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A Study On Refractive Errors Of A Random Population Selected From Urban Areas Of Visakhapatnam, India

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Abstract

A statistical study has been conducted on an endemic population of 322 young adults (in the age group 17-21)in the area of Visakhapatnam, India to establish statistical correlations between the presence of a refractive error and the most implicated risk factors : Diet, Heredity, Reading/Studying, Television watching and Exercise. In the randomly selected population, 95 (29.5%) subjects suffered from Myopia, 9 from Hypermetropia and the rest did not report any defect. There was found to be a statistically significant link between refractive error presence and television watching, diet, presence of a defect in the mother of the subject where as there was no link between refractive error presence and the amount of reading, or the quantum of exercise the subject indulged in.

1. Introduction And Background

Refractive errors are pervasive in today's world (about 1.6 billion people are affected worldwide), more so among the younger brigade. Of the refractive errors, myopia is most dominant. The diagnosis of myopia is made by measuring, in diopters, the strength or optical power of a corrective lens that correctly focuses distant images on the retina. The degree of severity of myopia is dependent upon this diopter measurement, with low myopia described as -3.00 diopters or less, medium/moderate myopia as between -3.00 and -5.00 diopters, and high myopia as -5.00 or more diopters. In Europe and America, up to 35% of the people have been found to suffer from myopia and this figure is significantly higher among Asian populations (notably Singapore, 80% of 18 year old males) [1]. There are many theories about the "cause" of myopia, mainly: i) A high carbohydrate/starch diet leading to excessive horizontal growth of the eyeball because of the production of IGF-1 (Insulin Like Growth Factor-1) [2] ii) An unhealthy diet causing a salt-water imbalance in the body (similar to glaucoma) leading to influx of excess fluid into the eyeball, causing it to expand [3],[4]. This is apparently caused by the improper functioning of the adrenal cortex, which causes retention of salt in the blood iii) Reading or excessive strain. The first one was a very popular school of thought some time back, the second one is a forceful argument though it is shunned by scientists worldwide and the third one is highly debated. The consensus view with respect to the last case maintains that reading and/or similar strain is a significant risk factor, rather than a cause. Apart from these, a totally different (and arguably modern) school of thought exists which believes that myopia is caused by genetic predisposition and exposure to risk factors. There have been up to 8 susceptibility loci identified, for example MYP 3(Chromosome**:** 12; Location**:** 12q21-q23), MYP 11 (Chromosome**:** 4; Location**:** 4q22-q27) which are autosomal dominant, MYP1 (Chromosome**:** X; Location**:** Xq28) and OPEM (Chromosome**:** X) [5]. A review of literature will show that there are numerous studies with contradicting results regarding the causes and risk factors of myopia. In this context, it is justified if one

says that there still seems a lot to be resolved regarding the cause of myopia.

There are a number of foods that are recommended in order to avoid/ mitigate myopia. These include vitamin and other protein-rich foods like meat, deskinned poultry, liver, dairy products. Citrus fruits, leafy vegetables and fish are also strongly advocated by some [9].

This study was inspired by a casual observation by two of the authors that their vegetarian classmates who are myopic greatly outnumbered non-vegetarians suffering from any sort of refractive errors. Sometimes the lack of knowledge prevents any presumptions. We were at that point, relatively unaware of the theories regarding myopia. We had assumed that there must be something that was causing this apparently huge anomaly, at least among the current generation. We thus started off with the hypothesis that vegetarians were more susceptible to refractive errors than non-vegetarians and aimed to test it in a moderate-sized population, by conducting a survey and then performing a statistical analysis. This study brings a fresh perspective to the fore, since vegetarians are rarely found outside the Indian sub-continent.

2. Materials And Methods

A population of 322 people was selected, in the age group of 17-21 years during March to June, 2010. Subjects were most commonly selected from University campuses. There was no rigidity exercised as to whether the subject was born and/or brought up in Visakhapatnam. Thus different subjects might have been in Visakhapatnam for different amounts of time. This factor was not included in the analysis also.

A standard questionnaire was prepared for the subject to fill. The categorical data for analysis was obtained from the responses of the subjects. The questionnaire yielded data about their habits and average exposure to widely professed risk factors like reading or watching television. Data was also collected about the presence (and where possible, extent) of refractive errors in either or both parents. All subjects were duly briefed about the nature of the study and the importance of providing information that is accurate to the best of their knowledge, prior to the questionnaire filling exercise.

The data obtained was then analysed using SPSS (Statistical Package for Social Science) version 16.0 (SPSS Statistics is a comprehensive, easy-to-use set of predictive analytic tools for business users, analysts and statistical programmers. It has been developed by International Business Machines).

Since the data obtained was categorical ("yes or no" type), co-relation coefficients were not calculated. Instead, the chi-square test for detecting an association between different variables was used. The level of confidence was assumed to be 95 % and consequently, a **p** value of less than 0.05 in the Pearson chi-square test was taken to be statistically significant.

3. Results

The following significant results were obtained,

1. 33.5% of the population (108/322) suffered from refractive errors, of which myopia constituted the majority, 88.0 % (95/108).
2. There was found to be a statistically significant link ($p<0.05$) between diet type and presence of an eye defect. (62.9% of vegetarians reported a defect, where as only 25.4% of non vegetarians did)
3. A statistically significant link ($p<0.05$) was also found to exist between the type of non-vegetarian food most frequently consumed and the presence of an eye defect (only 11.1% of fish eaters reported defects, where as 32.9% of chicken eaters did)
4. There was found to be a statistically significant link ($p<0.05$) between the average number of hours spent watching television per day and the presence of an eye defect.
5. There was found to be a statistically significant link ($p<0.05$) between the presence of an eye defect in the subject and that of his/her mother.
6. There was **NO** association found between the average number of hours spent reading per day and the presence of an eye defect.

4. Tables And Figures:

Table 1.0; This table shows the cross-tabulation between the presence of an eye defect and the type of defect.

			Type of defect				
			Myopia	Hyper	NoSight	others	Total
Eyesight defect presence	No	Count	0	0	214	0	214
		% within Eyesight defect presence	.0%	.0%	100.0%	.0%	100.0%
		% within Type of defect	.0%	.0%	100.0%	.0%	66.5%
		% of Total	.0%	.0%	66.5%	.0%	66.5%
	Yes	Count	95	9	0	4	108
		% within Eyesight defect presence	88.0%	8.3%	.0%	3.7%	100.0%
		% within Type of defect	100.0%	100.0%	.0%	100.0%	33.5%
		% of Total	29.5%	2.8%	.0%	1.2%	33.5%
Total		Count	95	9	214	4	322
		% within Eyesight defect presence	29.5%	2.8%	66.5%	1.2%	100.0%
		% within Type of defect	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	29.5%	2.8%	66.5%	1.2%	100.0%

Figure 1.0 : A Bar Chart showing the prevalence of a refractive error along with the type.

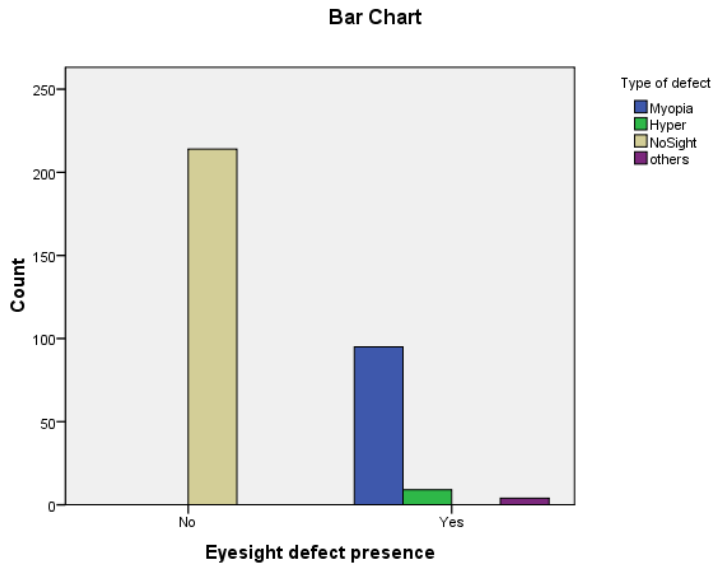

Table 2.0 : A table showing the cross- tabulation between the presence of an eye defect and the diet type.

Eyesight defect presence * Diet Type Crosstabulation

			Diet Type		
			non-veg	Veg	Total
Eyesight defect presence	No	Count	188	26	214
		% within Eyesight defect presence	87.9%	12.1%	100.0%
		% within Diet Type	74.6%	37.1%	66.5%
		% of Total	58.4%	8.1%	66.5%
	Yes	Count	64	44	108
		% within Eyesight defect presence	59.3%	40.7%	100.0%
		% within Diet Type	25.4%	62.9%	33.5%
		% of Total	19.9%	13.7%	33.5%
Total		Count	252	70	322
		% within Eyesight defect presence	78.3%	21.7%	100.0%
		% within Diet Type	100.0%	100.0%	100.0%
		% of Total	78.3%	21.7%	100.0%

Figure 2.0 : A Bar Chart showing clearly the association between the presence of an eye defect and the diet type.

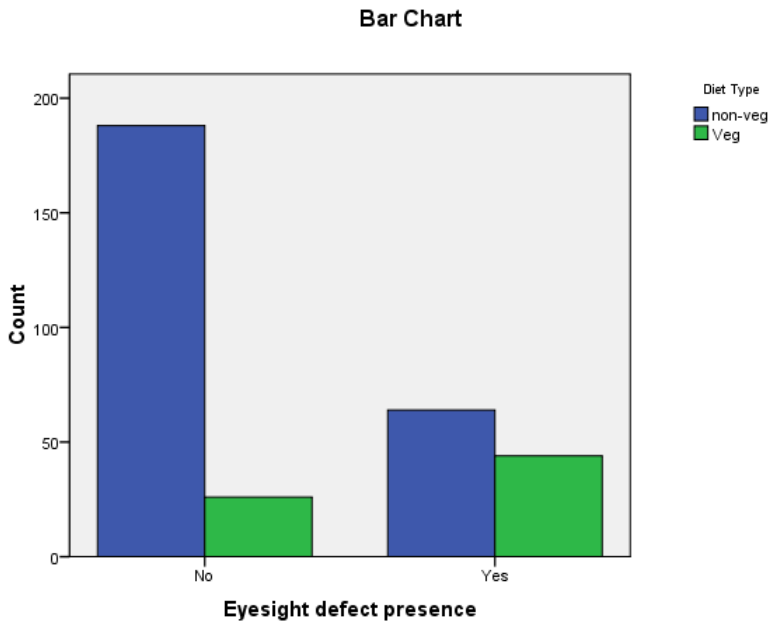

Table 2.1; A table showing the results of the chi-square test conducted to test the association between the presence of an eye defect and diet type.

Since the p value obtained from the chi square test is less than 0.05 (the assumed level of significance), we conclude that there is an association between the presence of an eyesight defect in the subject and the diet type.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	34.487[a]	1	.000		
Continuity Correction[b]	32.827	1	.000		
Likelihood Ratio	32.880	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	34.380	1	.000		
N of Valid Cases[b]	322				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 23.48.

b. Computed only for a 2x2 table

Table 3.0; A table showing the cross-tabulation between presence of an eye defect and type of non vegetarian food consumed most frequently

Eyesight defect presence * Type of non-veg consumed most frequently Crosstabulation

			Type of non-veg consumed most frequently				
			Chicken	Mutton	Fish	Only Veg.	Total
Eyesight defect presence	No	Count	116	14	56	28	214
		% within Eyesight defect presence	54.2%	6.5%	26.2%	13.1%	100.0%
		% within Type of non-veg consumed most frequently	67.1%	82.4%	88.9%	40.6%	66.5%
		% of Total	36.0%	4.3%	17.4%	8.7%	66.5%
	Yes	Count	57	3	7	41	108
		% within Eyesight defect presence	52.8%	2.8%	6.5%	38.0%	100.0%
		% within Type of non-veg consumed most frequently	32.9%	17.6%	11.1%	59.4%	33.5%
		% of Total	17.7%	.9%	2.2%	12.7%	33.5%

Total	Count	173	17	63	69	322
	% within Eyesight defect presence	53.7%	5.3%	19.6%	21.4%	100.0%
	% within Type of non-veg consumed most frequently	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	53.7%	5.3%	19.6%	21.4%	100.0%

Figure 3.0 : A Bar chart showing the cross tabulation of the presence of an eye defect and the type of non veg consumed most frequently.

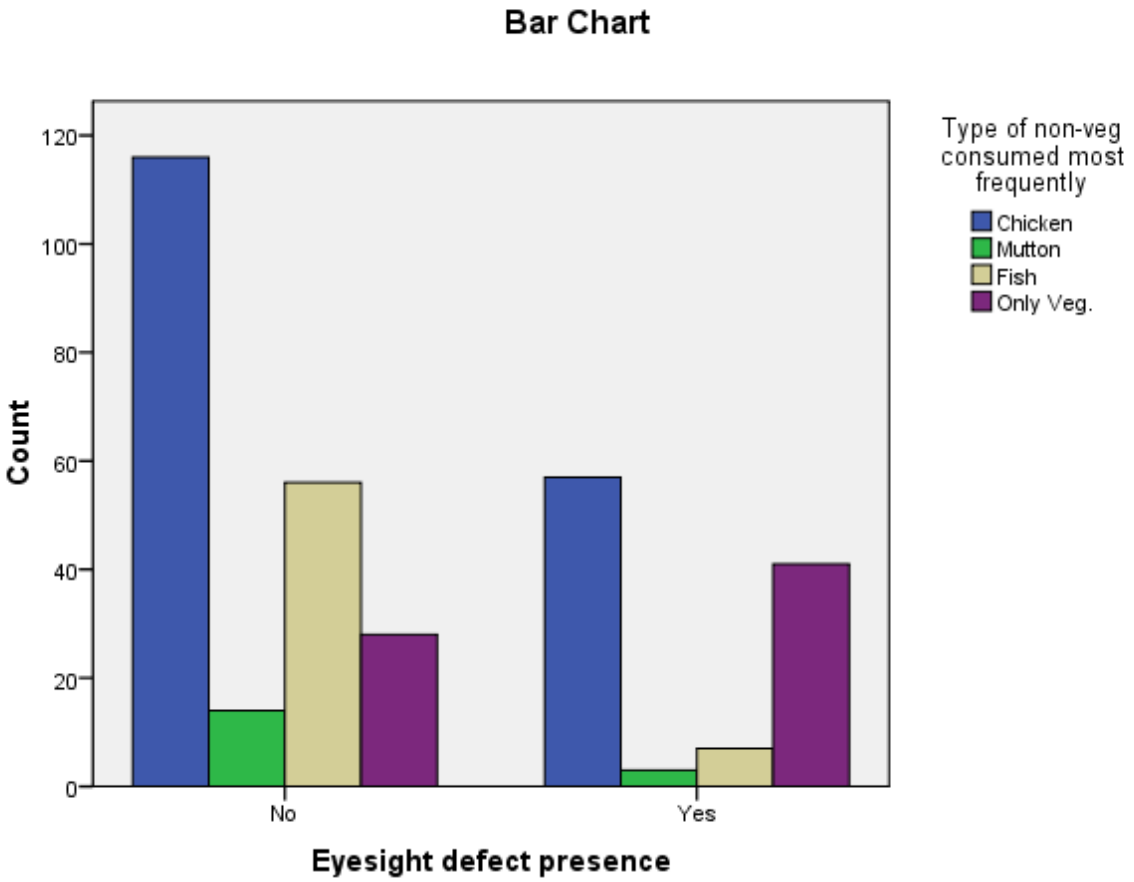

Table 3.1 : A table showing the chi-square tests conducted to test the association between presence of an eyesight defect and the type of non-vegetarian food consumed.

Since the p value obtained from the chi square test is less than 0.05 (the assumed level of significance), we conclude that there is an association between the presence of an eyesight defect in the subject and the type of non-vegetarian consumed most frequently.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.904[a]	3	.000
Likelihood Ratio	38.548	3	.000
Linear-by-Linear Association	4.486	1	.034
N of Valid Cases	322		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.70.

Table 4.0 : A table showing the crosstabulation between presence of an Eyesight defect and the Average number of hours spent watching tv (per day)

Eyesight defect presence * Average number of hours spent watching tv (per day) Crosstabulation

			Average number of hours spent watching tv (per day)			Total
			<1	1-3	>3	
Eyesight defect presence	No	Count	84	79	51	214
		% within Eyesight defect presence	39.3%	36.9%	23.8%	100.0%
		% within Average number of hours spent watching tv (per day)	66.1%	60.8%	78.5%	66.5%
		% of Total	26.1%	24.5%	15.8%	66.5%
	Yes	Count	43	51	14	108
		% within Eyesight defect presence	39.8%	47.2%	13.0%	100.0%
		% within Average number of hours spent watching tv (per day)	33.9%	39.2%	21.5%	33.5%
		% of Total	13.4%	15.8%	4.3%	33.5%

Total	Count	127	130	65	322
	% within Eyesight defect presence	39.4%	40.4%	20.2%	100.0%
	% within Average number of hours spent watching tv (per day)	100.0%	100.0%	100.0%	100.0%
	% of Total	39.4%	40.4%	20.2%	100.0%

Figure 4.0 : A Bar Chart showing the cross tabulation between the presence of an eye defect and the average number of hours spent watching television per day.

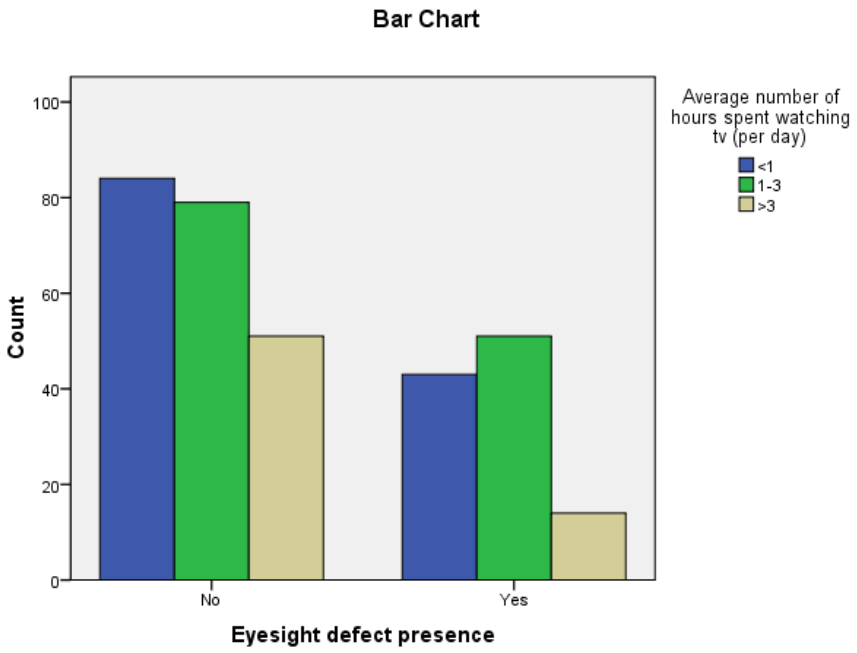

Table 4.1 : A table showing the chi-square tests conducted to test the association between presence of an eyesight defect and the average number of hours spent watching television per day.

Since the p value obtained from the chi square test is less than 0.05 (the assumed level of significance), we conclude that there is an association between the presence of an eyesight defect and hours spent watching television per day.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.095[a]	2	.047
Likelihood Ratio	6.380	2	.041
Linear-by-Linear Association	1.672	1	.196
N of Valid Cases	322		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 21.80.

Table 5.0 : A table showing the cross-tabulation between the presence of an eye defect in a subject and the presence of an eye defect in his/ her mother.

Eyesight defect presence * Type of deficiency in mother Crosstabulation

			Type of deficiency in mother				
			myopia	hypermetropia	none	both	Total
Eyesight defect presence	No	Count	42	41	91	40	214
		% within Eyesight defect presence	19.6%	19.2%	42.5%	18.7%	100.0%
		% within Type of deficiency in mother	70.0%	59.4%	75.2%	55.6%	66.5%
		% of Total	13.0%	12.7%	28.3%	12.4%	66.5%
	Yes	Count	18	28	30	32	108
		% within Eyesight defect presence	16.7%	25.9%	27.8%	29.6%	100.0%
		% within Type of deficiency in mother	30.0%	40.6%	24.8%	44.4%	33.5%
		% of Total	5.6%	8.7%	9.3%	9.9%	33.5%
Total		Count	60	69	121	72	322
		% within Eyesight defect presence	18.6%	21.4%	37.6%	22.4%	100.0%
		% within Type of deficiency in mother	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	18.6%	21.4%	37.6%	22.4%	100.0%

Figure 5.0 : A bar chart showing the cross-tabulation between the presence of an eye defect in a subject and the presence of an eye defect in his/ her mother.

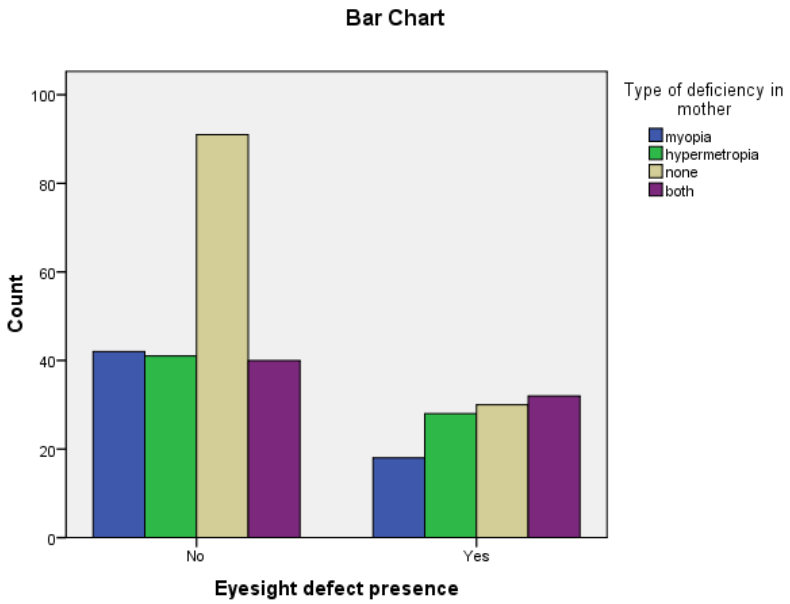

Table 5.1 : A Table showing the chi-square tests conducted to test the association between presence of an eyesight defect in a subject and the presence of an eye defect in his/her mother.

Since the p value obtained from the chi square test is less than 0.05 (the assumed level of significance), we conclude that there is an association between the presence of an eyesight defect in the subject and the presence of an eyesight defect in his/her mother.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	9.865[a]	3	.020
Likelihood Ratio	9.884	3	.020
Linear-by-Linear Association	.693	1	.405
N of Valid Cases	322		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 20.12.

Table 6.0 : A Table showing the cross-tabulation between the presence of an eye defect and the average number of hours spent reading per day.

			Average number of hours spent reading (per day)			Total
			<1	1-3	>3	
Eyesight defect presence	No	Count	79	95	40	214
		% within Eyesight defect presence	36.9%	44.4%	18.7%	100.0%
		% within Average number of hours spent reading (per day)	67.5%	68.3%	60.6%	66.5%
		% of Total	24.5%	29.5%	12.4%	66.5%
	Yes	Count	38	44	26	108
		% within Eyesight defect presence	35.2%	40.7%	24.1%	100.0%
		% within Average number of hours spent reading (per day)	32.5%	31.7%	39.4%	33.5%
		% of Total	11.8%	13.7%	8.1%	33.5%
Total		Count	117	139	66	322
		% within Eyesight defect presence	36.3%	43.2%	20.5%	100.0%
		% within Average number of hours spent reading (per day)	100.0%	100.0%	100.0%	100.0%
		% of Total	36.3%	43.2%	20.5%	100.0%

Figure 6.0 : A bar chart showing the cross-tabulation between the presence of an eye defect and the average number of hours spent reading per day.

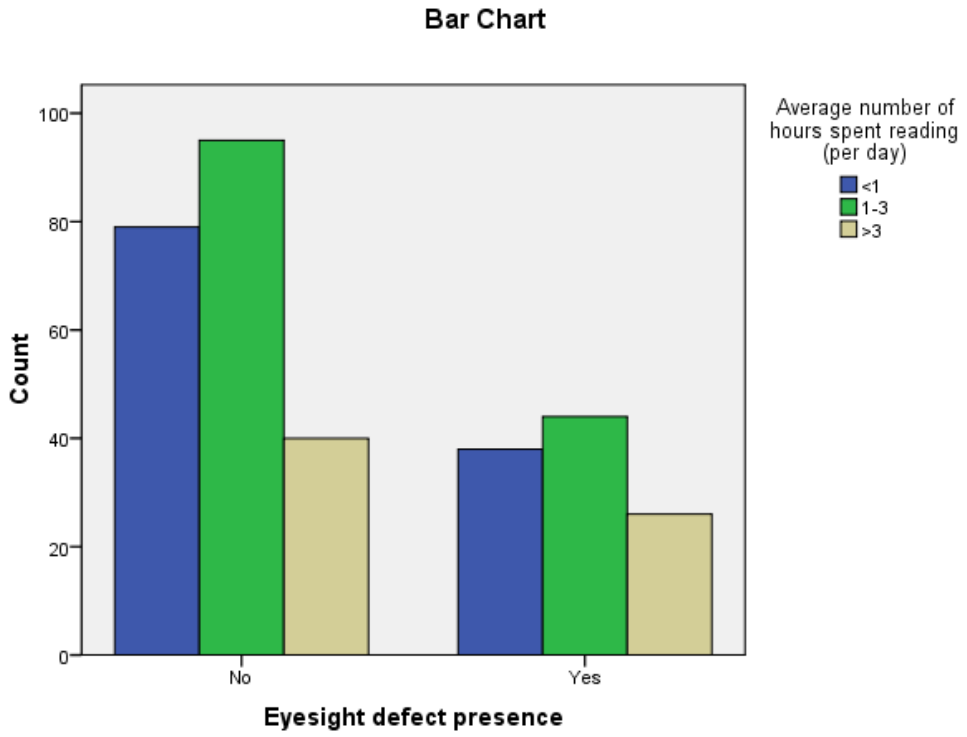

Table 6.1 : A Table showing the chi-square tests conducted to test the association between presence of an eyesight defect in a subject and the average number of hours spent reading per day.

Since the p value obtained from the chi square test is more than 0.05 (the assumed level of significance), we conclude that there is no statistically significant association between the presence of an eyesight defect in the subject and the average number of hours spent reading per day.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.295[a]	2	.523
Likelihood Ratio	1.272	2	.529
Linear-by-Linear Association	.666	1	.414
N of Valid Cases	322		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 22.14.

Table 7.0; A table showing the cross-tabulation between presence of an eyesight defect in a subject and the average number of hours spent reading and watching television per day.

Eyesight defect presence * number of hours tv + books Crosstabulation

			number of hours tv + books					
			0 to 2 hours	2 to 3 hours	3 to 4 hours	4 to 6 hours	>6 hours	Total
Eyesight defect presence	No	Count	31	61	78	37	7	214
		% within Eyesight defect presence	14.5%	28.5%	36.4%	17.3%	3.3%	100.0%
		% within number of hours tv + books	70.5%	63.5%	64.5%	72.5%	70.0%	66.5%
		% of Total	9.6%	18.9%	24.2%	11.5%	2.2%	66.5%
	Yes	Count	13	35	43	14	3	108
		% within Eyesight defect presence	12.0%	32.4%	39.8%	13.0%	2.8%	100.0%
		% within number of hours tv + books	29.5%	36.5%	35.5%	27.5%	30.0%	33.5%
		% of Total	4.0%	10.9%	13.4%	4.3%	.9%	33.5%
Total		Count	44	96	121	51	10	322
		% within Eyesight defect presence	13.7%	29.8%	37.6%	15.8%	3.1%	100.0%
		% within number of hours tv + books	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	13.7%	29.8%	37.6%	15.8%	3.1%	100.0%

Figure 7.0 : A figure showing the cross-tabulation between presence of an eyesight defect in a subject and the average number of hours spent reading and watching television per day.

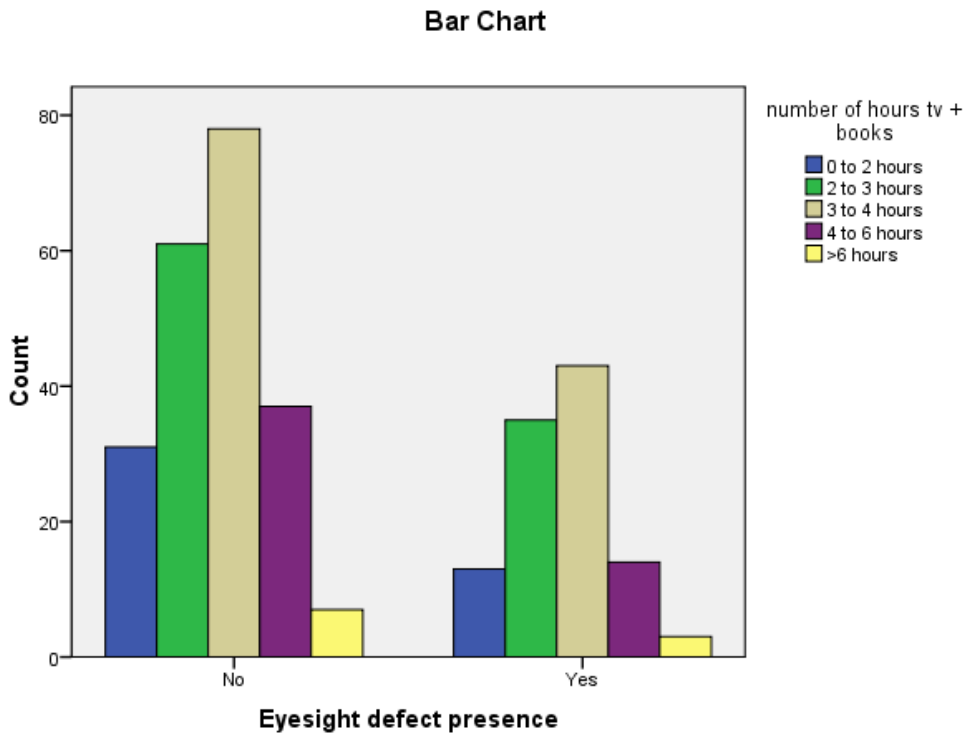

Table 7.1: A Table showing the chi-square tests conducted to test the association between presence of an eyesight defect in a subject and the average number of hours spent reading and watching television per day.

Since the p value obtained from the chi square test is more than 0.05 (the assumed level of significance), we conclude that there is no statistically significant association between the presence of an eyesight defect in the subject and the average number of hours spent reading and watching television per day.

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.803[a]	4	.772
Likelihood Ratio	1.833	4	.766
Linear-by-Linear Association	.133	1	.715
N of Valid Cases	322		

a. 1 cells (10.0%) have expected count less than 5. The minimum expected count is 3.35.

5. Discussion And Conclusion

Keeping in mind the sample size and the endemic nature of the population, we first of all would like to emphasize that by citing any statistically significant association between variables, we do not imply that a causal relationship has been established between the factors/variables in question. Taking cognizance of the resources in hand, we have looked to establish scientifically, the associations that have been claimed in relevant literature. After a suitable statistical analysis, we have presented our results and compared them with prior literature in each case (if extant) with a certain degree of circumspection as results have been found to vary greatly depending on the race , ethnicity, occupation, environment and other factors [11], [12].

The prevalence of myopia, according to our study, was found to be consistent with prior studies (South and South East Asian countries have an average rate of myopia incidence of 41 %, primarily in young adults) [13],[14].

As stated previously, there has been a dearth of knowledge regarding the association between the presence of a refractive error (we assume here that susceptibility is a concomitant conclusion) and the diet type of the subject. This can be attributed to the sparse number of vegetarians present outside the Indian sub-continent. It is also to be noted that by a vegetarian diet, we do not mean 'primarily vegetarian' and that the classification is absolute (inclusive of lactose over vegetarians who consume eggs). We have found one similar study by Niroula and Saha [7] who examined refractive errors with respect to various factors (including diet type) in Pokhara city, Nepal and found that 10.52 % of vegetarian and 6.17 % of non-vegetarian school going children had refractive errors. In their study this disparity was not statistically significant though they cite nutritional differences as important factors in causing refractive errors in children. We went one step ahead and also tried to eke out any differences that may arise due to the type of meat consumed. We have found that only 11.1% of fish eaters reported a refractive error where as 32.9% of chicken eaters did. It is of course to be noted that 173 chicken eaters were examined in contrast to 63 fish eaters. There is no documented disparity prior to our study, though it is common hearsay along the coasts of the Bay of Bengal that fish meat keeps the eyes healthy.

One extremely interesting finding that we wish to highlight is the statistically significant association between the presence of an eye defect in the subject and in that of his/her mother (the association was not to found to be significant with the case of the father). Heredity has already been established as a key factor implicated in the onset of juvenile myopia. Our study opens up the scope for wider investigation into myopia onset even at the later stages of childhood and adolescence.

A number of studies have shown higher incidence of myopia with the level of education, literacy [15],[16] and also the levels of IQ (Intelligence Quotient) [17]. This has been attributed to the "near work" or studying/ reading habits of the subjects. The previous observation has been buffeted by a possible converse: Hyperopic children have lesser IQ and fewer scholastic achievements. Regarding IQ there have been several theories: IQ testing is near work and hence lesser strain for the myopes. Conversely, myopes have are more voracious readers and hence have better IQ's. Still another theory is that the pleiotropic genes affect the size of the brain and the eyes simultaneously. Our study has found that there is no significant association between the number of hours spent reading and the presence of a refractive error (91.3 % of subjects with a refractive error are myopes). This particular finding, though in absolute disagreement with the theory proposed to explain the different rates of myopia prevalence in rural and urban children in north India[6], can be construed to be in concord, at least in part, with two most recent studies that myopia may be associated with higher IQ independent of the number of hours read [18]. Contrary to our observation with reading, we have found an association with of the presence of a refractive error with the average number of hours spent watching television per day. There has been a widespread campaign all over the world to reduce television watching in children, citing the fact that fifty years ago myopia was hardly seen and now about 1.6 billion people world over suffer with this affliction – a trend that is concurrent with the rise of the television, initially, and the computer, later on, to be pervasive domestically. To allow tractable comparison with previous studies, we have attempted to formulate the "near work" variable by adding the number of hours spent reading and the number of hours spent watching television by each subject. This "strain" was also found to be statistically independent of the presence of a refractive error. Thus, based on our data, myopia seems to be the culmination of a complex symphony of certain types of strain, diet and heredity.

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