

A STATISTICAL ASSESSMENT OF EFFECT OF NUTRITIONAL HABITS ON HUMAN HEALTH AND WEIGHT

Pallavi Rastogi^{*1}, Dr. Vaibhav Rastogi², Prof. B. K. Singh³

^{*1,3}Department of Mathematics, IFTM University, Moradabad, (India)

² Department of Pharmaceutics, Faculty of Pharmacy,
IFTM University, Moradabad, (India)

ABSTRACT

Background: The objective of this study is to assess the prevalence of weight status and the nutritional habits among the citizens of Moradabad.

Methods: A total of 422 study participants were examined in this cross-sectional study via questionnaire on eating habits, lifestyle and socio-demographic characteristics. The data were analysed using descriptive statistics and a Chi-square test.

Results: The anthropometric variables for the urban and rural residents were found to be normal, with their mean BMI of 22.97 and 21.68 kg/m², respectively. About, 51% of the rural's possess normal weight, however, the rate of obesity and underweight were comparatively high (27% and 22%, respectively, $p < 0.05$). Similarly, 53% of the urban's has normal weight while 21% and 26% has underweight and heavy weight, respectively ($p < 0.05$). 38% of females has high BMI than males (17%). The dietary habits were unhealthy. The regularity of meals was only 19.73% and 38.19% but the consumption of energy drinks, alcohol and fast food was high.

Conclusion: The results show the prevalence of overweightness and underweightness were equal in the society and it will be a reason of worry in terms of health and diseases. The study shows the need for health education programs to aware them towards healthy nutrition habits.

Key words: Body mass index, Cross-sectional study, Moradabad, Overweight, Underweight.

1. INTRODUCTION

It is well known that India is facing a nutritional transition phase, a phase in which there is a shift in the dietary consumption and energy expenditure that coincides with the economic, demographic and epidemiological changes [1,2]. Children and adolescents in India are also a part of this burden of malnutrition [3,4]. Along with the existing problem of undernourishment among the population, the fraction of overweight people is also increasing rapidly. Being underweight or overweight both tends to increase the risk of developing health

problems such as anaemic, diabetes, altered blood pressure, heart disease, altered fertility, some types of cancer and may even death/mortality also [5,6].

Many International and domestic studies have assessed the nutritional habit, BMI (Body Mass Index) score and weight status among many communities [7,8], but till now there is no such type of study reported among the citizens of Moradabad district of Uttar Pradesh by the researchers. In this investigation, it is therefore, important to monitor the health status of the citizens of Moradabad including their weight, BMI score, diet structure, disease status and to generate a statistically sound results and information. The role of statistics in research is to function as a tool in designing research, analyzing its data and drawing conclusions there from. Most research studies result in a large volume of raw data which must be suitably reduced so that the same can be read easily and can be used for further analysis. A field of applied statistics of human research surveys, survey methodology studies the sampling of individual units from a population and the associated survey data collection techniques, such as questionnaire construction and methods for improving the number and accuracy of responses to surveys. This study will focus on the importance of statistical parameters such as descriptive statistics, inferential statistics, in assessing the information obtained from the population and will tend to promote the healthy nutrition with healthy lifestyle.

II.METHODS

This study was depended on an observational cross-sectional survey design and was conducted by administering a validated questionnaire to the study participants belonging to IFTM University, urban and rural parts of Moradabad, U.P, India. Moradabad is a city, commissioner, and a municipal corporation in Moradabad district in the Indian state of Uttar Pradesh. The district has a population density of 1,284 inhabitants per square kilometre (3,330/sq mi). Moradabad has a sex ratio of 903 females for every 1000 males, and a literacy rate of 58.67% [9]. IFTM university is a leading educational institution in Moradabad region, which is located in Lodhipur-Rajput, Delhi road, NH-24, Moradabad, U.P, India. The University was established in 2011 and is now populated by more than 7500 students registered in various course works.

2.1 Sampling

The sample size for this study was calculated to be 480 study participants based on a sample size formula for cross-sectional study design [10]. Parameters used for sample size estimates: P=50%, 95% Confidence Interval (C.I.), error below 5% and a non-response rate of 10% for the study participants was considered. However, the sampling design was stratified random sampling where study participants from the university, urban and rural part of Moradabad will be divided into two groups of mode of living or society- urban livings and rural livings.

2.2 Data collection

At data entry stage, a standardized self-administered questionnaire was used for collecting the data. The questionnaire was prepared after studying a number of previous work conducted in the same sphere of influence [11-15]. The final questionnaire contained approximately 20 multiple-choice/no choice questions (Appendix-1). The questions include demographic and social information, dietary habits and physical activity. Anthropometric

data, anthropometric measurements, nutritional habits as well as participant's weight and height were also assessed. Height and weight were measured using standardized instruments.

2.3 Statistical analysis

To ensure the quality of the data collection stage, we have reviewed the questionnaires daily. Any errors or inconsistencies were reviewed and corrected immediately. At the data entry stage, data were reviewed for errors and entered into an excel database by the study team. The SPSS version 17 (SPSS Inc, Chicago, IL, USA) and Minitab version 17 (Minitab Inc) will be used for data analysis. Body Mass Index (BMI) is derived from the height and weight of the study participants and it will act as a marker for the healthy person. The Body Mass Index (BMI) was categorized according to World Health Organization (WHO). These guidelines suggest that individuals with ($BMI < 16.0 \text{ kg/m}^2$) are severely underweight, ($BMI = 16.0-18.4 \text{ kg/m}^2$) as underweight, ($BMI = 18.5-24.9 \text{ kg/m}^2$) as normal weight, ($BMI = 25.0-30.0 \text{ kg/m}^2$) as overweight, and ($BMI \geq 30.0 \text{ kg/m}^2$) as obese [16].

Statistical analysis involved descriptive statistics as well as inferential statistics. Descriptive statistics included simple tabulation, frequencies and proportion for categorical variables including cross-tabulations. The BMI categories as well as differences in nutritional habits and other categorical variables of the study participants will be compared for significance using the Chi-square (χ^2) test. The Yates correction term was also used to ensure the accuracy of the Chi Square test. P-value less than 0.05 was used to indicate statistical significance.

The Chi-square statistic is a non-parametric (distribution free) tool designed to analyze group differences when the dependent variable is measured at a nominal level. Like all non-parametric statistics, the Chi-square is robust with respect to the distribution of the data. Specifically, it does not require equality of variances among the study groups or homoscedasticity in the data. It permits evaluation of both dichotomous independent variables, and of multiple group studies. Unlike many other non-parametric and some parametric statistics, the calculations needed to compute the Chi-square provide considerable information about how each of the groups performed in the study [17].

2.3.1 Calculating Chi-square

The Chi Square statistic compares the tallies or counts of categorical responses between two (or more) independent groups. (note: Chi square tests can only be used on actual numbers and not on percentages, proportions, means, etc.) The use of the chi-square distribution to test for differences of proportions in two groups has two advantages: (a) the computations are easy and (b) a continuity correction can be easily applied.

The 2×2 contingency (the fourfold table) chi-square is used for the comparison of two groups with a dichotomous dependent variable [18]. We might compare males and females on a yes/no response scale, for instance. Let us take an example of dieting response in male and female-

Observed Table

Gender	Response		Total
	Yes	No	
Male	A	B	R1=A+B
Female	C	D	R2=C+D
	C1=A+C	C2=B+D	N=A+B+C+D

where R1= Total frequency of Row 1, R2= Total frequency of Row 2, C1= Total frequency of Column 1, C2= Total frequency of Column 2. A and C are the observed frequency of males and females who give dieting response in ‘Yes’ and B and D are the observed frequency of males and females who give dieting response in ‘No’.

The chi-square statistic is calculated as follows:

$$\sum \chi^2 = \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

(1)

where O is the observed number/frequency in a cell and E the expected number/frequency in a cell.

Calculation of expected frequency:

$$E = \frac{\text{row total} \times \text{column total}}{N \text{ (Sample size)}} \tag{2}$$

Expected frequency table

Gender	Dieting response	
	Yes	No
Male	$E_{11} = \frac{R_1 \times C_1}{N}$	$E_{12} = \frac{R_1 \times C_2}{N}$
Female	$E_{21} = \frac{R_2 \times C_1}{N}$	$E_{22} = \frac{R_2 \times C_2}{N}$

The degree of freedom (d.f.) for the test described above (the fourfold table) are equal to 1. In general, the d.f. for an R × C contingency table, where R is the number of rows and C is the number of columns, are equal to (R – 1)(C – 1). If the calculated χ^2 value is less than the tabulated χ^2 value at defined level of significance then the null hypothesis is accepted.

III. RESULT AND DISCUSSION

The aim of this study is to assess nutritional habits and weight status among the citizens of Moradabad district of Uttar Pradesh, India. The study will provide new data on this important aspect of healthy or unhealthy life style so that a change or up-gradation in the nutritional habit, healthy eating and quality life of the residents of Moradabad could take place. However, none of the similar work was reported for the quality lifestyle among the residents of Moradabad, hence, this work will act to be a base line of all statistically gathered, significant and summarized information of Moradabad residents which will help in further research for assessing the improvements so occur.

Since, this study was carried out during 2016-2017, the response rate by the population of Moradabad for the study was fairly good and was found to be 87.9% (422 out of 480), excluding the missing data. TABLE 1 provides the gender characteristics of the study participants. The study participants enrolled in this study were usually adults (above 18years of age). After the collection of data at the data entry stage, the information that was extracted was very satisfactory for the research point of view. The data so obtained reflects that both the major societies of Moradabad i.e. urban and rural has equally enrolled in the study. The TABLE 1 showed that 47.16% was the response rate obtained from the persons of rural background whereas 52.84% constituted by the urban population. However, from the table it was clearly observed that the response given by the females were significantly lower than that of males of both the backgrounds (34.9% females in urban and 30.6% in rural were enrolled in the study). This could be attributed to the busy schedule in maintaining the daily routine works of home and office and also to the fact that women's of rural background are not literate and they still not feel comfortable or feel shy to talk to strangers.

Table 1: Characteristics of the study participants.

Gender		Mode of Living	Total study participants
Male participants	Female participants		
145	78	Urban	223 (52.84%)
138	61	Rural	199 (47.16%)
Total Males = 283 Total Females = 139			422

Anthropometry is the scientific study of the measurements and proportions of the human body. The anthropometric variables such as weight (kg), height (cm) and BMI (Kg/m^2) from both the societies were mentioned in TABLE 2. Although the values for the anthropometric variables in the TABLE 2 corresponds to the normal and healthy well being of both the societies as the mean BMI of them were lies in between the normal range of $18.5\text{-}24.9 \text{ kg/m}^2$, but the bigger picture comes into existence when the data from each society were divided and arranged according to the WHO guideline for BMI [16].

Table 2: Mean anthropometric data of the societies.

Mode of Living	Anthropometric Variables (Mean ± SD)		
	Weight (Kg)	Height (cm)	BMI (Kg/m ²)
Urban	60.96 ± 13.56	163.77 ± 13.20	22.97 ± 6.17
Rural	63.36 ± 14.64	164.95 ± 11.87	21.68 ± 5.11

It is well known that what a person eats has a profound effect on his/her health. The human choice of foods is a complex process involving a multiplicity of influencing factors such as socioeconomic actors, cultural effects, access to and availability of food as well as education and a person’s age. Maintaining a healthy weight is an important way to make sure that the person will stay in good health and reduce the likelihood of developing a number of long-term health problems [19].

Fig. 1 and 2 represents the prevalence of obese, overweight, normal, under weight and severely underweight among the study participants of both the societies, i.e. rural and urban, respectively. According to the pie chart of Fig. 1, 6.53% were obese, 16.08% were OW, 50.75% were Normal, 15.07% were UW and 11.55% were SUW. On the other hand, according to the pie chart of Fig. 2, the urban’s were found to be 6.72% obese, 18.38% OW, 53.36% Normal, 14.34% UW and 7.17% SUW. Taking due consideration to the modernization and globalization, both the societies has shown similar results in their BMI categories and were marginally differ from each other. But these results are giving warning that only 50% of study participants were found to have normal BMI and the remaining 50% comprises of overweight and underweight problems. However, the percentage of obesity and overweight were significantly higher for women’s, women’s were found to be 5% and 16% more obese and over weight than men’s (Fig. 3). This could be alarming signal for the women’s to take necessary measures to control this, as being overweight or obese increases the risk of developing health problems including coronary heart disease, stroke, type 2 diabetes, osteoarthritis and some types of cancer too. On the other hand, being underweight is associated with increased mortality relative to the normal weight category.

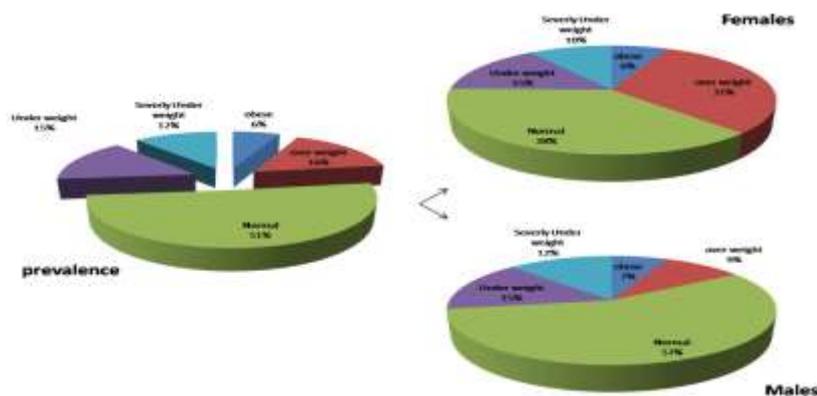


Figure 1: Prevalence of BMI categories in rural society.

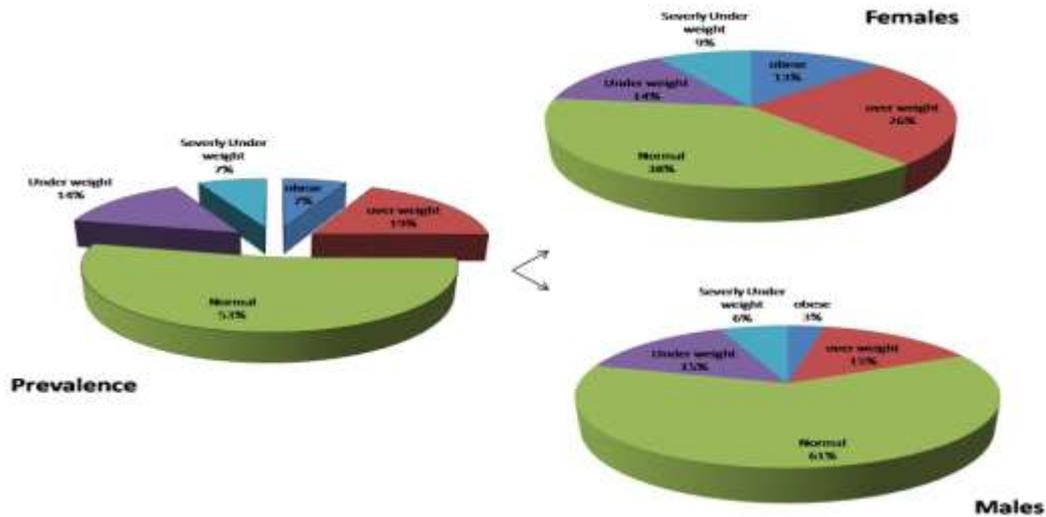


Figure 2:- Prevalence of BMI categories in urban society.

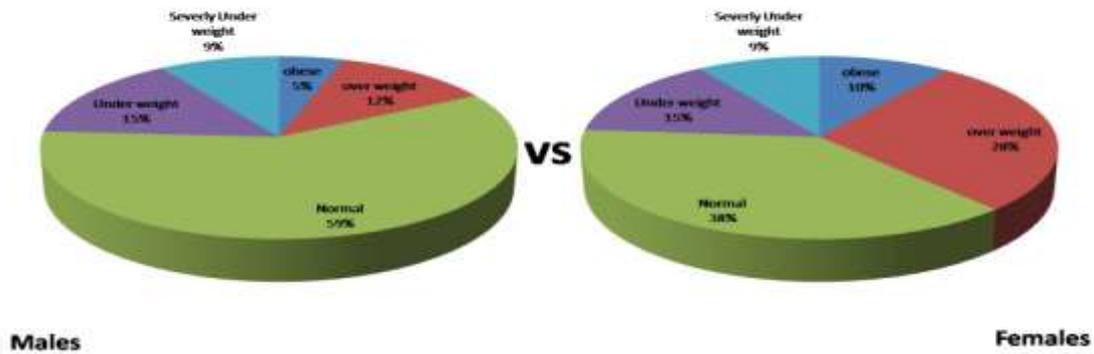


Figure 3: Prevalence of BMI categories in males vs females.

TABLE 3 compares weight status between males and females and also across the societies. By the application of Chi square test (non-parametric test) the results obtained from the BMI status clearly revealed that there is a significant difference ($p < 0.05$ at 95% C.I) in the weight or BMI status between the males and females. The men are more likely to be underweight and women were more likely to be overweight. However, the overall proportions of normal weight were seen high in the men's only. A comparison of these indicators across the societies showed no significant difference. But, the percentage of being overweight and obese was comparatively very high in urban people in comparison to rural's and vice versa for being under weight and severely under weight.

Table 3: Weight status according to study participants gender and mode of living (society).

BMI_Category	Gender		x ² value	P- value	Mode of Living		x ² value	P- value
	Males	Females			Urban	Rural		
Obese	14 (4.94%)	14 (10.07%)	25.37	<0.05	15 (6.72%)	13 (6.53%)	2.68	0.61
Over weight (OW)	34 (12.01%)	39 (28.05%)			41 (18.38%)	32 (16.08%)		
Normal	167 (59.01%)	53 (38.12%)			119 (53.36%)	101 (50.75%)		
Underweight (UW)	42 (14.84%)	20 (14.38%)			32 (14.34%)	30 (15.07%)		
Severely under weight (SUW)	26 (9.18%)	13 (9.35%)			16 (7.17%)	23 (11.55%)		

This could be attributed to the fact that India is facing a nutritional transition phase where, along with the existing problem of undernourished population, the proportion of overweight people is increasing rapidly [1,2]. Children and adolescents in India are also a part of this double burden of malnutrition [3,4]. While undernourished children and adolescents are more likely to have lower resistance to infections and a higher risk of morbidity and mortality [5], childhood obesity is associated with increased risk of non-communicable diseases like cardiovascular disease (CVD) and diabetes in adulthood [20,21]. It is, therefore, important to monitor the nutritional habits and its associated BMI and weight status of children, adolescents and adults at population level in order to make effective programs to handle this double burden among them [8].

TABLE 4 compares the nutritional habits between the male and female study participants and also across both the societies. At present, the results were very prominent in terms of poor nutritional status among the residents of moradabad and it can be one of the reasons for such poor weight status. Hence, the results were indicating the necessity of changing the life style for obtaining the quality of nutrition in their diet. The interpretation of results mentioned in table 4 is as follows:-

1. There was no significant difference observed among the males and females for their regularity in taking meals and breakfast ($p > 0.05$), both the genders are not regular with their meal intake. On the other hand, there was a significant difference in between both the societies in the consumption of meals and breakfast. The rural's were found to be more regular in their meals than urban but the regularity in taking breakfast were high in urban's.
2. The consumption of soft drink by the females (78.41%) were found to be high in comparison to males (42.40%) and it may be one of the reasons for being overweight as sugary drinks has relatively high caloric value. While, the consumption of alcohol by the males (91.87%) was comparatively very higher than females

(28.77%) and hence constituted for weight gain as alcoholic drinks contain many more calories than most people think — for example, a 20-ounce serving of beer can pack 250 calories, a 6-ounce glass of wine contains 120, and a 1.5-ounce shot of liquor contains about 100. Similarly, the residents of urban society takes more soft drink in comparison to rural residents. However, both the societies show equal percentage in alcohol consumption ($p>0.05$).

3. There is a significant difference ($p<0.05$) in the daily intake of vegetables, breads, cereals and milk among the males and females. The women's were found to consume more vegetables and milk than men's while the men's were found to consume more breads and cereals than women's. This rate was relatively similar to the survey conducted by National Family Health Survey (NFHS-4) 2015-16, the health ministry revealed that fewer than half (47%) of all women consume dark green, leafy vegetables daily and another 38% eat them only once a week [22]. A well-balanced diet is one that contains enough proteins, fats, carbohydrates, vitamins and minerals. However, despite of very busy life schedule, persons of both genders were giving importance to the nutrition in the form of calcium, iron, fibers, vitamins they are gaining.

4. Also, there was a significant difference present in the consumption of breads, cereals and milk by the urban society than rural. The urban's has higher percentage of intake than rurals. However, the rural's were found to be largely dependent on the vegetables than urban's. This difference can be attributed to the fact that the main source of earning for the rural community is the farming and during survey we have received a common answer from all of them, is that they used to prefer selling of crops rather utilization of all for their selves.

5. Both males and females were found to take fruits in their daily diet and hence there was no significant difference was observed ($p>0.05$). Interestingly, there was a difference in the daily intake of fruits in both the societies. The urban people's (65.91%) largely prefer to take fruits than rural ones (45.72%). In India, however, more than half (over 54%) of women do not consume fruits even once a week. Very few women consume chicken, meat, fish or eggs on a daily basis, and about a third of them consume these foods weekly [22].

6. As expected, the consumption of fast food by the rural society was significantly lesser than that of urban society ($p<0.05$). 85.20% percent of the urban society usually takes fast food in their daily life while only 25.12% of the persons belonging to rural background takes fast food.

7. To keep themselves fit, both the societies shares equal percentage in preferring exercise and yoga. 50% of the study participants of both the societies usually prefer exercise and yoga for fitness. While still this percentage is very lower.

8. Male and female section of the study participants and also the urban and rural section of study participants when asked for the nutritional diet knowledge, the results were very shocking. The greater percentage of the people of both gender and society has no knowledge about the healthy nutritional diet required daily. Although, the Urban's showed significant difference but the percentage of knowledge (39.91%) by the urban residents was still very lower.

9. No significant difference was observed among the male and female section of the study participants and also among the urban and rural section of study participants, when they were asked to upgrade their knowledge in adopting good nutritional habit or not. All were ready to adopt good nutritional habit.

“In India by and large, food habits are discriminatory in terms of gender. There are two classes in India—those who can’t afford vegetables, fresh fruits and milk and the others who can afford them but discriminate between male and female children. Women in India are trained to eat less and their dietary requirements are not understood, so most of them suffer from anaemia [22]. Health and nutrition are the most important contributory factors for human resource development in the country. India has been classified by the World Bank as a country with a lower middle income, with per capita GNP of US \$ 996-3945. It ranks 160th in terms of human development among 209 countries. Among the Indian population, about 28% in the rural and 26% in the urban areas are estimated to be below the poverty line, which is defined as the expenditure needed to obtain, on an average, 2400 Kcal per capita per day in the rural areas and 2100 Kcal in urban areas. Long-term malnutrition leads to stunting and wasting, non-communicable chronic diet related disorders, increased morbidity and mortality and reduced physical work output. It is a great economic loss to the country and undermines development [23].

Table 4: Nutritional status according to study participants gender and mode of living (society).

Nutritional Status	Gender		x ² value	p-value	Mode of Living		x ² value	p-value
	Males	Females			Urban	Rural		
Regularity of meals								
Yes	48 (16.96%)	32 (23.02%)	2.22	0.13	44 (19.73%)	76 (38.19%)	17.60	<0.05
No	235 (83.03%)	107 (76.97%)			179 (80.26%)	123 (61.80%)		
Soft drink/energy drink								
Yes	120 (42.40%)	109 (78.41%)	48.71	<0.05	150 (67.26%)	79 (39.69%)	32.19	<0.05
No	63 (57.59%)	30 (21.58%)			73 (32.73%)	120 (60.30%)		
Consumption of Fruits								
Yes	168 (59.36%)	70 (50.35%)	3.07	0.07	147 (65.91%)	91 (45.72%)	17.43	<0.05
No	115 (40.63%)	69 (49.64%)			76 (34.08%)	108 (54.27%)		
Consumption of Vegetables								
Yes	117	84	13.61	<0.05	101	100	1.03	0.31

	(41.34%)	(60.43%)			(45.29%)	(50.25%)		
No	166 (58.65%)	55 (39.56%)			122 (54.71%)	99 (49.74%)		
Eating Breads and Cereals								
Yes	161 (56.89%)	50 (35.97%)	16.31	<0.05	122 (54.70%)	89 (44.72%)	4.19	0.04
No	122 (43.11%)	89 (64.02%)			101 (45.29%)	110 (55.27%)		
Consumption of Milk								
Yes	128 (45.22%)	80 (57.55%)	5.66	0.01	155 (69.50%)	53 (26.63%)	77.33	<0.05
No	155 (54.77%)	59 (42.44%)			68 (30.49%)	146 (73.36%)		
Daily Excercise / yoga								
Yes	128 (45.22%)	92 (66.18%)	16.40	<0.05	119 (53.36%)	101 (50.75%)	0.28	0.59
No	155 (54.77%)	47 (33.81%)			104 (46.63%)	98 (49.24%)		
Alcohol consumption								
Yes	260 (91.87%)	40 (28.77%)	180.56	<0.05	160 (71.74%)	139 (69.84%)	0.18	0.66
No	23 (8.13%)	99 (71.23%)			63 (28.26%)	60 (30.15%)		
Fast food								
Yes	180 (63.60%)	60 (43.16%)	15.87	<0.05	190 (85.20%)	50 (25.12%)	154.73	<0.05
No	103 (36.39%)	79 (56.83%)			33 (14.79%)	149 (74.87%)		
Breakfast								
Yes	105 (37.10%)	55 (39.56%)	0.24	0.62	110 (49.32%)	50 (25.12%)	26.16	<0.05
No	178 (62.89%)	84 (60.43%)			113 (50.67%)	149 (74.87%)		
Nutritional diet knowledge								
Yes	95 (33.56%)	48 (34.53%)	0.038	0.84	89 (39.91%)	45 (22.61%)	14.51	<0.05
No	188	91			134	154		

	(66.43%)	(65.46%)			(60.08%)	(77.36%)		
Adoption of good nutritional diet habit								
Yes	192 (67.84%)	93 (66.90%)	0.037	0.84	200 (89.68%)	171 (85.92%)	1.39	0.23
No	91 (32.15%)	46 (33.09)			23 (1031%)	28 (14.07%)		

IV.CONCLUSION

The findings of the present study showed significance of promoting healthy nutrition habit among the citizens of Moradabad, since the nutrition knowledge increases the nutrition confidence which will in turn influences the health beliefs. The Chi-square is a significance statistic, and should be followed with a strength statistic. Unlike most statistics, the Chi-square (χ^2) can provide information not only on the significance of any observed differences, but also provides detailed information on exactly which categories account for any differences found. Thus, the amount and detail of information this statistic can provide renders it one of the most useful tools in the researcher's array of available analysis tools. One possible limitation of the study is that it was based on a cross-sectional survey design. The direction of relationships and causal relationships cannot be determined. In addition, the use of a self-administered questionnaire on dietary assessment may produce subjective measurements that are less reliable than objective methods.

V. ACKNOWLEDGEMENT

The authors express their sincere thanks to the Honorable, Vice Chancellor, IFTM University, Moradabad, Uttar Pradesh, India, for his constant encouragement to carry out this work.

VI.CONFLICT OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

REFERENCES

- [1] P. Ramachandran, The Double Burden of Malnutrition in India, FAO, The Double Burden of Malnutrition: Case Studies from Six Developing Countries. Rome: Food and Agricultural Organization of the United Nations, *Food and Nutrition Paper*, 84, 2006, 99-160.
- [2] A. Sengupta, T.S. Syamala, Double burden of malnutrition in India: An investigation. Institute for Social and Economic Change, Bangalore, India. 2012. Available from: <http://dataspace.princeton.edu/jspui/handle/88435/dsp01mk61rk205> [Accessed October 10, 2017].
- [3] P. Jeemon, D. Prabhakaran, V. Mohan, Double burden of underweight and overweight among children (10 to 19 years of age) of employees working in Indian industrial unit, *The National Medical Journal of India*,

22(4), 2009, 172-176. Available from: http://mdrf-eprints.in/447/1/Double_burden_of_underweight_and_overweight_among.pdf.

- [4] A. Gupta, D. Sharma, D. Thakur, A. Thakur and S.R. Mazta, Prevalence and predictors of dual burden of malnutrition among adolescents in north India, *Saudi Journal of Obesity*, 2(2), 2014, 63-67.
- [5] A.T. Nicklas, T. Baranowski, K.W. Cullen and G. Berenson, Eating patterns, dietary quality and obesity. *Journal of the American College of Nutrition*, 20(6), 2001, 599-608.
- [6] A. Tukker, T. Visscher, and H. Picavet, Overweight and health problems of the lower extremities: Osteoarthritis, pain and disability, *Public Health Nutrition*, 12(3), 2009, 359-368.
- [7] L.D.C.F. Costa, and F.D.A.G Vasconcelos, Prevalence and factors associated with nutritional status among female university students in Florianópolis, *Revista Brasileira de Cineantropometria e Desempenho Humano*, 15(3), 2013. <http://dx.doi.org/10.5007/1980-0037.2013v15n3p326>.
- [8] G. Grover, V.K. Gupta, and M. Arora, Trend in BMI z-score among Private Schools Students in Delhi using Multiple Imputation for Growth Curve Model. *Epidemiology Biostatistics and Public Health* 13(2), 2016, e11836-1-e11836-8.
- [9] Moradabad, Information accessed from Moradabad official website, <http://moradabad.nic.in/default.htm>, [Accessed January 18, 2018]
- [10] C.E. Utazia, S.K. Sahu, P.M. Atkinson, N. Tejedor, and A.J. Tatem, A probabilistic predictive Bayesian approach for determining the representativeness of health and demographic surveillance networks, *Spatial Statistics*, 17, 2016, 161–178.
- [11] R.C. Plotnikoff, S.A. Costigan, and R.L. Williams, Effectiveness of interventions targeting physical activity, nutrition and healthy weight for university and college students: A systematic review and meta-analysis, *International Journal of Behavioral Nutrition and Physical Activity*, 12, 2015, 45.
- [12] P. Alam, Nutritional status and eating practices among university students in selected universities in Selangor, Malaysia, *Asian Journal of Clinical Nutrition*, 4(3), 2012, 77-87.
- [13] K. Ganasegeran, S.A. Al-Dubai, A.M. Qureshi, A.A.A. Al-abed, and S.M. Aljunid, Social and psychological factors affecting eating habits among university students in a Malaysian medical school: A cross-sectional study, *Nutrition Journal*, 11(1), 2012, 1-7.
- [14] V.L. Van den Berg, A.P. Okeyo, A. Dannhauser, and M. Nel, Body weight, eating practices and nutritional knowledge amongst university nursing students, Eastern Cape, South Africa, *Primary Health Care and Family Medicine*, 4(1), 2012, 323.

- [15] G. Mani, Assessment of body mass index and its associated nutritional factors among undergraduate medical students in Tamil Nadu, India: A cross sectional study, *Journal of Pioneering Medical Sciences*, 4(3), 2014, 137-142.
- [16] World Health Organization. Obesity: Preventing and managing the global epidemic. Report of a WHO Consultation on Obesity. Geneva: WHO/NUT/NCD, 1998.
- [17] L. Mary, and McHugh, The Chi-square test of independence, *Biochemical Medicine*, 23(2), 2013, 143–149.
- [18] S. Bolton, and C. Bon, Pharmaceutical Statistics Practical and Clinical Applications. Fifth edition, Informa Healthcare: New York, pg-114-116.
- [19] Healthy Diet, <https://www.nhp.gov.in/healthyliving/healthy-diet>. [Accessed January 18, 2018].
- [20] T. Bridger,. Childhood obesity and cardiovascular disease, *Paediatric child health* 14(3), 2009, 177-182.
Available from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2690549/pdf/pch14177.pdf> . [Accessed January 18, 2018]
- [21] T.S. Hannon, G. Rao, S.A Arslanian, Cildhood obesity and type2 diabetes melitus. *Pediatrics*, 116(2), 2005, 473-480.
Available from: <http://pediatrics.aappublications.org/content/116/2/473.short> [Accessed January 18, 2018]
- [22] Most Indians eat unbalanced diet, says national family health survey,
<http://www.livemint.com/Politics/4x1Py35VFQqA3yzg0KMrPO/Most-Indians-eat-unbalanced-diet-says-national-family-healt.html>. [Accessed January 18, 2018]
- [23] Dietary guidelines for Indians- A Manual, Published by National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India, <http://ninindia.org/DietaryGuidelinesforNINwebsite.pdf>. [Accessed January 18, 2018]

Appendix 1: Questionnaire for obtaining the nutritional status/habits of study participants.

Note: This questionnaire is only meant for obtaining and utilizing the information for Ph.D (in Mathematics) research only. Your data will be kept confidential and will not be a part of third party/public access. Please answer the following questions as accurately as you can, so that your data can be used to generate a meaningful information to the society for the betterment of healthy life.

Name:..... Gender:.... Age:.....(years) DOB:.....

1. **Marital status** Single (), Married (), Separated (), Widow ()
2. **Mode of Living** Urban (), Sub-urban (), Rural ()
3. **Please mention your height:**
4. **Please mention your weight:**
5. **Do you have diabetes?** Yes (), No ()
6. **Do you take meals on a regular basis?** Yes (), No ()
7. **How much fruits you take on a per day basis?** one or less (), 1-3 (), 4-6 (), 7 or more ()
8. **How much breads and cereals you take on a per day basis?** one or less (), 1-3 (), 4-6 (), 7 or more ()
9. **How often you take eat breakfast?** Always (), Sometimes (), Never ()
10. **How often you eat fast food in restaurants?** Always (), Sometimes (), Never ()
11. **Do you take vegetables in your diet?** Yes (), No ()
12. **Do you take soft drink on a regular basis?** Yes (), No ()
13. **Do you take energy drinks?** Yes (), No ()
14. **Are you alcoholic?** Yes (), No ()
15. **How often you take milk on a daily basis?** one or less (), 1-3 (), 4-6 (), 7 or more ()
16. **Are you regular in eating snacks?** Yes (), No ()
17. **Do you exercise/yoga everyday?** Yes (), No ()
18. **Do you know about Nutritional diet?** Yes (), No ()
19. **Do you know about Healthy life style?** Yes (), No ()
20. **Do you want to adopt good nutritional habit?** Yes (), No ()