www.jmscr.igmpublication.org
Index Copernicus Value: 79.54
ISSN (e)-2347-176x ISSN (p) 2455-0450
crossrefDOI: https://dx.doi.org/10.18535/jmscr/v7i2.83

IGM Publication
Journal Of Medical Science And Clinical Research
An Official Publication Of IGM Publication

Study of association between BMI, body fat and height with visual acuity in school going children in Ghaziabad

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Abstract
Introduction: *One of the most rapidly emerging serious public health problems among children of school going age is visual impairment and undernutrition is a common problem across developing countries like India. Not much literature is available to show the association between BMI and Visual Acuity in school children in Ghaziabad region of Uttar Pradesh. The study was conducted to determine if any correlation exists between BMI, body fat, height and visual acuity.*
Material & Methods: *1000 school going children between the ages of 3 to 17 were included in the study. Height and weight were measured using standard procedure; Body Mass Index (BMI) and body fat percentage were calculated. Visual Acuity (VA) for both right (Rt) and left (Lt) eyes were recorded separately using Snellen's chart.*
Statistical Analysis: *Data was analysed using one way ANOVA and correlation was done by Spearman correlation using Graph Pad Prism 8 software.*
Results: *Results of the study show that overweight students have significantly decreased Visual acuity when compared to normal weight students. No correlation was found between BMI, Body fat% and Height of the students and their acuity.*
Discussion: *The present study shows that in a localised urban region among school students, a decreased visual acuity was noticed as students become overweight. This may be related to the more indoor time of these students and more time staring in to a screen which may lead to more near accommodation and less distant accommodation as suggested by other studies as well. Thus, children should be advised to go outdoors more and spend less time looking at screens and have a balanced nutrition.*
Keywords: *Visual Acuity, Nutrition, BMI, Snellen's chart, School children, Ghaziabad.*

Introduction

Nutritional derangement leads to prevalence of both underweight and overweight children in the population. The problem of malnutrition has become very common in rural and urban India because of difference in socioeconomic status and educational levels[(1)]. According to World Health Organisation (WHO) people with BMI <18.5 are classified as underweight, 18.5-24.99 as normal and >25 as over-

weight[2]. Studies have shown the prevalence of underweight children to be the highest in South East Asia in the world[1]. School plays an important role in the physical, mental and emotional development of children[9]. The diet of school children is important because it is the time to store nutrients which are used for body building during adolescence[9]. Improper diet leading to protein/energy malnutrition is detrimental to school going children as it leads to stunted growth, body weight below normal and decreased cognitive effect and learning[10,11]. Nutrition status in children is analysed through the measurement of weight and height using standard protocol and subsequently calculation of Body Mass Index (BMI) for the same and comparing it to standard reference values as laid out by World Health Organisation (WHO)[2] Body Mass Index(BMI) is an age and gender independent variable which is used to classify individuals[2]. Visual acuity is defined as the ability of an individual to read a standard test pattern at a standard distance, usually measured in terms of a ratio to normal vision. Factors that determines visual acuity of an individual are: convergence of light on fovea in the retina, physiological state of retina, functioning of visual cortex and ambient light[4].

The single most common cause of decreased visual acuity is myopia/hypermetropia. Snellen's chart is most commonly used to test visual acuity in the clinical setting[4]. Studies have shown the association of nutritional status with visual pathologies like age related Diabetic retinopathy, Maculopathy and Glaucoma[5,6,7]. A positive association has been observed between nutritional status and age related maculopathy[8]. A negative association of visual acuity with body weight was reported by Bergman[3].By these studies, nutritional status of an individual has been shown to affect vision[23]. A search of literature shows that there are a number of studies which have documented the effect of amount of time spent indoors, duration of outdoor activity, height and other genetic factors on visual acuity in children but most of them have been conducted outside India[14,15,16]. There is scarcity of literature which shows the effect of nutritional status of an individual on the visual acuity among school children in urban north India, Ghaziabad in particular. This study was undertaken to investigate whether nutritional status and variation in BMI has any effect on the visual acuity of urban school going children between 3 to 20 years age group in Ghaziabad city.

Methods

The present study was a cross-sectional study, conducted by Santosh Medical College and Hospital, Ghaziabad. Ethical approval was taken from the research committee of the Institution before starting the study. Study was conducted in seven schools, which included both Government and private schools, of Ghaziabad. The schools were selected using simple random sampling technique. One thousand children of both sexes, in the age group of 3-20 years were randomly selected for the study. The administrative staff in the selected School was contacted and the objectives of the study explained. A letter was sent to every parent explaining the procedure and seeking permission to evaluate the child.

Inclusión Criteria: School going children in the age group of 3-20 years present at the day of the study.

Exclusión Criteria: Those students who were absent at the day of the study and could not be contacted by the teacher.

Anthropometric parameters*:* Age was taken as completed years on the school records. Height was measured using a standard stadiometer with the subject standing in erect posture with the heel and back against the wall without footwear. The readings were taken to the nearest 0.1cm. Weight was recorded in Kgs using a calibrated portable weighing machine (Avery), with a capacity of 120kg and a sensitivity of 0.05kg. The students were weighted without wearing shoes and with minimal clothes bearing equal weight on both feet. Visual Acuity was measured using Snellen's chart by an optometrist. Visual acuity noted as a fraction was finally denoted as a number e.g 6/6 was noted as 1 and 6/12 was noted as 0.5. Children with visual acuity of 1 were said to have normal acuity while less than 1

were said to have impaired visual acuity. Children with visual Acuity of 6/9 and less were taken as refractive Error. Body Mass Index was calculated as the ratio of weight in kilograms divided by the square of the height in meters [weight(kg)/ height(m^2)]. On the basis of the value of the BMI calculated, participants were categorised as underweight<18.5, normal 18.5-24.99 and overweight>25(2). Body Fat% (BF %) was estimated from the BMI using the following formula: Adult Body Fat % = (1.20 × BMI) + (0.23 × Age) - (10.8 × gender) - 5.4 [Gender values for male =1, female = 0][12]

Statistical Analysis: Age, height, weight, BMI, Body fat percentage and visual acuity (expressed numerically) were noted for the whole study population.Mean and Standard Deviation was calculated for all the parameters. Data was divided in to groups according to range of age and groups according to range of of BMI and one way ANOVA was analysed to compare between groups and Spearman correlation test was used to analyse association between visual acuity and BMI, Body fat% and height with each other independently and XY plots were made for the same. P value of less than 0.05 was considered statistically significant. The data was analysed by Graph Pad Prism 8 software (San Diego,CA).

Results

Table 1 shows that the mean age of students was 13 years, they ranged from 3-20 years. Of these, 76% were males and 24% were females. Their mean BMI was calculated to be 16.6 kg/m^2 and body fat to be 17.6%.Mean visual acuity in both eyes were 0.9.Figure 1 shows a histogram which depicts the age wise distribution of all students. Maximum students were between 15-20 yrs(413) followed by 11-14 yrs(373) followed by 7-10 yrs(148) and then by 3-6 yrs(67) of age. Thus, we can see that most students belonged to senior school and least to junior school. The whole population of students were classified in to underweight, normal weight and overweight groups according to their BMI data as recommended by WHO and plotted in to a histogram.It can be seen from Figure 2 that the majority of students were underweight(769),very few were overweight(22) and rest of them were of normal weight(209).

Figure 3 shows the comparison of difference between visual acuity in both eyes across these three groups and we have noted a statistically significant difference between ($p<0.05$)the visual acuity of left eye of normal weight and overweight students with decreased visual acuity in overweight students. No statistically significant difference was found between the right eye acuity between all three groups or left eye acuity between underweight and normal students. Next BMI of either group was correlated to the visual acuity and the plot for the same is depicted in Figure 4 which shows no significant correlation($r=0.01$) between these parameters. Each point on the plot denotes a visual acuity value from either eye. Height of students was also correlated with acuity and the result is depicted in Figure 5 which shows no correlation ($r=0.02$) between these two parameters. Body fat% was also correlated with visual acuity and Figure 6 shows that there was no significant correlation($r=0.04$) between these parameters.

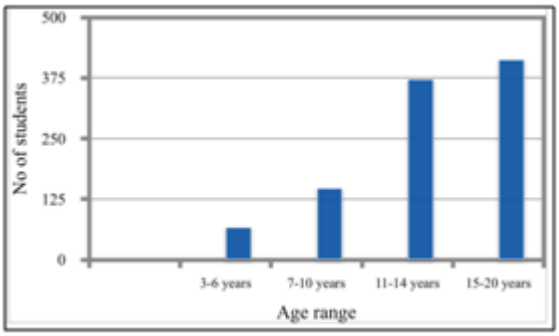

Figure 1. Age wise distribution of students

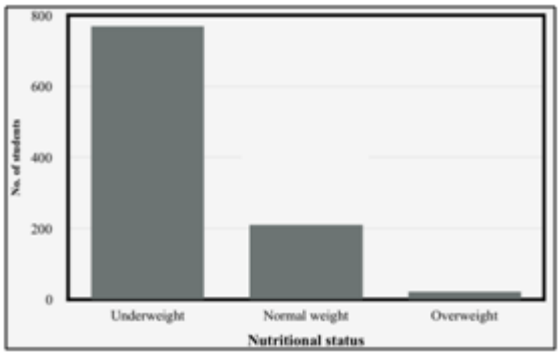

Figure 2. Distribution of students according to BMI

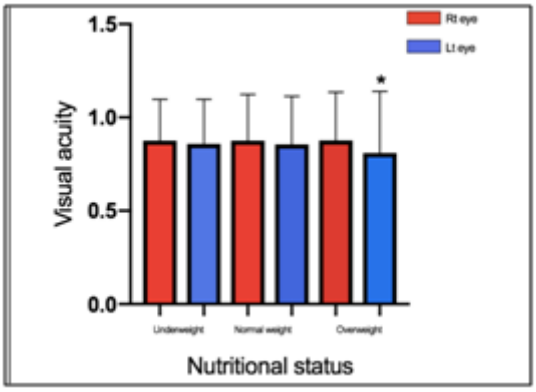

Figure 3. Comparison of mean visual acuity of both eyes according to nutritional status
*Statistically significant p<0.05

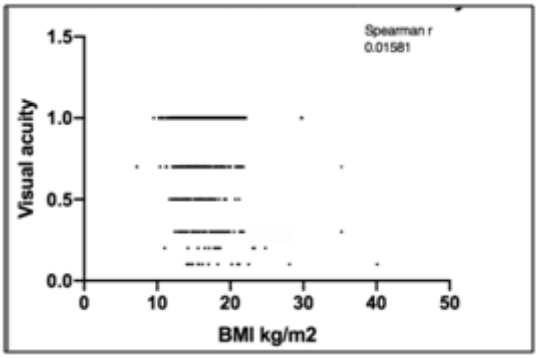

Figure 4. Plot showing correlation of BMI with visual acuity

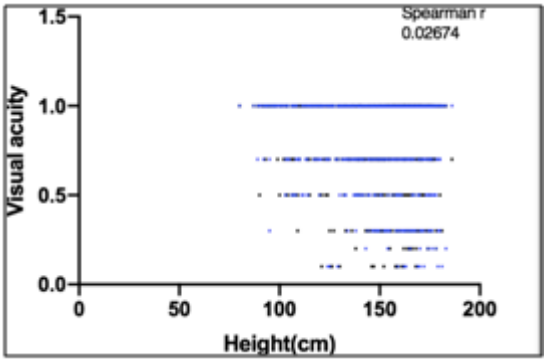

Figure 5. Plot showing correlation of height with visual acuity

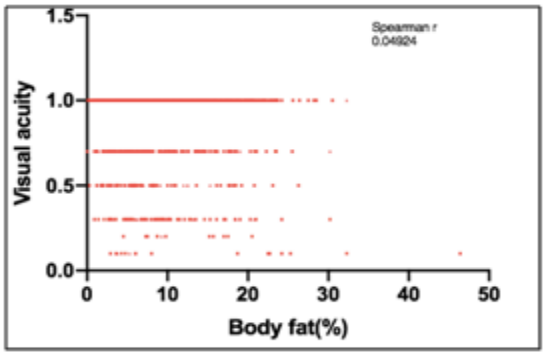

Figure 6. Plot showing correlation of body fat with visual acuity

Table 1 Anthropometric parameters

Variables	Mean ±SD
Age (years)	13.1 ±3.57
Height (cm)	172 ± 20.86
Weight(kg)	39.4 ± 13.98
BMI(kg/m2)	16.6 ± 3.22
Body fat(%)	17.6 ± 6.07
Visual acuity (Fraction converted to number) Right eye	0.9 ± 0.2
Visual acuity (Fraction converted to number) Left eye	0.9 ± 0.2

Discussion

The results indicate that the majority of population of students were males as compared to females. Most of them were of 11-20 years of age. If we look at the values of BMI and distribution of students, we can see that the majority of students were underweight with respect to their nutritional status. This has also been reported earlier by other authors in their studies in north and south India[10,11,12,22,24,25].

A new finding observed in our study was the significantly decreased visual acuity in left eye of overweight children when compared to normal and underweight children. Increased body weight and specifically increased BMI has been found to have a negative effect on visual acuity in young adolescents and school children by other authors also[23,26]. Besides this, increased BMI has been shown to be a risk factor for various ocular morbidities like Age related macular degeneration (ARMD)[5], Retinopathy in Type I Diabetes Mellitus[6], increased incidence of glaucoma in eye[7] and maculopathy in males[8]. All of these pathologies in the eyes will eventually lead to decrease in visual acuity as they affect the cornea, lens or retina all of which need to be in good physiological state to form a sharp image. Thus, we can explain our observation that increased BMI is associated with decrease in visual acuity. All of the other studies discussed earlier which have shown the effect of BMI on visual acuity have been done either on adolescents, middle aged men or mainly elderly people. But to our knowledge, no study has been done on Indian population, especially in school children where the effect

of increased BMI on visual acuity has been studied. This result is important because a number of studies by WHO[12],UNICEF[9] and other authors[10,11] have proved that school going age is the age of growth and when most of the refractive errors are diagnosed[20,21].Increased BMI in school children especially in urban settings has been most commonly reported due to a diet rich in nutrients, children being less active , spending less time outdoors in natural light, more indoors time and more time spent staring at screens of various devices like television, mobile phones, tablets and computers. Rose et al[15] have studied the time spent by children outdoors engaged in physical activity and have shown that outdoor activity reduces the prevalence of myopia. Also, Ashby et al[16] have shown that less ambient light leads to myopia in chick model. More time indoors excessive internet use and television viewing has also been associated with refractive error in children[27].

Next we have also tried to see whether there was a correlation between BMI of the entire sample population with with visual acuity in which we could not find a significant result. In other studies conducted on adolescents[23], no correlation was also noted between BMI and visual acuity. We would like to point out that this finding may be due to the large(n=1000) and very heterogenous sample population in terms of age, weight and height. Further we tried to study if a correlation exists between body fat percentage and visual acuity and again no significant result was obtained. This is an interesting finding which has not been studied earlier in the school children population. We propose the same reasons for these results as discussed for BMI earlier. Finally, we tried to see whether there was a significant correlation between height and visual acuity and again no significant value was obtained. Although some studies have shown the effect of height on visual acuity of school children in Singapore and Australia[17,18]. The authors have concluded that height is directly related to longer eyeball, shallow vitreous humour and flat corneas which affects the convergence of light which leads to refractive error. Our results did not show a significant effect again due to the wide range of values of height and age in the population and not only during puberty when most of the refractive errors are diagnosed in school children. We would like to point out that the large and diverse population in our correlation analysis is a shortcoming and the analysis would have been more meaningful if the same was divided on basis of age, puberty onset and nutritional status and correlation analysis was then done.

Conclusion

We conclude that proper nutrition in school children is of paramount importance in India as it has an important relation to visual acuity and visual errors. Appropriate education must be given to parents and school authorities and steps taken for the same

Acknowledgement

We would like to thank the parents of the students and the principal and teachers of the schools for their immense support.

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