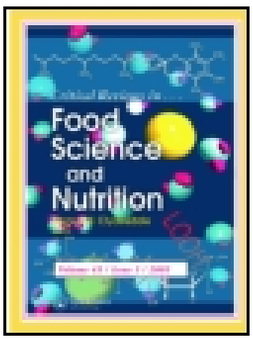

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REVIEW

Association of breakfast skipping with cardiovascular outcomes and cardiometabolic risk factors: an updated review of clinical evidence

Heitor O. Santos[a], Rafael Genario[b], Rodrigo C. O. Macedo[c], Manan Pareek[d,e], and Grant M. Tinsley[f]

[a]School of Medicine, Federal University of Uberlandia (UFU), Uberlandia, Minas Gerais, Brazil; [b]University of Sao Paulo (USP), Sao Paulo, Brazil; [c]University of Santa Cruz do Sul (UNISC), Santa Cruz do Sul, Brazil; [d]Department of Cardiology, North Zealand Hospital, Hilleroed, Denmark; [e]Department of Internal Medicine, Yale New Haven Hospital, Yale University School of Medicine, New Haven, Connecticut, USA; [f]Department of Kinesiology and Sport Management, Texas Tech University, Lubbock, Texas, USA

ABSTRACT

"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 evidence concerning the appropriate proportioning of daily meals. At the same time, with the popular and scientific dissemination of the concepts of intermittent fasting and time-restricted feeding, well-controlled clinical trials have emerged showing the safety or even possible benefits of skipping breakfast. In this comprehensive literature review, we discuss recent evidence regarding breakfast intake, cardiovascular outcomes and cardiovascular risk markers. Overall, breakfast omission appears to be associated with a higher risk for atherosclerotic and adverse cardiovascular outcomes. However, caution should be employed when deciphering these data as many complex, unmeasured confounders may have contributed. Unfortunately, long-term randomized, clinical trials with detailed dietary control that have assessed clinical outcomes are sparse. Notwithstanding the observational findings, current trials conducted so far—albeit apparently smaller number—have shown that breakfast addition in subjects who do not habitually consume this meal may increase body weight, particularly fat mass, through caloric excess, whereas skipping breakfast may be a feasible strategy for some people aiming for calorie restriction. To date, definitive benefits of breakfast omission or consumption are not supported by the best evidence-based research, and the question of whether skipping breakfast per se is causally associated with cardiovascular outcomes remains unresolved.

KEYWORDS

Cardiovascular disease; clinical nutrition; intermittent fasting; skipping breakfast; time-restricted feeding

Introduction

Breakfast has been considered "the most important meal of the day" by many for more than a century (Sievert et al. 2019). A decline in breakfast intake may be associated with an increased worldwide prevalence of weight gain and obesity, allowing for a potential relationship between skipping breakfast and cardiometabolic diseases (St-Onge et al. 2017). Recent studies (Rong et al. 2019; Uzhova et al. 2017) have demonstrated an association between skipping breakfast and the risk of cardiovascular outcomes. However, it is difficult to generalize findings from existing research, in part due to the plethora of health conditions, varying from illnesses to high levels of fitness, that have been considered. Indeed, there are observational data describing cardiology inpatients (Uzhova et al. 2017; Vieira Musse et al. 2019), as well as randomized controlled trials conducted in healthy patients performing physical exercise and consuming a balanced diet (Chowdhury et al. 2019; Moro et al. 2016). Hence, dietary quality, physical activity and exercise also deserve attention when considering the influence of breakfast consumption on health and disease risk.

Given physiological mechanisms which lead to a reduction in hunger upon waking, as well as the increasing interest in alternative nutritional practices such as intermittent fasting (IF), breakfast consumption may be inadvertently or intentionally neglected by some people. Although several broad types of IF are practiced today, with the absence of energy intake varying from 8 h to 3 weeks (Santos and Macedo 2018), the simple habit of intentionally skipping breakfast may be considered an IF strategy. As such, consideration of some forms of IF is also relevant in the discussion of breakfast skipping.

Based on these considerations, our aim was to critically review and discuss the contemporary evidence regarding the influence of breakfast skipping, compared to breakfast intake, on cardiovascular outcomes and cardiometabolic risk markers.

Methods

A narrative review was performed using Cochrane, MEDLINE and Web of Science databases with the aim of identifying relevant studies to describe and consolidate data regarding the effects of breakfast skipping vs. breakfast

CONTACT Heitor O. Santos heitoroliveirasantos@gmail.com School of Medicine, Federal University of Uberlandia (UFU), Uberlandia, Minas Gerais, Brazil.

intake on cardiovascular outcomes and cardiometabolic risk markers. A detailed English search was based on the keywords: "Skipping Breakfast" OR "Breakfast Omission" OR "Breakfast Skipping" AND "Cardiovascular Disease" OR "Cardiovascular Risk" OR "Cardiovascular Outcomes" OR "Cardiovascular markers" OR "Cardiometabolic biomarkers." Studies published over the past 10 years were selected preferentially. Clinical trials, cross-sectional and observational studies, as well as systematic reviews and meta-analyses, were the study designs adopted for inclusion. In order to expand the evidence on medical care, the population was not delimited as a means of involving individuals with illnesses, potential risk for cardiovascular events, and seemingly favorable health statuses and physical activity levels.

Articles that used the terms skipping breakfast or breakfast skipping at least in the title and/or methods were considered for first inclusion. We preferentially included and appraised articles in which breakfast was defined similarly to St-Onge et al. (2017): (1) the first meal of the day eaten before or at the start of daily activities and within 2 h of waking, typically no later than 10 AM, and consisting of a calorie content of 20%–35% of total daily energy needs; or (2) the consumption of food or beverage (excluding water) between 5 and 9 AM. In addition, studies on IF or time-restricted feeding (TRF) were included in the case of total omission of breakfast and substantial dietary control. Despite the omission of breakfast intake, any investigation on Ramadan IF was excluded due to the natural lack of control associated with this religious fasting regimen.

Breakfast consumption: Observational studies

Subclinical cardiovascular outcomes

To determine the association between breakfast consumption and subclinical atherosclerosis, Uzhova et al. (2017) performed a cross-sectional analysis involving 4052 Spanish individuals aged 40–54 years and free from cardiovascular disease, selected from the Progression of Early Subclinical Atherosclerosis (PESA) study (Uzhova et al. 2017). The investigators considered three distinct breakfast patterns: (1) high-calorie breakfast (>20% of daily caloric intake); (2) low-calorie breakfast (5%–20% of daily caloric intake); and (3) skipping breakfast (<5% of daily caloric intake). Compared with subjects who consumed a high-calorie breakfast, those who did not routinely consume breakfast had an independently greater risk of generalized atherosclerotic disease [29% versus 10%, adjusted odds ratio (OR): 2.57, 95% confidence interval (CI): 1.54–4.31]. The risks of coronary and non-coronary atherosclerosis, respectively, were non-significantly greater among those who skipped breakfast (Uzhova et al. 2017). However, the study should be interpreted in light of its limitations. First and foremost, any inferences about causality would be hypothesis-generating, given the cross-sectional design of the study. Only 3% of the population comprised the skipping breakfast group. In addition, at baseline, this group had a higher energetic intake of animal protein, total fat, cholesterol, processed foods, and alcoholic beverages, and a lower intake of dietary fiber, vegetables, and whole grains. Finally, individuals who skipped breakfast had the least favorable cardiometabolic profile, including a higher prevalence of smoking, central obesity and dyslipidemia, older age, and greater body weight, body mass index, waist circumference, and fasting blood glucose (Uzhova et al. 2017).

Clinical cardiovascular outcomes

Recently, Rong et al. (2019) conducted a prospective, observational study of 6550 American adults aged 40–75 years from the National Health and Nutrition Examination Survey III (Rong et al. 2019). Study participants were divided into those who never consumed breakfast, rarely consumed breakfast, consumed breakfast some days, or consumed breakfast every day. After adjusting for several risk factors, subjects who never consumed breakfast had a marginally significantly increased risk of all-cause mortality (OR: 1.19; 95% CI: 0.99–1.42) and a significantly increased risk of cardiovascular mortality (OR: 1.87; 95% CI: 1.14–3.04) when compared with individuals who consumed breakfast every day. Of note, breakfast skippers in this study also had an unfavorable cardiometabolic profile and lifestyle at baseline. Moreover, information on specific foods was not available.

In a prospective observational study, Musse et al. examined 113 patients with an ST-segment elevation myocardial infarction who were admitted for primary percutaneous coronary intervention (Vieira Musse et al. 2019). At 30 days after hospital discharge, the authors noted that patients who skipped breakfast at least three times weekly and were concomitant late-night dinner eaters had a 4–5 times (depending on the multivariable model used) greater odds of the combined endpoint of death, reinfarction, or postinfarction angina. Nevertheless, basic data on dietary habits were not reported.

Breakfast consumption: Randomized controlled trials

Chowdhury et al. (2019) did not detect relevant changes in hormonal responses related to appetite, glucometabolic parameters, and daily energy consumption in a trial that randomized 22 obese patients to either breakfast or morning fasting for six weeks (Chowdhury et al. 2019). In a short-term fashion, Edinburgh et al. (2019) demonstrated that skipping breakfast followed by physical activity may be a strategy to control energy intake. The researchers randomized, using a crossover design, 12 healthy, active, young men to three interventions: (1) breakfast followed by rest; (2) breakfast followed by physical activity; and (3) overnight fasting (i.e. no breakfast intake) followed by physical activity. The total energy balance was significantly lower in group 3 compared to the other groups (Edinburgh et al. 2019).

Le Cheminant et al. (2017), in turn, randomized 49 women who were non-habitual breakfast eaters to either breakfast or no breakfast for four weeks (Le Cheminant et al. 2017). Mean daily caloric intake was 266 kcal greater

among participants who were required to eat breakfast, particularly due to carbohydrate ingestion. This led to an average gain of 700 g of body weight, 500 g of which was fat mass. Corroborating these findings, a recent meta-analysis of randomized clinical trials showed that patients assigned to breakfast versus no breakfast had a greater daily calorie intake and possibly, greater weight gain (Sievert et al. 2019). However, despite recent investigations indicating potential benefits of breakfast skipping for promoting a negative energy balance, the preponderance of evidence from contemporary systematic reviews and meta-analyses suggests worse cardiometabolic outcomes when comparing breakfast skippers with breakfast consumers (Table 1). A noteworthy consideration for the vast majority of these syntheses is the reliance on non-experimental data.

Intermittent fasting

It is worth emphasizing that skipping breakfast and some forms of IF are closely related. Indeed, since fasting is often defined as the absence of calorie ingestion from 8 h to 3 weeks, skipping breakfast is a common strategy for implementing IF (Santos and Macedo 2018). Most variants of IF, including TRF, periodic fasting, and alternate-day fasting involve skipping breakfast on some or all days. As such, consideration of the health effects of IF may provide additional information regarding the influence of breakfast skipping. Recent syntheses of IF research have indicated that, in the general population, these programs are viable but not necessarily superior alternatives to traditional dietary measures for weight loss and health improvement (Coutinho et al. 2018; Harris et al. 2018; Seimon et al. 2015).

Several studies have also examined IF in exercising populations. For example, Moro et al. (2016) examined 34 healthy men with an average of five years of strength training, i.e. resistance training, experience. Participants were randomized into two groups: (1) IF in the form of TRF with an 8-h daily feeding period, in which meals were ingested at 1300, 1600, and 2000 h or (2) normal diet, with meal consumption at 800, 1300, and 2000 h. Patients also underwent standardized strength training three days a week. At 8 weeks, fat mass had decreased significantly by ~1.6 kg in the group that skipped breakfast (i.e. the IF group), while lean mass was maintained. Significant reductions in triglycerides, glucose, and insulin, and a significant increase in HDL-c concentrations were observed, though not when compared directly with the temporal changes seen in the normal diet group. Of note, dietary plans were prescribed with the goal of maintaining body weight and there was no difference between energy consumption and daily macronutrients between groups. More recently, Tinsley et al. (2019) examined a TRF program, in which all calories were consumed within ~7.5 h daily for 8 weeks, but they did not find changes in blood lipids, glucose and insulin, blood pressure, arterial stiffness, or cortisol responses in a healthy, active, female population (Tinsley et al. 2019).

TRF, also known as time-restricted eating (TRE), is a dietary pattern that often limits intake to a period of 8–12 h/d for conservative programs and $\leq$ 8 h/d or even a single meal for more aggressive programs (Moro et al. 2016; Queiroz et al. 2020; Stote et al. 2007; Tinsley et al. 2019). The interest in TRF programs has grown as a result of data indicating that many individuals exhibit prolonged daily eating periods, with median periods of up to 15 h/day in some reports (Gill and Panda 2015). As such, a truncation of the daily feeding period may represent a viable target for reducing energy intake and promoting the attendant health benefits. For those with a prolonged daily eating period, both breakfast skipping and abstaining from nighttime eating represent strategies to reduce the daily duration of eating periods. Although they performed the aforementioned interventional study of IF that restricted breakfast (Moro et al. 2016), Moro et al. currently suggest food restriction, particularly at night, may hold potential health benefits (Paoli et al. 2019). Accordingly, these researchers recommend food restriction at night while conceptualizing breakfast as an essential meal. Although they suggest ingestion of two to three meals daily, with restriction of caloric intake during the evening and night hours, they also state the importance of considering the desirability and feasibility of a particular eating pattern (Paoli et al. 2019), which is likely essential from an adherence perspective.

Physiological mechanisms

In animal models, hypercaloric and high-fat diets consumed at night have been shown to induce body fat gain, glucose intolerance, hyperinsulinemia, hypertriglyceridemia, and hyperleptinemia (Bray et al. 2013; Wu et al. 2011; Yoshida et al. 2012). In rats, the absence of breakfast is accompanied by delayed circadian phases of the hepatic peripheral clock and downstream metabolic genes, whereas down-regulated expression of the clock genes Per2, Bmal1, and Rev-erbα are noted in the absence of supper. Such a metabolic shifts have a interplay with delayed and decreased expression of *FAS* in lipogenesis and ensuing reductions in adipose tissue accumulation and body weight gain (Wu et al. 2011).

More importantly, when examining individuals from the UK Biobank ($n = 193{,}860$), Dashti et al. (2019) detected six independent genetic variants among breakfast skippers (Dashti et al. 2019). Variants included those implicated in caffeine (ARID3B/CYP1A1), carbohydrate metabolism (FGF21), schizophrenia (ZNF804A), and encoding enzymes important for N6-methyladenosine RNA transmethylation (METTL4, YWHAB, and YTHDF3), which modulates the circadian clock and timing of hunger. Furthermore, the authors carried out Mendelian randomization and noted causal links between genetically determined breakfast skipping and higher body mass index (Dashti et al. 2019).

Breakfast intake may be favorable for promoting physiological insulin secretion (Figure 1), and circadian and glucometabolic alterations caused by breakfast omission coupled with subsequent daily overnutrition are concerning (Figure 2). As such, both healthy people and individuals with type 2 diabetes who skip breakfast are likely to have dysregulation in glucose homeostasis (Jakubowicz et al. 2017). In this

Table 1. Overview of systematic reviews and meta-analyses of skipping breakfast and their effects on body composition, cardiovascular risk and risk for type 2 diabetes.

Meta-analyses

Reference	Study type (no.)	No. of subjects and characteristics	Duration	Breakfast classification	Cardiometabolic outcomes
Takagi et al. (2019)	Case-control, cross-sectional, longitudinal, or cohort studies (8)	A total of 284,484 healthy subjects or showing some initial sign of CVD were identified and included	–	Rare or never breakfast consumption	Increased risk of heart disease
Sievert et al. (2019)	Randomized controlled trials (13)	Normal body weight, overweight, and obesity subjects were studied. 486 subjects were examined for the relation between breakfast consumption or omission and changes in body weight and 930 subjects were examined for the effect of breakfast consumption on 24-h energy intake.	24 h to 16 weeks	Consumed or not breakfast	Breakfast consumers had a higher average consumption of 259.79 kcal/day and slight weight gain (mean difference 0.44 kg) compared to the non-breakfast group
Horikawa et al. (2011)	Observational studies (19)	Healthy, normal weight or overweight individuals were studied. 93,108 total participants and 19,270 overweight or obese cases.	–	Breakfast consumption never, sometimes or always	Positive association between skipping breakfast with overweight and obesity

Systematic reviews

References	No of trials	No. of subjects and characteristics	Average duration (minimum duration)	Breakfast rating	Cardiometabolic outcomes
Monzani et al. (2019)	Observational studies (39)	Overall 286,804 children and adolescents were included and 16,130 children were investigated for cardiometabolic outcomes	–	Never, sometimes or always breakfast consumption	Skipping breakfast was associated with a worse lipid profile, blood pressure levels, insulin-resistance, and metabolic syndrome. Skipping breakfast was associated with overweight and obesity.
Ofori-Asenso, Owen, and Liew (2019)	Prospective Cohort Studies (4)	A total of 199,634 healthy adults aged $\geq$40 years (48.5% female) without known CVD at baseline	17.4 years	Never, sometimes or always breakfast consumption	Breakfast skippers were 21% more likely to experience incident CVD or die from CVD than people who regularly ate the breakfast
Szajewska and Ruszczynski (2010)	Cross-sectional or cohort trials (16)	59,528 children and adolescents from Europe were included. 57,481 of them were assessed for the association between breakfast skipping and overweight/obesity.	–	Never, sometimes or always breakfast consumption	Breakfast intake was associated with reduced risk for overweight or obese development

Type 2 diabetes

Reference	No of trials	No. of subjects and characteristics	Average duration (minimum duration)	Breakfast rating	Cardiometabolic outcomes
Ballon, Neuenschwander, and Schlesinger (2019)	Prospective cohort studies (6)	96,175 subjects were included in the meta-analysis of ever or never skipping breakfast and risk of T2DM, involving 4935 cases	6–18 years	Ever or never skipping breakfast	Skipping breakfast was associated with increased risk of T2DM being partially mediated by BMI
Bi et al. (2015)	Observational studies (8)	A total of 106,935 participants and 7419 patients with T2DM were included	6–18 years	Breakfast consumption never, sometimes or always	Breakfast skipping was associated with increased risk of T2DM

CVD: cardiovascular disease; BMI: body mass index; T2DM: type 2 diabetes mellitus.

regard, Jakubowicz et al. observed that breakfast skipping adversely affects clock and clock-controlled gene expression and is correlated with an increased postprandial glycemic response (Jakubowicz et al. 2017). For instance, after lunch with no breakfast, the individuals with diabetes experienced reduced expression of AMPK, Bmal1, Per1 and Per2. Ultimately, circadian changes collectively affect glycolytic metabolism, mainly due to dysregulation in insulin and glucagon secretion (Jakubowicz et al. 2017). Given that postprandial hyperglycemia is a risk factor for development of cardiovascular diseases (Cavalot et al. 2011; Levitan et al. 2004; O'Keefe and Bell 2007), the aforementioned pathways offer insights into the importance of the timing of food intake, which potentially speaks for personalized nutrition recommendations based on meal timing.

Physical activity and exercise

Breakfast consumption or omission has several implications for physical activity and exercise. For example, it is worth noting that daily breakfast consumption may be associated with greater physical activity in the morning in both lean and obese adults (Betts et al. 2014; Chowdhury et al. 2016). Taking into account that light- or moderate-intensity physical activity (e.g. regular walking and even moderate or heavy gardening) are predictors of mortality (Sandvik et al. 1993; Wannamethee, Shaper, and Walker 2000), people display higher physical activity in the morning coupled with breakfast may likely obtain superior physical activity-related health promotion when compared with sedentary breakfast skippers, assuming no differences in physical activity or exercise for the remainder of the day. Furthermore, a number of people perceive breakfast consumption as being an obligatory healthy habit, potentially reinforcing the importance of other health-promoting behaviors such as engaging in physical activity.

Conversely, breakfast omission may be a feasible strategy for optimizing working time and avoiding gastrointestinal problems during morning exercise (Wilson 2019). For instance, many people only have early morning for exercising while a typical American breakfast can cause gastric discomfort during exercising by virtue of hindered digestion.

Recently, aerobic exercise performed during fasted conditions have gained attention among the fitness, sparking the development of research in this setting (Aird, Davies, and Carson 2018; Vieira et al. 2016). Aerobic exercise may be feasible and safe for many individuals, however, there is a paucity of clinical meaningful data pertaining aerobic exercise performed in fasted vs. fed state in a chronic manner (Aird, Davies, and Carson 2018). Clayton, Stensel, and James (2016) demonstrated that skipping breakfast was safe and did not alter perception of effort nor energy expenditure during 60 min of steady-state cycling exercise performed 3 h after lunch (Clayton, Stensel, and James 2016). Appetite sensations and metabolic effects were transient and counterbalanced by a standardized lunch (Clayton, Stensel, and James 2016). While limited information is available concerning breakfast consumption and resistance exercise performance, preliminary work has indicated that breakfast omission reduces total repetitions completed during upper- and lower-body resistance exercise in habitual breakfast consumers (Bin Naharudin et al. 2019). It is also important to consider that side effects of fasted exercise may occur in particular settings, such as in patients with type 1 diabetes mellitus (Yardley and Sigal 2015). Particularly in clinical populations, the prudence of fasted exercise should be examined on an individual basis by a qualified dietitian.

Children and adolescents

Nutrients (including micronutrients) are essentials for proper growth and development during childhood and youth (Santos, Teixeira, and Schoenfeld 2019; Yakoob and Lo 2017). In contrast, overnutrition and unhealthy environmental factors may increase the burden of cardiometabolic disturbances, such as obesity and dyslipidemia (Găman, Cozma, et al. 2020; Kumar and Kelly 2017; Yoon 2014). Therefore, special attention should be paid to meal timing and frequency meals among children and teenagers. The HELENA (Healthy Lifestyle in Europe by Nutrition in Adolescence) study showed that, using a multicenter cross-sectional design, adolescents who regularly ate breakfast had more appropriate blood concentrations of vitamins D, C, E, pyridoxine, cobalamin and folate compared with breakfast skippers (Mielgo-Ayuso et al. 2017). In addition, in a large sample of Polish teenagers ($n = 1566$), Wadolowska et al. (2019) noted that approximately 44% usually skipped both breakfast and the meal at school (Wadolowska et al. 2019). Frequent breakfast skippers were more likely to be overweight/obese and centrally obese (Wadolowska et al. 2019). However, as discussed previously, these cross-sectional associations do not demonstrate causality.

Visceral adipose tissue content is an important predictor of incident atherosclerotic events (Karastergiou and Fried 2013; Oikonomou and Antoniades 2019). Asymptomatic atherosclerosis is a challenge even among young people, ultimately leading to manifest cardiovascular events, typically in middle and old age (Berenson et al. 1998). Interestingly, Alexander et al. (2009) analyzed the relationship between breakfast intake and visceral fat, measured by magnetic resonance imaging, in 93 overweight children (Alexander et al. 2009). Breakfast skippers presented higher intra-abdominal adipose tissue content compared with breakfast consumers ($49.1 \pm 22.1\ cm^2$ vs. $29.2 \pm 14.8\ cm^2$) (Alexander et al. 2009). While the utilization of valid visceral fat estimates is a strength of this investigation, the relatively small sample and cross-sectional nature of the research are noteworthy limitations.

Importantly, meta-analyses have demonstrated that children and adolescents who routinely consume breakfast have a reduced risk of becoming overweight or obese, whereas breakfast omission is associated with cardiometabolic dysregulation in this population (Table 1) (Monzani et al. 2019; Szajewska and Ruszczynski 2010). Thus, given these seemingly unfavorable effects of breakfast omission, a nutritious

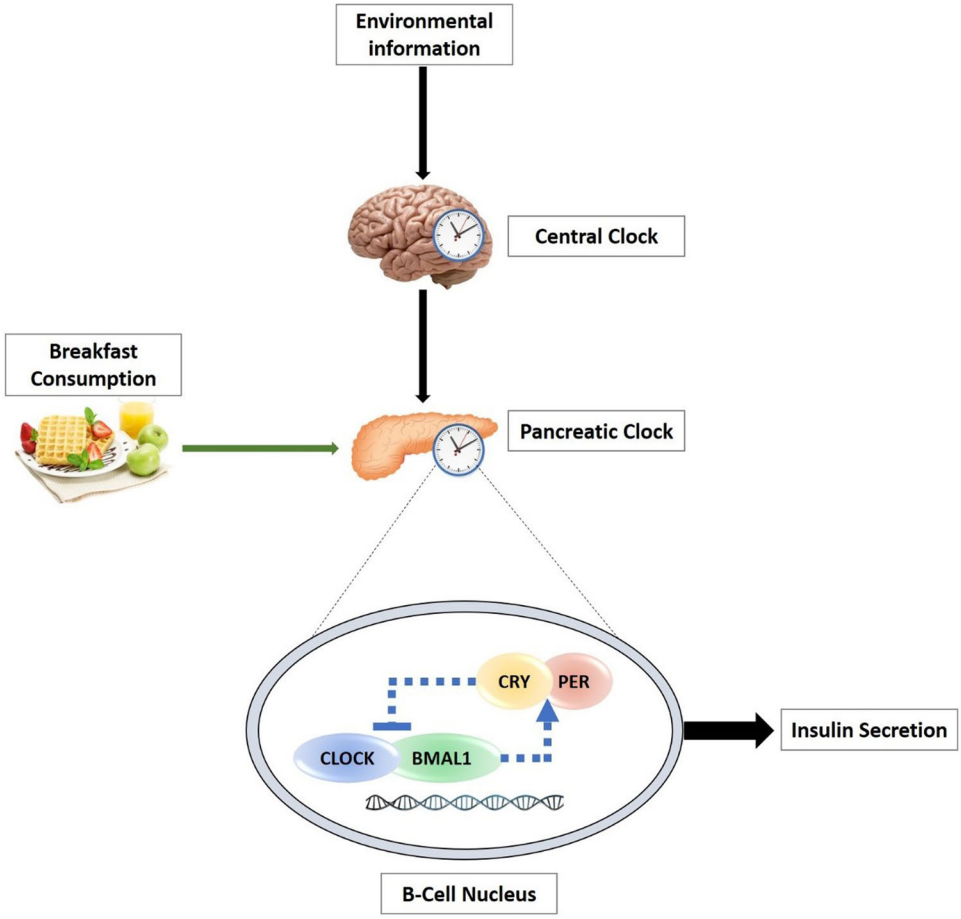

Figure 1. Relationship between environmental factors (e.g. luminosity and temperature) and breakfast consumption on the circadian control of endocrine pancreas. This circadian regulation plays important nuclear control in beta-pancreatic cells yielding insulin production and secretion (Jakubowicz et al. 2017; Perelis et al. 2015).

breakfast based on fruits, whole cereals (e.g. oatmeal), and a protein source such as milk may be important for children and teenagers in order to acquire essential nutrients. Such food items also have primary preventive effects on cardiovascular diseases and obesity (Bertoia et al. 2015; Reynolds et al. 2019; Whitehead et al. 2014). Altogether, breakfast could be viewed as a fundamental meal for promoting optimal daily doses of micronutrients and fibers among children.

Overall limitations and perspectives

Due to limitations of the existing body of research, the majority of investigations included in the present review were cross-sectional and observational studies rather than randomized clinical trials. In addition, effects of the presence or absence of breakfast are influenced by the actual nutritional content of the meal, a factor which depends on specific eating habits that certainly differ across studies and individuals. Whether someone is a breakfast consumer or not can also be viewed on a spectrum, even though dichotomous classifications are often employed. Subjects may be classified as never consuming breakfast, rarely consuming breakfast, consuming breakfast some days, or consuming breakfast every day (Rong et al. 2019). Additionally, the relative contribution of breakfast to daily energy intake is a factor not fully accounted for in existing research, although thresholds of >20%, 5%–20%, <5% of daily caloric intake have been presented for high-calorie breakfast, low-calorie breakfast and skipping breakfast, respectively (Uzhova et al. 2017).

Given the limitations of observational designs, long-term, randomized clinical trials are needed to affirm whether or not skipping breakfast is a cause of cardiovascular events. Nevertheless, it is crucial to consider that the effects of skipping breakfast in free-living subjects would likely differ from the effects of skipping breakfast in controlled trials of weight loss and other lifestyle interventions. In free-living conditions, people may or may not compensate for the acute calorie deficit induced by breakfast skipping, relative to breakfast consumption. However, in weight loss or exercise trials, participants may make a conscious effort to alter their normal instinctive behaviors during subsequent meals, thereby producing a disparity as compared to the real-world effects of skipping breakfast. These and other factors influencing overall energy balance are relevant as caloric restriction per se may influence oxidative stress and inflammation, which play key roles in the development of cardiometabolic disorders (Epingeac et al. 2019; Găman, Epîngeac, et al. 2020).

To date, the quality of diet based on adequate consumption of nutrient-dense foods including vegetables, fruits,

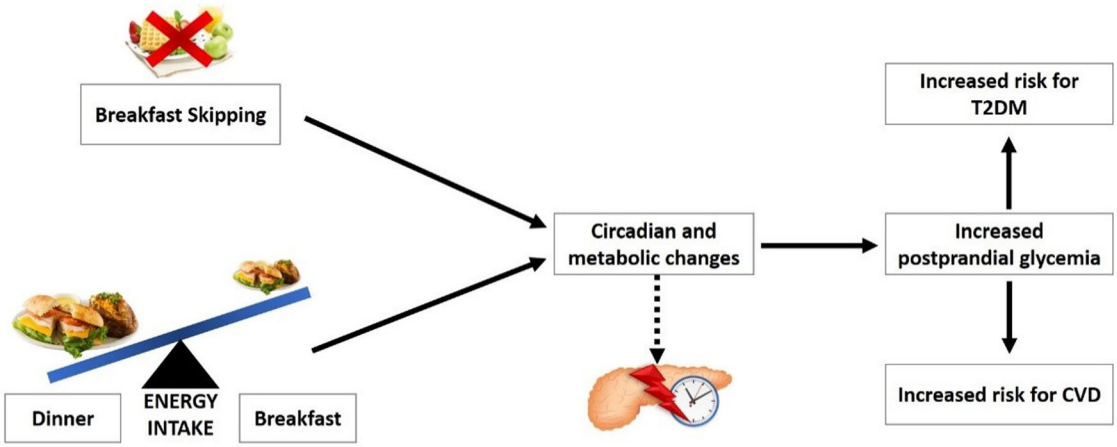

Figure 2. Skipping breakfast, particularly when associated with higher caloric intake at dinner, is associated with dysregulated circadian clock in pancreas, which drives increased levels of postprandial blood glucose and thus having linkage with incidence for T2DM and for CVD. T2DM: type 2 diabetes mellitus; CVD: cardiovascular diseases.

whole-grains, and the appropriate intake of total calories seem to be decisive points for long-term promotion of health through nutritional means. Breakfast consumption or omission may be of importance to the extent it improves or impairs diet quality and quantity, a matter which likely varies among individuals.

Conclusion

At present it is unclear whether skipping breakfast per se is causally associated with cardiovascular events, although breakfast omission appears to be associated with a higher risk for atherosclerotic and adverse cardiovascular outcomes. However, caution should be exercised in interpreting these findings as many complex, unmeasured confounders may have contributed. Unfortunately, there is a lack of long-term randomized, clinical trials with detailed dietary control that have assessed clinical outcomes. Contrasting observational data, smaller trials conducted so far have shown that breakfast addition in subjects who do not habitually consume this meal may increase body weight, particularly fat mass, through caloric excess, whereas skipping breakfast may be a safe and feasible strategy for some people aiming for calorie restriction. Thus, as the proposed benefit of breakfast skipping is primarily a decrease in the total number of calories consumed in a day, implementation of an isocaloric diet containing breakfast would likely remove any purported benefit.

The proposed benefits of breakfast intake, in turn, could be linked to the quality of the meal more than its sheer absence or presence. As such, breakfast followers may be motivated to be healthy through influential lifestyle recommendations promoting the intake of foodstuffs recognized as important sources of nutrients (i.e. fruits, dairy products, and whole grains) in this meal, adopting physical exercise in their routine and abstaining from unhealthy behaviors as well. This is one of the major challenging aspects to breakfast research thereby requiring further observational studies with rigorous confounder adjustments, as well as long-term controlled trials.

Potential competing interests

Dr. Pareek has the following relationships: Advisory Board: AstraZeneca; Speaker Honorarium: AstraZeneca; Bayer, Boehringer Ingelheim. Dr. Tinsley served as a consultant for a digital application that helps users perform intermittent fasting. This consulting consisted of providing research-based information about intermittent fasting.

The other authors report no competing interests.

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ORCID

Heitor O. Santos http://orcid.org/0000-0003-4317-9365

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