 4935 cases of T2DM [7]. The RR for T2DM, comparing ever with never skipping breakfast was 1.33 (95% CI: 1.22, 1.46, n = 6 studies) without adjustment for BMI, and after adjustment for BMI, it was, 1.22 (95% CI: 1.12, 1.34, n = 4 studies). A dose-response nonlinear meta-analysis revealed that risk of T2DM was enhanced with each additional day of skipping of breakfast, however the curve reached a plateau at 4-5 d/wk, showing an elevated risk of 55% (summary RR: 1.55; 95% CI: 1.41, 1.71). The results indicate that skipping of breakfast may be associated with an increased risk of T2DM, which was partly mediated by body mass index [7]. Although, most breakfast skipping studies have been considered to be associated with obesity, among younger people, a few studies have addressed this issue in a middle-aged population considering sex and the conditions prior to breakfast [3]. In a cross-sectional survey among 892,578 non-diabetic adults, aged 40-74 years, breakfast skipping and late night dinner were more prevalent in men (20.7% and 40.5%, respectively, than women (10.9% and 17.4%) [3]. However, late night snacking was more prevalent in women (15.0%) than men (12.2%; all $p < 0.0001$). The overall prevalence of breakfast skipping increased linearly with increasing BMI. The prevalence of skipping of breakfast showed a U-shaped relationship with BMI in men (n = 479,203). When the population of men was restricted to those in their 40s or those reporting late night dinner, the prevalence of skipping of breakfast became furthermore, maintaining a U-shaped curve. It is clear that an unexpectedly high prevalence of skipping of breakfast causing lower body weight is possible in middle-aged men. Some

experts have suggested that intermittent fasting and time-restricted feeding, have emerged showing the safety or even possible benefits of lower energy intake on CVDs [12]. It is possible that skipping breakfast should provide benefits rather than any adverse effect which is also observed in a few studies [3]. Therefore, there is a need to have caution, while analyzing these data as many complex, unmeasured confounders may be existing. Moreover, breakfast skipping could be a feasible strategy for some people aiming for calorie restriction [3].

4. Breakfast Consumption and Cardiometabolic Health

Interestingly, definitive benefits of skipping of breakfast or of regular breakfast intake are not supported by the best evidence-based research. In a meta-analysis including 14 cohort studies, the comparison was made among subjects having breakfast frequency of ≤ 3 times/week, with people having breakfast in a frequency of >3 times/week [13]. Those subjects taking regular breakfast more than 3 days per week, showed a decline in the risk of T2DM (RR = 0.8 [95% CI: 0.7–0.91], $P = .142$, $I^2 = 37.6\%$), obesity (RR = 0.74 [95% CI: 0.59–0.94], $P < .001$, $I^2 = 89\%$), metabolic syndrome (RR = 0.86 [95% CI: 0.75–0.99], $P = .512$, $I^2 = 0\%$), low high-density lipoprotein cholesterolemia (RR = 0.75 [95% CI: 0.61–0.93], $P = .643$, $I^2 = 0\%$), CVDs (RR = 0.87 [95% CI: 0.81–0.93], $P = .479$, $I^2 = 0\%$), cardiovascular mortality (RR = 0.63 [95% CI: 0.51–0.78], $P = .396$, $I^2 = 0\%$), hypertension (RR = 0.92 [95% CI: 0.86–0.98], $P = .419$, $I^2 = 0.7\%$), and strokes, (RR = 0.89 [95% CI: 0.79–0.99], $P = .238$, $I^2 = 29\%$), respectively. It is clear that a relatively regular daily breakfast intake may have beneficial effects on the cardio-metabolism causing decline in the risk of CVDs and T2DM, hypertension, strokes, obesity, metabolic syndrome, mortality due to CVDs, low high-density lipoprotein cholesterolemia, and abdominal obesity [13]. However, regular breakfast intake was not significantly related to hypercholesterolemia and coronary artery disease (CAD) regardless of gender. It seems that, skipping breakfast once a week may greatly reduce the benefits on CVDs and metabolic diseases. Therefore, guidelines should promote and encourage people and communities to cultivate habit of taking breakfast regularly. Most of the previous dietary studies have focused on dietary and nutrient components and combinations [3-5,11] such as whole grain, dietary fat, and the Mediterranean diet patterns, only some of the studies, considered the effects of daily eating behavior on CVDs and metabolic diseases. In addition, many studies that have revealed the relationship between skipping breakfast and diseases, were cross-sectional ones.

In most developed countries (Table 1), the major content of breakfast are bread, added sugar, refined carbohydrates, cereals, dairy products, with low fiber and protein containing foods (Table 1). In a more recent study from West Bank, among 193 school children, only 32% were taking breakfast all year round [19]. The causes for skipping breakfast were lack of appetite, no time to eat, and no feeling of hunger. In a previous study from India, involving 186 subjects, 132 (71%) patients reported that they do not consume breakfast regularly [20]. Out of these 84 (63.6%) were from obese group and 48 (36.3%) had normal BMI. In India, the average intake of fruits and vegetables is 3.5 servings per day, which comprises 1.5 servings of fruits and 2 servings of vegetables. The intake is lower for younger generation but those in the age group 18-25 years, it is 2.97 servings per day [20]. There is a need to examine individual studies from various countries to highlight this issue, because it is not clear how, and why and which type of food content in the breakfast provides the benefits. Table 1.

Table 1. Breakfast intake and its content in various countries.

Country	Authors, reference No.	Number of subjects	Breakfast frequency/wk NRF	Nutrients and energy/K Cal	Food groups
France	14	1721 all age groups	5-7days, 9.3	339.4 kcal, 17.6% en, vitamin B,C, Ca, Mg, K, iron,	wholegrain, fruits, and dairy (milk, fresh dairy), High CHO
Spain	15	Children and adults	85% take 9.3	16-19% K cal. Vitamins B, iron, Na, Ca, Mg, K,P,	Whole grain, dairy products, chocolate, bakery and pastry, fruits,High CHO, low protein, fiber.
UK	16	8,174, all age groups	9.3	B vitamins, vitamin D, iron, calcium, iodine and magnesium	Whole grain, dairy products, chocolate, bakery and pastry, fruits,High CHO, low protein, fiber
Canada	17	18,287, aged 6-12 years	9.3	389 K Cal, 21.6% en, micronutrients+	whole grain, fruit, and fluid milk, containing; CHO, total sugars, fiber, calcium, and vit. D
Denmark	18	3,090 subjects, 6-75 years	9.3	18-20% en high in dietary fibre, Ca, B vitamins, and Mg and low in added sugar, total fat, Na, vitamin D and A	bread, breakfast cereals and dairy products as well as water, coffee and juice, while intakes of fruits, vegetables, cakes and soft drinks
WestBank	19	193 children 32% taking breakfast	traditional	Moderate	High CHO, dairy products, egg
India	20	186 29% taking breakfast	Traditional foods	Moderate	Whole grain products, vegetables, cooked in oils
Russia	21,22	78% take breakfast	Traditional	Moderate	Cereals, dairy products, egg.
Countries, 31	23	455,391 children			

The State Committee for Statistics of Russia has reported on food balance trend in 1990-1997 [21]. The availability of meat, fish, dairy products, vegetable oil were not freely available and the intake of vegetables and fruit in 1990 was low because per person, availability was 340 grams per day. There were no changes in the consumption of bread and bakery products, while that of potatoes increased. The availability of dietary protein decreased from 88 to 77 grams per person, and fat intake from 125 to 83 g or from 36 to 30% of total energy, indicating healthy trend in fat intake. Similar trends were revealed from the data collected by the State Committee for Statistics in more than 60 regions of Russia in the course of the household budget survey [21]. A survey of low-income families in Russia, revealed that children in such families consume significantly less fruit, vegetables

and milk products compared to families with higher income. In a more recent survey in July 2019, three quarters of Russians aged between 18 and 24 years were found to eat vegetables and meat within a week. The share of respondents consuming fish and seafood on a regular basis was measured at 40 percent and 25 percent, subjects, respectively [22]. In Russia, vegetables, meat, pasta, cereals, fruits, eggs are consumed every week by 50-80% people, and approximately 22% people skip their breakfast due to various reasons.

A multicenter, cross-sectional survey in 31 countries, included nationally representative samples of 11–15 year old children (n = 455,391) [23]. In all countries, those children having both parents, were more likely to take daily breakfast, compared to single parent families. Daily breakfast intake was associated with family affluence in 19 of the countries. Canada, Netherland, Macedonia, Scotland, Wales, and England showed an increase in daily breakfast intake, from 2002. A significant reduction in daily breakfast intake was observed in 11 countries; Belgium, France, Germany, Croatia, Spain, Poland, Russian Federation, Ukraine, Latvia, Lithuania and Norway. However, in 5 countries; Portugal, Denmark, Finland, Ireland, Sweden, there was no significant changes in breakfast intake between 2002 to 2010[23]. Daily breakfast intake showed significant increase in only 6 out of 19 countries during this period. Many of the previous studies have been examined and new data sets have been created by the International Breakfast Research initiative (IBRI) and others on value of breakfast intake [24–26]. However, these studies did not give enough consideration to time of eating and food content of breakfast which are known to influence the circadian physiology and metabolism that could be crucial in the pathogenesis of increased risk of CVDs after heavy breakfast [27–29].

5. Role of Circadian Dysfunction and The Breakfast

In numerous studies, Halberg and Cornelissen, much earlier reported the role of circadian function and circadian misalignment causing variations in energy metabolism, resulting in to weight loss or weight gain [28,29]. There is consistent evidence from previous studies that there is circadian rhythm of increased oxidative stress and inflammation in the morning at sun rise, due to increased sympathetic activity with low parasympathetic tone [27–31]. Several previous studies also reported increased prevalence of CVDs and sudden cardiac death, occurring in between 8.00 to 11.00 AM [30,31]. Figure 3.

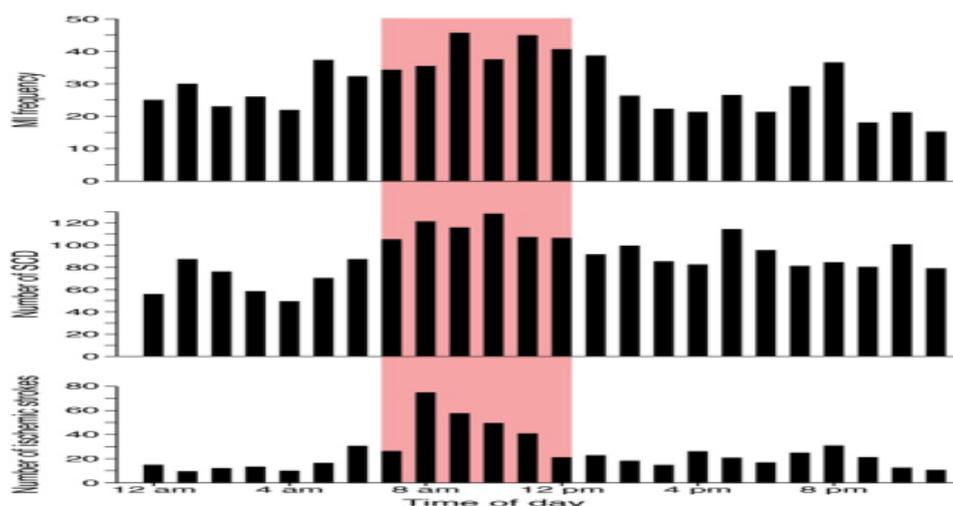


Figure 3. Showing increased frequency of cardiovascular events in the morning (Adapted from Thosar et al, 2018, reference 31).

Singh et al found an increased concentrations of lipoprotein(a), circadian rhythms of cardiac events, and metabolic reactants in the morning in patients with acute myocardial infarction in relation to large breakfast [27]. Although breakfast intake has been considered protective against CVDs, however, if the foods are western type, heavy breakfast

intake may be associated with increased risk of cardiovascular events [27,30-32]. Figure 4.

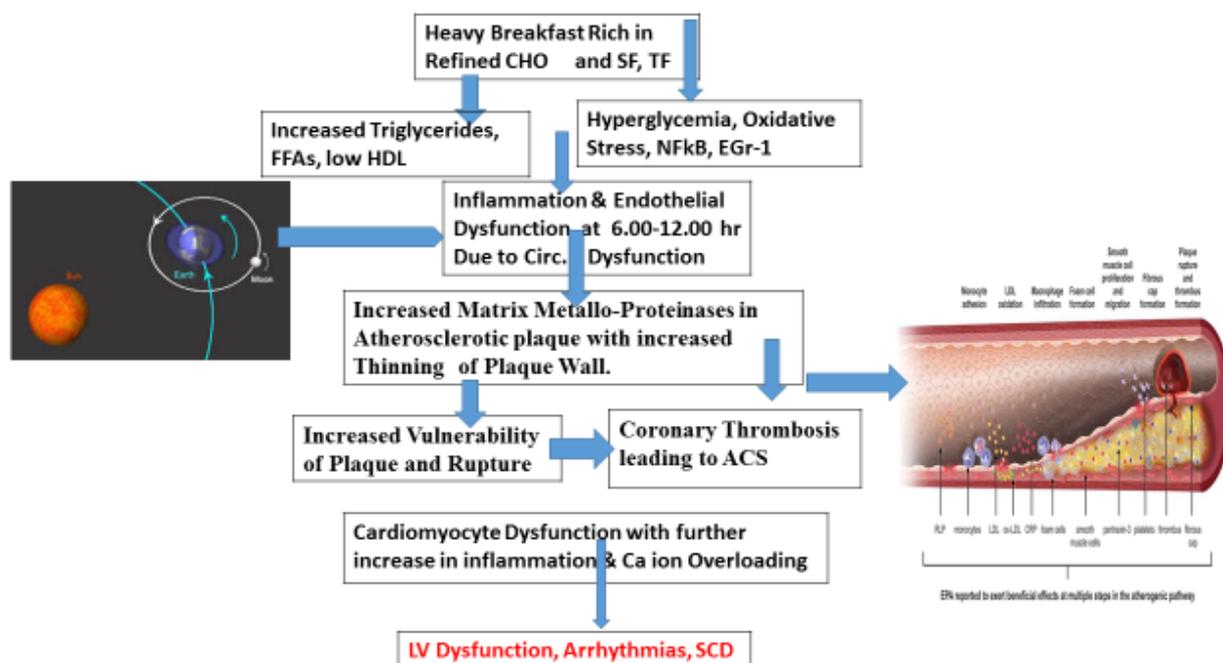


Figure 4. Effects of heavy western food breakfast induced hyperglycemia and oxidative stress on cardiovascular events.

It seems that, missing breakfast but with restriction in energy (1200 Kcal/day) intake was associated with reduced risk of CVDs and T2D [33,34]. Eating in the night may be associated with circadian dysfunction in conjunction with nocturnal hyperglycemia which may increase the risk of CVDs and T2DM [33-35]. Thus, there is controversy, whether it is breakfast skipping or night time eating or western type diet breakfast was the cause of increased cardio-metabolic risk in subjects with breakfast skipping [36]. In a preliminary study, we reported that low caloric diet taken in a window period of 1.00 PM to 7.00 PM, may be associated with decreased risk of CVDs and T2DM [33]. Thus, it should be emphasized that missing breakfast, in certain conditions, may not be associated with increased risk of CVDs, if the intake of total energy/day, is also reduced and the meals are consumed in a window period before sunset [33,34]. There is evidence that circadian time of eating, modifies the metabolic response to meals, but less data exist on the circadian variations in the hedonic drive to eat [36-38].

Circadian rhythms are under influence of light-dark cycle, as well as by food uptake, related metabolic signal [37]. Circadian regulation of metabolic genes affects metabolic outcomes, which indicates that feeding time such as morning, and the circadian clock are tightly intertwined [36-38]. It is known that breakfast is important to jumpstart daily metabolism. It seems that the irregular intake of breakfast may induce circadian misalignment between central circadian clock and peripheral clocks leading to oxidative stress, resulting in to metabolic dysfunction and increased risk of CVDs and T2DM [35,38]. In a clinical trial, it has been reported that breakfast skipping adversely affected circadian gene expression and correlated with increased postprandial glycaemic response [38]. In a cross-over design, 18 healthy volunteers and 18 volunteers with T2DM, BMI 30.7 ± 1.1 kg/m², and HbA_{1c} $7.6 \pm 0.1\%$ (59.6 ± 0.8 mmol/mol) were randomly assigned to a test day with breakfast and lunch (on Breakfast) and a test day with only lunch (No Breakfast) [39]. The expression level of *Per1*, *Cry1*, *Rora*, and *Sirt1* was lower ($P < 0.05$) in healthy subjects, but *Clock* was higher ($P < 0.05$) after breakfast. However, in subjects with

T2DM, *Per1*, *Per2*, and *Sirt1* showed only slight, but significant, decrease and *Rora* increased ($P < 0.05$) after breakfast. The expression level of *Bmal1*, *Rora*, and *Sirt1* was higher in healthy control subjects ($P < 0.05$) after lunch in the group on breakfast day, whereas the other clock genes showed no change. In T2DM subjects, *Bmal1*, *Per1*, *Per2*, *Rev-erba*, and *Ampk*, increased ($P < 0.05$) after lunch on the breakfast day. Breakfast skipping was associated with alteration in metabolic and clock gene expression in both healthy and T2DM subjects [38]. This study confirms that breakfast intake may acutely affects clock and clock-controlled gene expression which may lead to normal oscillation. Skipping of breakfast may have adverse effects on circadian clock and clock-controlled gene expression and could be correlated with increased postprandial glycemic response in both healthy subjects as well as among patients with T2DM.

The Korea National Health and Nutrition Examination Surveys included a total of 21,193 (9022 men and 12,171 women) subjects [36]. A total of 11,952 (56.4%) subjects took regular breakfast. The prevalence of abnormal metabolic outcomes was higher among those with irregular habit of breakfast intake. Irregularity in breakfast eating was associated with a higher risk of abnormal metabolic outcomes (odds ratio, 1.15; 95% confidence interval, 1.03–1.27). The risk of adverse metabolic outcomes was significant in young men in the working population.

6. International Breakfast Research Initiative, Recommendations

Breakfast consumption is associated with higher overall dietary adequacy; however, there is a lack of quantitative guidelines for optimal nutrient intakes at breakfast in most countries of the world. There is an unmet need to guide the communities and populations about the quality of diet and foods that should be consumed as breakfast. Breakfast is often considered the most important meal of the day and all the people starting from children and adolescents to adults and elderly, can benefit from breakfast consumption in several ways [19, 24, 25]. The International Breakfast Research Initiative (IBRI) [19] examined the reports of the contribution of breakfast to daily food and nutrient intakes, as well as other studies which have compared daily food and nutrient consumption by the subjects taking breakfast compared to breakfast skippers. It seems that there are significant variations in the definitions of breakfast and breakfast skippers, and in methods used to find out the relation of nutrients in the breakfast to overall quality of diets. The initiative by IBRI group used a harmonized approach in finding out nutritional impact of breakfast, involving national dietary survey data from USA, UK, France, Canada, Denmark, and Spain [19]. The French Paradox is well known; that British, Swedish and French eat same amount of total and saturated fat but CAD and cancer are more common in UK and Northern Europe compared to France, because French consume more vegetables and wine that are rich in flavonoids. It is possible that the analysis of such data along harmonized lines, may allow the project to define, food and nutrients in an optimal breakfast, which may be of great value for the policy-makers and food industry. It may also allow consistent message to consumers to optimize food choices at breakfast.

The IBRI also developed nutritional recommendations for a balanced breakfast using a standardized analysis of national nutrition surveys from Canada, Denmark, France, Spain, UK and the US [20]. In all the countries, the frequency of breakfast consumption by age was high and U-shaped with children and older adults having a higher frequency of breakfast intake. The consumption of daily energy via breakfast was 16% to 21%. Breakfast was a carbohydrate- and nutrient-rich meal, providing more carbohydrates (including sugars), thiamin, riboflavin, folate, calcium, potassium, and magnesium, and less vitamin A, fats and sodium relative to its contribution to daily energy intakes. The IBRI used World Health Organization (WHO) diet guidelines, to propose nutrient recommendations advising foods with high nutrient density in the existing breakfast, with emphasis on concerns regarding added sugars, high salt, total and saturated fats, dietary fiber, calcium and vitamin D.

It seems that definitions of breakfast skipping vary widely across studies from high income countries compared to low and middle income countries and feature differential methodological costs and benefits. These inconsistencies are challenging, when evaluating and comparing these studies, because it has been shown that whether or not an association exists between breakfast skipping and obesity, it depends on definition of breakfast skipping [19, 24-26]. It is possible that assessment of breakfast skipping on a dietary survey day may accurately represent point of prevalence but may not reflect influence of seasonal alteration in food availability and food choices or other fluctuation in dietary habits due to culture and religion. There may be greater possibility in the recall biases while assessing breakfast skipping on a specific number of days per week or other defined time period which may better capture such fluctuations [24-26]. It is also possible that studies assessing the construct in more qualitative terms can capture self-perception of the participants as breakfast skippers, that may or may not accurately correspond to actual frequency and quality of meals and time of intake, which varies from 7.00 AM to 11.00 AM. It is not only time of eating but also frequency of eating as well as content of foods and also possibly mastication of foods which can influence the risk of CVDs and T2DM [35-39]. It seems that eating moderate amount of Indo-Mediterranean foods as breakfast, may be crucial for prevention of CVDs and T2DM as well as all-cause mortality, because such foods are considered to be potential immune-modulators [40,41].

In brief, breakfast skipping is a risk factor of CVDs and T2DM and may be associated with increased risk of CVDs morbidity and mortality and all- cause mortality. However, many studies also reported that regular consumption of breakfast decreases the risk of CVDs and T2DM as well as all-cause mortality. Recent studies indicate that skipping and eating of breakfast, both, are crucial to alter the expression of clock genes, in providing adverse or beneficial effects, respectively. The protective effects of breakfast, may also be, at least in part, due to nutrient dense foods rather than time of eating. Previous studies showed an increased circadian rhythm of CVDs and SCD in the morning, which may worsen due to heavy breakfast, in particular with western type of meals. Eating in the night may be associated with circadian dysfunction in conjunction with obesity, and nocturnal hyperglycemia which may increase the risk of CVDs and T2DM. However, eating no breakfast, with lower daily energy (1200 Kcal/day) intake was associated with reduced risk of CVDs and T2D, indicating a complex physiology of energy metabolism. It is known that, eating in the night may be associated with adverse effects on cardio-metabolic health. Thus, there is controversy, whether it is breakfast skipping or night time eating or heavy breakfast or western type meal, was the cause of increased cardio-metabolic risk in certain studies. Cohort studies and randomized, controlled trials would be necessary to provide a proof that breakfast skipping may be a risk factor for CVDs and T2DM. In the meantime, people may be advised to eat moderate amount of Indo-Mediterranean foods as breakfast for prevention of these problems.

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