

Effect of body mass index on physical self concept, cognition & academic performance of first year medical students

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Background & objectives: The relationship between obesity and self perception, particularly in children and young adults has important implications for physical and psychosocial health and well-being. A better understanding of this relationship could help target psychology services and public health strategies more effectively. The aim of the present study was to assess the effect of body mass index (BMI) on physical self concept and cognition of the first year medical undergraduate students in a medical college in north India. The relationship between physical self concept and academic performance and presence of any gender differences were also examined.

Methods: The study was carried out on 18-21 yr old first year M.B.B.S. students of Maulana Azad Medical College, New Delhi, India. Physical self concept was assessed using short version of Physical Self Description Questionnaire (PSDQ-S) which is a psychometrically strong instrument for measuring multiple dimensions of physical self-concept. Cognition was assessed by P300 evoked potentials and academic performance was evaluated on the basis of marks obtained in anatomy, physiology and biochemistry subjects.

Results: There was no association between BMI and physical self-concept or between BMI and cognition. Gender differences on physical self-concept were also insignificant. No correlation was seen between physical self-concept and academic performance.

Interpretation & conclusion: The present results suggest that negative consequences of high body mass index on physical self-concept and cognition are not seen in young adults. It may be that academic achievement nullifies the effect on physical self-concept and the effect on cognition accumulates as the age progresses, therefore, appears later in life.

Key words Academic performance - body mass index - cognition - PSDQ-S

The prevalence of obesity is increasing worldwide and the major causative factors are related to lifestyle changes occurring due to rapid socio-economic transition. Reduced physical activity at work due to mechanization, improved motorized transport,

preferences for viewing television and video games during leisure time and consumption of fast food and sweetened carbonated drinks have resulted in positive energy balance in most of the Asian countries^{1,2}. As youths move through adolescence, their participation

in physical activity declines markedly^{3,4}. The immediate risks of obesity for physical health are well established. However, studies based predominantly on western research have shown that obesity in childhood may have adverse effects on cognitive performance and self concept development⁵. Shavelson *et al*⁶ have defined self concept as an individual's perception of self formed through experience with environment, interactions with significant others and attributions of his/her own behaviour. It is multi-dimensional and hierarchically organized. Self-esteem or general self-concept is positioned at the apex and is divided into academic (English and Maths) and non-academic (Physical, social and emotional) components⁶. Marsh and Craven⁷ have shown that academic achievement though systematically related to academic self concept is nearly uncorrelated (or even negatively related) to non academic components of self concept. In another study, Crandall⁸ has observed that individuals are discriminated against on the basis of weight; that this discrimination generalizes over race, gender, age and socio-economic status, and that the associated stigmatization influences the individuals self-perceptions and perceptions by significant others.

Based upon Shavelson's model of self-concept, Marsh *et al*⁹ developed the Physical Self Description Questionnaire (PSDQ) in which nine components specific to physical self-concept (strength, body fat, activity, endurance, sports competence, co-ordination, health, appearance and flexibility) and two general components (global physical self concept, and global esteem) are measured. The PSDQ is a comprehensive, valid, stable and consistent instrument designed to measure multiple dimensions of physical self-concept.

There is a growing evidence that obesity is associated with impaired cognitive function including executive function, attention and memory not only in patients with co-morbid medical conditions like cerebrovascular pathology, hypertension and diabetes but also in healthy subjects¹⁰. The mechanisms underlying this effect are not understood. The P300 event-related potential (ERP) reflects neuroelectric activity related to cognitive processes such as attention allocation and activation of immediate memory. The P300 latency time is generally accepted as a measure of speed of cognitive processing, and its amplitude to reflect the number of neurons allocated to the eliciting task^{11,12}. It is clinically used as an index of cognitive function.

Given that obesity and self perception are both amenable to intervention, an examination of the nature

of relationship between obesity and self-perception has important implications for physical and psychosocial health and well-being. The present study was undertaken to assess the amplitude and latency of P300 along with PSDQ-S in 18-21 yr old first year undergraduate medical (M.B.B.S.) students to determine if any relationships exist between the body mass index (BMI) and physical self concept, gender and physical self concept, BMI and cognition, and physical self concept and academic performance.

Material & Methods

The study was conducted in the department of Physiology, Maulana Azad Medical College, New Delhi, India, during December 2011.

Subjects: The study population consisted of 30 first year MBBS students of both sexes belonging to 2011-2012 batch of Maulana Azad Medical College, New Delhi. The height and weight of each student was recorded and BMI was calculated as the weight in kilograms divided by the square of height in meters. Subjects were divided into two groups depending on new BMI cut off point for Indian population¹³. All obese students with BMI ≥ 25 kg/m² (n=30) were considered to form the study group. The students with normal weight and BMI of 18 to 22.9 kg/m² (n=30) were selected randomly to form the control group. There were only a few students with BMI in the range 23-24.9 kg/m². Therefore, the overweight category was excluded and the study was restricted to normal weight and obese categories. The average age for control and study groups was 18.58 ± 0.67 and 18.81 ± 1.11 yr, respectively.

Measuring instruments: The physical self concept was evaluated by using PSDQ-S and cognition by P300 event related potential (ERP). PSDQ-S is a short version of PSDQ with all the psychometric strength of the longer version plus the advantage of a reduced length from 70 to 47 items¹⁴. Each item is a simple declarative statement in which responses vary from false [1] to true [6] on a 6 point Likert Scale. The scoring for the negatively worded items [8,11,17,19,22,25,29,30,33,39,46,47] was reversed. Total score of the PSDQ-S ranged from 47 to 282. The scoring was done using multi-dimensional profile as self concept is better captured by multi-dimensional profile of self-concept scores rather than a single self-esteem score¹⁵.

Procedure: Written informed consent was obtained from the students and PSDQ was administered to all the students on a single occasion. Confidentiality of subject's information and data were maintained. The questionnaires were distributed during class time and

instructions delivered verbally to complete the PSDQ-S sincerely and no discussion was allowed throughout the test. Ethical clearance was obtained from the Institutional ethics committee.

Event related potentials recording: ERPs are generated by subject's response to auditory, visual or other sensory stimuli. Auditory stimuli were used in this study. An auditory cognitive ERP is generated by playing a baseline series of frequently occurring rhythmic auditory stimuli for a subject and then presenting secondary auditory stimuli (rare stimulus) at random. The subject mentally counts the secondary auditory "oddball" (rare) stimuli, and this specific intellectual function generates a discrete waveform of cognitive evoked response called the P300 component since its latency is about 300 ms (millisecond) after the stimulus¹⁶. EB Neuro machine (Evoked potential measuring system- Galileo NT) supplied by Firenze, Italy was used to record the evoked potentials. The evoked potentials were recorded as per the guidelines of International Federation of Clinical Neurophysiologists (IFCN)¹⁷. The examination was conducted under standardized conditions in all the subjects. The subjects assumed a comfortable position in a standard audiometric, sound proof, and air conditioned room so that they were relaxed. The method was fully explained to all the subjects to get the best compliance. During the P300 recording session subject was instructed to fixate his/her eyes on a particular spot on the ceiling in order to avoid artefacts due to eye movements and improve his concentration and attention to target stimulus. Silver/silver chloride disc electrodes were used. Foremost the scalp sites were cleaned with a cotton pad moistened with alcohol and then rubbed with an appropriate amount of Neuprep skin prepping jelly to abrade the skin for impedance reduction. The disc electrodes with 10-20 EEG conducting paste were applied to the sites. The active electrodes were placed using the 10-20 international system on Fz, Pz and Cz sites referred to linked earlobes with a forehead ground. Electrode to skin impedance was kept below 5 kilohms. P300 was measured in response to random application of two types of stimuli. "Odd-ball" acoustic paradigm was adopted, 200 stimuli were presented of which 40 were the rare or the target stimuli; 80 per cent of the tones were frequent (500 Hz stimuli) and 20 per cent were rare (2000 Hz stimuli), randomly received by patients. Acoustic stimuli were of 80 dB each. Linear tone with a starting condensation phase with a plateau phase of 100ms, rise/fall of 10ms and a rate of once every one second was used. The signals were in phase at the two

ears. The Galileo NT settings were selected so as to filter the evoked responses to the frequent and the rare stimuli with a band pass of 0.1-20 Hz and averaged simultaneously for 40 responses.

The P300 wave was identified as the largest positive peak occurring for all electrode sites with latency more than 250ms. The latency and amplitude of the waveform were recorded. The latency was calculated from the point of stimulation. It has already been demonstrated by other researchers that the quality of cognitive response is interrelated to amplitude and latency of the P300 wave, with higher amplitudes and shorter latencies being linked with improved cognitive function¹⁸.

Academic performance was evaluated on the basis of marks obtained in all the tutorials, completion tests and first terminal exams of Anatomy, Physiology and Biochemistry subjects.

Statistical analysis: Descriptive statistics were used to calculate the means and standard deviations of the BMI, P300 amplitude and latency and the eleven PSDQ subscales scores for the subjects. Pearson's product moment correlations were used to examine the relationships between BMI and P300 amplitude and latency and also between BMI and scores on the PSDQ with significance set at <0.05. Independent t-tests were employed to examine gender differences and also the differences between obese and non-obese subjects. All analyses were carried out on SPSS Version 17 (SPSS Inc. Chicago, IL). The Cronbach's alpha coefficients for this sample were found to be adequate for all eleven subscales.

Results

The characteristics of the study and control groups are summarized in Table I. The mean weight and BMI of

Table I. Characteristics of study and control population

| | Control group | Study group |
|---|---------------|----------------|
| Number of Subjects | 30 | 30 |
| Age (yr) | 18.58 ± 0.67 | 18.81 ± 1.11 |
| Male : Female | 15 : 15 | 16 : 14 |
| Height (cm) | 165.92 ± 7.13 | 166.50 ± 8.35 |
| Weight (kg) | 56.04 ± 8.82 | 83.50 ± 12.83* |
| BMI (kg/m ²) | 20.46 ± 2.82 | 30.12 ± 2.85* |
| *P<0.05 compared to control group Values are mean ± SD | | |

Table II. Descriptive statistics and internal consistency reliability for short version of Physical Self Description Questionnaire (PSDQ-S)

| Scale PSDQ-S | Control group (n=30) | $\alpha^{\#}$ | Study group (n=30) | $\alpha^{\#}$ | P value | Control group (n=30) | | P value | Study group (n=30) | | P value |
|---------------------|-------------------------|---------------|-----------------------|---------------|---------|-------------------------|-------------------|---------|-----------------------|----------------------------|---------|
| | | | | | | Males (n=15) | Females (n=15) | | Obese males (n=16) | Obese females (n=14) | |
| Action | 12.83 ± 7.11 | 0.80 | 13.81 ± 4.46 | 0.79 | 0.66 | 12.63 ± 7.23 | 13.25 ± 7.93 | 0.89 | 16.33 ± 3.88 | 12.30 ± 4.24 | 0.07 |
| Appearance | 16.25 ± 4.61 | 0.97 | 14.44 ± 5.21 | 0.86 | 0.35 | 15.00 ± 5.13 | 18.75 ± 2.06 | 0.10 | 14.00 ± 3.41 | 14.70 ± 6.22 | 0.77 |
| Body fat | 20.75 ± 4.16 | 0.85 | 9.06 ± 3.3 | 0.73 | 0.00* | 20.88 ± 4.36 | 20.50 ± 4.36 | 0.89 | 11.00 ± 2.76 | 7.90 ± 3.14 | 0.06 |
| Coordination | 23.67 ± 5.1 | 0.89 | 21.75 ± 4.36 | 0.75 | 0.29 | 23.38 ± 5.66 | 24.25 ± 4.50 | 0.77 | 19.50 ± 2.17 | 23.10 ± 4.86 | 0.06 |
| Endurance | 16.83 ± 4.61 | 0.89 | 11.88 ± 5 | 0.74 | 0.01* | 17.63 ± 5.10 | 15.25 ± 3.50 | 0.37 | 11.33 ± 5.01 | 12.20 ± 5.25 | 0.74 |
| Flexibility | 16.83 ± 3.81 | 0.79 | 15.31 ± 4.05 | 0.80 | 0.32 | 15.88 ± 4.19 | 18.75 ± 2.22 | 0.15 | 13.50 ± 3.02 | 16.40 ± 4.33 | 0.13 |
| Health | 24.83 ± 4.61 | 0.97 | 24.88 ± 4.21 | 0.79 | 0.98 | 23.88 ± 5.49 | 26.75 ± 0.50 | 0.18 | 25.50 ± 3.08 | 24.50 ± 4.88 | 0.62 |
| Sport competence | 14.00 ± 6.35 | 0.94 | 12.44 ± 4.07 | 0.78 | 0.43 | 14.88 ± 6.47 | 12.25 ± 6.65 | 0.53 | 14.00 ± 3.29 | 11.50 ± 4.35 | 0.21 |
| Strength | 13.42 ± 3.82 | 0.92 | 15.50 ± 3.95 | 0.76 | 0.17 | 12.13 ± 2.70 | 16.00 ± 4.83 | 0.21 | 15.67 ± 2.66 | 15.40 ± 4.70 | 0.88 |
| Global physical | 18.00 ± 4.86 | 0.94 | 12.38 ± 4.83 | 0.79 | 0.01* | 16.38 ± 5.13 | 21.25 ± 2.06 | 0.06 | 11.33 ± 4.97 | 13.00 ± 4.90 | 0.52 |
| Global esteem | 22.92 ± 3.85 | 0.77 | 21.44 ± 5.81 | 0.78 | 0.45 | 23.13 ± 3.83 | 22.50 ± 4.43 | 0.81 | 20.00 ± 3.52 | 22.30 ± 6.86 | 0.39 |

#Cronbach's Reliability Coefficient, *P<0.05 (P values for two tailed t test)

Table III. Evoked potentials in the study and control groups

| | Control group (n=30) | | Study group (n=30) | | Study vs Control |
|--|----------------------|---------------------------------|--------------------|---------------------------------|------------------|
| | Mean ± SD | P value of correlation with BMI | Mean ± SD | P value of correlation with BMI | P value |
| P ₃₀₀ Latency (ms) F _z | 286.67 ± 25.96 | 0.30 | 276.63 ± 25.96 | 0.68 | 0.32 |
| P ₃₀₀ Latency (ms) c _z | 277.83 ± 25.19 | 0.97 | 274.25 ± 25.85 | 0.8 | 0.72 |
| P ₃₀₀ Latency (ms) P _z | 285.83 ± 33.78 | 0.54 | 285.00 ± 24.11 | 0.07 | 0.94 |
| P ₃₀₀ Amplitude (µV) F _z | 8.93 ± 3.41 | 0.09 | 9.33 ± 6.22 | 0.51 | 0.84 |
| P ₃₀₀ Amplitude (µV) C _z | 10.28 ± 5.77 | 0.25 | 12.91 ± 4.74 | 0.81 | 0.2 |
| P ₃₀₀ Amplitude (µV) P _z | 7.62 ± 4.34 | 0.26 | 10.61 ± 4.02 | 0.60 | 0.07 |

P values are for two-tailed t-test

the study group were significantly higher ($P < 0.05$) than that of control group. The scores of eleven subscales of PSDQ-S, comparison of scores between the study and control group and between obese males and females of the study group are presented in Table II. Except for body fat, endurance and global physical all other subscales did not differ significantly between the two groups (study vs control). No differences were found for the physical self-concept scales between males and females in both study and control groups.

The findings of cognitive evaluation are summarized for both groups in Table III. There was no correlation between BMI and the P300 amplitude and latency.

For comparison, correlations among the PSDQ-S sub-scales and BMI, academic performance and P300 amplitude and latency are presented separately for control and study groups in Table IV.

Discussion

The study was designed to examine the relationships between BMI and cognition and between BMI and physical self-concept. The effect of gender differences on physical self-concept and the relationship between physical self-concept and academic performance were also studied.

In concurrence to a previous study on self-concept research¹⁹, our results have shown small declines in the scores of the 11 subscales of physical self-concept in the obese subjects. However, this trend was found to be significant only for the endurance, body fat and the global physical subscales. There were no significant differences between the two groups in terms of global self esteem. These results demonstrate that being obese *i.e.* the presence of a socially undesirable characteristic has little negative consequence on the self perceptions of Indian students. Similar results have been reported

earlier in a study carried out on Chinese students aged 8-15 yr¹⁵. The authors have suggested that apparently the negative stigma associated with obesity varies from culture to culture and, therefore, there are no negative consequences in Chinese students. Studies based predominantly on western research have shown that obese children and adolescents have significantly lower self esteem^{20,21}.

BMI showed no significant correlation with the 11 subscales of physical self-concept. This further suggests that factors associated with self esteem may be related to culture and, therefore, obesity apparently does not have the socially undesirable connotations for Indian youth. The pattern of obesity stigmatization is not uniform across race and gender. A study by Michelle and Julie²² indicates that standards and ideals of weight differ among White and Black Americans. They have concluded that the consequences of obesity may differ by race as a result of cultural differences in ideal body size and obesity stigma. Similarly, Lee and Lee²³ have shown that the desire for thin body varies as a function of location. They carried out a research on high school girls in three cities which differed substantially in the degree of westernization and modernization (Hong Kong, Shenzhen and rural Hunan) and found that the desire for a lower BMI was highest in the most modern city (Hong Kong) and lowest in the least modern city (rural Hunan)²³.

Marsh *et al*²⁴ reported reciprocal effects between self-concept and accomplishment *i.e.* self-concept is both a cause of subsequent accomplishments and an effect of prior accomplishments. Our study subjects were first year undergraduate medical students of a prestigious medical college which in itself is a big academic achievement. It may be inferred that academic achievement has nullified the negative

Table 4. Correlations of PSDQ-S subscales with BMI, P300 and academic performance among normal weight and obese first year medical student

| | 1. BMI | 2. Pzamp | 3. Pzlat | 4. Czamp | 5. Czlat | 6. Fzamp | 7. Fzlat | 8. Co-ordination | 9. Sport competence | 10. Appearance | 11. Strength | 12. Flexibility | 13. Endurance | 14. Health | 15. Action | 16. Body fat | 17. Global esteem | 18. Global physical | 19. Total score | 20. Academic performance | |
|--------------------------|--------|----------|----------|----------|----------|----------|----------|------------------|---------------------|----------------|--------------|-----------------|---------------|------------|------------|--------------|-------------------|---------------------|-----------------|--------------------------|---------|
| 1. BMI | 1 | 0.1396 | 0.4642 | 0.0645 | -0.0674 | 0.1766 | -0.1123 | -0.4513 | -0.1994 | -0.4378 | 0.0216 | -0.0972 | -0.121 | 0.1298 | 0.2743 | -0.2693 | -0.3109 | -0.3554 | -0.2752 | -0.0274 | |
| 2. Pzamp | | 1 | 0.2402 | 0.52 | 0.2613 | 0.4009 | 0.106 | -0.2875 | -0.0495 | 0.2862 | -0.3488 | -0.4015 | -0.0585 | -0.5434 | 0.2344 | 0.1932 | 0.3127 | 0.2516 | -0.0265 | -0.3495 | |
| 3. Pzlat | | | 1 | -0.041 | 0.3966 | 0.0074 | 0.3973 | -0.1269 | 0.1041 | -0.0175 | -0.2464 | -0.1716 | -0.2674 | 0.0394 | 0.3044 | 0.2525 | 0.3299 | 0.1603 | 0.0581 | 0.0061 | |
| 4. Czamp | | | | 1 | -0.1413 | 0.7856 | -0.1573 | -0.3504 | 0.1931 | 0.0027 | -0.3328 | -0.486 | -0.1394 | -0.3452 | 0.0951 | 0.1284 | 0.0519 | -0.2795 | -0.2032 | -0.0938 | |
| 5. Czlat | | | | | 1 | -0.3859 | 0.8831 | -0.0219 | 0.1778 | 0.2375 | -0.1306 | 0.0413 | 0.229 | -0.2289 | 0.1808 | 0.3535 | 0.4389 | 0.6476 | 0.2986 | -0.3665 | |
| 6. Fzamp | | | | | | 1 | -0.5007 | -0.4026 | 0.0521 | -0.2238 | -0.2497 | -0.4415 | -0.265 | -0.0712 | 0.1973 | 0.1054 | -0.2777 | -0.4265 | -0.3052 | -0.0332 | |
| 7. Fzlat | | | | | | | 1 | -0.1281 | 0.0023 | 0.1879 | -0.3062 | -0.1036 | 0.0294 | -0.3458 | -0.091 | 0.1912 | 0.419 | 0.5521 | 0.09 | -0.2509 | |
| 8. Coordination | | | | | | | | 1 | 0.2962 | 0.536 | 0.6505 | 0.6135 | 0.4721 | 0.2852 | -0.0403 | 0.08 | 0.4233 | 0.369 | 0.6803 | 0.2675 | |
| 9. Sport competence | | | | | | | | | 1 | 0.3834 | 0.1723 | 0.2708 | 0.455 | 0.4475 | 0.6004 | 0.6745 | 0.412 | 0.188 | 0.6866 | -0.1308 | |
| 10. Appearance | | | | | | | | | | 1 | 0.2541 | 0.1795 | 0.5718 | 0.0391 | 0.1843 | 0.4366 | 0.8033 | 0.7502 | 0.7799 | -0.2353 | |
| 11. Strength | | | | | | | | | | | 1 | 0.5237 | 0.5767 | 0.4531 | 0.0738 | 0.0845 | -0.048 | 0.1154 | 0.5306 | -0.0873 | |
| 12. Flexibility | | | | | | | | | | | | 1 | 0.7002 | 0.5193 | 0.2769 | -0.2316 | 0.0505 | 0.2189 | 0.5858 | 0.2145 | |
| 13. Endurance | | | | | | | | | | | | | 1 | 0.3505 | 0.411 | 0.1985 | 0.2772 | 0.551 | 0.8062 | -0.3551 | |
| 14. Health | | | | | | | | | | | | | | 1 | 0.613 | 0.1111 | -0.0331 | -0.155 | 0.4881 | 0.107 | |
| 15. Action | | | | | | | | | | | | | | | 1 | 0.682 | 0.9032 | 0.5666 | 0.0551 | 0.7042 | |
| 16. Body fat | | | | | | | | | | | | | | | | 1 | 0.4269 | 0.4467 | 0.5054 | -0.576 | |
| 17. Global esteem | | | | | | | | | | | | | | | | | 1 | 0.0991 | 0.0829 | 0.0458 | 0.0246 |
| 18. Global physical | | | | | | | | | | | | | | | | | | 1 | 0.676 | 0.6508 | 0.0267 |
| 19. Total score | | | | | | | | | | | | | | | | | | | 1 | 0.6478 | 0.2539 |
| 20. Academic performance | | | | | | | | | | | | | | | | | | | | 1 | -0.1832 |
| | | | | | | | | | | | | | | | | | | | | | 0.5134 |
| | | | | | | | | | | | | | | | | | | | | | 0.0511 |
| | | | | | | | | | | | | | | | | | | | | | 0.8746 |

Correlations above the diagonal (Study group), Below the diagonal (Control group). In each cell, upper value is r and lower value is p; amp, amplitude; lat, latency

impact, if any, of obesity on self concept and hence there are no differences between the obese and non-obese medical students. The absence of significant association between BMI and self perception could be a consequence of small sample size.

No gender differences have been observed in the overall self-concept. However, it was observed that females have scored more on co-ordination and flexibility while males have scored more on sports competence. These findings support the earlier views that there was no evidence for sex differences in overall self-concept at any age level, however, sex differences do exist in specific components of self-concept²⁵.

In the present study, no association between BMI and cognition was established. There were no significant differences in the P300 amplitude and latency at Fz, Cz and Pz sites between the obese and non-obese students. This was in contrast to a previous prospective study which has shown that those with a higher BMI in midlife were at a higher risk of cognitive impairment later in life²⁶. The authors have suggested that perhaps obesity leads to thickening and hardening of cerebral blood vessels and the development of insulin resistance²⁵. In another study, Raji *et al*²⁷ have reported that BMI > 30 kg/m² was associated with atrophy in frontal lobes, the anterior cingulate gyrus, hippocampus and thalamus as compared to normal weight individuals. The reason for discrepancy in the present study may be due to the young age (18-21 yr) of subjects, as the steepest decline in cognition occurs in late middle age. It appears that the effect of obesity on cognition accumulates over the adult life course and, therefore, it is important to use a life-course approach to study the association between BMI and cognition²⁸. Another limitation for the present study was that the physical activity was not measured; thus, it is not possible to rule out its contribution, particularly because physical activity has already been shown to have a beneficial effect on cognition²⁹.

No significant correlation was found between the 11 subscales of physical self-concept and academic performance. Alexander³⁰ and Castor³¹ in two independent separate studies have shown that non-academic self-concept does not correlate significantly with measures of academic performance whereas academic self-concept strongly correlates with academic achievement. It seems that certain groups of people may be less susceptible to experiencing academic decline due to being obese. However, obese females exhibited higher academic performance than obese males. This was consistent with the earlier findings

which documented gender differences in relation between obesity levels and academic achievement³².

In conclusion, no association was observed between BMI and physical self-concept and also between BMI and cognition. Gender differences on physical self-concept were also insignificant. Further research is needed in large number of subjects of different age groups (preadolescents, adolescents and adults) and economic/professional groups to evaluate the generalizability of present results.

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