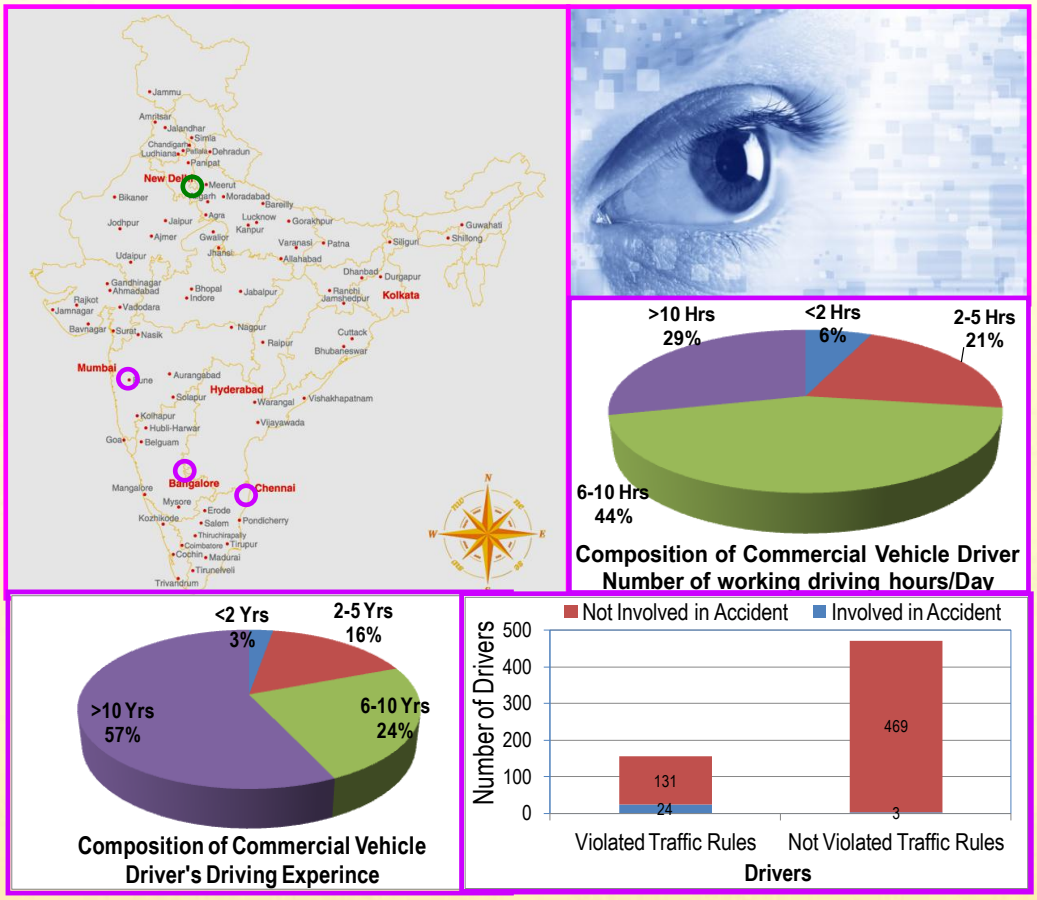
Assessment of Visual Limitations of Commercial Drivers in Metropolitan Cities in India

Interim Report

Submitted to

VISION IMPACT INSTITUTE™
Giving Vision a Voice



September, 2017

सी एस आई आर - केंद्रीय सड़क अनुसंधान संस्थान, नई दिल्ली-110025

CSIR - CENTRAL ROAD RESEARCH INSTITUTE

NEW DELHI-110025

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1.0 INTRODUCTION

Blindness at any stage of life is a concern to public health. It is estimated that about 45 million populations suffer from blindness in the world and out of that 73 % of live in low-income countries (Gilbert et al., World Health Organization 1997). Five hundred thousand children become blind each year, one per minute or 60 % of them die within one or two years of becoming blind (WHO, 1999).

As such, the prevalence of childhood blindness is estimated to vary significantly, from 0.3 per 1000 children in the wealthy regions of the world to as high as 1.5 per 1000 children in the poorer regions (Gilbert C et al, 2001). Mortality in blind children is higher in developing countries than in developed ones, and nine out of 10 blind people live in the developing world (Thylefors B. 1998). The WHO - Vision 2020 Global Initiative has set a number of priorities focused on for five major eye conditions which are preventable or treatable. These are cataract, trachoma, childhood blindness and refractive error. According to many studies on refractive error, uncorrected refractive error is one of main cause of visual impairment. Failure to treatment of refractive errors may lead to blindness. Refractive error in children is one the priorities of the World Health Organization (Vision 2020). In India, there is no study has been reported at the national level on the prevalence of refractive error and the effectiveness of the spectacles for mitigating refractive errors . Therefore, an attempt has been made in this study to conduct a survey at the Pan India to extent possible so as estimate the burden of refractive error amongst commercial drivers and an assessment of the level of utility of spectacles amongst drivers for minimizing chances of road crashes.

While driving, ninety percent information are taken from visual inputs about the road itself, other vehicles, pedestrians, signs, the passing scenery, etc. rest of the information, the driver may be processing through other information sources such as auditory inputs (listening to the radio, talking on a cell phone, carrying on a conversation with another passenger), or internal inputs (remembering directions or planning for other things). Research has shown that road crashes occur due to one of three main reasons. The first is perceptual error. Sometimes critical information was below the threshold for seeing the light was too dim, the driver was blinded by glare, or the pedestrian's clothes had low contrast. In other cases, the driver made a perceptual misjudgment (a curve's radius or another car's speed or distance). The second, and far

more common cause, is that the critical information was detectable but that the driver failed to attend/notice because his mental resources were focused elsewhere. Third, when the position of the object falls outside the centre of the visual field. All the above factors can cause "intentional blindness" which can lead to the incidence of road crashes.

2.0 NEED FOR THE STUDY

Current Driving Licensing System followed in India and the issuance of license is essentially a state subject / matter. In each state, driving license is issued by the Regional Transport Offices (RTOs). Unfortunately, prior driver education is not kept mandatory for getting a driver license. As per Sub-section (3) of Section-8 of the Motor Vehicle Act 1988, a self-declaration, medical certificate from a registered medical practitioner in case of a non-transport and transport vehicle respectively, is sufficient for grant of learner's license in India. If not declared with truthfulness, this could pose serious safety hazards due to presence of drivers with certain physical abnormalities in traffic and which may hinder the driver from safe driving. This risk is clearer from the recent study of Chauhan S. 2009. Above all, the present system in India is totally based on conventional driver education and testing, which has serious limitations with respect to road safety as highlighted by Christie. In a recent study done at Guwahati, India (Chauhan S.) an attempt was made to identify the shortcomings in physical attributes of the drivers that may pose road safety hazards such as visual acuity, peripheral vision, depth perception, glare recovery, colour vision, contrast sensitivity, phoria, etc. Based on the analysis of data collected, the following important findings were reported by them: Three per cent of the drivers failed in the phoria test, which checks for proper eye muscles and co-ordination of both eyes to correctly identify the placement of an object ahead. If a particular driver performs „unacceptable" in this test, then it indicates that the driver may not be able to identify the position of an object such as, vehicle, pedestrian, etc. in front of him/her on the road correctly. Seven per cent of the drivers failed in the glare recovery test, which is an important parameter for safe driving during night, especially on undivided roads, which are predominant in India, and where there is a substantial glare of headlight of the opposing vehicles. Five per cent of the drivers were found to have problem of tunnel vision while driving, which shows that such drivers may not be able to identify the side obstructions and correspondingly respond to

the stimulus on time. Fifteen per cent of the drivers were found to have unacceptable acuity vision in one of the eyes and 4 % in both the eyes. Five per cent of the drivers had problem with night vision (vision in the presence of headlight). Performance of 5% of the drivers was found „unacceptable" in colour vision test. It is reported that there is high incidence of road crashes caused by drivers with visual impairments in a CSIR sponsored research study by **Verma A. et al 2011-12** by the Indian Institute of Science (IISc), Bangalore along with CSIR – CRRI (2014)**. The above study was conducted covering** 387 bus drivers with the aim to analyze scientifically the effect of visual disabilities on road crashes. The study found that among the bus drivers who were involved in crashes, a massive 81 per cent had at least one visual disability, even as 52 per cent of the entire sample failed in at least one vision test. The study concludes that there is significant influence of vision defects on crash involvements of tested drivers. According to the 2013 report of the Ministry of Road Transport and Highways, GoI, "driver fault" forms a significant share of the causes of road accidents in India and it stands at 78 per cent."Road safety is a critical issue that needs focus in this era of increased road-crash deaths. India is one of the perilous countries in terms of road fatalities in the world. Among the human factors that influence safe driving, visual skills of the driver can be considered fundamental. The results showed a significant relation between road crash tendencies of drivers and visual defects such as phoria (coordination of both eyes to correctly identify placement of an object ahead), peripheral vision and contrast sensitivity (seeing objects in similar brightness as that of color).

Further based on request received from M/S Vision Institute to study impacts on commercial drive in metropolitan cities of India and considering the above reviewed literature, the objectives of the present study has been conceived as presented in next section.

3.0 OBJECTIVES AND SCOPE OF THE STUDY

3.1 Objectives

Considering the above need of the study and literature review on study the visual impacts of commercial drivers in metropolitan cities of India, the main objectives of the present study are as follows:

a) Development of the evidence based unique database of Uncorrected Refractive Errors (URE) of the Commercial vehicle Drivers operating in different four metropolitan cities of India to understand the overall visual health.
b) Assessment of the need for visual correction
c) Fostering a collaborative approach with the visual experts in the related area
d) Advocating for action based dissemination through eye testing; provision for correction and policy change by publications, organising workshop and training programmes

3.2 Scope of the Study

The broad scope of the study is given below:

a) Assessment of visual traits and socio economic profile of about 625 commercial drivers / subjects in Delhi which will be used as the base to study the subjects in . Subsequently, the field studies at three other metropolitan cities namely, Pune, Bangalore and Chennai covering about 625 random samples in each city.
b) Based on the above data (sample format of as given in Annexure-I), the data will be analysed.
c) The report will be prepared contains existing conditions of drivers and recommendations relating to the vision in India.

4.0 METHODOLOGY

The definition of visual impairment in the **International statistical classification of diseases, injuries and causes of death, 10th revision** (ICD-10), H54, is based on "best-corrected" vision, i.e. visual acuity obtained with the best possible refractive correction. Hence the following tests has been conducted with the help of Keystone View Vision Screeners test for all of the essential visionary functions including acuity (monocular and binocular), colour blindness, peripheral vision, stereopsis and glare recovery.

The RESC studies also report the prevalence of uncorrected visual acuity in the age group 5–15 years: the prevalence of uncorrected, presenting and best-corrected visual acuity (VA < 6/18) provides an estimate of the percentage coverage of refractive services using the formula:

$$100-\left[\frac{(\text{presenting VA}-\text{best corrected VA})}{(\text{uncorrected VA}-\text{best corrected VA})}\times 100\right]$$

Since percentage coverage is based on presenting visual acuity, it is an estimate of both the provision of refractive services and the compliance to prescription.

The data will be stored, tabulated and automatically will be saved to a database with the help of PC software. Based on the output of a questionnaire survey these drivers will be further divided into small groups i.e. drivers with and without previous road crash history, age, experience, gender and qualification, previous visual deficits and spectacle use, alcohol consumption history etc.

Database will be reviewed by the expert committee members. Based on the feedback received from various experts a sample of total 627 drivers will be screened in Delhi. Out of these drivers who will be requiring visual attention or low visual acuity has noted separately and suggested for immediate medical attention. The data collected from Delhi has been compiled and analysis has been carried out.

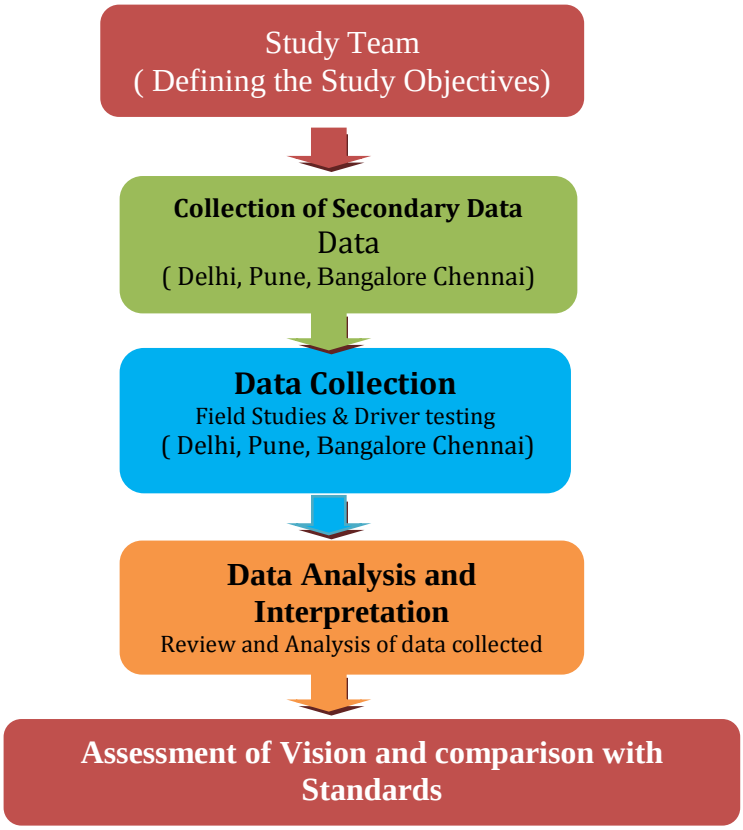

Figure 4.1: Methodology proposed

4.1. Tools

Refractive errors (myopia, hyperopia and astigmatism; presbyopia is not included in this study, but it is recognized that uncorrected, it could lead to an impaired quality of life) affect a large proportion of the population worldwide, irrespective of age, sex and ethnic group. Such refractive errors can be easily diagnosed, measured and corrected with spectacles or other refractive corrections to attain normal vision. If, however, they are not corrected or the correction is inadequate, refractive errors become a major cause of low vision and even blindness. All Uncorrected Refractive Errors (URE) tests of the Commercial vehicle Drivers were conducted with the help of Keystone View (as shown in Figure 4.2) which has several unique features such as testing in reflected light rather than with backlit targets to mirror everyday visual function. Each of these permanently-mounted test targets presents somewhat differing images to the two eyes. Questionnaire survey (developed by CSIR-CRRI) was simultaneously carried out on same group of drivers to find out the detail history and other details of their behavioral parameters and other demographic characteristics.

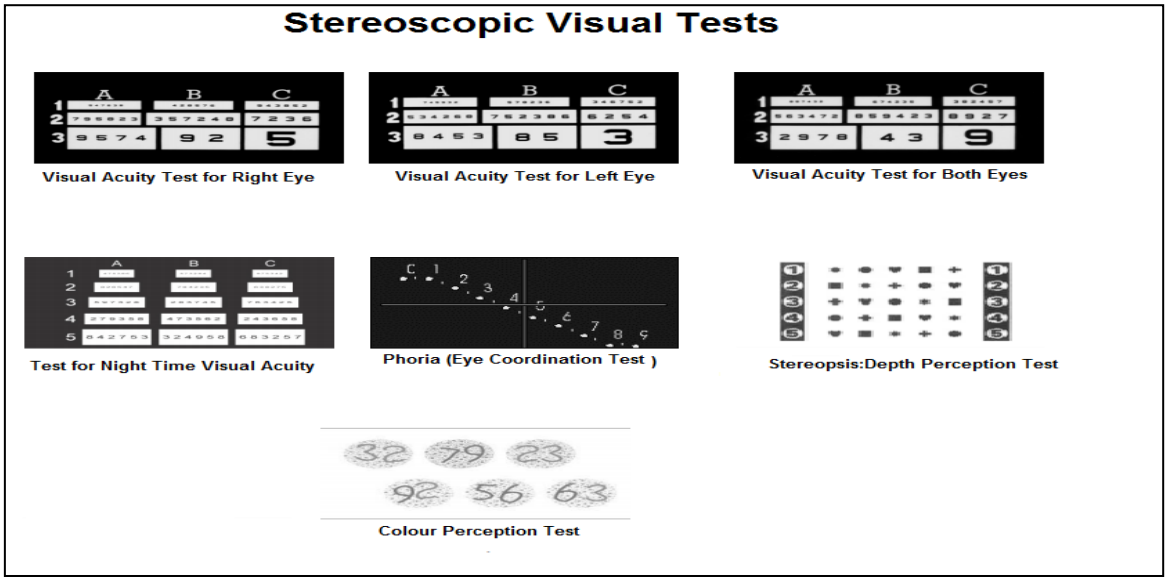

Figure 4.2: Vision tests of Keystone View

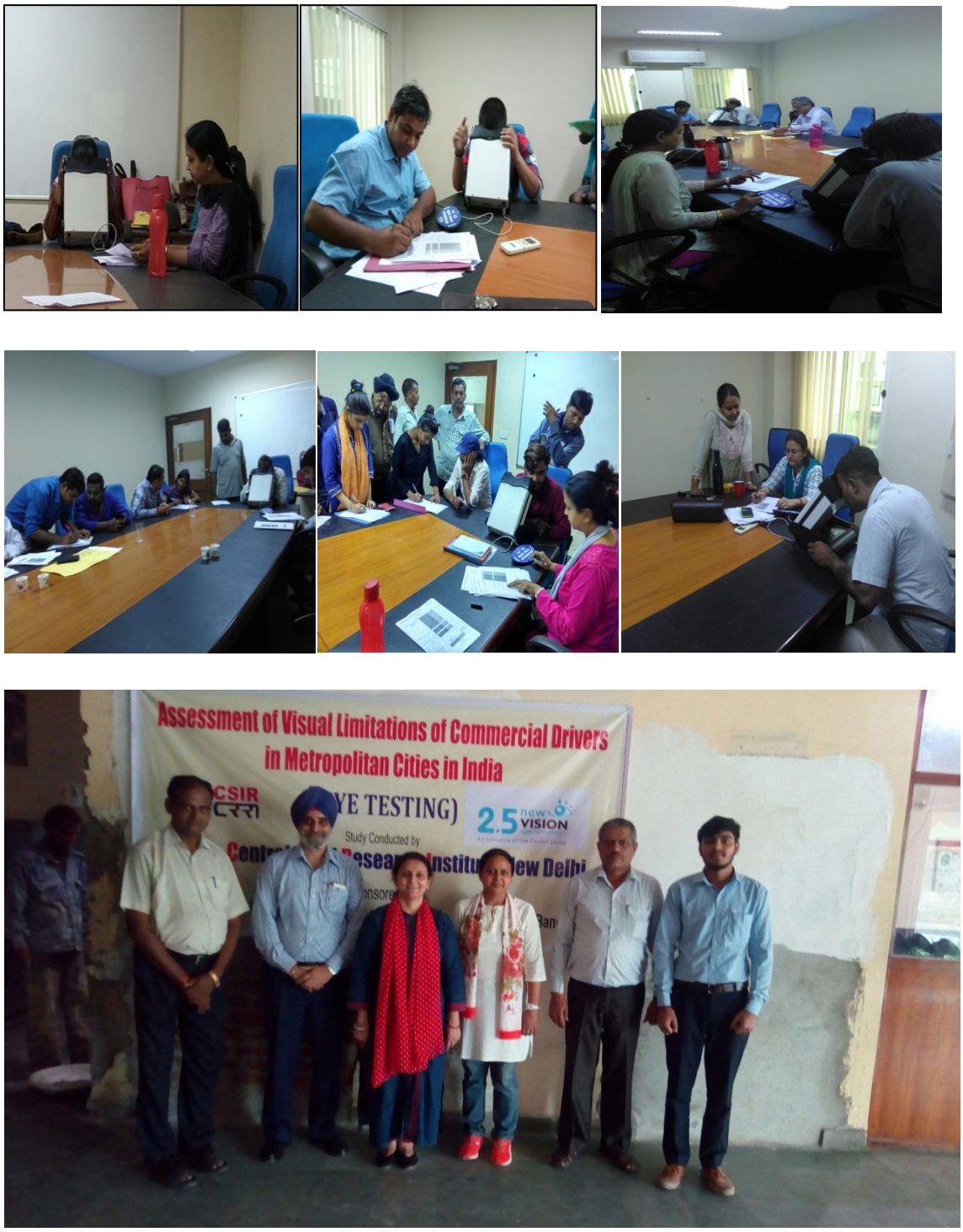

Figure 4.3: CSIR-CRRI, New Delhi team along with the team of Ashok Leyland Driver Training Institute at Ashok Leyland Driver Training Institute at Delhi while Administering Vision Screening Tests (conducted between August 8 -14, 2017)

4.2. Process of Testing:

The subject sits before the testing instrument with the head in the headrest to view target slides and lamps. The examiner controls the entire procedure through the hand control or Keystone View Software. The examiner explains the targets, prompted by easy-to-follow instructions, and the subject reports what they see. Responses are recorded on an included record form or via the software. Following test series were conducted to screen vision functions:

4.2.1. Binocular Testing:

In order to replicate everyday natural visual function, all tests are given with both eyes open, even tests checking acuity in each eye separately.

4.2.2. Far-point Visual Acuity :

For testing vision at far point, the Keystone View replicates an actual distance of 20 feet by using a unique bifocal lens system. The system conserves space with this compact, versatile instrument. If five of the six numerals are correctly identified the subject is considered as having 20/20 acuity in the right eye and need not read further. If the first block is not correctly read, have the subject continue across each row consecutively from left to right until the numbers in a block are called correctly.

4.2.3. Near-point Visual Acuity:

To test vision at "reading distance", the VS-V replicates an actual distance of 16 inches.

4.2.4. Stereopsis (Depth Perception):

This test incorporates a 3-D target to measure depth perception.

4.2.5. Color Blindness Test:

This test measures for severe (red/green) and mild (blue/violet) deficiencies in color perception. In the test the subject has to identify displayed numerals of 32, 79, and 23 under red/green colours which is the measurement for severe colour blindness and numerals 92, 56, and 63 under blue/violet colours which is the measurement of mild colour blindness.

4.2.6. Low Light/Night Vision (Contrast Sensitivity):

Contrast sensitivity is a very different visual function than acuity. A person with 20/20 (6/6) acuity under high contrast conditions may have the equivalent of 20/400 (6/120) or worse in low-contrast conditions, for example. The \contrast sensitivity test images at different levels of contrast are shown, using reflective light to mimic real-world vision. For measuring results, a person who is able to detect details in very low contrast conditions is said to have high-contrast sensitivity. A person who cannot detect details in very low contrast conditions is said to have low-contrast sensitivity. Subjects are presented with nine blocks of numbers varying in contrast from 10 to 90 percent (%) under dusk/night driving conditions. All tests are given at 20/70 (6/21) acuity. Line 1, Column A is 10% contrast, Line 1 Column B is 20% contrast, Line 1 Column 3 is 30% contrast, Line 2 Column A is 40% contrast, etc.

5.0 METHOD OF INTERPRETATIONS OF TEST SCORES

5.1. Visual Acuity Test:

20/40 (6/12) acuity as a passing minimum is accepted by some authorities and many driver licensing agencies accept 20/40 (6/12) as a minimum standard. Also, if a subject's occupation demands good vision at the reading distance then 20/30 (6/9) is considered as a minimum score for near point and 20/40 (6/12) as the minimum score at far point. The scores in the lightly shaded areas are showing "marginal" and scores falling in the darkly shaded "Unacceptable" areas.

5.2. Color Vision Tests:

This test two subtest of tests a) Test for Severe Color Blindness (red/green) in which the subject must identify numerals 32, 79, and 23 and b) Test for Mild Color Blindness (blue/violet) in which the subject has to identify numerals 92, 56, and 63.

5.3. Depth Perception Test or Stereopsis:

Stereoscopic vision or depth perception is important in identifying Stereopsis. Stereovision is defined as how each eye may see an object from different angles as shown in Figure 5.1, but combines these different angles to produce a 3D image. There are many tests which have been developed separately to measure stereoscopic/depth perception for children and adults. Many of the tests ask the subject to identify the "raised" letters, shapes or animals. An Ophthalmological practice has a variety of these

while serving various subjects of different age group. It is a highly developed visual skill. The score lying in the dark area i.e. 10% to 40% is "Unacceptable level" followed by lightly shaded area i.e. 75% which is "Marginally Acceptable level". Acceptable level indicates 85% stereopsis on the Shepherd-Fry Scales. In Keystone View in this test, the subject has to identify the raised symbols as shown in the Test Key below:

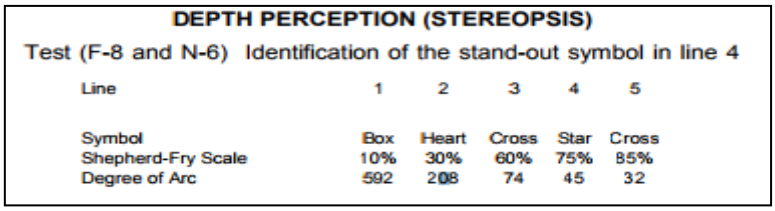

Figure 5.1: Depth Perception Test Plate

5.4. Contrast Sensitivity Test:

Is a very important measure of visual function, especially in situations of low light, fog or glare, when the **contrast** between objects and their background often is reduced. Driving at night is an example of an activity that requires good **contrast sensitivity** for safety. For measuring results, a person who is able to detect details in very low contrast conditions is said to have high-contrast sensitivity. A person who cannot detect details in very low contrast conditions is said to have low-contrast sensitivity. Subjects are presented with nine blocks of numbers varying in contrast from 10 to 90 percent (%) under dusk/night driving conditions. All tests are given at 20/70 (6/21) acuity. Line 1, Column A is 10% contrast, Line 1 Column B is 20% contrast, Line 1 Column 3 is 30% contras, Line 2 Column A is 40% contrast, etc. If the first line is read correctly, /he has the ability to read a 20/70 (6/21) acuity test at 10% contrast and need not read any further. Continue across each line reading each block from left to right until your test subject reads all three numbers in a single block successfully. Reading a minimum of all three numbers on Line 2 Column A is considered acceptable. If the test subject is unable to correctly identify all three numbers in the 40% block further examination by a vision professional is recommended.

5.5. Glare Recovery Test:

In this test glares equivalent to headlights are displayed followed by the letters to read. Reading six out of the seven numbers in any one line in less than 5 seconds is

considered passing. If at least 6 of the 7 numbers in a row are not correctly identified, further examination by a vision professional is recommended.

5.6. The Keystone View Record Form :

The testing report has to be filled up in the Keystone View Record Form as shown in Figure 5.2 below. In the form the Visual Acuity test different letters from Snellen Chart are displayed and the results have been categorized in three parts as the Unacceptable, Marginal, and Acceptable for each of the three acuity areas: Far Point, Intermediate, and Near Point and for the other tests such as Night Vision ,Glare Recovery and Colour Vision Test. In the form the darkest area highlights the Unacceptable result, Semi Dark area relates to Marginal result and Bright Part highlights Acceptable result.

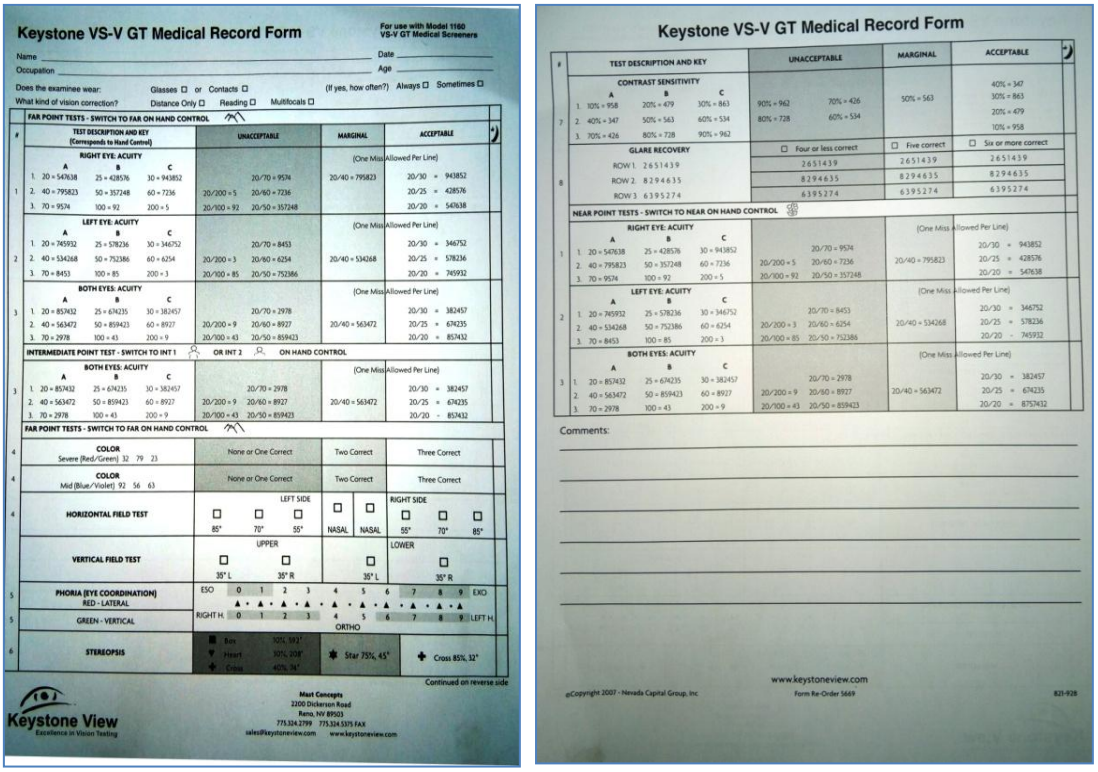

Figure 5.2: Keystone View Record Form

6.0 FINDINGS OF THE KEYSTONE TEST RESULTS

A summary of the data collected across 627 drivers / subjects from 8th August 2017 to 14th August 2017 at Delhi is presented in Table-6.1 and pictorially presented in Figure 6.1. The data revealed that drivers were suggested to wear glasses by the ophthalmologists increased with age group for near or far sightedness (Table-6.1,Figure 6.1) .

Table 6.1: The Sample population with percentage for Wearing Glasses (Yes/No)

Age Code	Glasses	Raw Data	%	Total
Upto 20 Years	Yes	1	11	9
	No	8	89	
21-30	Yes	33	16	208
	No	175	84	
31-40	Yes	41	22	183
	No	142	78	
41-50	Yes	57	41	140
	No	83	59	
51-60	Yes	30	43	70
	No	40	57	
61-70	Yes	11	65	17
	No	6	35	

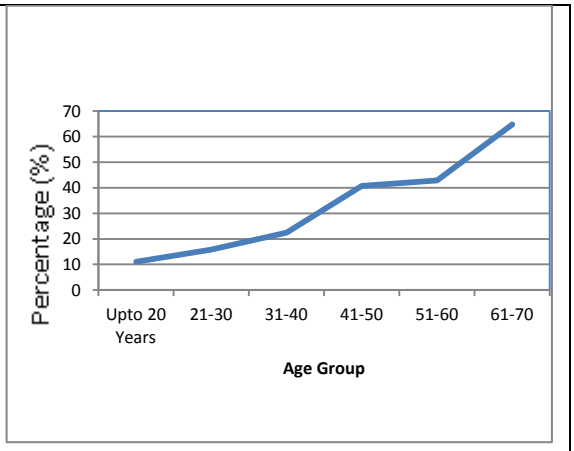

Figure 6.1: Percentage of Drivers Suggested for Wearing Spectacles

6.1. Driver Performance for Visual Acuity (for Far) for Left, Right and Both Eyes (Whole Sample Population)

The observation of data revealed that 37 % , 36 % and 31 % of the drivers experienced visual limitation for left eye only, right eye only and for both eyes respectively. The above subjects were found to have either marginal or poor ***Far Visual Acuity*** (Table 6.2).

Table 6.2: Visual Acuity (Far) for Left, Right and Both Eyes (Whole Sample Population)

Eyes	Acceptable	Acceptable (%)	Marginal	Marginal (%)	Unacceptable	Unacceptable (%)
Left Eye	398	63	98	16	131	21
Right Eye	400	64	106	17	121	19
Both Eyes	433	69	96	15	98	16

Table 6.3: Visual Acuity (Near) for Left, Right and Both Eyes (Whole Sample Population)

Eyes	Acceptable	Percent Acceptable	Marginal	Percent Marginal	Unacceptable	Percent Unacceptable
Left Eye	317	51	86	14	224	36
Right Eye	308	49	103	16	216	34
Both Eyes	342	55	82	13	203	32

Similarly, the observation of data revealed that 50 % , 50 % and 45 % of the drivers experienced visual limitation for left eye only, right eye only and for both eyes respectively. The above subjects were found to have either marginal or poor ***Near Visual Acuity*** (Table 6.3).

Table 6.4: Age Wise Visual Acuity for Left, Right and Both Eyes

AGE	FAR									NEAR								
	LEFT			RIGHT			BOTH			LEFT			RIGHT			BOTH		
	20/30	20/40	Ab 20/40	20/30	20/40	Ab 20/40	20/30	20/40	Ab 20/40	20/30	20/40	Ab 20/40	20/30	20/40	Ab 20/40	20/30	20/40	Ab 20/40
>20 Years	5	4	0	8	1	0	8	1	0	9	0	0	9	0	0	9	0	0
21-30	121	82	5	179	16	13	186	14	8	175	23	10	171	29	8	187	16	5
31-40	102	72	9	134	33	16	145	26	12	116	25	42	112	37	34	122	26	35
41-50	56	65	19	60	38	42	73	37	30	14	29	97	13	29	98	20	28	92
51-60	25	25	20	17	16	37	19	16	35	3	8	59	3	8	59	4	10	56
61-70	10	4	3	2	2	13	2	2	13	0	1	16	0	0	17	0	2	15

Present study findings highlight that RE Far are associated with the increase in age group as the data shows that with the increase in age drivers Visual Acuity (VA) deteriorated drastically (Fig 6.2,6.3 and 6.4) except the VA for left eye where the data show sample population was having slight increase in 20/30 VA but in Right Eye VA and Both Eyes VA cases the reverse is found i.e VA was more inclined towards more than 20/40 (deteriorating trend) with the increase in age group. The findings are supported with the findings of RE in Latinos from Arizona state which highlighted that RE are associated with increasing age [9].

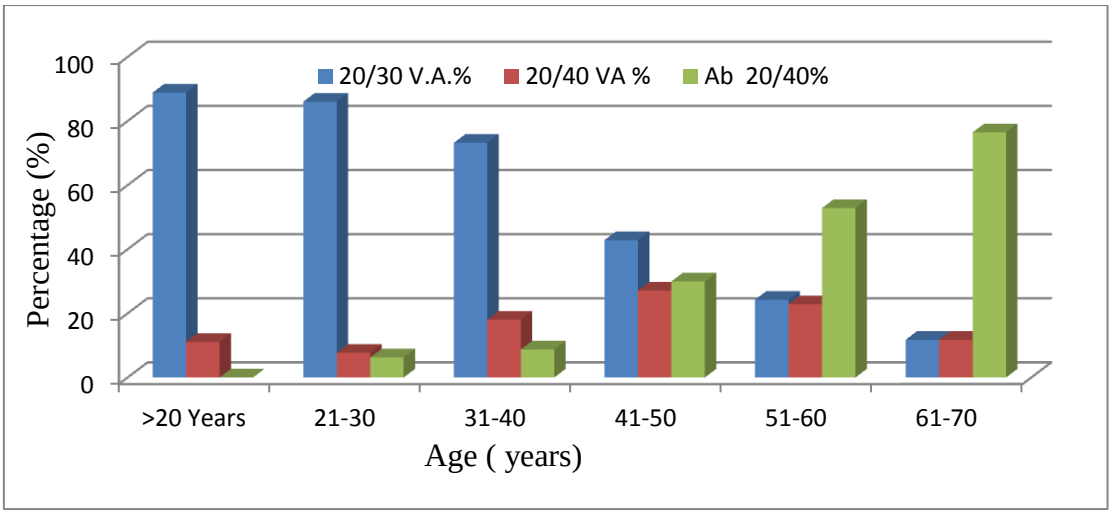

Figure 6.2: Age Wise Percent Far V A for Right Eye

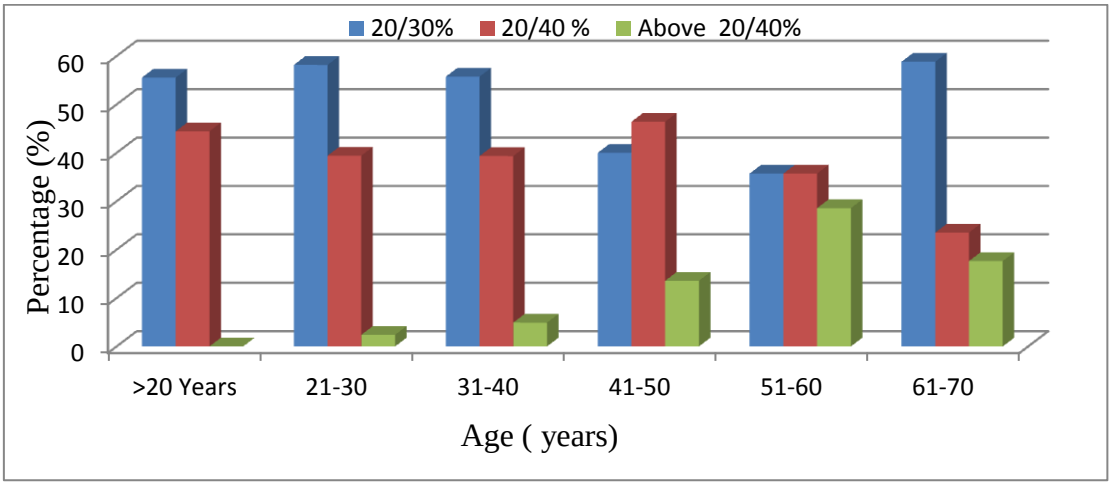

Figure 6.3: Age Wise Percent Far V A for Left Eye

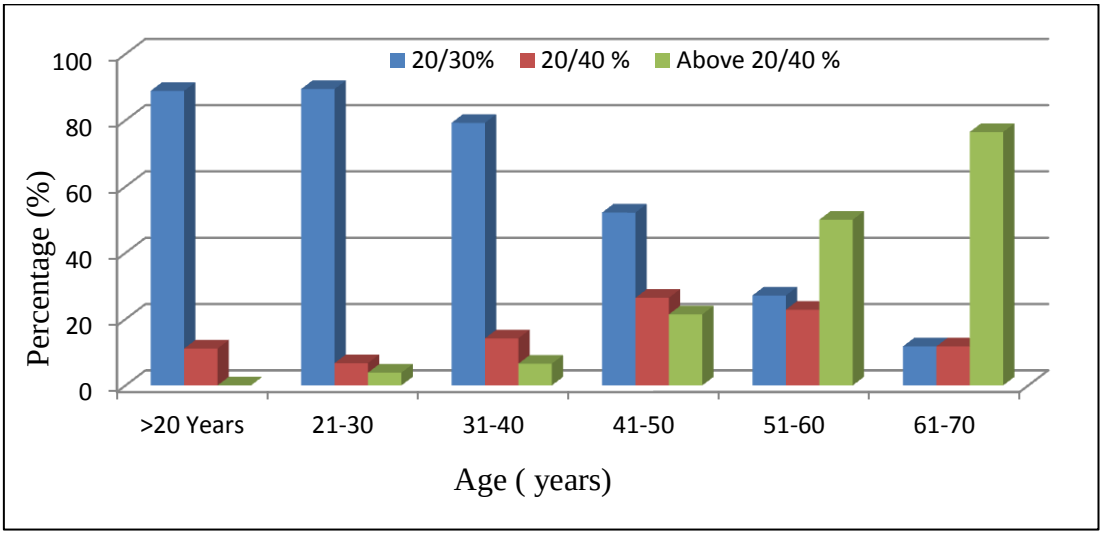

Figure 6.4: Age Wise Percent Far V A for both Eyes

6.2. Relationship between Accident Involvements with Visual Acuity Test Performance

Visual parameters such as colour vision, depth perception and contrast sensitivity of drivers influence crash involvement rates in India . In this study Far and Near Both Eye Test for Visual acuity were compared with accidents frequency of the drivers. This study found that out of the 627 sample population of drivers 6 % of drivers having both eyes Marginal or Unacceptable ***Near Visual Acuity*** were involved in road crashes as against 3 % of the drivers with Acceptable grade in Visual Acuity. Similarly for Far Both Eye Visual Acuity this study found that 8 % of drivers with Marginal or Unacceptable ***Range of Acuity*** were involved in accidents as against 3% of the drivers with Acceptable grade in Visual Acuity as shown in Table 6.5. Similarly a **decreasing trend of Visual Acuity with increase trend in involvement in accident has been observed with increase in age of the drivers (Figure 6.5).**

Table 6.5: Relationship between Involvements in Accident with Visual Acuity Test Performance

Visual Acuity	Range	Both Eye		Left Eye		Right Eye	
		Accident	No Accident	Accident	No Accident	Accident	No Accident
Near	Marginal & Unacceptable	17(6)*	268(94)*	11(4)*	294(96)*	18(6)*	301(94)*
	Acceptable	10(3)*	332(97)*	16(5)*	306(95)*	9(3)*	299(97)*
Far	Marginal & Unacceptable	16(8)*	178(94)*	11(5)*	213(95) *	15(7)*	212(93)*
	Acceptable	11(3)*	422(97)*	16(4)*	387(96)*	12(3)*	388(97)*

*Percentage in bracket

Fisher exact test calculation for a 2 x 2 contingency table were carried out between acceptable range vs. Marginal & Unacceptable range of performances of URE i.e. Visual acuity for Far and near both the tests with accident involvement as shown in Table 6.6. Here the independent factor was and dependent

Table 6.6: Fisher Chi^2 2 x 2 Contingency Table

	Accident Involvement	Accident Free	Marginal Row Totals
Group 1: Marginal/Unacceptable	88	1466	1554
Group 2: Acceptable	74	2134	2208
Totals	162	3600	3762 (Grand Total)

The Fisher exact test statistic value is 0.000779. The result is significant at p < .05. A significant association exists between the two groups VA (Acceptable Vs Marginal /Unacceptable) and two categories in columns (Accident Involvement Vs Accident Free) is considered to be extremely statistically significant.

In all the other cases Far and Near Visual acuity except Near Visual Acuity for Left Eye , all the drivers who were having Marginal or Unacceptable Visual Acuity were significantly up to p < .05 having more accident involvement as compared to the drivers with acceptable visual acuity range**.** Similar findings has been observed in another study done in India by Verma et al on 2011 highlights that 81 percent of drivers out of 387 sample population of drivers had at least one visual defect, were involved in some sort of an accident.

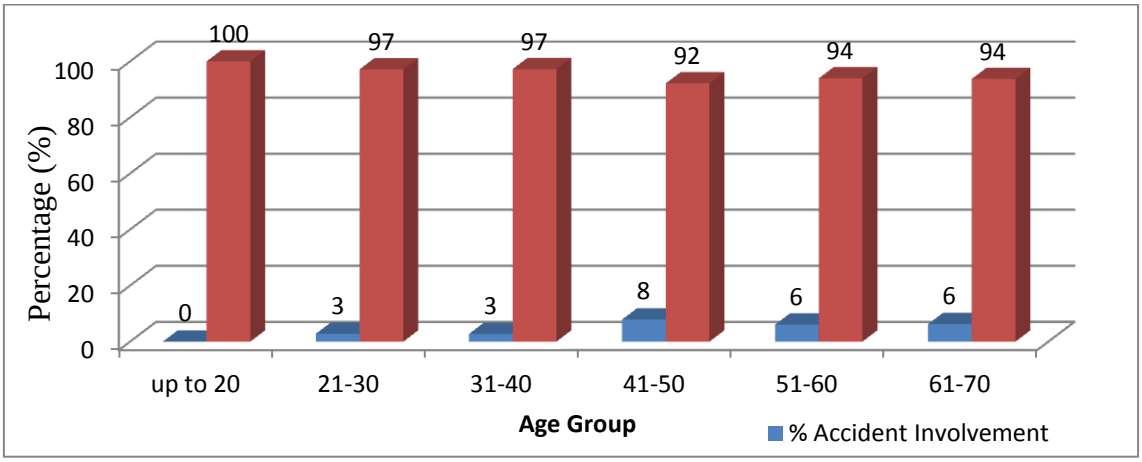

Figure 6.5: Accident Trend with Increasing Age Group

6.3. Driver Performance for Colour Blindness Test for Severe and Mild Symptoms (Whole Sample Population)

The age wise performance of data analysis has been done for the severe and mild type of colour perception tests. The observation of data revealed that from the whole sample population 19% drivers were severely colour blind and 23% drivers were having mild colour perception problem. Age wise analysis of data revealed that acceptable range of colour perception in severe and mild cases significantly increased in old age group of drivers as compared to young age group (Table 6.7 to 6.10 & Figure 6.5 to 6.7)

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Age (years)

Table 6.7: Severe Colour Perception Test (Whole Sample)			Table 6.8: Mild Colour Perception Test (Whole Sample)		
Answers	Raw Data	Percent	Answers	Raw Data	Percent
None Or One Correct	119	19	None Or One Correct	142	23
Two Correct	128	20	Two Correct	150	24
Three Correct	380	61	Three Correct	335	53

Table 6.9: Severe Colour Perception Test (Whole Sample)				Table 6.10: Age Wise Performance on Colour Perception Test (Mild)			
Age Group	Unacceptable*	Marginal	Acceptable**	Age Group	Unacceptable	Marginal	Acceptable
> 20 Yrs	0	3	6	> 20 Yrs.	0	5	4
21-30	16	24	168	21-30	13	44	151
31-40	25	40	118	31-40	42	41	100
41-50	36	36	68	41-50	41	40	59
51-60	32	18	20	51-60	34	17	19
61-70	10	7	0	61-70	12	3	2

* $p \leq 0.10$

T-value with One-tailed hypothesis was calculated between the data of Acceptable range in Severe Colour Perception Test vs. Unacceptable range. Here two dependent means were Acceptable** and Unacceptable Ranges of test performance* and Independent variable is age. The analysis proved that Performance of drivers related to the Acceptable Range is significantly greater at $p \leq 0.10$ than the performance value of drivers related to unacceptable range of colour perception. Thus the value of t is 1.617279. The value of p is 0.083371. However, for mild colour perception test no significant difference was observed (Table-6.9).

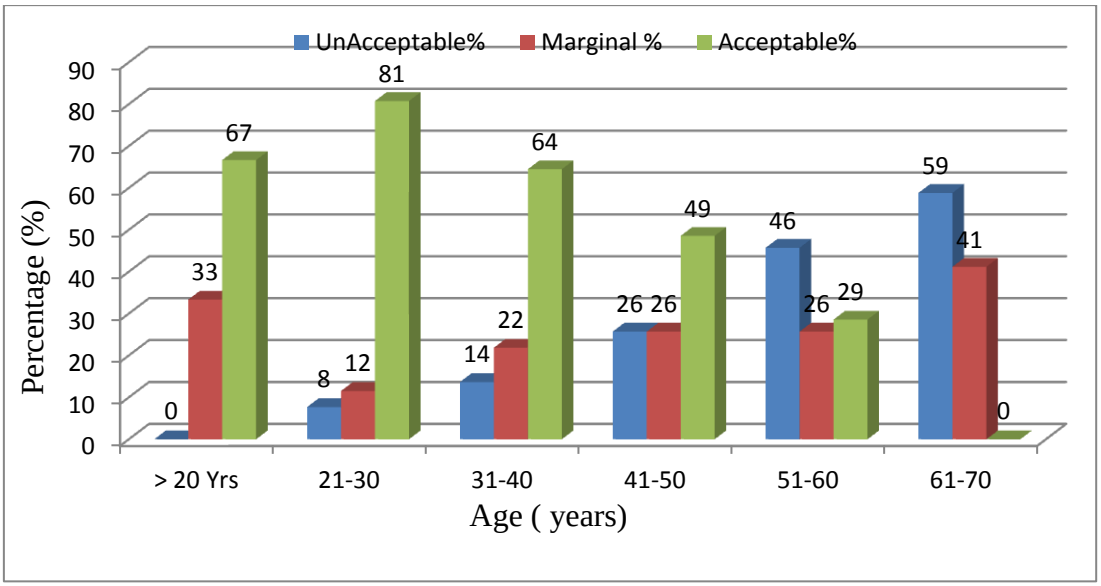

Figure 6.6: Age Wise Percent Performance of drivers for Severe Level Colour Perception Test

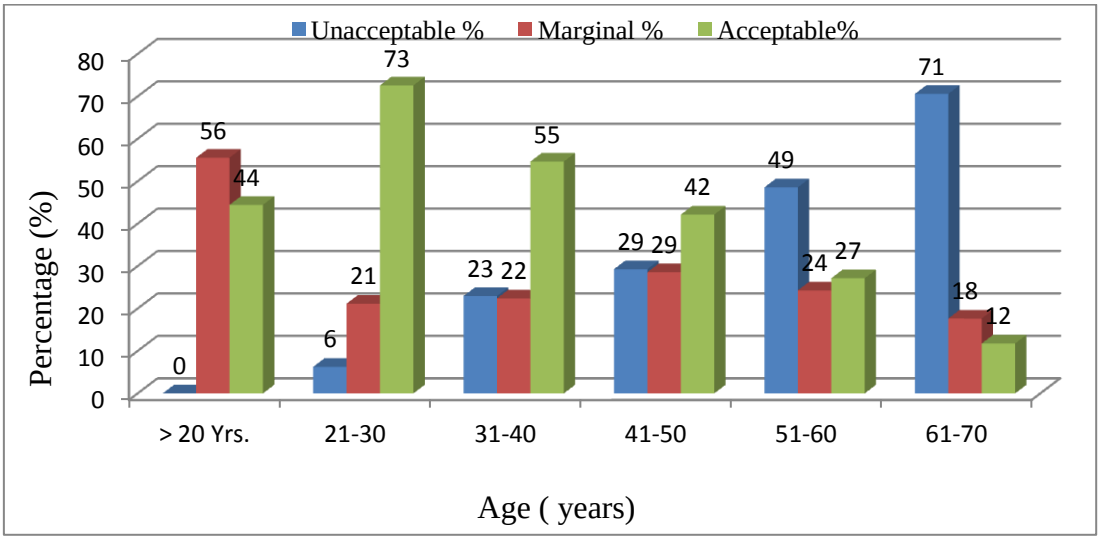

Figure 6.7: Age Wise Performance on Mild Level Colour Perception Test

6.4. Driver Performance in Depth Perception or Stereopsis Test (Whole Sample Population)

When visual problem arises, binocular foveal fixation is the first skill to be suppressed. Since refined space judgment is based on binocular foveal fixation stereoscopic awareness also suffers loss at any early date. Deterioration of depth discrimination becomes corroborative evidence of central depression. The drivers with poor Depth Perception traits cannot judge properly the size, distance and speed of

oncoming vehicles. The older driver shows not only a decline in visual performance on most tests but also an increase in reaction times, general psychomotor slowing, and cognitive changes relating to attention and recognition which may lead to a reduced ability to perform two tasks simultaneously[20]. Review of related literature suggests that there is a relationship between stereopsis and accident records[21]. Another study considers the correlation between poor stereopsis and accident rate is also likely to be due to other associated factors, such as lowered acuity in one eye. Stereopsis is useful in low speed manoeuvring and parking[22].

The findings of the present study highlights that Overall 29% drivers falls under unacceptable range in the depth perception test (Table-6.11) where older group of drivers were more having inclinations towards marginal and unacceptable stereopsis problems as compared to the young age groups and also the data observed that they were more involved in accidents (Table 6.12 & 6.13;Figure 6.8).

Table 6.11: Driver Performance for Stereopsis(Depth Perception)

	Grade	Raw Data	Percent
Unacceptable Range	10%	183	29
	30%	108	17
	40%	141	22
Marginal Range	75%	141	22
Acceptable Range	85%	54	9

Table 6.12: Age –Wise Driver Performance Depth Perception or Stereopsis

Age Group	**10%**	**30%**	**40%**	**75%**	**85%**
>20 Yrs	4	0	0	4	1
21-30	53	39	51	45	20
31-40	41	28	49	45	20
41-50	47	26	27	30	10
51-60	29	13	9	17	2
61-70	9	2	5	0	1

Table 6.13: Percent Accident Involvement with Depth Perception Test Performance (Whole Population)

Grade	Degree	Accident Involved	Accident Free Involved	Percent Accident Free
Unacceptable	10-40%	17	415	4
Marginally Acceptable	75%	4	137	3
Acceptable	85%	1	53	2

Table 6.14: Age Wise Percent Accident Involvement with Depth Perception Test Performance

Age Group	No of Accident Stereopsis (Depth Perception)		Type of Accident Stereopsis (Depth Perception)					
			Marginal & Unacceptable			Acceptable		
	Marginal & Unacceptable*	Acceptable**	Pedestrian	Two wheeler	Static	Pedestrian	Two wheeler	Static
> 20 Yrs.	0	0	0	0	0	0	0	0
21-30	4	1	1	3	0	1	0	0
31-40	4	0	1	3	0	0	0	0
41-50	10	0	4	6	0	0	0	0
51-60	5	0	1	1	3	0	0	0
61-70	2	1	1	0	1	0	0	1

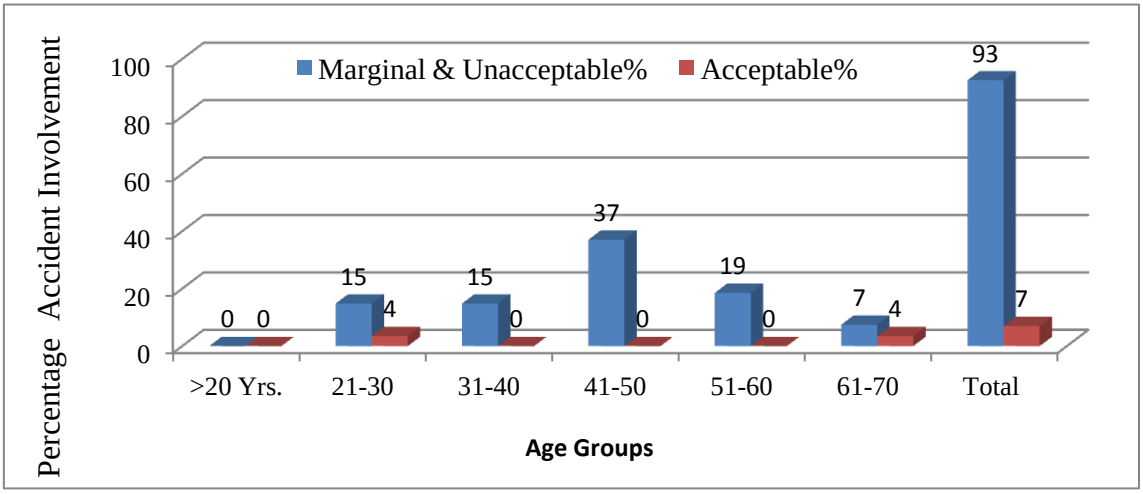

Figure 6.8: Age Wise Accident Involvement in Depth Perception Test

The T-Test for two Dependent Means was calculated with the summary data sheet where the Independent variable is Age while Dependant Variables are i) Stereopsis Maginal / Unacceptable Range* vs. ii) Acceptable Range** (Table 6.14) .The value of t is -2.648757. The value of p is 0.022747. The result is significant at $p \leq 0.05$.

The type of accident involvement includes maximum with two wheeler riders (Figure 6.9) followed by pedestrians. The study found that drivers with marginal and poor stereopsis problems significantly involved in more accidents as compared to the drivers who had acceptable range of vision in the test.

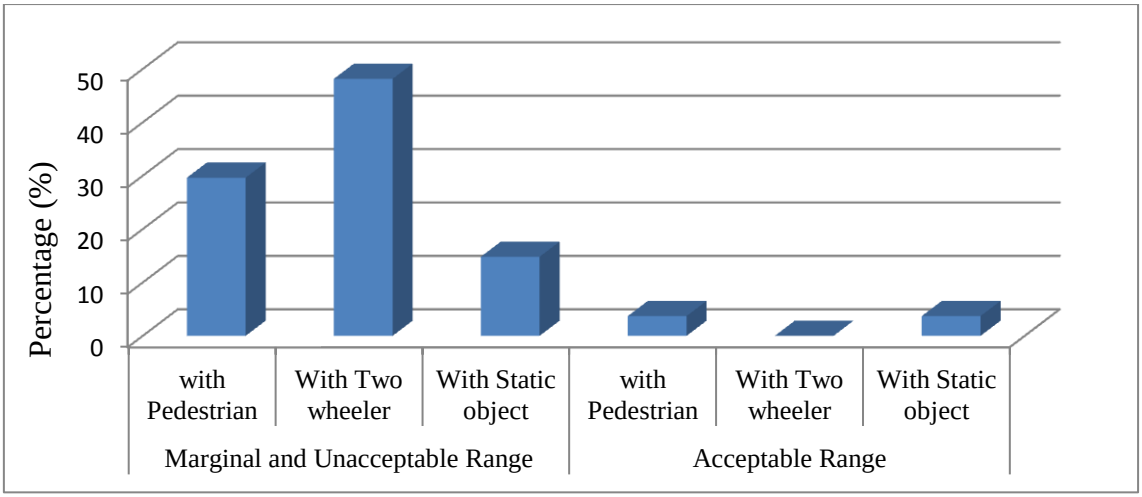

Figure 6.9: Type of Accident Involvement with Stereopsis or Depth Perception Performance

6.5. Driver Performance in Contrast Sensitivity Test (Whole Sample Population)

The data revealed that 94% drivers performed Unacceptable range of contrast sensitivity followed by 2% of the drivers who performed "Marginal" in the test only 4% performed up to "Acceptable Range" in the test (Table 6.15). T test was calculated for two dependent means is t = -2.734414, where the independent variable is age and two dependant variables are unacceptable* and acceptable range ** of contrast sensitivity (Table 6.16). The value of p is 0.020532. The significant result is observed as $p \leq 0.05$ level was found.

However with contrast sensitivity factor accident involvement among two groups i.e. Marginal/Unacceptable Range vs. Acceptable were not found significant difference in t-test up to $p \leq 0.05$ level (Figure 6.10).

Table 6.15: Driver Performance in Contrast Sensitivity

Range	Raw Data	Percentage
10% to 40%	588	94
50%	10	2
60% to 90%	29	4

Table 6.16: Age Wise Performance for Contrast Sensitivity

	Unacceptable	Marginal	Acceptable
Age Group	10% to 40%*	50%	60% to 90%**
> 20 Yrs	9	0	0
21-30	205	0	3
31-40	177	2	4
41-50	126	5	9
51-60	58	2	10
61-70	13	1	3

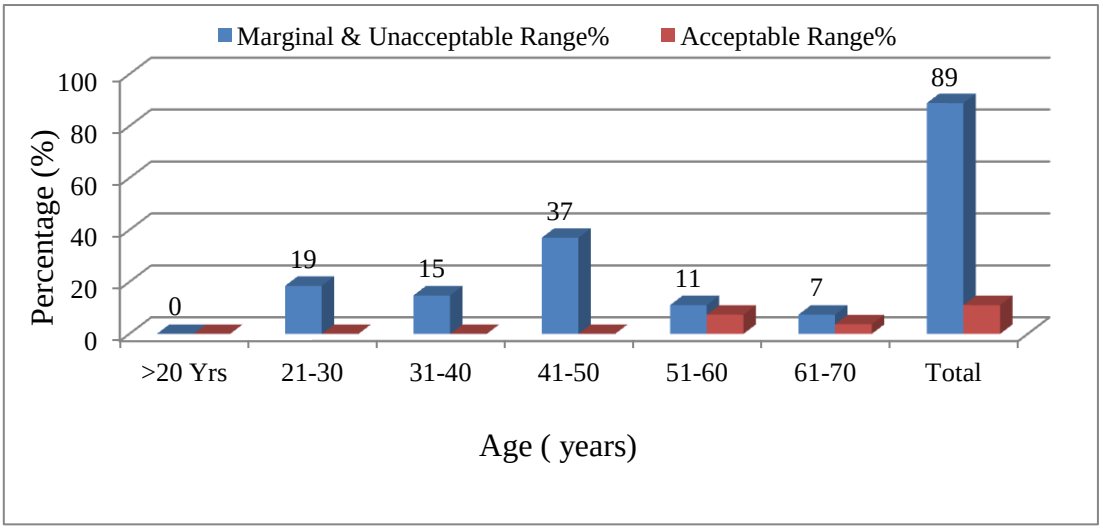

Figure 6.10: Age Wise Comparative Performance in Contrast Sensitivity

6.6. Driver Performance in Glare Recovery Test (Whole Sample Population)

Visual standards as measured by a variety of tests tend to decline after early middle age (Hills and Burg, 1977 *)* and the rising proportion of older licensed drivers in all countries, considerable interest has been focused on the possible visual problems of the older driver (see. e.g., Keltner and Johnson. 1987;Bailey and Sheedy, 1988; North. 1988; Scheiber. 1988;Ball and Owsley. 1991; Barr, 1991; Klein. 1991; Shinar and Scheiber. 1991; Waller. 1991; Stelmach and Nahom, 1992; Ball *et al.*. 1993; Hakamies-Blomqvist,1993; Schlag. 1993; Brouwer and Ponds, 1994;Grundy, 1994; Owsley, 1994;

Age (years)

Wood, 1994; Shipp and Penchansky, 1995; Medical Commission on Accident Prevention, 1995).

The analysis of data revealed that 34% drivers from whole sample population were found glare blind .Here the data revealed that younger group of drivers were 56-60% having glare related problems as compared to old groups with 29-44% (Table 6.17 to 6.18 and Figure 6.11).

Table 6.17: Glare Recovery

Performance	Raw Data	Percent
Unacceptable or Glare Blind	214	34
Marginally Glare Blind	59	9
Acceptable Range(Normal)	354	56

Table 6.18: Glare Recovery Test Performance With Age Group

Age Group	Acceptable	Acceptable %	Marginal	Marginal%	Unacceptable	Unacceptable%	Total
>20 Yrs	3	33	1	11	5	56	9
21-30	75	36	11	5	122	59	208
31-40	56	31	12	7	115	63	183
41-50	42	30	22	37	76	54	140
51-60	28	40	11	16	31	44	70
61-70	10	59	2	12	5	29	17

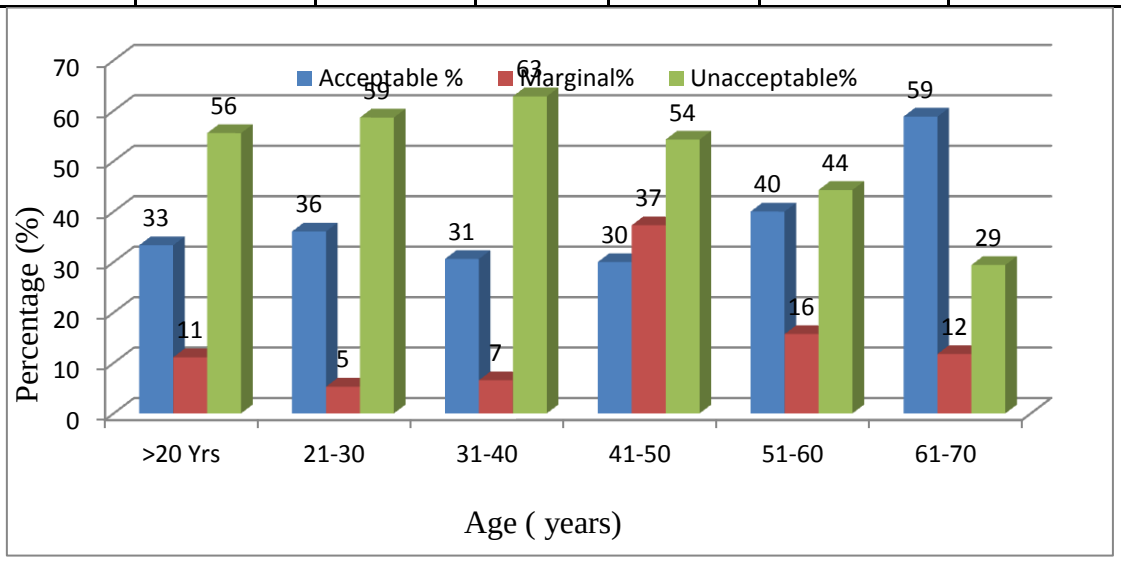

Figure 6.11: Age Wise Comparative Performance in Contrast Sensitivity

7.0 ANALYSIS OF SOCIO ECONOMIC SURVEY

The questionnaire (Annexure –I) had twenty two questions some are having options "Yes" or "No" or some are multiple choice type questions. Analysis of those parameters which were having significant impact on either accident involvement factor or any keystone parameters have been analyzed separately. Those parameters which were having insignificant impact or percent differences were not included in the part.

7.1. Classification of Sample Population According to Type of Vehicle

The observation of survey data showed that 70% drivers were light motor vehicle drivers while 24% were heavy motor vehicle drivers, 4 % were private bus drivers while 1% were Govt bus drivers as shown in Figure 7.1.

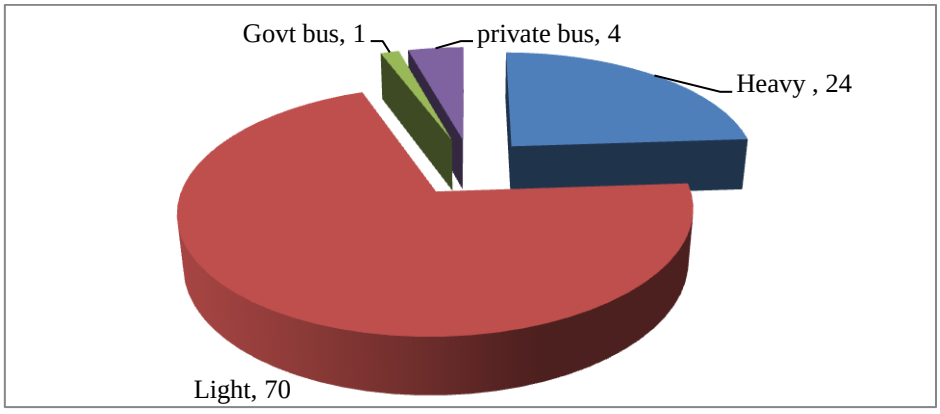

Figure 7.1: Type of Driver Categories Interviewed

Out of the total sample population 72% drivers were commercial drivers while rest of the 22% were private drivers (Figure 7.2).

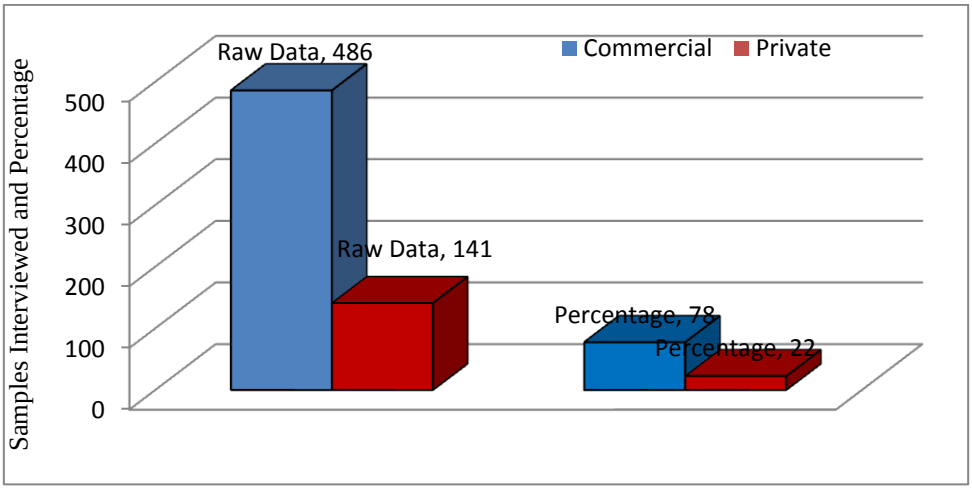

Figure 7.2: Sample Classification according to Type of Vehicle Driving

7.2. Classification of Sample Population According to Driving Experience

The data showed that mostly the drivers were highly experienced drivers as 57% of them were having more than ten years experience followed by 24% who were having six to ten years of driving experience as shown in Figure 7.3.

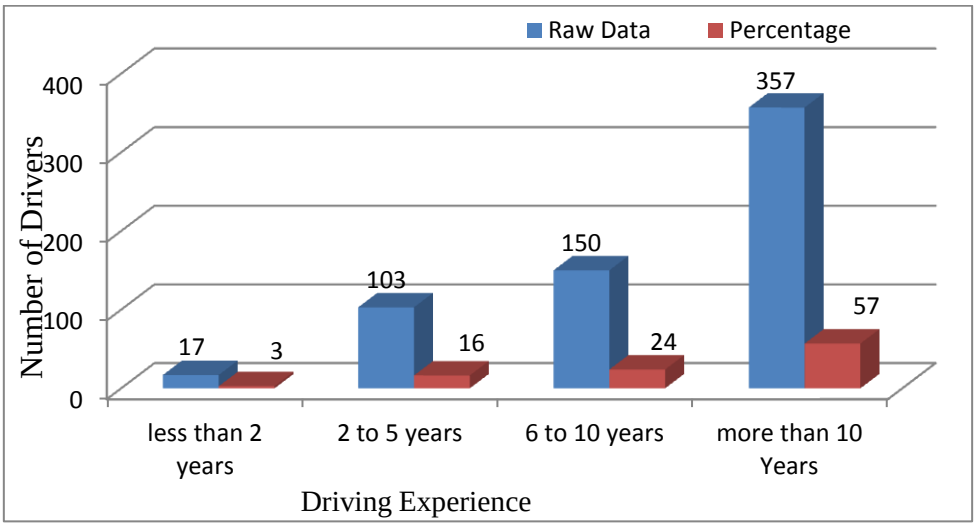

Figure 7.3: Sample Classification according to Driving Experience

7.3. Classification of Sample Population According to Driving Duty hours

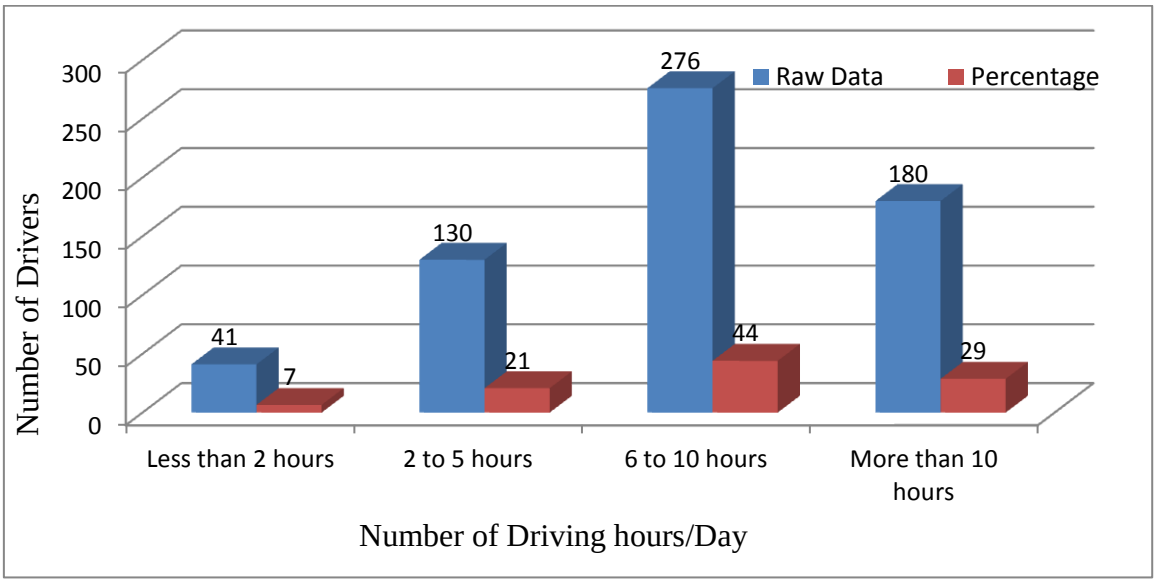

Figure 7.4: Classification of Sample according to Number of Driving Hours/day

The data showed that 29 % drivers were involved in duty for more than 10 hours as shown in Figure 7.4, which is against the rule of Indian Motor Vehicle Act 1988 clearly states that not more than 8 hours a driver can drive. It is a natural corollary of

the long driving hours in India which is resulting in lack of adequate rest, fatigue and psychosomatic stress disorders. The data is supported by another study by Ford Motor Company[12] in 2015; the study found that 49 % of respondents in Indian drivers spend at least 12 hours (half-a-day) or more than 100 minutes every day driving their vehicles. About 14 % respondents have admitted spending up to three hours behind the wheel every day. According to the survey, 49 per cent of the respondents in India spend about 12 hours or more every week in their cars (100 minutes/day). This also includes a large number of Indian drivers that spend more than 3 hours daily behind the steering wheel. In comparison the average time spent in driving in other parts of the Asia-Pacific region stands at 42 per cent. Further about 97 percentage drivers were drive during the day and night time as shown in Figure 7.5.

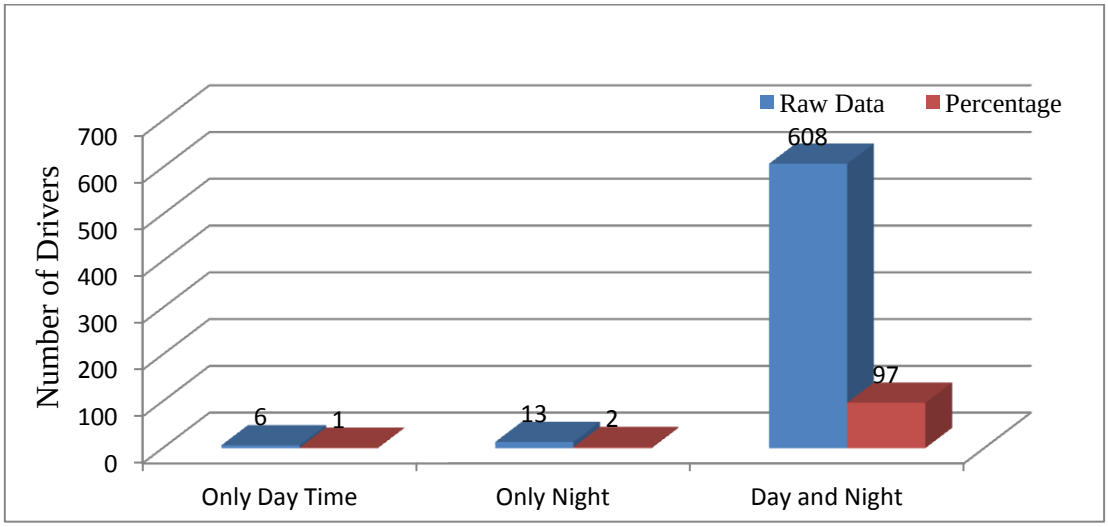

Figure 7.5: Sample Classification according to the Time of Driving

7.4. Subjects Classification according to drivers who were fined vs. not fined against Violation of Traffic Rules with accident involvement

Out of the total sample population 15 % drivers who committed traffic violation were involved in any type of accident as against 1% of those drivers who did not violated the traffic rules. These data showed that drivers who generally commit traffic violations are more likely to be involved in road crashes as shown in Table 7.1 and Figure 7.6.

Table 7.1: Violation of Traffic Rules with accident involvement

Groups	Violation of Road Rules	
	Yes	**No**
Accident Involved	24	3
Accident Free	131	469

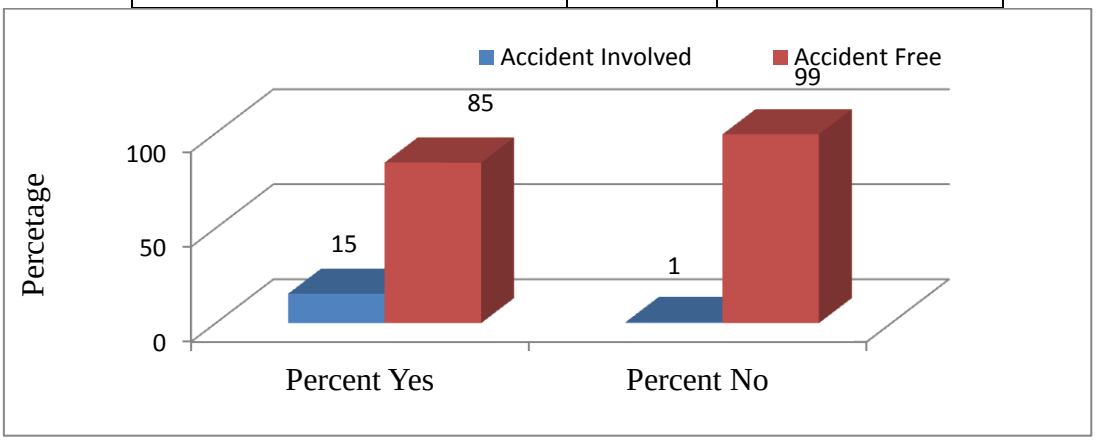

Figure 7.6: Violation of Traffic Rules with Accident Involvement

In a recent survey by Ford Motor Company[12] in 2015, the study found that 49% of respondents in Indian drivers spend at least 12 hours (half-a-day) or more than 100 minutes every day driving their vehicles. About 14% respondents have admitted spending up to three hours behind the wheel every day. According to the survey, 49 per cent of the respondents in India spend about 12 hours or more every week in their cars (100 minutes/day). This also includes a large number of Indian drivers that spend more than 3 hours daily behind the steering wheel. In comparison the average time spent in driving in other parts of the Asia-Pacific region stands at 42 per cent.

8.0 FINDINGS AND INFERENCES

It is concluded from the findings of the study that correlations between poor vision as assessed by some tests and accident rates can be shown in significant samples of drivers, single test or combination of tests has been shown to be able to effectively screen out those at risk of accidents. Significant findings and inferences drawn from this study from Delhi data have been summarized as following:

i. The observation of data revealed that 37 % , 36 % and 31 % of the drivers experienced visual limitation for left eye only, right eye only and for both eyes respectively. The above subjects were found to have either marginal or poor ***Far Visual Acuity*** (refer Table 6.2).

ii. Similarly, the observation of data revealed that 50 % , 50 % and 45 % of the drivers experienced visual limitation for left eye only, right eye only and for both eyes respectively. The above subjects were found to have either marginal or poor ***Near Visual Acuity*** (Table 6.3)

iii. The data shows sample population was having slight increase in 20/30 VA but in Right Eye VA and Both Eyes VA cases the reverse is found i.e. VA was more inclined towards more than 20/40 (deteriorating trend) with the increase in age group.

iv. This study found that out of the 627 sample population of drivers 6% of drivers having both eyes Marginal or Unacceptable Near Visual Acuity were involved in accidents as against 3% of the drivers with Acceptable grade in Visual Acuity. Similarly for Far Both Eye Visual Acuity this study found that 8% of drivers with Marginal or Unacceptable Range of Acuity were involved in accidents as against 3% of the drivers with Acceptable grade in Visual Acuity. Similarly a decreasing trend of Visual Acuity with increase trend in involvement in accident has been observed with increasing age group of drivers

v. All the drivers who were having Marginal or Unacceptable Visual Acuity were significantly up to $p < .05$ having more accident involvement as compared to the drivers with acceptable visual acuity range.

vi. The observation of data revealed that from the whole sample population 19% drivers were severely colour blind and 23% drivers were having mild colour perception problem. Age wise analysis of data revealed that acceptable range of colour perception in severe and mild cases significantly increased in old age group of drivers as compared to young age group

vii. The analysis proved that Performance of drivers related to the Acceptable Range is significantly greater at $p \leq 0.10$ than the performance value of drivers related to unacceptable range of colour perception. Thus the value of t is 1.617279. The value of p is 0.083371. However, for mild colour perception test no significant difference was observed.

viii. Overall 29% drivers falls under unacceptable range in the depth perception test (table-10) where older group of drivers were more having inclinations towards marginal and unacceptable stereopsis problems as compared to the young age groups and also the data observed that they were more involved in accidents

ix. The study found that drivers with marginal and poor stereopsis problems significantly involved in more accidents as compared to the drivers who had acceptable range of vision in the test.

x. With the contrast sensitivity factor accident involvement among the two groups i.e. Marginal/Unacceptable Range vs. Acceptable were not found significant difference in t-test up to $p \leq 0.05$ level.

xi. Questionnaire analysis showed that 70% drivers were light motor vehicle drivers while 24% were heavy motor vehicle drivers, 4 % were private bus drivers while 1% were Govt bus drivers.

xii. Out of the total sample population 72% drivers were commercial drivers while rest of the 22% were private drivers.

xiii. The data showed that 29% drivers were involved in duty for more than 10 hours which is against the rule of Indian Motor Vehicle Act 1988 clearly states that not more than 8 hours a driver can drive.

xiv. 15% drivers who committed traffic violation were involved in any type of accident as against 1% of those drivers who did not violate the traffic rules.

9.0 RECOMMENDATIONS

There is a dire need for improved publicity and information emphasising the continuing legal requirement for good vision and the associated need for both by the number plate test and for clinical eye examinations at regular intervals, particularly for older drivers.

It has been observed in the study that many drivers did not aware about their eye sights. So there is a dire need to disseminations of mass campaign for creating consciousness among the drivers to relate their need for visual correction behavioral aspects to increase state of living a healthy life. There is a need to always wear any prescribed distance spectacle as advised by doctor while driving and the desirability of keeping a spare pair of spectacles in the vehicle is also be stressed. Such educational material highlighting to importance of correcting the vision related problems can be distributed at the same time as reminders for vehicle licenses.

Non-correction of refractive errors is due to several factors: the lack of screening, and the availability and affordability of refractive corrections are the most important. However, cultural disincentives also play a role, as in many countries where

routine screening and provision of corrections are free of charge or easily accessible, but compliance remains low (S. Wedner, unpublished observations, 2006) [16, 17]. Even in economically advantaged societies, refractive errors can go undetected or uncorrected in children[16]. So, this study recommends further research into this area highlighting usefulness of more elaborate and scientific screening procedures for drivers before learner licensing and renewal.

Review of literature highlight that an estimated number of people aged 50 years and older visually impaired from uncorrected refractive errors is over 94 million, a figure that could be an underestimate, being based in part on studies that used only pinhole in place of full refraction [19]. In countries where the prevalence is very high, important underlying causes are index myopia caused by cataract, uncorrected aphakia and insufficient intra-ocular lens correction [17, 18]. This is particularly true in rural areas.

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Annexure –I Questionnaire

1. a) Name and address नाम और पता (optional)

b) Date of Birth जन्म की तारीख/Age :(optional)

c) Gender: Male / Female लिंग :पुरुष/ महिला: Male : 625 and Female : 2

2. Marital Status: Married / Un-married वैवाहिक स्थिति: विवाहित/ अविवाहित: (Optional)

3. Number of Dependents (आश्रित)(optional) (optional)

4. a) Driving experience (Years) ड्राइविंग अनुभव (साल)

Age Group	Less Than two years (Raw Data)	2 to 5 years (Raw Data)	6 to 10 years(Raw Data)	more than 10 years(Raw Data)
up to 20	2	7	0	0
21-30	12	75	94	27
31-40	3	13	45	122
41-50	0	8	9	124
51-60	0	0	2	68
61-70	0	0	0	16

b) When did you get your license? आपको अपना लाइसेंस कब मिला? **Not Significant**

c) When did you renew your commercial license? आपने अपना वाणिज्यिक लाइसेंस कब नवीकृत किया? **Not Significant**

d) Number of hours of driving per day? प्रति दिन ड्राइविंग के घंटे की संख्या?

Age Group	Less Than two hours (Raw Data)	2 to 5 hours (Raw Data)	6 to 10 hours (Raw Data)	more then 10 (Raw Data)
up to 20	1	1	5	2
21-30	17	56	18	55
31-40	15	29	83	56
41-50	5	24	62	50
51-60	3	14	40	13
61-70	0	6	7	3
Total	41	130	215	179

e) Normal time of vehicle operation? Day/Night? वाहन आपरेशन का सामान्य समय : दिन /रात

Age Group	Normal time of vehicle operation(Raw Data)	
	Day	Night
up to 20	9	9
21-30	202	207
31-40	181	179
41-50	136	140
51-60	70	70
61-70	16	16
Total	598	605

5. Normal Terrain of vehicle operation: Plains / Hilly / Urban/Rural/Snowy वाहन संचालन के सामान्य क्षेत्र मैदान / पहाड़ी / शहरी / ग्रामीण / हिमपात के क्षेत्र

Age Group	Normal Terrain of vehicle operation(Raw Data)				
	Plain	Hilly	Urban	Rural	Snowy
up to 20	9	3	6	4	1
21-30	193	87	180	137	37
31-40	173	85	159	116	44
41-50	127	62	128	92	37
51-60	66	32	63	56	22
61-70	16	6	14	12	2

6. Type of vehicle you drive? Heavy Commercial Vehicle / Light Commercial Vehicle /Government Buses/Private Buses वाहन का प्रकार जिसे आप ड्राइव करते हैं ? भारी वाणिज्यिक वाहन / लाइट वाणिज्यिक वाहन / सरकारी बसें / निजी बसें

Type of Vehicle

Age Group	Heavy	Light	Govt bus	private bus	total
up to 20	1	8	0	0	9
21-30	42	158	1	7	208
31-40	41	131	3	8	183
41-50	39	93	3	6	141
51-60	22	43	1	4	70
61-70	5	8	1	2	16

7. Monthly Income आपकी मासिक आय कितनी है ? Optional

8. Education: Un-educated/Primary/Middle/High-School/College **Not Significant**

9.आपकी शिक्षा कहाँ तक है : अशिक्षित/प्राथमिक/माध्यमिक/हाई स्कूल/कॉलेज

1. How did you learn Driving? Through Driving School/Fellow Drivers/Any Other

Age Group	Driving school	Fellow drivers	other
up to 20	3	1	5
21-30	48	108	52
31-40	46	90	47
41-50	24	78	39
51-60	14	33	23
61-70	2	10	4
Total	137	320	170

ड्राइविंग में प्रशिक्षण आपने कहाँ से लिया? एजेंसी/ दोस्तों ड्राइविंग/स्कूल/कोई अन्य

10. (a) Previous accident ?: No/ Yes (अ) पिछली दुर्घटना ?: नहीं/हाँ

Age Group	Yes	NO
up to 20	0	9
21-30	6	207
31-40	5	178
41-50	11	129
51-60	4	62
61-70	1	15
Total	27	600

(b) if Yes (Specify): No of Accidents …… , Nature of accident …….
(आ) यदि हां (निर्दिष्ट करें): दुर्घटनाओं की संख्या……दुर्घटना का प्रकृति……

Age Group	Accident		Type of Accident		
	Yes	NO	Pedestrian	two wheeler	static
up to 20	0	9	0	0	0
21-30	6	207	1	4	2
31-40	5	178	0	4	1
41-50	11	129	1	9	0
51-60	4	62	2	1	1
61-70	1	15	0	0	1
Total	27	600	4	18	5

11. Did you paid any fine against violation of road rules? Yes / No क्या आपने सड़क नियमों के उल्लंघन के खिलाफ कोई दंड का भुगतान किया? हाँ / नही

Age Group	Given	Not Given
up to 20	2	7

21-30	37	174
31-40	48	135
41-50	39	102
51-60	22	44
61-70	1	16
Total	149	478

12. Do you have any eye disease? Yes / No क्या आपको कोई आख की बीमारी है? हाँ / नही

Age Group	Yes	No
> 20 yrs.	0	9
21-30	9	199
31-40	10	173
41-50	9	132
51-60	9	61
61-70	1	15
Total	38	589

13. Do you smoke? Often/ Sometimes /Rarely/ Never क्या आप धूम्रपान करते हैं? अक्सर/कभी कभी/ बहूत कम / कभी नहीं

Age Group	Smoke Record			
	Often	Sometimes	Rarely	Never
up to 20	0	0	0	9
21-30	5	17	6	180
31-40	13	23	4	143
41-50	19	13	8	101
51-60	8	7	2	53
61-70	1	1	0	14

14. a) Do you take any stimulant to keep yourself awake while driving ? Often/ Sometimes /Rarely/ Never वाहन चालन के समय क्या आप जागते रहने के लिए किसी उत्तेजक लेते हैं? अक्सर / कभी कभी / शायद ही / कभी नहीं

b) Do you drink? Often/ Sometimes /Rarely/ Never क्या आप मदिरा पान करते हैं? अक्सर / कभी कभी / शायद ही कभी / कभी नहीं

Age Group	yes	no
up to 20	0	9
21-30	9	199
31-40	10	173
41-50	9	132
51-60	9	61

61-70	1	15
Total	38	589

15. Do you wear Spectacles? Often/ Sometimes /Rarely/ Never

Age Group	Often	Sometimes	Rarely	Never
up to 20	0	1	0	8
21-30	6	24	1	177
31-40	11	20	0	152
41-50	24	20	0	97
51-60	18	11	0	41
61-70	4	3	1	8
Total	63	79	2	483

16. Do you have difficulty judging distance correctly while driving? Yes No ड्राइविंग करते समय क्या आपको आने वाले वाहनो की दूरी ठीक से समझने में कठिनाई होती है? हा/ नही

Age Group	Yes	No
up to 20	1	8
21-30	8	200
31-40	5	178
41-50	3	138
51-60	2	67
61-70	1	16
Total	20	607

17. Did you go through an eye examination prior to renewal of licence? Yes/No क्या आपने लाइसेंस के नवीकरण से पहले आंखों की परीक्षा हुयी ? हां/ नहीं

Age Group	Yes	No
> 20Yrs.	2	7
21-30	102	106
31-40	120	63
41-50	106	35
51-60	54	16
61-70	13	3
Total	397	230

18. Date of last evaluation: Month/Year अंतिम मूल्यांकन की तिथि: महीना / वर्ष:(optional) **No Significant Value**

19. Reason for eye examination: नेत्र परीक्षा के कारण: **No Significant Value**

20. Were glasses, contact lenses or other optical devices recommended? चश्मा, संपर्क लेंस या अन्य ऑप्टिकल उपकरणों की सिफारिश की गई? Yes **/** No **/** If yes, what? हाँ o /नहीं o यदि हां, तो क्या? **No Significant Value**

21. Are they used? Yes/No ----------

a) if yes, when? ----------

क्या वे इस्तेमाल करते हैं? हाँ o नहीं o यदि हाँ, कब?----------

b) If no, why not? ----------

यदि नहीं, क्यों नहीं?----------

c) Were any additional tests, treatments, or therapies recommended concerning your vision? Yes / No **/**If yes, what?----------

क्या आपकी दृष्टि से संबंधित किसी भी अतिरिक्त परीक्षण, उपचार या चिकित्सा की सिफारिश की गई थी? हां/नहीं यदि हां, तो क्या? ----------

22. Did you undergo any treatments? Yes / No क्या आप इन उपचारों से गुजरेथे? हाँ / नहीं ----------

23. Any other specific Problem? Headache/Night Glare/Blurred/Skipping of words/Depth Perception कोई अन्य विशिष्ट समस्या? सिरदर्द / रात की चमक / धुंधला / शब्दों का छूटना / गहराई का अंदाज? **No Significant Value**

Age	Headache	Glare problem at night	Blurred Vision	skipping words	Watery Eyes/	itching/burning Sensation
> 20 Yrs	0	0	0	0	0	0
21-30	3	1	5	0	0	0
31-40	2	4	3	1	0	0
41-50	3	3	4	0	1	2
51-60	0	2	1	1	0	1
61-70	0	1	0	0	0	0

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Mathura Road, New Delhi

110 025

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