Impact of iron levels on cognitive functioning among dental students of Udaipur, Rajasthan (India) [v1; ref status: awaiting peer review, http://f1000r.es/T4aiJR]

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ABSTRACT Health and intelligence are two closely related aspects of human well being. Nutrition, including iron levels, affects cognitive function and thereby may influence the occupational performance of an individual. Inadequate nutrition during adulthood may lead to decreased work efficiency, poor exercise tolerance and increased susceptibility to infections. The profession of dentistry requires keen recognizing abilities and decision making skills as well as ample physical stamina, which may be impaired in a state of malnourishment. Keeping this in view, this study was designed to assess the possible impact of iron levels on cognitive function among dental students. In this study 206 dental students (150 females and 56 males) participated and their cognitive functioning was determined by answering a questionnaire. The questionnaire evaluated the confidence level, work pattern and the tendency to be distracted by the physical environment of the study participants. Iron status was determined by estimating the haemoglobin level of the individuals. Each of the three cognitive traits was correlated with haemoglobin levels. The results revealed that that majority of dental students had good levels of confidence, work patterns with a low level of restriction and low levels of distraction by the physical environment. No significant correlations were found between any of the cognitive parameters and haemoglobin levels (p value>0.05) in female participants. In male participants significant correlations were found in two out of three cognitive functioning tests, confidence levels and work pattern (p<0.05). The results of this study suggest that these three cognitive functions may not be influenced by haemoglobin levels in females and may be slightly or, due to the small male sample size which may have confounded the results, not influenced by haemoglobin in males.

Introduction

Nutrition is a fundamental pillar of human life[1]. The influence of nutrition on cognitive functioning may in turn influence the occupational performance of an individual[1,2]. Several studies in this regard have been done among growing children[3–11]. For instance in a study conducted by Gabr M. Sayed *et al* to assess the magnitude of malnutrition among pre-school and primary school children and its impact on health, intellectual development and scholastic achievement the results yielded a positive correlation between nutritional status and intellectual development as well as scholastic achievement[4].

One partially accepted theory is that malnutrition is associated with low iron levels and that anaemia, via cerebral hypoxia and other possible mechanisms, has a major negative influence on cognitive function[1]. But nutritional deficiencies and their adverse outcomes are not age limited. Inadequate nutrition during adulthood may lead to decreased work efficiency, poor exercise tolerance and increased susceptibility to infection[2].

Studies related to the impact of hemoglobin levels on mental functioning in adult populations are few and the outcomes are inconclusive[12,13]. Keeping this in view, the present study was

designed to assess the possible impact of iron nutritional status on cognitive functioning among dental students between the ages of 18–25 years as the profession of dentistry requires keen recognizing abilities, decision making skills as well as ample physical stamina, which may be impaired by low iron/hemoglobin levels thereby influencing one's ability to be a successful dentist.

Materials and methodology

A total of 206 students, 150 (73%) females and 56 (27%) males studying dentistry at Udaipur, Rajasthan, India, volunteered for the study. The brain functioning of the individuals was determined by answering a questionnaire.

The questionnaire was adapted from the Inventory of Barriers to Creative Thought and Innovative Action[14]. This test identified and measured the degree of inhibitors affecting a person's ability to create and innovate. The questionnaire consisted of thirty-six items, set up in a sixpoint Likert-scale format. This test identifies and measures barriers in six different categories. Out of these six traits the scores identifying barriers related to 'need for conformity', 'ability to abstract' and 'ability to use systematic analysis' were not considered. Only scores of three traits were included which consisted of barriers related to self confidence, task achievement and ease of distraction by the physical environment. Each trait was graded according to the scores obtained and a grading system was introduced to classify each trait into different categories (Tables 1, 2 and 3).

Questionnaire: Adapted inventory of barriers to creative thought and innovated action

1 Questionnaire

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Table 1 Questionnaire scoring and grading system used to determine confidence level.

Score	Grade	Inference
31–36	1	Total Lack Of Confidence
25–30	2	Less Confident
19–24	3	Somewhat Confident
13–18	4	Confident
Less than 13	5	Highly confident

Table 2 Questionnaire scoring and grading system used to determine work pattern.

Score	Grade	Inference
31–36	1	Highly Restricted
25–30	2	Restricted
19–24	3	Somewhat Restricted
13–18	4	Less Restricted
6–12 (Less than 13)	5	Non Restricted

Table 3 Questionnaire scoring and grading system to determine physical distraction.

Score	Grade	Inference
31–36	1	Highly Distracted
25–30	2	Distracted
19–24	3	Somewhat Distracted
13–18	4	Less Distracted
Less than 13	5	Not At All Distracted

The second stage in the study involved estimation of haemoglobin levels of the individuals. The haemoglobin level was determined by Sahli's method. In this method the fingertip was first sterilized using rectified spirit. A quick prick was made to get a moderately large drop of blood. The blood was aspirated in the haemoglobin pipette up to the 20 cubic millimeter mark. The blood was immediately transferred into the hydrochloric acid taken in the diluting tube. The acid and blood was mixed and kept undisturbed for 10 minutes, to ensure that the haemoglobin was converted to acid haematin. After 10 minutes, the contents were diluted by adding distilled water drop by drop and mixing the contents after each drop with the stirrer, till the colour matches with the colour of the standard. Then the reading was taken both in grams and percentages by noting the lower meniscus.

Results

The mean haemoglobin level of female participants was 10.4gm/dL and that of male participants was found to be 11.6gm/dL. Considering the normal range of haemoglobin is 12–14g/dL for females and 14–16g/dL for males, only 8% females (n=13) had haemoglobin within the normal range and none of the male participants (n=0) had haemoglobin level over 14g/dL.

The outcome of the cognitive functioning tests revealed that no study participant scored grade 1 in any of the categories, and the greatest proportion of participants scored grade 4 in all three categories indicating good level of confidence, less restricted work patterns and lower amounts of physical distraction respectively. 47% females and 57% males belonged to grade 4 in confidence level, 61% females and 53% males belonged to grade 4 in work pattern and 50% females and 57% males belonged to grade 4 in physical distraction [Table 4, 5 and 6].

Table 4 Number of individuals and mean hemoglobin levels in each confidence level grade.

	Female			Male		
Grade	Average of Hbg/dL	n	n%	Average of Hbg/dL	n	n%
2	10.60	12	8%	11.65	4	7%
3	10.48	52	35%	11.39	17	30%
4	10.40	71	47%	11.83	32	57%
5	10.11	15	10%	12.07	3	6%
Total	10.42	150		11.70	56	

Table 5 Number of individuals and mean hemoglobin levels in each work pattern grade.

Grade	Female			Male		
	Average Hbg/dL	n	n%	Average Hbg/dL	n	n%
2				10.60	1	2%
3	10.21	32	22%	11.31	14	25%
4	10.46	92	61%	11.89	30	53%
5	10.53	26	17%	11.77	11	20%
Total	10.42	150		11.70	56	

Table 6 Number of individuals and mean hemoglobin levels for each physical distraction grade.

Grade	Female			Male		
	Average of Hbg/dL	n	n%	Average of Hbg/dL	n	n%
2				11.90	2	4%
3	10.33	38	25%	10.76	17	30%
4	10.36	75	50%	10.77	32	57%
5	10.63	37	25%	10.71	5	9%
Total	10.42	150		11.70	56	

A significant positive correlation between was revealed between haemoglobin levels and both confidence levels and work pattern restrictiveness in males (r=0.20 and 0.25 respectively). However, no significant correlation was found between heamoglobin levels and distraction in males and heamoglobin levels did not significantly correlate with any of these three parameters in females (r=-0.11, 0.10 and 0.10 for confidence levels, work pattern restrictiveness and ease of distraction by the physical environment respectively) [Table 7].

Table 7 Correlation coefficients between haemoglobin levels and each of the three mental functioning categories in males and females.

Coefficient of correlation (r)	Confidence level	Work pattern	Physical distraction
Female (r)	-0.11	0.10	0.10
	NS	NS	NS
Male (r)	0.20	0.25	-0.09
P Value	<0.05 (S)	<0.05 (S)	NS

NS-Not significant, S-Significant

Test scores for each cognitive trait and haemoglobin levels of study participants

1 Data File

http://dx.doi.org/10.6084/m9.figshare.97571

Grades for each cognitive trait and haemoglobin levels of study participants

1 Data File

http://dx.doi.org/10.6084/m9.figshare.97570

Discussion

The present study revealed that the correlations of all the cognitive function tests with haemoglobin levels in male participants were found to be positive. This could be explained by the fact that the number of male participants compared with the number of female participants was far less. Out of the 206 study participants 150 (73%) were females and 56 (27%) were males. This could be a reason for getting such correlations in male participants as the smaller number of male participants might have affected the statistical analysis.

Further the results of the study reflected a few limitations of the present study.

First as the evaluation of the cognitive function was determined by using questionnaire, the chances of getting exact results were diminished. The chances of giving fake answers by the study participants, particularly by the male participants who had a chauvinistic approach in answering questions evaluating confidence level and work efficiency could have attributed to such results.

Secondly the assessment of nutritional status was done by evaluating only the haemoglobin level of study participants, which had its own limitations. For the assessment of haemoglobin level Sahli's method was used. This method is not highly sensitive[15,16] and resulted in errors in determining the exact values of haemoglobin levels of individuals in the present study.

Conclusion

The results of the study revealed that iron levels appears to have less of an impact on cognitive functioning in adult female participants than it does in adult male participants, though the smaller male sample size may have contributed to a false positive result in males. These results may be due, in part, to limitations with the study. As such we recommend further studies in this regard.

Author contributions

Mohit Sareen wrote the article and carried out research. Rateesh Sareen contributed to the design of study. Sarang Khajuria contributed in conception of study and revised the article for intellectual content. Sayak Roy contributed to the data analysis.

Competing interests

No competing interests were disclosed.

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