

Breakfast; the most important meal of the day or a myth?

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ABSTRACT

Breakfast earned the title ‘most important meal of the day’ through business strategies by breakfast manufacturers. Breakfast is important as it has various health benefits, but we cannot call it the most important as each meal is equally important. An ideal breakfast should have items from all the food groups to ensure food variety. Some researchers think that the benefits associated with breakfast are due to a healthy lifestyle, not particularly on consuming breakfast alone. But skipping breakfast is noted to cause a lack of energy due to low glucose in the body, hormonal disruption, insulin resistance and heart disease. In the Bath Breakfast Project, a detailed report was made with major findings including that body mass index (BMI) remained unaltered in both the feeding and fasting groups in lean and obese individuals. Breakfast balances the blood sugar levels of later meals. If breakfast is skipped, the person can compensate for the missing calories in later meals such that the overall energy intake is slightly lower or unaltered. No evidence is found that could support the long-standing public opinion that breakfast skipping aids in weight loss because people may adjust their physical activity. Resting metabolic rate remain unaltered in both groups. No difference is seen in total energy expenditure (TEE) in both groups within 24 hours showing that diet-induced thermogenesis is slightly modified by morning eating. Long-term interventions are required to fully understand their effects. Breakfast consumers have higher levels of physical activity thermogenesis. After a mixed-macronutrient breakfast, carbohydrate oxidation increases while suppressing fat oxidation during exercise. Chronic morning fasting does not negatively affect health markers except by lowering glucose tolerance.

Keywords: Breakfast, Obese, Lean, Bath Breakfast Project

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Introduction

Breakfast earned the title ‘most important meal of the day’ in 1960 when Adelle Davis, an American nutritionist, stated, “Eat breakfast like a king, lunch like a prince, and dinner like a pauper” [1]. This concept originated in the USA in the 19th or 20th centuries with the advance of the industrial revolution, urbanisation and liberalisation. Due to these factors, a poor lifestyle prevailed. When women entered offices, it was seen that families were shifting to easy-to-made and instant foods for breakfast. It was the point where food companies introduced cereals, pancakes, croissants and cornflakes. Further, they emphasised breakfast being the most important meal of the day through cereal ads and it quickly caught on with people [2]. After the discovery of vitamins, cereal companies carried out their business strategies at an advanced level, they put forward that their cereals are fortified with every essential vitamin required for everyday life, making breakfast much more important. Manufacturers and fitness influencers earned a lot by selling their breakfast products. According to 2024 statistics, worldwide revenue in the breakfast cereals market is about US\$82.16 billion (Statista 2024).

Nowadays there is too much emphasis on breakfast that many believe it is the most important meal of the day, and it is considered a crime to skip it. Breakfast has many potential health benefits, but we cannot call it the most important meal because all meals are equally important, and the person can achieve his required calorie intake by compensating for the nutrients missed in breakfast in other meals [3]. The definition of importance is based on how effectively we eat any meal to have its full benefits, not on a specific meal and it varies from person to person.

Breakfast also has an impact on health problems like obesity, diabetes particularly type 2, hypertension and cardiovascular diseases [4]. Breakfast is composed of two words “break” and “fast”, meaning it breaks our fast which in this condition is our sleep. Most individuals tend to sleep six hours at night. This means that they have been fasting for about one-third of the day, which lowers their blood glucose level and breakfast fills their bodies with energy and nutrition. Breakfast skippers are noted to have diets that are higher in fat, cholesterol and calories because of high-calorie and processed snacking [5].

What is an ideal breakfast?

A good breakfast should include all the necessary and basic nutrients, it should have ingredients from all the food groups. It should be rich in proteins, healthy fat and high-fibre carbohydrates. Mostly for breakfast people use bread, eggs, butter, bacon, sausages, beans, pancakes, oatmeal, cheese, olives and yoghurt. Working people prefer to purchase croissants, pies and other bakery items on their way to work. But surveys show that most people prefer only house-made breakfasts [6]. Whole grain bread or any other form of carbs should be the major portion of the breakfast because it has glucose which is the main nourishment of our brain. The brain depends almost entirely on glucose and is also the most important and primary source of energy in our body [7]. Eggs should also be a must ingredient in our breakfast because their protein and fat content are helpful in our brain development and maintenance. Milk and yoghurt aid in digestion and so must be a part of the morning meal, especially for school-age children milk is compulsory, it makes their bones and teeth healthy and strong [8]. Fresh fruits and juices should also be considered in this meal because they are rich in vitamins, minerals and micronutrients like zinc, calcium, iron and phosphorus that are equally important for our body and help in the metabolism and maintenance of tissue functions. Chia seeds are also getting attention in breakfast meals day by day because of their health benefits; they are rich in omega-3 fatty acids, aid in weight loss and give a feeling of fullness in the stomach [9]. So, a wholesome breakfast provides us with day-long nourishment and plays an important role in our mental and physical physique.

Benefits of Breakfast

Breakfast may not be the most important meal of the day but it is of great significance.

- Breakfast fuels our body with essential nutrients and energy after 6-8 hours of fasting.
- Studies also suggest that breakfast improves cognition and attention and diminishes confusion and forgetfulness [10].
- Our metabolism slows down in the morning because of low blood sugar. Breakfast boosts this metabolism by providing nutrients.
- Breakfast is also seen to maintain a healthy weight as it reduces cravings one might feel in the morning [11].
- Having breakfast regularly is also linked to reduced risks of cardiovascular diseases, diabetes, obesity and hypertension.

- Breakfast balances our blood sugar and prevents spikes and crashes.
- Breakfast helps to alleviate mood. [12]
- Having breakfast improves your diet quality and overall health [13].

However, some researchers conclude that there is no clarity if these health benefits are related to having breakfast or a healthy lifestyle because it has been observed that people who eat breakfast pay more attention to their overall health and well-being. They also focus on the quality of breakfast to make it nutrient-rich and refreshing for the body. If a person is having a poor-quality breakfast, he is doing more harm than good. Breakfast alone cannot do us enough good; it has to be combined with adequate sleep and daily exercise to have these health benefits [14].

Effects of Skipping Breakfast

Some research suggests that skipping breakfast is not as harmful, while other research suggests otherwise. Blood glucose level drops down in fasting and if we skip breakfast we may face brain fog, lack of energy and more food cravings. These cravings demand instant energy foods such as processed items and high-calorie foods like chips and bakery items. These can satisfy you for a while but cannot make you feel full in the long run. So, you tend to eat more. In this way, your overall calorie intake increases [15]. If a person skips his breakfast and extends his fasting period, there is a chance that he could disturb his hormone levels. The stress hormone, cortisol, is particularly at high levels when you wake up. So having breakfast keeps its level in balance. An increase in cortisol level increases appetite and the person tends to eat more in later meals if he doesn't have breakfast. Furthermore, it is also seen that breakfast Skippers experience stress, anxiety and depression perhaps due to cortisol [16]. Particularly in women, hormonal imbalances can disturb the menstrual cycle. If a person's hormone is off course, he may experience mood swings, notably seen in women. Further hormones like leptin and ghrelin regulate our appetite and must be kept at balanced levels by listening to the body's needs and hunger cues. So, breakfast not only maintains our physical but mental and emotional well-being as well [17].

Skipping breakfast can increase the risk of heart disease. This may be due to the effects that breakfast has on blood sugar level regulation. Additionally, overeating later in the afternoon and the connection of skipping breakfast with poor lifestyle habits contribute to an increased risk of heart disease. Breakfast Skippers also tend to have more LDL cholesterol derived from unhealthy snacking which plays a role in heart attack, coronary artery disease and stroke [18].

Some people habitually skip breakfast in the perception of losing weight, but it may affect healthy metabolism. Studies show that without breakfast, our energy level drops and the body starts to look for energy sources. As a result, the body uses its reserves from fat and muscle tissues. But this process needs energy to initiate. In this scenario, the body shifts to survival mode and slows its metabolism and other processes to conserve energy. The body retains energy reserves in fat tissues for later use in this condition. So, skipping breakfast to lose weight is not the right choice [19]. Also skipping breakfast does not help in weight loss as expected because if overall calorie intake is lower, the body compensates for it in physical activity thermogenesis [20]. Breakfast skipping can also cause insulin resistance as when the blood sugar levels dramatically increase after lunch or dinner, the levels of insulin increase accordingly and the receptors for insulin will fall short, hence causing downregulation. The body cells will become less sensitive to insulin due to prolonged exposure to the hormone [21].

Current research does not confidently state the effects of having or skipping breakfast on body mass index (BMI), basal metabolic rate (BMR) or diet-induced thermogenesis (DIT). It is also seen that both lean and obese persons spend less energy in the morning when fasting than when consuming breakfast [22]. In order to understand whether breakfast is the most important meal, we have to understand what breakfast is and what is meant by important. If breakfast is vital in maintaining health, then physical exercise and quitting smoking are much more important in promoting the overall health of an individual, but that also doesn't eliminate the role of breakfast in sustaining health.

What is meant by 'breakfast'?

Generally, breakfast is regarded as the first meal of the day. Based on the etymology breakfast means to break the fast, but that does not give us a scientific insight into the topic and there is a need for a proper scientific definition of breakfast [23]. Some studies consider only solid foods as breakfast despite many high-calorie beverages. While others argue that, 'a calorie is a calorie'. However, under the Federal Food, Drug, and Cosmetic Act (FFDCA), beverages are considered a subcategory of conventional foods [24]. Hence, beverages alone are not considered breakfast. Any meal lower than 50kcal neither fulfils a person's hunger cues nor shifts our body's physiology towards the fed state, so is not considered a meal.

At what time to have breakfast is much more complex and depends on the time of day and the time of waking up. One concept of breakfast as a

morning meal is based on clock time rather than sleep-wake patterns. But it is not applicable to night-shift employees. Another definition of breakfast regards it as a meal that is consumed after 1-2 hours of waking up. So, the most appropriate definition of breakfast regarding time is the first meal one has taken within 2 hours of waking up from the longest period of sleep in any 24 hours [25].

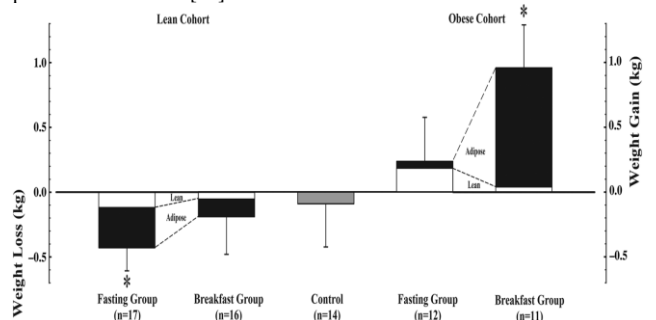
What is meant by 'important'?

Many people feel hungry upon waking up. So, to satisfy their hunger breakfast is the most important, that is the only, meal to do so. If you do physical exercise every morning, then a carbohydrate-rich breakfast is the most important to you for achieving your health goals [26]. But if you want to have long-term health benefits and fitness, it does not count only on having a single meal, your importance should be on a regular healthy dietary pattern paired with physical activity and other factors. Hence, the definition of 'important' varies from person to person depending upon their desired goals [27].

Bath Breakfast Project (BBP)

Bath Breakfast Project was a randomized controlled trial that examined the effects of having breakfast daily versus morning fasting on health and energy balance. It was conducted by the University of Bath and funded by the Biotechnology and Biological Sciences Research Council (BBSRC). In this project, breakfast skippers and consumers were divided into two groups. Breakfast consumers were those who had 350kcal within 2 hours of waking up and 700kcal before 11 am every day and breakfast skippers were those who had zero calories until midday. This was only a 6-week intervention [28].

This project concluded that no particular difference was seen in BMI change between the fasting and breakfast groups, whether they were lean or obese [29]. In dual-energy X-ray absorptiometry (DXA) it was seen that lean individuals in the fasting group did not compensate for the energy missed in the breakfast later in the day, so there was a decrease in BMI due to fat burning. However, lean individuals in the breakfast group did not gain weight despite having 700kcal before 11 a.m. every day for 6 weeks [30]. Obese individuals in the fasting group showed the greatest compensation without losing weight although they didn't consume a single calorie until noon and the obese persons in the breakfast group didn't compensate by spending energy and hence increased their energy stores in the form of body fat. The conclusion was that no matter if the person was in the fasting group or breakfast, lean individuals had a more negative energy balance and obese persons had a more positive energy balance. This leads to another approach that the body's ability to compensate decides the amount of body fat in a person or vice versa [31].



Cross-sectional observation showed a low energy intake in breakfast skippers because they didn't consume any calories before midday. This lower energy intake depends on compensatory eating later in the day. If they compensate for the calories missed in the morning meal their overall energy intake will be balanced [32]. Analysis from The National Health and Nutrition Examination Survey (NHANES) shows that when breakfast is skipped, men might skip 247kcal, while women might skip 187kcal [33].

An experiment to determine the energy intake was performed in which a group of people was fed under controlled laboratory conditions while the other was fed in their free environment. Lab-controlled results provided precise measurements of the actual intake, but we cannot call them their real behaviours because such controlled conditions exclude all external factors that might influence nutrient intake [34]. However, in labs, it is convenient to study the role of hormones in appetite regulation. Hormones like leptin, gastric inhibitory polypeptide (GIP), pancreatic polypeptide (PP), glucagon-like peptide-1 (GLP-1), peptide tyrosine-tyrosine (PYY) and oxyntomodulin were seen to reduce appetite. While ghrelin hormone appeared to stimulate appetite [35]. So, in postprandial testing of breakfast consumers, there were reduced levels of ghrelin and increased levels of PYY. Lunch again increased the PYY hormone levels that hold on throughout the afternoon, meaning that PYY is an indicator of total cumulative intake rather than the energy content of the previous meal.

Surprisingly, acylated ghrelin (AG) levels remained increased throughout the afternoon if the person, either lean or obese, had a carbohydrate-rich breakfast and lunch. This was perhaps due to the decreased body's response to insulin in lunch meals because of the postprandial glycemic response (PPGR) [36]. Hormones certainly play their role in appetite regulation, but other factors also contribute to their part.

Research on how appetite is regulated after skipping breakfast showed that when a snack before lunch was given to both breakfast skippers and consumers, it was seen that energy intake increased during the lunch meal in lean individuals. As far as the question of compensatory feeding is concerned it is only true when the breakfast is relatively small, about 250kcal. Because the energy content of a typically large breakfast is about 400kcal that has a low possibility of being compensated in the later meal alone [37]. The research that investigated the intake of energy at lunch, dinner and snacks also concluded that if breakfast was omitted, no compensatory intake of energy was seen. Lean individuals do some compensatory intake in later meals if breakfast is skipped, but the postprandial glycemic response in such cases is comparatively short-term. However, in obese, no matter if breakfast was consumed or skipped, there was a similar intake of energy. In both cases, there is a lack of evidence for prolonged compensatory eating patterns and further research should be conducted [38].

In a one-week intervention, a primary investigation held under controlled conditions showed that there was no variation in intake whether breakfast was skipped or consumed, provided that breakfast was ad libitum high-carbohydrate. In the following investigation when participants were asked to choose breakfast freely, it was seen that for those who omitted breakfast, there was a reduction in energy intake of about 160kcal, keeping in mind that the average caloric content of a breakfast ranges between 400-500kcal [39].

In another investigation, the lean cohort showed limited dietary compensation, in which the breakfast group consumed 539 more calories than the fasting group. But, in obese people, there wasn't much difference in energy intake, with the breakfast group consuming 338kcal more [31]. Another likewise research showed that in lean there was a difference of about 265kcal, while in obese this difference was merely 60kcal between the breakfast and the fasting groups. This information pointed out that obese people better compensate for their missing calories in later meals as compared to lean individuals in free-living conditions [39]. Obese cohorts were subjected to two studies; one where no compensation was seen at lunch meals because the energy compensation in them was because of their dietary choices and food frequency, in contrast with the single homogenous food they consumed in controlled laboratory conditions. In the second study, there was no significant difference in the energy intake of both groups in a free-living environment. But when we saw lean persons, they had lower compensation when breakfast was omitted no matter whether the study was performed in a laboratory or open environment [30]. This approach suggests whether lean and obese individuals respond to different study designs differently or it may be because, with increasing adiposity, environmental factors affect energy intake more strongly [38]. Now we discuss the effect on various types of energy expenditures.

Resting metabolic rate (RMR)

It is the amount of energy our body needs to perform basic body functions while resting along with light activities like eating, walking etc. It accounts for the major contribution to energy expenditure estimated at 60-75% of the total energy needs [40]. Past research showed that when obese women were subjected to weight loss by reducing their calories, they also reduced their resting metabolic rate no matter if breakfast was consumed or not. Another research showed that when the same test was performed on lean women, no difference was observed in their RMR. On the other hand, a previous study on lean and overweight individuals showed no effect on RMR [41]. In the bath breakfast project, the six-week-long intervention also showed that there was no effect on RMR in both groups of lean and obese individuals. It indicates that the morning eating pattern does not affect RMR [42]. So, fasting does not cause any significant change in reducing RMR that could alter body mass/composition.

Diet-induced thermogenesis (DIT)

It is the amount of energy used by the body in the processes of digestion, absorption and storing food. It has the smallest contribution to our total daily energy expenditure (TDEE) i.e., 5-15%. This thermogenesis varies according to the macronutrient consumed [43]. In most cases, when a mixed meal is consumed, DIT typically consists of only 10% of the actual food intake. Some evidence suggests that DIT has a higher value in the morning as compared to the other meals in the day, indicating that breakfast has a higher thermogenic effect. It may be due to the body's biological clock or sleep and eating patterns [44].

In BBP, it was seen that both the lean and obese cohorts in the feeding group had higher rates of DIT in the morning and afternoon when breakfast and an ad libitum lunch were consumed with leans expending 276kcal and obese 284.5kcal. A second approach showed that when a fixed lunch meal was given either after the breakfast was consumed or skipped, DIT was then greater in the afternoon meal following the breakfast [45]. However, when it was recorded 2 to 4 hours later after the consumption of lunch, it showed the same results as morning fasting. To record energy expenditure in 24 hours, participants were subjected to breakfast omission, and compensatory eating was adjusted in their later meals, the result was that there was no difference recorded in the total energy expenditure (TEE) in the 24 hours. This shows that diet-induced thermogenesis is slightly modified by morning fasting [46]. However, the effect of breakfast consumption on the overall DIT is quantitatively small and can easily be cancelled out by compensating for the energy intake.

Physical activity thermogenesis

It is the amount of energy that the body expends during physical activity. In very active people, it can account for 50% of the total daily expenditure [47]. It can easily be modified. To understand the effect of breakfast and fasting on physical activity thermogenesis, we employed two methods; heart rate and accelerometry combined, because it is more reliable and with high precision under a free-living environment. This technique not only helps to monitor low-to-moderate physical activity but also non-exercise activities like walking, standing etc [48]. When the study was applied to lean individuals, it was seen that those who consumed breakfast had a greater level of physical activity thermogenesis, about 442 kcal per day, than those who skipped breakfast [30]. On the other hand, the obese cohorts were overall less physically active. So, as such no difference was seen in the physical activity thermogenesis between their fasting and breakfast groups. In obese, its average was about 272kcal/day. But as the effect on breakfast energy expenditure was evident in lean individuals, so were in obese, of about 188kcal [31]. This indicates that physical activity is affected by our eating schedules, especially by morning meals. The reason for this is not very clear, but it may be due to laziness or mental readiness towards exercise, low exposure to exogenous substrates and systemic metabolites that perhaps lessen non-exercise activity thermogenesis (NEAT). So, skipping breakfast to lose weight does not provide the expected results as physical activity thermogenesis is lower in the fasting state [49].

James A. *et al* stated a very interesting approach here that before the agricultural revolution, the human genome ensured that they had developed mechanisms to prevent them from being energy deficit because at that time we had to spend some energy to get food as compared to today when everything is available to us at hand [50]. So, the energy-balance equation should be $\text{Balance} = - \text{Expenditure} + \text{Intake}$, not $+\text{Intake} - \text{Expenditure}$. The net result will be the same. But it shows more correctly how humans respond in survival mode, that their energy expenditure comes first and is inexorable. Whereas food intake can be zero, like in fasting [51].

So, understanding how compensatory feeding mechanisms work to eliminate the risk of a person being energy deficient is very important. Reducing physical activity to conserve energy is only effective in the short term. In situations of chronic food shortages like famines, human beings select more sedentary lifestyles [52]. There is also a possibility that a hypoenergetic diet due to fasting on a daily basis could cause an increase in energy expenditure by increasing spontaneous physical activities as happened in starvation-induced hyperactivity (SIH) observed in rodents and patients with anorexia nervosa [53]. Therefore, it is important to pay equal attention to both diet and physical activity.

Exercise-fasting interactions

Energy expenditure during exercise is greatly determined by its intensity and extent; however, nutrition also impacts it. If a person has eaten a breakfast rich in mixed macronutrients, it will increase its carbohydrate oxidation while suppressing fat oxidation during exercise. This energy expenditure is also influenced by the type of carbohydrate ingested. Insulin levels remain elevated after a mixed-macronutrient breakfast and it suppresses palmitic acid oxidation and plasma non-esterified fatty acids (NEFA) [54]. During exercise, the suppression of fatty acid availability is not because of a reduction in lipolysis, but because of an increase in re-esterification of free fatty acids. If breakfast has a high glycemic index, then the concentration of glycogen in muscles before exercise can further cause the reduction of lipid oxidation. It was seen that when breakfast was omitted coupled with exercise, lipid oxidation increased creating a less positive fat balance in both lean and obese individuals [55].

Carbohydrate availability during exercise can be influenced by limiting carbohydrates in the diet, doing numerous bouts of exercise and adjusting the time of carbohydrate intake. These methods facilitate fatty acid availability. Moreover, carbohydrate intake before and during exercise can

reduce the increase in Vo2max, glucose tolerance, insulin sensitivity and resting muscle glycogen concentrations [56].

Health outcomes

People who omit breakfast are at increased risk of developing diseases. A study found that the total and LDL cholesterol increased along with raising insulin levels when breakfast was delayed till 10:30 am for two weeks in response to a test drink. However, when breakfast was consumed, these levels appeared to decline [57].

The group fasting during the afternoon or evening in lean individuals showed a slight fluctuation in blood glucose levels, whereas obese cohorts showed no fluctuation for 24-hour glycemic control. In an oral glucose tolerance test (OGTT) it was seen that the insulinemic response was greater in the fasting group relative to the feeding group. As such no health concern was noted in healthy people because of the chronic morning fasting or perhaps the problems were undetectable because the research lasted only 6 weeks, and such health problems develop after a long period of unhealthy activities [58]. However, the effects on glucose tolerance and insulin sensitivity were evident.

Conclusion

Some components of energy balance are affected by breakfast omission and no evidence suggests that breakfast consumption affects resting metabolic rate and diet-induced thermogenesis of later meals. In laboratory studies, it is seen that when breakfast is skipped, there is compensatory eating in the later meals but still this compensation is not equal to the energy deficit in the missed meal. In the free environmental study, the energy intake is either unaltered or slightly lower when breakfast is omitted. Both fasting and feeding groups in lean and obese individuals respond differently to energy compensation depending on adiposity.

Energy expenditures are also studied in this project. It is seen that physical activity thermogenesis is lower when breakfast is omitted in both the lean and obese cohorts. However, a fixed statement is difficult to make from a short-time interventional study and it requires more research and analysis. The relation between body weight and breakfast omission is also studied and no evidence is found that can suggest that breakfast omission is related to weight gain.

Long-term interventions are required to effectively understand the effect of breakfast omission on health markers. Breakfast may not be the most important meal of the day, but it is definitely an important one like others and not to be ignored.

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