

Research article

Effect of skipping breakfast on cognition and learning in young adults

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ABSTRACT

Introduction and Aim: Consumption of breakfast has been commonly associated with cognitive parameters among school children and adolescents. The current cross-sectional study was conducted with the aim to investigate the effect of breakfast consumption/omission on cognitive functioning and learning among young adults.

Materials and Methods: Sixty college-going students, divided into two groups such as breakfast consumers and breakfast skippers were asked to fill a physical condition-based study questionnaire. The results of which were assessed along with the performances given in a collective cognition-based task. The obtained data was retained and later analyzed by GraphPad Prism (version 5).

Results: The overall performance, attentiveness, response time and alertness were significantly higher among the college-going breakfast consumers when compared to breakfast skippers thereby highlighting the importance of daily consumption of breakfast among young adults.

Conclusion: Breakfast consumption is of paramount importance among college going students, omission of which could influence cognitive performances and behavioral aspects. Hence, academic programs should promote nutritionally balanced breakfast consumption among college students.

Keywords: Breakfast consumption; breakfast omission; cognition; attention; reaction time; vigilance.

INTRODUCTION

Breakfast is contemplated to be the most crucial meal as it is intended to contribute to salient macro and micro-nutritional intake and overall health of the individual (1). Young adolescents with regular intake of breakfast tend to be physically more active due to better sustenance, therefore less likely to become overweight (2, 3). In spite of the spectrum of benefits, multiple studies have documented a significant rise in the prevalence of skipping breakfast by children and young adults (3, 4).

Various reasons can contribute towards breakfast omission based on the dietary habits of the individual and socio-economic status of the family. Laziness, habitual, unavailability of resources, financial restrictions and increase in snack consumption are a few among them. This sort of habit raises a substantial concern as breakfast is considered to be the first meal of the day, after a prolonged intermission of about eight hours of sleep at night. As children are thought to have an increased brain glucose metabolism, they tend to be more sensitive towards nutritional deficiencies and related cognitive outcomes (5).

Both government and non-government, national and international agencies have designated special attention on the consumption of breakfast. Institutions on dietetics from all over the world have

recommended adding breakfast as a vital meal in ones' regular diet (6-8). Several countries have come up with comprehensive specific guidelines related to breakfast consumption (9, 10). A study conducted by the experts of World Health Organization (WHO) have communicated that sixty one percent of European school children tend to have the habit of consuming breakfast, with a drastic 6% fall as children grow up (11).

Regular consumption of breakfast has proven to be very useful for the cognitive functioning of school children (12). Previously published literature have reported a positive correlation of breakfast consumers with learning and academia when investigated among school children and adolescents (12). Cognitive scientists have claimed a significant association of breakfast consumption with improvement in attention, memory, mood and overall behaviour in healthy children (13-16).

On the other hand, children with nutritional deficiencies are more likely to generate inconsistent cognitive outcomes when associated with breakfast consumption (16, 17). Cooper and co-workers (18) have suggested that breakfast consumption/omission have an important role to play in tasks that include a higher level of cognition thereby incorporating information processing. Most of the studies published were carried out specifically targeting the school-aged

children approximately between eight to eleven years of age, very less have thoroughly investigated the effect of breakfast consumption/omission on cognitive parameters among college-going students, especially medical or paramedical students.

As young adults undergo rapid development and hormonal changes, increased amount of academic stress and peer pressure, and have a subsequently higher metabolic rate relative to the weight of the brain, learning about their cognitive functions with respect to the most important meal of the day is the need of the hour. Due to the heterogeneity in results and paucity of literature that involves young college-going adults, this study was designed with the intention to carefully examine some vital indices of cognitive functioning among breakfast skippers and to correlate them with breakfast consumers.

MATERIALS AND METHODS

Characteristics of the participants

Sixty volunteers (30 males and 30 females) in first-year-paramedical college with adequate health were recruited to participate in the study. Out of 60, 50% (n=30) reported consuming breakfast consistently for seven days a week between 8.00 - 8:30 AM Indian Standard Time (IST), rest 50% (n=30) reported skipping breakfast at least thrice a week.

Study design

The study was conducted after receiving approval from the Institutes' ethical advisory committee. Additionally, individual informed consent was also obtained before the beginning of the study. Volunteers were specifically in their first-year students of paramedical college. Inclusion criteria involved only those participants who were willing to participate in the study and are in good physical health and mental well-being according to a self-reporting questionnaire.

Study questionnaire

The study questionnaire was validated by conducting a pilot study. The validated questionnaire was supplied to all the participants to evaluate their level of energy and mood during the morning hours. The questionnaire primarily consisted of two main parts – general demographic information and physical condition as per the individuals' feedback. The latter part of the questionnaire predominantly consisted of four questions, such as follows:

- Self-sensation – how happy or sad does one feel after waking up from bed in the morning
- Energy evaluation – how much energized does one feel after waking up from bed in the morning
- Appetite evaluation – how much hungry does one feel after waking up from bed in the morning
- Concentration level – does one feel one has adequate amount of concentration in class throughout the day

The volunteers would be asked to rate the questions 1-3, wherein 1 stands for good, 2 for average while 3 stands for poor. The questionnaire is followed by performing three cognition-based collective tasks.

Cognitive function tests

A battery of three different indices of cognitive function testing was performed by each participant via a laptop which lasted for about thirty to forty minutes collectively. The cognitive parameters such as attention, reaction time and vigilance were assessed through an application called PsychLab 101. It is a collection of non-invasive psychology-based cognitive experiments that are simple, less time consuming, feasible, and can be performed with ease. PsychLab 101 does provide several cognitive experiments, out of which the relatable experiments are chosen based on the aim of the study, the typical cognitive indices that are to be studied and the target participants.

Before the start of each test, both written and verbal instructions appeared on the screen for easy understanding of the participant. It also provides a mock displaying the whereabouts of the specific task before the commencement of the actual task for better understanding of the participants. At the end of the mock, feedback is to be provided to all the participants so that one would know whether the responses provided were correct or incorrect. In case if a participant fails to understand the protocol of the study task at one go, the investigator re-familiarizes the task to the participant and the mock is repeated. Once the participant is well familiarized, the task is performed in a noise cancellation room to nullify any surrounding disturbances. Results attained from the practice stimuli are discarded, only the data collected from the final task are retained. The three indices of cognitive function tests are administered in the given order as mentioned herewith:

1. **Attention:** To effectively measure attention without any bias, the 'dot probe (image) task' is administered. In this task, dots are presented as stimuli on both the sides of the computer/laptop screen. Initially two random images would appear for a brief period on both the sides of the screen followed by the disappearance of the images. Finally, a dot would appear on either side of the screen. Participants are expected to determine the correct side of the screen where the dot appeared and give the appropriate response as early as possible. If the dot appears on the left side, one must touch the left side of the screen and if it appears on the right side, one must touch the right side of the screen. For devices where touch facilities are not available, two separate keys on the keyboards are designated to do the same. Exact proportions of correct responses are automatically generated from the software and retained.

2. **Reaction time:** Being one of the fundamental parameters in the field of cognitive psychology, reaction time is defined as the time difference between the onset of the stimuli and the response from the participant. There are several ways by which reaction time can be calculated, among which 'simple reaction time' test is one such experiment wherein the participants' response can be quickly measured without any additional co-interventions. A participant must touch the screen (or press the designated key on the keyboard) as quickly as possible each time when a red box (stimuli) appears on the screen. One should not anticipate the appearance of the stimuli from beforehand. The fastest, slowest and average response attained during the task are generated at the end of the task and retained for future referral.
3. **Vigilance:** It is a measure of how long one can stay completely focused on the given task at hand. For the 'vigilance task' experiment, a large, blue-colored box would appear at the center of the screen for a brief period. A small rectangle would appear inside the box on either of the four sides. One must pay careful attention to the white colored rectangle and touch the screen only when the rectangle appears on the top part of the box whereas skip giving any response when it appears on the left, right or bottom part of the box. One should not anticipate the appearance of the rectangle on the top part of the box from beforehand. It is advised to pay focused attention for the entire length of the task to provide utmost

correct responses as possible. At the end of the task, the total number of hits, total number of misses and false alarm are recorded by the software and retained by the investigator for future data analysis.

Statistical analysis

The cognitive parameters were analyzed using GraphPad Prism (version 5) via Wilcoxon signed rank test for nonparametric data presented as median along with interquartile range. The data obtained from physical condition are represented in binary format as well as median along with interquartile range. For all the above analysis, level of significance was set at $p < 0.05$.

RESULTS

In this cross-sectional study, cognitive parameter indices of 60 students of first year paramedical students were assessed out of which 30 were breakfast consumers whereas the rest 30 were breakfast skippers. Table 1 suggests that the physical condition-based study questionnaire revealed both male and females who have the habit of consuming breakfast on a regular basis have significantly higher level of concentration in class, adequate energy, appropriate self-sensation, and sufficient appetite as and when compared to the ones who prefer to skip breakfast at least thrice a week. In addition, the results are consistent with the implication that consumption of breakfast has a significant effect on various indices of cognition, as denoted in Table 2.

Table 1: Physical condition between breakfast consumers and breakfast skippers

Parameters	Breakfast consumers (n=30)			Breakfast skippers (n=30)			p-value
	Good	Average	Poor	Good	Average	Poor	
Concentration	73(22/30)	27(8/30)	0(0/30)	23.33(7/30)	43.33(13/30)	33.33(10/30)	0.0004
Energy evaluation	63(19/30)	30(9/30)	7(2/30)	13.33(4/30)	73.33(22/30)	13.33(4/30)	0.0070
Self-sensation	83(25/30)	17(5/30)	0(0/30)	0 (0/30)	87(26/30)	13(4/30)	<0.0001
Appetite evaluation	100(30/30)	-	0(0/30)	7 (5/30)	-	83(25/30)	<0.0001

Values are specified as percentage (count/total count), p-value < 0.05 are considered as significant. Significant results are highlighted in bold.

Table 2: Cognitive parameters between breakfast consumers/breakfast skippers

Parameters	Breakfast consumers (n=30)	Breakfast skippers (n=30)	p-value
Proportion correct	98.75(98.75-100)	97.50(93.75-98.75)	0.0004
Average response	239.7(211.0-246.4)	403.7(328.4-506.1)	<0.0001
Fastest response	192.5(136.0-209.3)	280.0(238.5-347.8)	<0.0001
Slowest response	297.0(280.4-300.5)	736.5(509.5-1178.0)	<0.0001
Total hits	4(4-4)	4(3-4)	0.0313
Total miss	0(0-0)	0(0-1)	0.0313
False alarm	0(0-0)	0(0-1)	0.0086

Values are specified as median (interquartile range), p-value < 0.05 are considered significant based on the Wilcoxon signed rank test. Significant results are highlighted in bold.

DISCUSSION

With the development of a recent trend in the tendency of skipping breakfast among children, teenagers, and young adults has become very essential to investigate whether the omission of breakfast does have any significant effect on the cognitive framework and overall attention span among school and college-going students. Our study was primarily conducted with the sole aim to examine the functioning of cognitive parameters among breakfast consumers and to note whether it differs from breakfast skippers. From the above cognitive tasks performed in our study, a consistent pattern has emerged between both the groups.

It has been evident that consumption of breakfast has a positive impact on the somatic condition, attention, reaction time and vigilance of the participants. This sort of result does reasonably suggest imparting a long-lasting impact on the overall learning and academic performances of everyone who chooses to omit breakfast for a prolonged period. When deciphering the results of our cross-sectional study, it is very crucial to interpret the data keeping in mind the strengths and limitations of the study so that future prospective can be accordingly established and new guidelines could be fabricated for the betterment of college students.

According to the best of our knowledge, this is the very first study that has scrutinized the three vital cognitive parameters concurrently among paramedical students at a tertiary medical college. Results obtained from the collected data implies that the performance among breakfast consumers is significantly enhanced by the regular consumption of breakfast and that breakfast can impart a huge influence on the cognitive performances of a college-going student, specifically strengthening the attentiveness and upgrading the alertness of the students. The results of our study are in accordance with a previous study that implies the positive effect of breakfast consumption on cognitive processes among school-going children (19).

Published literature indicates that consumption of breakfast is associated with the stimulation of spatial and long-term memory, auditory attentiveness, and recall and recollection memory (19, 20). Enhancement in learning and memory post breakfast is most likely due to the rise in circulating blood glucose level channelized through the production of acetylcholine (21, 22). With the advancement of research in the field of learning and cognition, it has come to notice that increase in blood glucose followed by breakfast consumption can effectively modify a persons' mood, behaviour as well as memory (23, 24). Conversely, a shortage of the same can thereby be presumed to alter the enhanced cognitive functioning of the body.

Multiple studies highlighting the decline in cognitive processes with the omission of breakfast in school children were in line with the results attained in our study (15, 19). However, a group of researchers who conducted a study among high school students have concluded that breakfast consumption has no effect on sustained attention (25, 26). Similar results have been reported by Dickie and Bender wherein the consumption/omission of breakfast have shown absolutely no effect on the mental performances in school-going children (27). As previously no studies have been conducted among the college students, the results accomplished from our data can be utilized to warrant further investigations in the near future.

One of the many strengths of this observational study is that all the participants have filled the study questionnaire, thereby eliminating the occurrence of selection bias. The study participants included fifty percent males and fifty percent females thereby can be generalized among all the college-going students. The individual-level socio-economic status of the participants did not vary much as the sample was selected from a similar socio-economic background. Most importantly, the sample size can be considered to be adequate enough so as to correlate the various indices of cognitive processes and to detect its association among breakfast consumers and breakfast skippers.

Along with the above mentioned strengths of the study, it is imperative to mention the several limitations of the study as well. The fact that the sample size is limited to only sixty participants calls in for the occurrence of random bias. The detection gained from the current study cannot be generalized to older or working men and women with the habit of breakfast consumption/omission. Detailed demographic characteristics and information on the ethnic background were not included in the study questionnaire. Additionally, as the breakfast consumed by the participants were self-defined, specific ingredient consumed or exact micro or macro-nutritional consumption could not be determined.

CONCLUSION

A spectrum of cognitive parameters and behavioural specifications are associated with omission of breakfast. Acknowledging the importance of breakfast consumption among college students is paramount. Academic programs with the purpose of promoting nutritionally-balanced breakfast consumption among college-going students are to be promoted. Further research in this line of work is encouraged to validate the results obtained from our study.

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CONFLICT OF INTEREST

The authors hereby declare that there is no conflict of interest.

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