

Original Article

Association between Sleep Quality and Different Aspects of Memory along with Assessment of Post Exercise and Post Meditation Effects

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Background and Aims : Sleep is a highly conserved behaviour across animal evolution. The functions of sleep include restoration, memory processing, dreaming etc. Memory is informational processing system with explicit and implicit functioning made up of sensory processor, short term memory and long term memory. The present study was designed to analyse the impact of sleep quality on memory and effect of exercise and meditation on same.

Material and Method : The present study was performed on 110 subjects chosen randomly with no gender bias. In first phase, baseline values were assessed for different sub tests of sleep quality and different aspects of memory. Subjects were divided into two groups with each group including 27 males and 27 females. One group was required to perform moderate intensity exercise and other meditation for one month duration. In the second phase, parameters were again assessed.

Statistical analysis : Paired t-test was used for comparison of memory and sleep components between males and females. Independent t-test was used between baseline and post intervention values of exercise, meditation. Correlation studies were also carried out between sleep quality and different aspects of memory using Pearson correlation coefficient.

Result : Significant and non significant results were obtained on comparison of memory and sleep components in males and females. Total memory score was better in females. Exercise and meditation exhibited statistically significant result on memory and sleep quality.

Conclusion : Good sleep quality is associated with better memory. There is improvement across domains of memory and sleep with meditation and exercise.

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Key words : Daytime dysfunction, Recall, Recognition, Retention, Sleep latency.

Sleep is a naturally recurring state of body and mind characterized by altered consciousness, relative inhibition of sensory activity, reduced voluntary muscles activity during REM sleep along with reduced interactions with the surroundings¹. Memory is the faculty of the brain by which data or information is encoded, stored and retrieved when needed. It is retention of information over time for the purpose of influencing future action².

Meditation is a practice of using mindfulness techniques to train attention, awareness, reach emotionally calm state, enhance peace and for overall well being of an individual³. Physical exercise is any bodily activity that enhances or maintains physical fitness and overall health and wellness⁴.

Memory is not a perfect processor and is affected

Editor's Comment :

- Appropriate sleep quality is required for proper brain functioning including memory.
- Exercise and meditation both helps to improve sleep quality and hence memory.

by many factors. The way in which information is encoded, stored and retrieved can be interrupted. Is memory affected by sleep quality? Is there any difference in memory in males and females? Does moderate intensity physical exercise and meditation has any effect on sleep quality and memory? To answer these intriguing questions, the present study was designed to study the effect of sleep quality on different aspects of memory along with post exercise and post meditation effects.

MATERIAL AND METHOD

Ethical clearance was obtained from the Institutional Ethics Committee. The subjects were briefed about the study and informed written consent for participation in the study was taken.

Sampling :

The present study was performed on 110 subjects chosen randomly with no gender bias in the age group

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of 30-40 years. From the selected subjects, two were non compliant and hence were excluded from the study. From total of 108 subjects, 54 were males and 54 females. A minimum sample size of 108 was calculated taking correlation coefficient between sleep quality and memory $r = -0.266$ and usual constrains Type 1 error $\alpha=0.05$ and Type 2 error $\beta=0.2$ by using MedCalc software.

The sample was collected via simple random sampling method. The subjects with significant medical history, significant drug/ alcohol history, psychiatric illness, clinical diagnosis of sleep or memory disorder, those already engaged in exercise or meditation practices were excluded.

Study design :

The present prospective study was conducted in two phases. In the first phase, informed written consent was taken and the procedure was explained to subjects. Their baseline value was assessed for different sub tests of sleep quality and different aspects of memory. Based on memory scores, they were divided into five groups of excellent memory, average, above average, below average and low level of memory. In each group, different aspects of sleep quality were assessed. They were divided into two groups ($n = 54$ each) with each group having 27 males and 27 females subjects (selected equally from each group based on memory scores). One group was required to perform Moderate Intensity Physical Exercise (MIPE) and other meditation for one month duration. In the second phase, parameters were again assessed and comparison was made between two interventions. Complete anonymity was maintained as honest responses are given. Only educated volunteers were chosen because adequate educational background is required for filling the questionnaires and performing memory test.

Study tool :

Sleep quality was assessed via Pittsburgh sleep quality index⁵ and for memory PGI memory test⁶ was used. The MIPE consisted of walking briskly at the rate of 4 mph⁷ for 30 min/day for 5 days/week (ie, 150 min/week)⁸. The meditation was performed for 15 - 20 min per day⁹. Both exercise and meditation were performed for one month duration.

Statistical analysis :

Comparison of different components of memory and sleep quality between males and females was done using paired t-test. Correlation studies were carried out between sleep quality and different aspects of memory using Pearson correlation coefficient. Independent t-test was used between baseline and

post intervention values of exercise, meditation in males and females. The results were computed as significant at $p<0.05$ level (*), more significant at $p<0.01$ level (**) and highly significant at $p<0.001$ level (***).

RESULT

Out of 108 chosen subjects, 54 were males and 54 females. Different components of memory and sleep quality were studied in males and females (Tables 1a & 1b and Figs 1a & 1b).

For 108 subjects chosen, results were analysed for correlation between sleep quality and different sub tests of memory as depicted in Table 2 and Fig 2.

Based on memory scores, subjects were divided into five groups. Sleep quality components (mean \pm SD) were analysed for different groups of memory in males and females as depicted in Table 3 and Figs 3a & 3b.

After one month practice of MIPE and meditation, results were compared with baseline value for sleep and memory in males and females (Table 4).

DISCUSSION

Memory is considered as the retention, reactivation and reconstruction of the experience with independent

Table 1(a) — Different sub tests of memory in males and females

Parameters	Males (n=54)	Females (n=54)	P value
Memory			
Recent	4.46 \pm 0.71	4.50 \pm 0.72	0.79
Remote	4.61 \pm 1.03	4.81 \pm 1.28	0.36
Mental balance	5.76 \pm 1.20	5.03 \pm 1.42	0.003**
Attention concentration	14.07 \pm 2.88	15.18 \pm 3.2	0.063
Recall			
Immediate	5.38 \pm 1.41	8.01 \pm 2.4	<0.001***
Delayed	4.77 \pm 1.64	6.55 \pm 1.97	<0.001***
Retention			
Verbal			
(a) Similar pairs	3.55 \pm 0.96	8.01 \pm 1.09	<0.001***
(b) Dissimilar pairs	8.01 \pm 1.09	10.05 \pm 2.42	<0.001***
Visual	7.70 \pm 1.19	9.27 \pm 2.00	<0.001***
Recognition	5.00 \pm 1.06	6.57 \pm 1.75	<0.001***
Total	62.83 \pm 11.30	73.50 \pm 16.67	<0.001***

Table 1 (b) — Different components of sleep quality in males and females

Sleep Quality	Males	Females	P value
Subjective sleep quality	1.57 \pm 0.83	1.31 \pm 0.77	0.098
Sleep latency	1.64 \pm 0.78	1.16 \pm 0.94	0.005**
Sleep duration	1.42 \pm 0.86	1.40 \pm 0.85	0.911
Habitual sleep efficiency	1.50 \pm 1.02	1.18 \pm 0.75	0.072
Sleep disturbances	1.38 \pm 0.87	1.16 \pm 0.96	0.214
Use of sleep medications	1.14 \pm 0.87	0.90 \pm 0.93	0.171
Daytime dysfunction	1.18 \pm 0.95	0.87 \pm 0.97	0.092
Global PSQI Score	9.88 \pm 4.12	8.00 \pm 4.55	0.026*

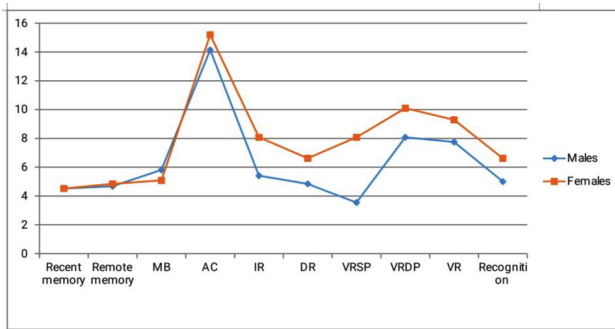


Fig 1a — Different sub tests of memory in males and females

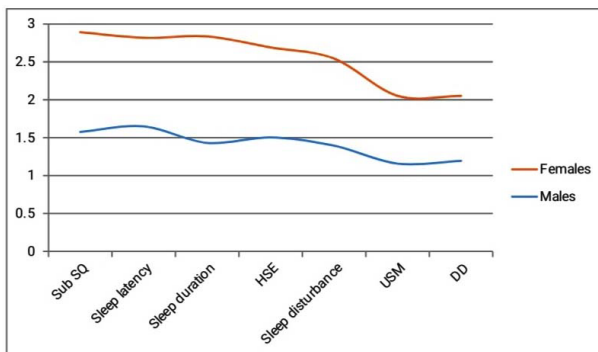


Fig 1b — Different components of sleep quality in males and females

Table 2 — Correlation between sleep quality and different sub tests of memory

Parameters	Males	Females
SQ/ Memory	• 0.75	• 0.87
SQ/MB	• 0.82	• 0.84
SQ/AC	• 0.80	• 0.82
SQ/Recall	• 0.88	• 0.90
SQ/Retention	• 0.85	• 0.83
SQ/Recognition	• 0.88	• 0.89

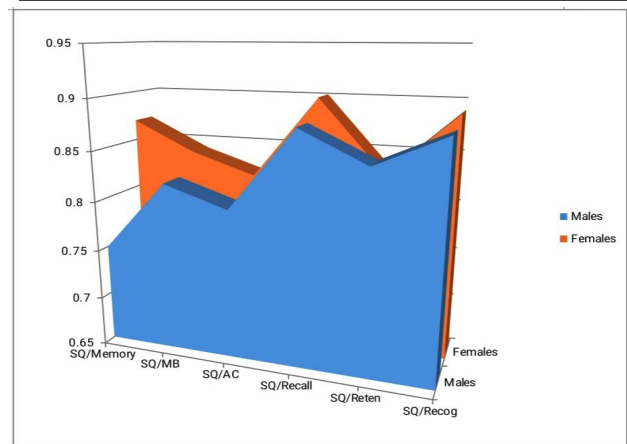


Fig 2 — Correlation between sleep quality and different sub tests of memory

internal representation. During sleep, most profound changes occur in brain. The present study was designed to study the effect of sleep on memory with post exercise and post meditation effects.

Present study reported no significant result in memory and attention concentration scores in males and females that is in corroboration with previous studies¹⁰. Also, in present study mental health and balance was stronger in males compared to females, the results being similar to previous studies¹¹. In the

present study, significant results were obtained for recall, retention and recognition in females compared to males. Previous studies have reported that females outperform males on recall of both positive and negative life events that is probably due to differences in the details of encoding¹², retention indicating long term memory capacity of females¹³ and recognition that was directly related to female scanning behaviour at encoding¹⁴.

Table 3 — Analysis of components of sleep quality in different memory groups

Groups	Subjective sleep quality	Sleep latency	Sleep duration	Habitual sleep efficiency	Sleep disturbance	Sleep medication usage	Daytime dysfunction	Global PSQI score
Excellent memory :								
M (n=10)	0.8 ±0.74	1.1 ± 0.7	1.1 ±0.53	0.8 ±0.6	0.5 ±0.5	0.2 ±0.4	0.1 ±0.3	4.6 ±1.11
F (n=20)	1.0 ±0.63	0.85 ±0.72	1.0 ±0.77	0.7 ±0.45	0.35 ±0.47	0.2 ±0.40	0.25 ±0.43	4.3 ±1.05
Above average :								
M (n=14)	1.12 ±0.55	1.28 ±0.69	0.85 ±0.63	0.78 ±0.77	0.92 ±0.59	1.0 ±0.53	1.0 ±0.65	7.07 ±1.09
F (n=21)	1.09 ±0.52	0.76 ±0.60	1.28 ±0.62	1.09 ±0.52	1.19 ±0.66	0.95 ±0.72	0.71 ±0.69	7.09 ±0.92
Average memory :								
M (n=22)	1.86 ±0.69	2.0 ±0.60	1.54 ±0.72	2.04 ±0.92	1.68 ±0.63	1.27 ±0.80	1.36 ±0.82	11.81±1.77
F (n=5)	1.6 ±0.48	1.8 ±0.74	1.6 ±0.48	1.6 ±0.48	2.4 ±0.48	1.6 ±1.01	1.4 ±0.8	12.0 ±1.41
Below average :								
M (n=6)	2.16 ±0.37	1.83 ±0.68	2.33 ±0.74	2.0 ±0.57	2.5 ±0.5	2.16 ±0.37	2.33 ±0.47	15.33±0.94
F (n=4)	2.25 ±0.43	2.5 ±0.5	2.75 ±0.43	2.25 ±0.43	2.25 ±0.43	2.0 ±0.70	2.25 ±0.43	16.25 ±0.82
Low level :								
M (n=2)	3.0 ±0.0	2.5 ±0.5	3.0 ±0.0	2.5 ±0.5	2.5 ±0.5	2.5 ±0.5	2.5 ±0.5	18.5 ±0.5
F (n=4)	2.75 ±0.25	2.75 ±0.43	2.5 ±0.5	2.5 ±0.5	2.5 ±0.5	2.25 ±0.43	2.75 ±0.43	18.0 ±0.70

M is males and F is females

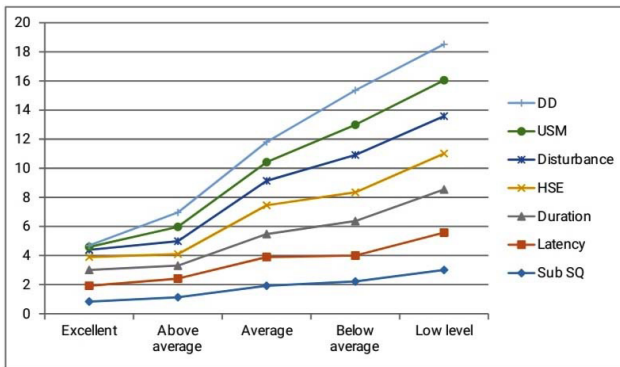


Fig 3a — Analysis of components of sleep quality in different memory groups in males

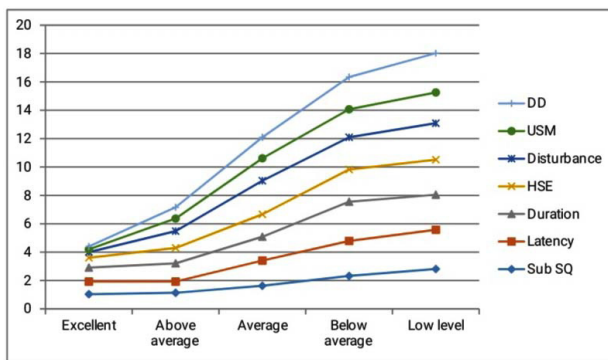


Fig 3b — Analysis of components of sleep quality in different memory groups in females

Present study reported that overall sleep quality was better in females than males. Previous studies have reported that women have better sleep quality compared with men, with longer sleep times, shorter sleep onset latency and higher sleep efficiency. Despite this, women have more sleep related complaints compared to men¹⁵.

Present study reported significant and negative correlation between sleep quality and different aspects of memory in males and females. Similar study concluded that sleep quality was associated with updating in working memory only when working memory demands were relatively high and with recall.^[16] Studies have also reported similar and significant association between sleep quality and psychological well being¹⁷; between sleep quality and attention concentration¹⁸. It was also reported that poor sleep quality was associated with significantly lower recall at the longer retention period (30-46 days) but not at shorter ones (2-15 days)¹⁹.

In the present study, sleep quality components were studied in different memory groups. Improved memory scores were observed with better sleep quality (as depicted by decrease in score). Previous studies have reported similar result of significant relation

Table 4 — Effect of exercise and meditation on parameters in males and females

Parameters	Males	Females	p value
Exercise :			
Sleep			
Baseline	9.96 ± 4.08	7.92 ± 4.70	0.095
Postexercise	5.37 ± 3.46	3.77 ± 3.65	0.106
Memory			
Baseline	62.77± 11.77	73.70± 16.41	0.007**
Post Exercise	72.77± 11.42	85.66± 16.75	0.002**
Meditation :			
Sleep			
Baseline	9.81 ± 4.25	8.07 ± 4.48	0.149
Post Spirituality	6.77 ± 3.78	5.66 ± 4.08	0.304
Memory			
Baseline	62.88 ± 11.04	73.29 ± 17.24	0.011*
Post Spirituality	73.03 ± 11.14	85.03 ± 17.39	0.004**

between sleep quality and memory signifying that poor sleep quality and long sleep duration were linked to low memory performance²⁰. Studies have reported that longer sleep latencies and poor sleep depth significantly predicted poorer next day prospective memory reaction time²¹. Scientists were of the view that habitual sleep quality was directly linked to memory recall of content, time and details of event¹⁹. Previous studies have reported that sleep deprivation and disturbances lead to impairment in working memory capacity due to decrease in speed of processing information²². With the use of sleep medications, memory deficits were reported²³. Excessive daytime sleepiness is a predictor of subjective memory impairment and such individuals are potential candidates for interventions related to dementia care²⁴.

In the present study, there was improvement in sleep quality and memory scores in both males and females after exercise and meditation interventions. However, the sleep quality scores were not significant on comparison between males and females at baseline and post intervention level. Memory scores were better in females both at baseline and post intervention level. Previous studies have reported similar results of great impact of physical training on working memory and executive attention²⁵; and positive interrelationship between sleep and exercise.^[26] Also, increase in memory test scores²⁷ and positive effect on sleep quality²⁸ post meditation have been reported, thus making way for mindfulness based interventions for greater benefits and treating aspects of sleep disturbances.

Limitation of Study : The result of the study maybe specific to the selected age group and educational background of the subjects. However, the study gave us important insight into the fact that sleep and memory are correlated and that exercise and meditation both had positive impact on them.

CONCLUSION

Memory shares positive relationship with sleep quality concluding that better sleep quality is associated with more effective memory. Overall memory and sleep quality was better in females. Meditation and exercise both had positive effect on sleep quality and memory in both sexes. Memory scores were better in females at post exercise and post meditation interventions. There was no significant difference in sleep quality scores in males and females post interventions with females having better tendency for good sleep quality than males.

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