Research Article

Effect of short-term breathing exercise practice on cognitive function in chronic mobile phone users

Dinesh Kumar E[1], Dinesh T[2]

1MBBS Student, Government Thiruvarur Medical College, Thiruvarur, Tamil Nadu, India, 2Department of Physiology, Government Thiruvarur Medical College, Thiruvarur, Tamil Nadu, India

Correspondence to: Dinesh T, E-mail: sclerombbs@yahoo.co.in

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ABSTRACT

Background: A widespread use of mobile phones among adolescents is of leading concern regarding common physical and emotional problems ranging from insomnia, headache, earache, problems in concentration, and fatigue. It is important to study the possible negative health effects of chronic mobile phone usage. **Objectives:** The objectives were to study the effect of 6 weeks of breathing exercise training on cognitive function in chronic mobile phone users. **Materials and Methods:** A total of 60 healthy volunteers (30 females and 30 males) who use mobile phones for >4 h/day for 1 year were included in the study. Breathing exercise training was given to them for 15 min in two sessions per day for 5 days in a week for a total period of 6 weeks under our direct supervision. Cognitive function parameters such as trail making A (s), tail making B (s), digit span, letter cancellation commissions, omissions, and letter cancellation time (s) were recorded before and after 6 weeks of the study period. **Results:** Average age of the male and female volunteers was 19.9 + 1.18 and 19.5 + 1.07, respectively. There was a significant decrease in trail making A and B ($P < 0.001$) and letter cancellation omissions and time (s) ($P < 0.01$ and $P < 0.001$, respectively) among the male volunteers. In female volunteers, trail making A and B ($P < 0.05$) and letter cancellation omissions and time (s) ($P < 0.01$) were significantly decreased. Furthermore, there was a significant increase in forward digit span ($P < 0.001$) in both male and female volunteers. **Conclusion:** Results of our study indicate that regular practice of breathing exercises for even short duration like 6 weeks improves autonomic functions and reduces stress which, in turn, improves cognitive functions.

KEY WORDS: Mobile Phone Users; Cognitive Function; Breathing Exercise Practice

INTRODUCTION

There is an alarming increase in mental health problems among the young adults due to quick development and widespread usage of mobile phones. This influences on communication and interaction in work as well as private life. Hence, it is necessary to study the negative health effects of chronic mobile phone usage which leads to various common physical and emotional problems ranging from insomnia, headache, earache, problems in concentration, and fatigue.[1,2]

Executive functions are the cognitive processes which include attention, working memory, scanning, retrieval of stored information, and mental flexibility, i.e., ability to shift from one criterion to another in sorting or matching tasks.[3-5] Cognitive function can be assessed by a battery of tests such as trail making, letter cancellation, and digit span as proposed by Lazek *et al*. 2004.[6]

Attention stands as one of the oldest issues in cognitive neuropsychology which remains integral to the evaluation of the presenting patient. The role of executive functioning is

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to coordinate other neurocognitive systems through various activities such as working memory, planning, and monitoring.[7,8]

During slow, deep breathing, there is a conscious alteration of cerebral activity and a definite pattern of activity is seen in the respiratory centers. Furthermore, there is a modulation in neuronal activity in cardiovascular and other medullary centers. Breathing with concentration improves mind-body coordination that helps the mind and body to cope up with stress, anxiety, and depression and makes the individual feel relaxed and calm.[9-12]

There are only a few studies available on the evaluation of the effect of slow breathing exercise practice on cognitive function parameters and perceived stress in the short-term basis. Hence, we planned to study the effect of 6 weeks of slow breathing exercises on the cognitive function parameters in chronic mobile phone users.

MATERIALS AND METHODS

The study was conducted on 60 medical students (30 males and 30 females) at the Department of Physiology, Government Thiruvarur Medical College, Thiruvarur, from May to July 2018. The study was conducted after obtaining approval from the Institute of Human Research and Ethics Committee of our institution. The subjects were briefed about the study design, and they were informed about their freedom to withdraw from the study at any point of the study. Motivated participants who met the inclusion and exclusion criteria mentioned below were enrolled for the study. The study was conducted in the Human Physiology Laboratory, Government Thiruvarur Medical College after obtaining informed, written consent from the participants.

Inclusion Criteria

The following criteria were included in the study:
1. Healthy volunteers of 18–25 years (both the genders)
2. Smart phone usage >4 h/day for >1 year.

Exclusion Criteria

The following criteria were excluded from the study:
1. Subjects on any medication
2. Subjects who are unable to perform breathing exercise due to reasons like nasal pathology including DNS and sinusitis
3. History of chronic respiratory diseases
4. Smokers
5. Alcoholics
6. Athletes.

Parameters

1. Cognitive function tests
2. Perceived stress score (PSS).

- Trail making test-A (TTA)
- Trail making test-B (TTB)
- Forward digit span (FDS)
- Letter cancellation test (LCT) (commissions, omissions, and time)
- Questionnaire (10 item analysis).

Trail making test tests the speed, attention, mental tracking, and visual search. Time to complete the task (s) as well as error rate gives an idea of the individual's level of attention.[13]

FDS measures the immediate attention and recall. In this, the participant has to listen to the increasing number of digits and repeat them in the same order which was read. Each point reflects successful completion of one trial of a list length.[14]

In LCT, the participant has to either cancel or to indicate by encircling/striking out a particular target stimulus embedded in a larger array of distracter items.[15]

The above-mentioned parameters were recorded at the start of the study and 6 weeks after the training of slow breathing exercises from all the study participants.

Slow Breathing Exercise Training

The subjects were trained for the breathing sequence as per the training protocol mentioned in Pal *et al*.[16] The breathing exercise training was given to the subjects in a well-ventilated room. The exercise was performed in sitting posture with the following steps:

- The subjects were instructed to close left nostril by thumb and to slowly inhale through the right nostril while counting 1–6 in mind which equals to 6 s.
- Then, they were asked to close the right nostril also by the index finger (now both nostrils closed) and to hold the breath for 6 counts. They were instructed to open the left nostril to slowly exhale in 6 s.
- Next, the subjects were instructed to breathe in through the left nostril (with right nostril closed) for 6 counts and then to close the left nostril (now both nostrils closed). Then, they were instructed to hold the breath for 6 s, and following this, they were asked to open the right nostril and exhale over a period of 6 s.

These three steps complete one breathing cycle and it was repeated for about 15 min. The subjects were motivated to practice this technique for 5 days in a week (both morning and evening) under our direct supervision and for the rest of 2 days at their residence. Attendance register was maintained for the training sessions. The data were obtained only from those subjects with attendance of at least 80%.

Statistical Analysis

Data for all the parameters were collected and computerized in Microsoft Excel database as per the study plan. Intergroup

comparison was performed by Student's unpaired *t*-test, and intragroup comparison was performed by Student's paired *t*-test. The statistical analysis was done at 5% level of significance and $P < 0.05$ was considered as statistically significant.

Ethics

The study was conducted after obtaining clearance from the Institute of Human Research and Ethics Committee, Government Thiruvarur Medical College, Thiruvarur, and carries less than minimal risks.

RESULTS

All of the study participants completed the study. There were no dropouts. The average age of the male and female volunteers was 19.9 ± 1.18 and 19.5 ± 1.07, respectively.

Table 1 shows the baseline characteristics of the study participants. When comparing the age and body mass index parameters, there was no statistically significant difference exist between male and female volunteers.

Table 2 shows the comparison of cognitive function parameters at baseline and after 6 weeks of breathing exercise practice. There was significant decrease in trail making A and B ($P < 0.001$), letter cancellation omissions and time (s) ($P < 0.01$ and $P < 0.001$, respectively), and perceived stress ($P < 0.001$) among the male volunteers. Among the female volunteers, trail making A and B ($P < 0.05$) and letter cancellation omissions and time (s) ($P < 0.01$) were significantly decreased. Furthermore, there was a significant increase in FDS ($P < 0.001$) and there was a trend toward a decrease in letter cancellation commissions in both male and female volunteers. Although the improvement in many of the parameters is comparable between male and female participants, it is more pronounced among the male volunteers.

Table 1: Comparison of the baseline characteristics of the study participants (*n*=60): Age and BMI

Parameters	Male (*n*=30)	Female (*n*=30)
Age	19.9±1.18	19.5±1.07
BMI	21.67±4.26	20.11±2.29

BMI: Body mass index, analysis done by Student's unpaired *t*-test. Values are expressed as mean±SD. **P*<0.05, ***P*<0.01, ****P*<0.001, SD: Standard deviation

DISCUSSION

Stress, anxiety, and other mental health problems have become unavoidable companions at all age groups of population.[17] During breathing exercise practice, attention is drawn away from external distracting stimuli when participants intentionally focus on breathing and intend to relax. With regular practice, the participants' concentration is enhanced and the changes in mental processing (e.g., reduction in stress and attention) are rapidly expressed through the autonomic and neuro-endocrine systems. This reorganizes the neural representation within the central nervous system which, in turn, improves bidirectional communication between the cerebral cortex and the autonomic, neuro-endocrine, emotional, and behavioral activation.[18]

In the present study, we observed a significant improvement in the cognitive domains such as attention and memory retention capacity among the study participants. Prefrontal cortex is an important area in the brain that regulates physiological functions by integrating information from ongoing cognitive, emotional processes, and current stress level.[18-20]

A study by Sharma *et al*. in 2014 is in line with our study which compared the slow and fast pranayama practice, reporting that, after 12 weeks of pranayama practice, there was a significant decrease in LCT (time) ($P < 0.001$), number of omissions in LCT ($P < 0.001$), duration of TTA ($P < 0.001$), and duration TTB ($P < 0.001$), in both slow and fast pranayama groups but not in the control group.[20] Our results are consistent with the various previous studies, which reported a significant improvement in the cognitive parameters with regular practice of different yogic breathing techniques.[21-24]

Table 2: Effect of 6 weeks of breathing exercise training (*n*=60) on cognitive function parameters: TTA (s), TTB (s), FDS, LCT-commissions, LCT-omissions, and LCT-time (s)

Parameters	Male (*n*=30)		Female (*n*=30)	
	Pre	Post	Pre	Post
TTA (s)	63.67±17.86	40.53±10.49***	53.6±17.27	37.37±7.48*
TTB (s)	87.33±21.15	55.53±13.79***	70.06±20.59	51.33±7.83*
FDS	5.6±1.04	7.6±0.93***	5.37±0.71	7.4±6.97***
LCT (Commissions)	0.13±0.35	0.03±0.18	0.2±0.41	0.07±0.25*
LCT (Omissions)	1.7±2.07	0.67±0.84	1.93±2.4	0.53±0.73**
LCT time (s)	50.53±6.45	41.53±6.59***	45.58±8.85	40.2±8.57**

TTA: Trail making A (s), TTB: Tail making B (s), FDS: Forward digit span, LCT: Letter cancellation test. Values are expressed as mean±SD. Analysis was done using Students paired *t*-test. **P*<0.05, ***P*<0.01, ****P*<0.001. SD: Standard deviation

We hypothesize that the improvements in cognitive function might have occurred due to reduction in stress level and parasympathetic dominance among the study participants. This particular contribution of breathing exercise to stress reduction might be mediated by the bidirectional vagal system. Vagal afferents from the stretch receptors of the lungs are connected with the nucleus tractus solitarius from which fibers ascend to the limbic areas, thalamus, and anterior cortical areas. The descending projection fibers from the higher centers modulate the autonomic, visceral, and stress arousal mechanisms at different levels of the neuraxis.[25,26]

LIMITATIONS

The study was conducted on healthy young adults only. We have to broaden our future studies with more number of participants and to include patients with psychiatric disorders, cognitive dysfunction, etc.

CONCLUSION

It can be concluded that regular practice of slow breathing exercises for even short duration such as 6 weeks is beneficial for stress reduction and improves cognitive functions. The participants of the study were from various social, environmental, and religious backgrounds. Hence, the results of our study may be widely applicable.

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