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Original Research Article

Effect of Vibration on Hand Steadiness in Delivery Boys Riding Geared Bikes

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ABSTRACT

Background: Vibration affects on human body in many different ways. Majority of the population in India depends on motorcycle for their transportation. Vibration in motorcycle comes from handles, engine, inertial imbalance or any other external factors. One such effect of vibration is seen on hand steadiness which is the ability to hold ones arm and hand in specific position for relatively short period of time without any undesirable movements. 9 hole steadiness test kit is used to check hand steadiness of the subjects.
Objective: To compare hand steadiness in normal individual and delivery boys riding geared bikes using 9 hole steadiness test kit.
Method: 100 subjects were selected as per inclusion and exclusion criteria, 50 were delivery boys riding geared bikes and 50 were normal individuals. Hand steadiness assessment was done using 9 hole steadiness test kit. Scores were noted, statistically analyzed and compared.
Result: Statistical analysis showed there was significant difference in hand steadiness in delivery boys riding geared bikes as compared to normal individuals.
Conclusion: Our present study concluded that hand steadiness is more affected in delivery boys riding geared bikes as compared to normal individuals.

Keywords: Vibration, Bike riders, Hand steadiness, 9 hole steadiness test kit, motorcycle.

INTRODUCTION

Vibration is defined as oscillation of a body about a reference position, can be described in terms of amplitude and frequency. [1] Vibration affects the bodies of people in many different ways. The human body response to vibration depends on various factors such as amplitude, frequency, the duration of exposure, vibration input direction, type and sensitivity of the tissue. Neurological effects of vibration can be numbness, reduced tactile sensitivity and reduced manual dexterity. Effects on locomotor system are seen on muscles, bones, joints and tendons. These disturb comfort and performance of workers in intensive or durable exposure to hand arm vibration. [2] One of the effects of vibration is seen on steadiness of hand.

Steadiness is the ability to hold ones arm and hand in a specific position for relatively short period of time without any undesirable movements. [3] Steadiness is an important component of skills which is required in aiming and general immobility. Hand steadiness is required for doing gross and fine motor movements with precision. Movements such as writing, using cutlery, holding a glass filled with water, approximating objects, holding big and heavy objects requires steadiness of hand and arm.

The majority of population in India depends on motorcycles for their transportation due to economic reasons. Vibration is common in most of the machine tools and it is more in motorcycle due to its dynamic nature. [1] Vibration from motorcycle might come from engine, handle, inertial imbalance and external factors such as roads. This vibration from motorcycle will cause various effects on structures of body before it is dampened and dissipated. The vibration on motorcycle handle bar ranges from 2.2 to 4.9m/s square and 3.82 to 9.77 m/s square. [4] Vibrations with less than 0.315m/s2 are found to be comfortable between 0.315m/s2 and 2.5m/s2 are found to be uncomfortable greater than 2.5m/s2 are found to be extremely uncomfortable. [1]

According to health guidance zones specified by ISO 2631-1, 1997 the impact of vibration on health of a worker depends on weighted rms acceleration and exposure duration per day. [1] RMS (Root Mean Square) value is useful because it is directly related to the energy content of the vibration profile and thus the destructive capability of the vibration.

Table 1 depicts ISO standards with respect to vibration exposure and its effects on health of driver/rider. [1]

Table 1: ISO standards for vibration exposure and its effects on health of the driver/rider

Exposure duration in hours	International Standard		
	ISO 2631-1, 1997 Average rms acceleration limits in m/s2		
	Likely health risk	Caution zone	Comfort level
8	0.8	0.5	0.315
12	0.7	0.4	0.315

Table 2 depicts frequency of vibration and its effect on human body. [8,9]

Table 2: Frequency of vibration and its effects on human body.

Frequency of vibration	Types of effects
Below 1 Hz	Motion sickness
3.5 to 6 Hz	Alerting effect
4 to 10 Hz	Chest and abdomen pain
Around 5 Hz	Degrades manual actions
7 to 20 Hz	Communication Problems
8 to 10 Hz	Back ache
10 to 20 Hz	Intestine and Bladder pain
10 to 30 Hz	Degrades manual and visual controls
10 to 90 Hz	Degrades visual actions

Many studies conducted among the manual workers such as quarry drillers, stone carvers, truck assemblers, forestry workers etc. have been published in scientific literature. However there is limited knowledge on signs and symptoms related to segmental exposure in motorcyclists. [5]

9 hole steadiness test (Koven Mathew steadiness test) is used to check the static steadiness of hand and arm of the subject. This test is designed to measure involuntary or any undesirable movements of hand. [2] It measures both small-motor coordination and steadiness of hand. Individuals are required to insert a metal stylus into series of holes which get progressively smaller. (r=0.63) [6]

MATERIALS AND METHODS

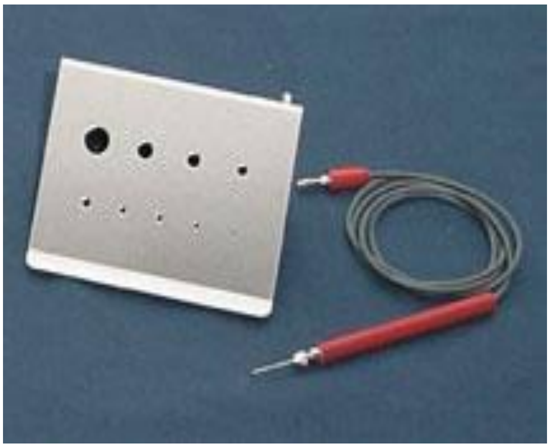
This study was a cross sectional observational study where 50 bike riders and 50 normal individuals were selected using convenient sampling. Inclusion criteria: Subjects willing to participate in 25-35 years, both male and female riding geared bikes for minimum of 2 years for at least 6 hours a day and with bare hands. Exclusion criteria: Any history of congenital deformities of hand, pain, hand surgeries or injuries less than 6 months, diabetic neuropathy and neurological impairment.

PROCEDURE:

A written consent was taken from all the subjects in the language best understood by them. Selection of the subject was done as per the inclusion and exclusion criteria. Purpose of the study and procedure was explained prior to the study. Demographic data was noted down. Nine hole steadiness test was done and comparison of the two groups was done.

METHOD

Subject was in sitting position on a chair without armrest. The steadiness kit was placed in front of the subject on table at the shoulder level of the subject. During this test, the subject was told to insert a metal stylus with the dominant hand into metal plate with several holes of different diameters in descending order and hold it for 15 seconds in each hole in such a way that the stylus should not touch the margins of the hole. A buzzer will ring as soon as the stylus touches the margin of the hole. The number of times the buzzer rings was noted down. The test was repeated 3 times, mean value of result was calculated.



Nine hole steadiness test kit.

STATISTICAL ANALYSIS:

Collected data was entered in Microsoft Excel and Graph Pad Prism 8.4.0 was used for the data analysis. Normality of the data was tested using the Shapiro-Wilk normality test. Since the data was not normally distributed, statistical analysis was done using the non-parametric test, i.e. the Mann-Whitney test.

Stopwatch

RESULT

The result of Mann-Whitney test showed that there was a statistically significant difference in hand steadiness in bike riders and normal individuals. Where hand steadiness is more affected in bike riders driving geared bikes then compare to normal individuals ($p<0.0001$)

1. The below table shows number of contacts in 12.5 mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0	0	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0	0	

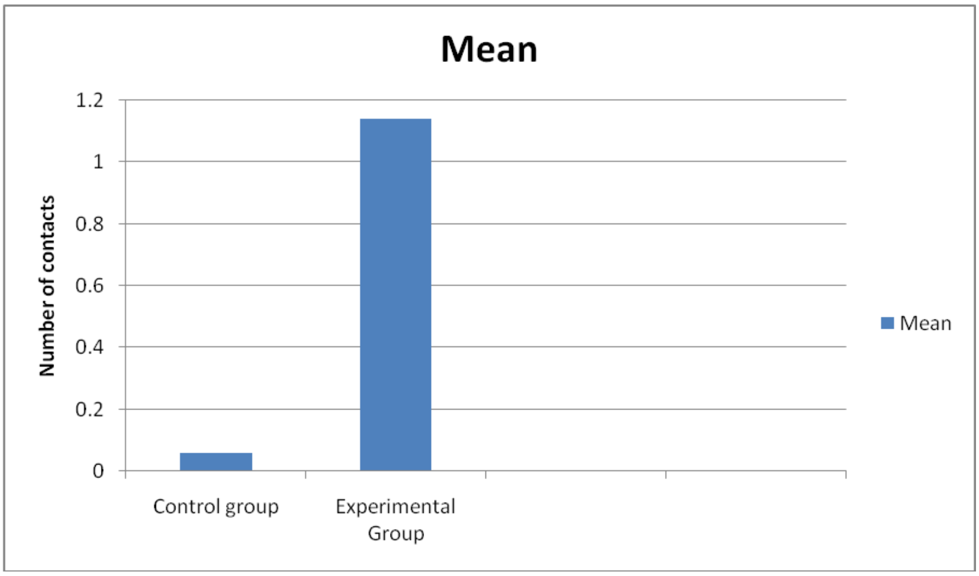
2. The below table shows number of contacts in 8.0mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0	0	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0	0	

3. The below table shows number of contacts in 6.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0.24	1.11	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.03	0.16	

A)

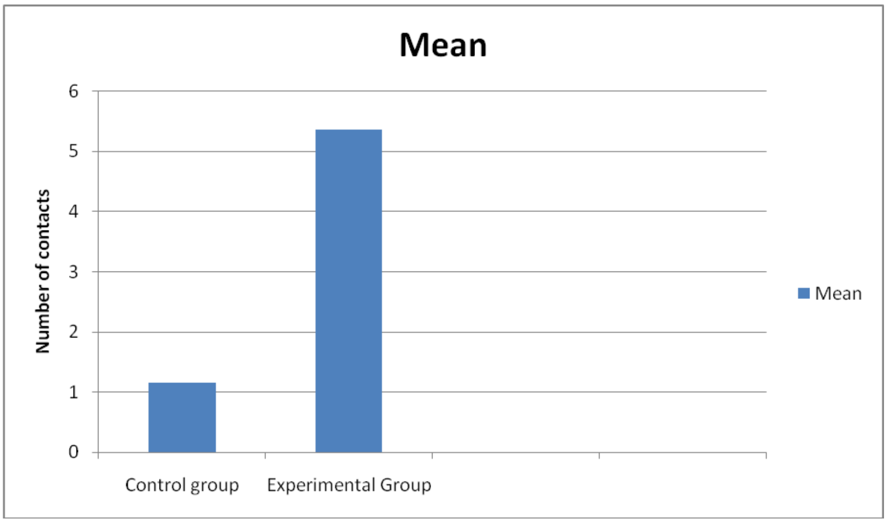


The above graph (A) shows that the number of contact was more in the experimental group as compared to control group.

4. The below table shows number of contacts in 5.0mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	2.38	3.03	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.34	0.43	

B)

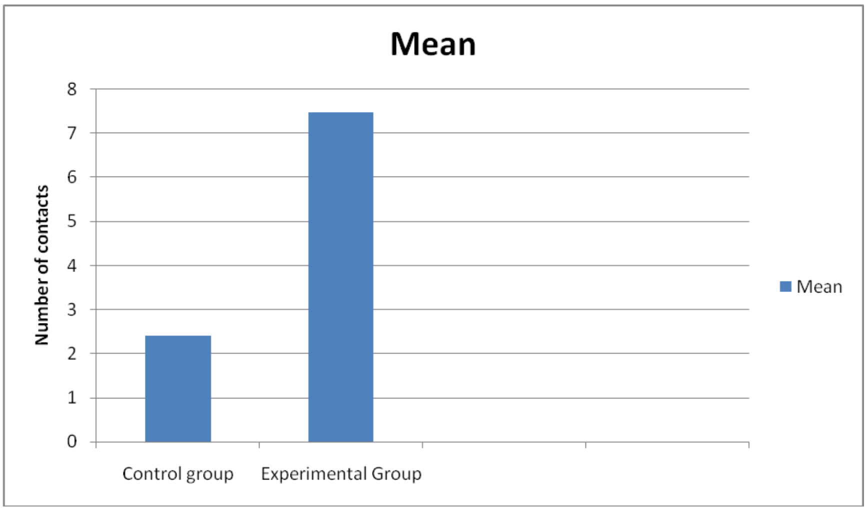


The above graph (B) shows that the number of contact was more in the experimental group as compared to control group.

5. The below table shows number of contacts in 4.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	1.46	3.66	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.21	0.51764	

C)

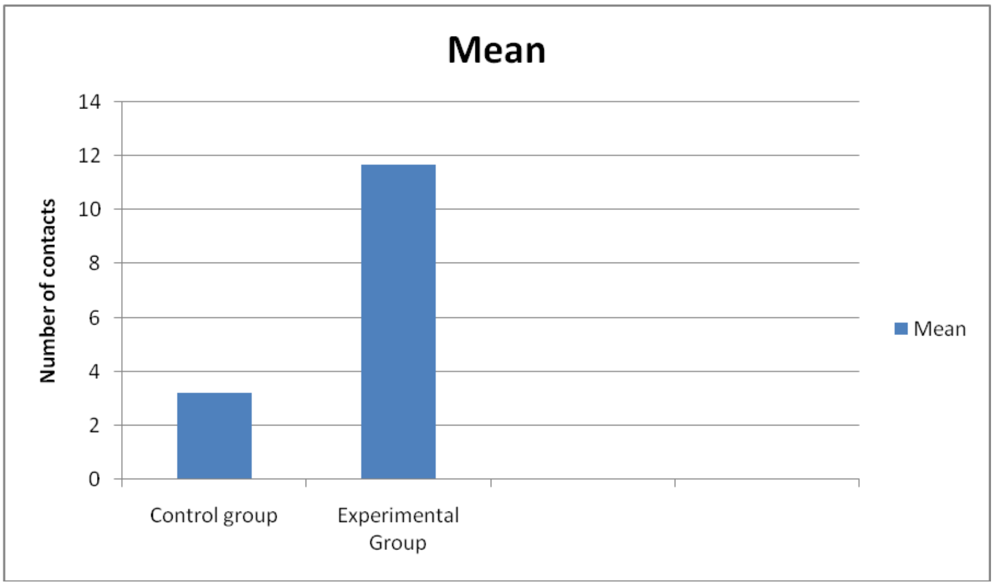


The above graph (C) shows that the number of contact was more in the experimental group as compared to control group.

6. The below table shows number of contacts in 4.0mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	2.45	4.93	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.35	0.697	

D)

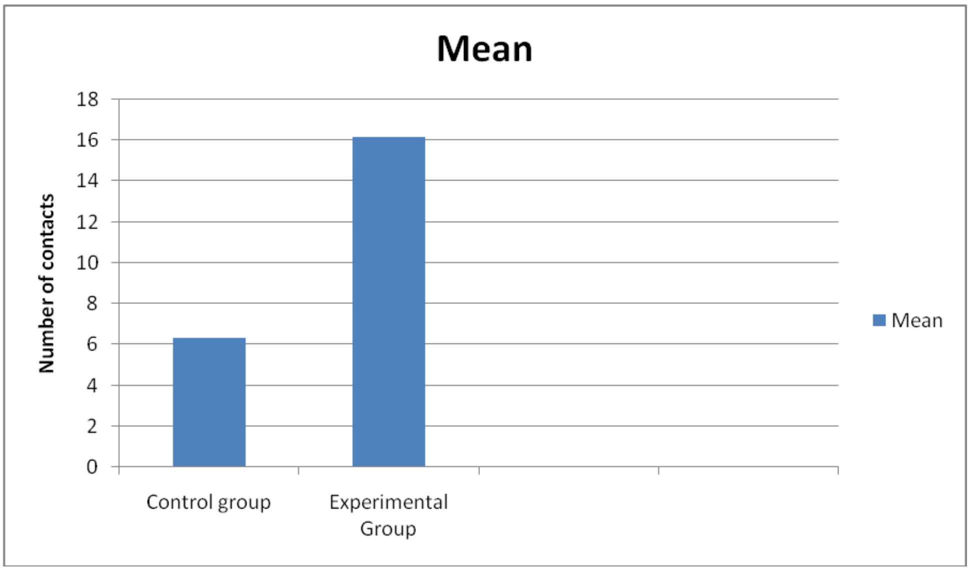


The above graph (D) shows that the number of contact was more in the experimental group as compared to control group.

7. The below table shows number of contacts in 3.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	3.01	4.22	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.43	0.596	

E)

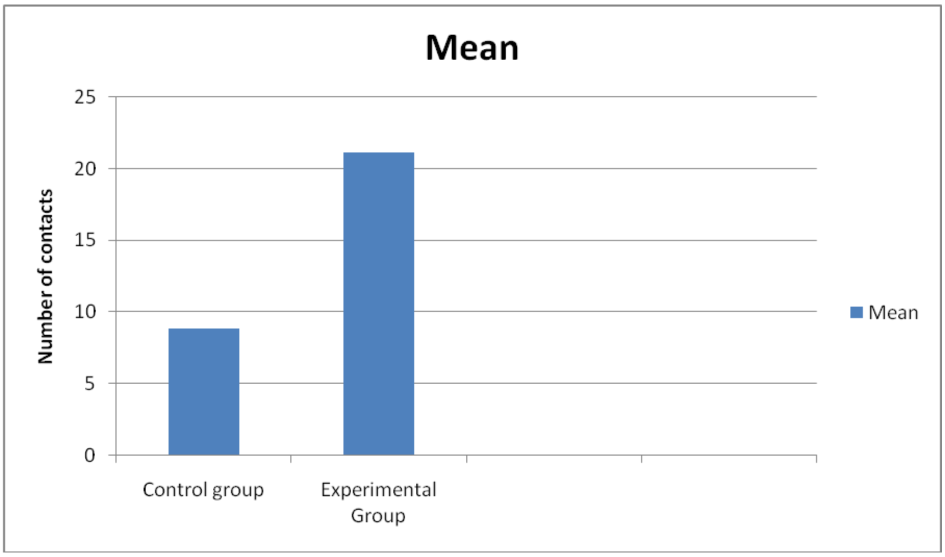


The above graph (E) shows that the number of contact was more in the experimental group as compared to control group.

8. The below table shows number of contacts in 3.0mm diameter hole.

Variables	Control Groups	Experimental Groups	P Value
Standard Deviation	4.18	3.73	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.59	0.53	

F)

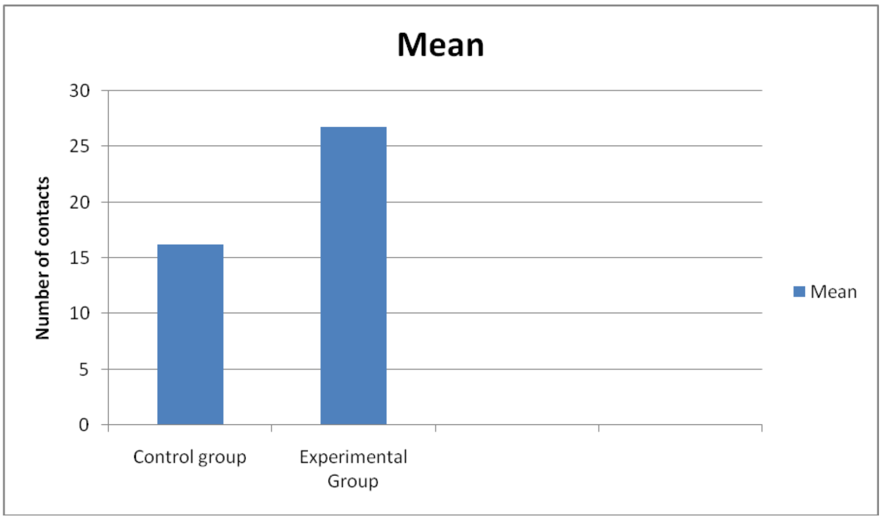


The above graph (F) shows that the number of contact was more in the experimental group as compared to control group.

9. The below table shows number of contacts in 2.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	3.37	3.14	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.48	0.45	

G)



The above graph (G) shows that the number of contact was more in the experimental group as compared to control group.

10. The below table shows Duration of contact in 12.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0	0	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0	0	

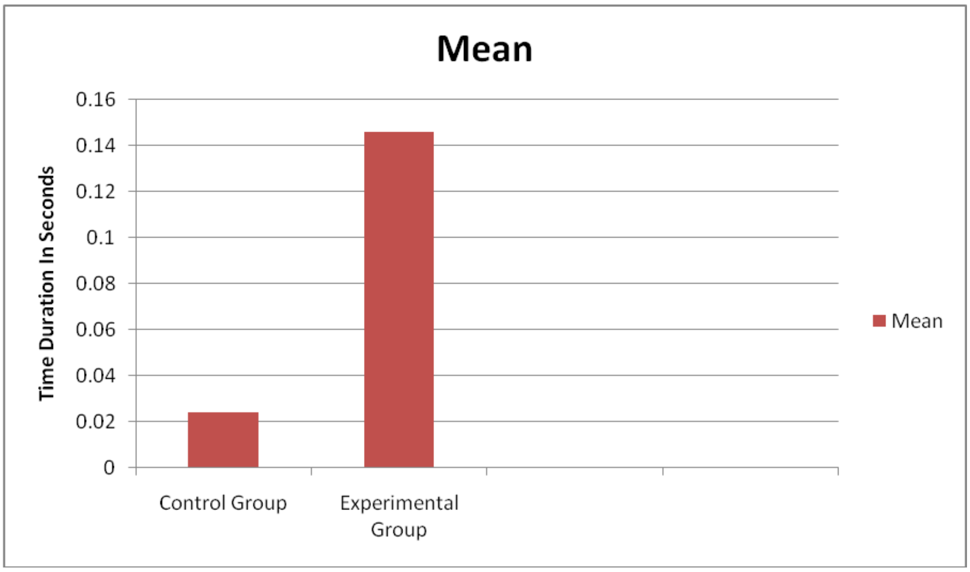
11. The below table shows Duration of contact in 8.00mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0	0	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0	0	

12. The below table shows Duration of contact in 6.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0.14	0.29	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.02	0.04	

H)

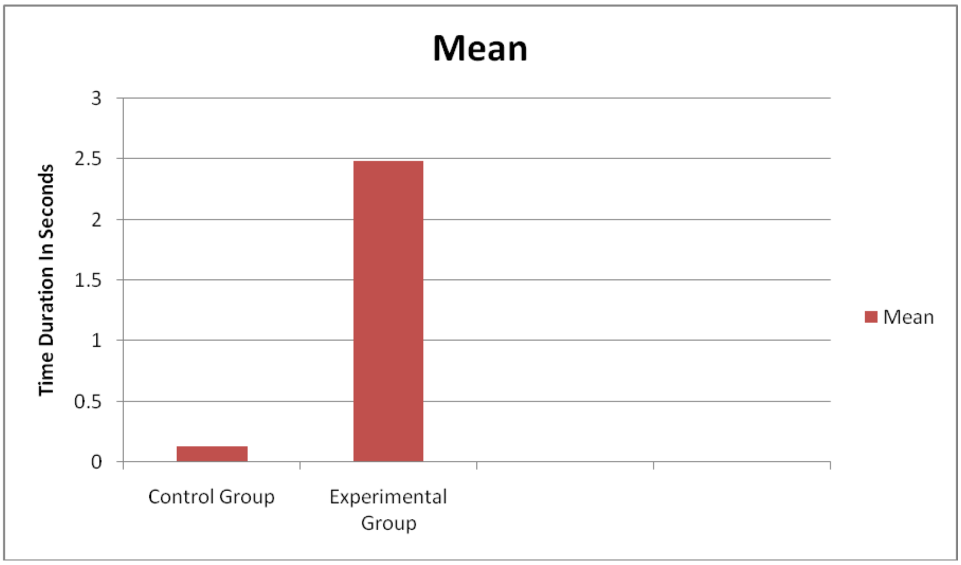


The above graph (H) shows that the total duration of contact (in seconds) is more in experimental group as compared to control group.

13. The below table shows Duration of contact in 5.00mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0.29	1.75	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.04	0.25	

I)

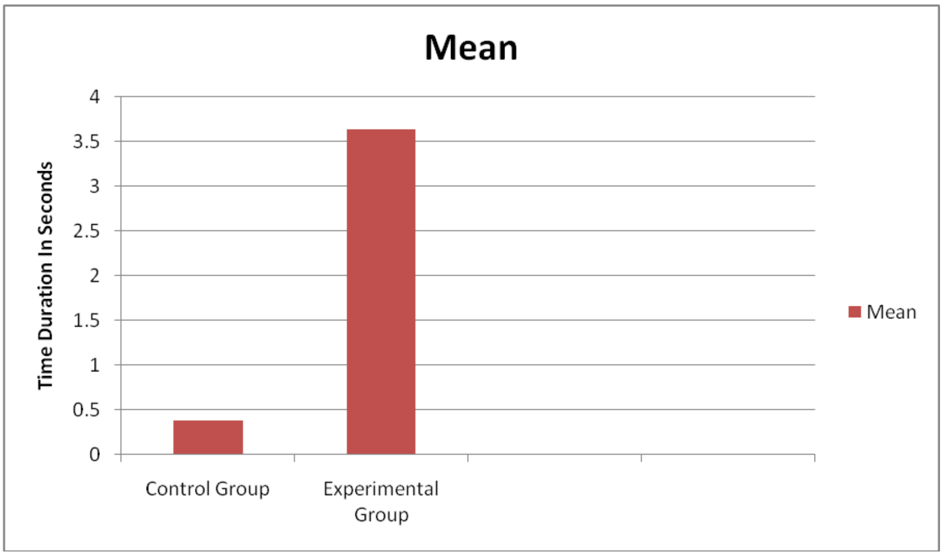


The above graph (I) shows that the total duration of contact (in seconds) is more in experimental group as compared to control group.

14. The below table shows Duration of contact in 4.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0.49	2.50	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.07	0.35	

J)

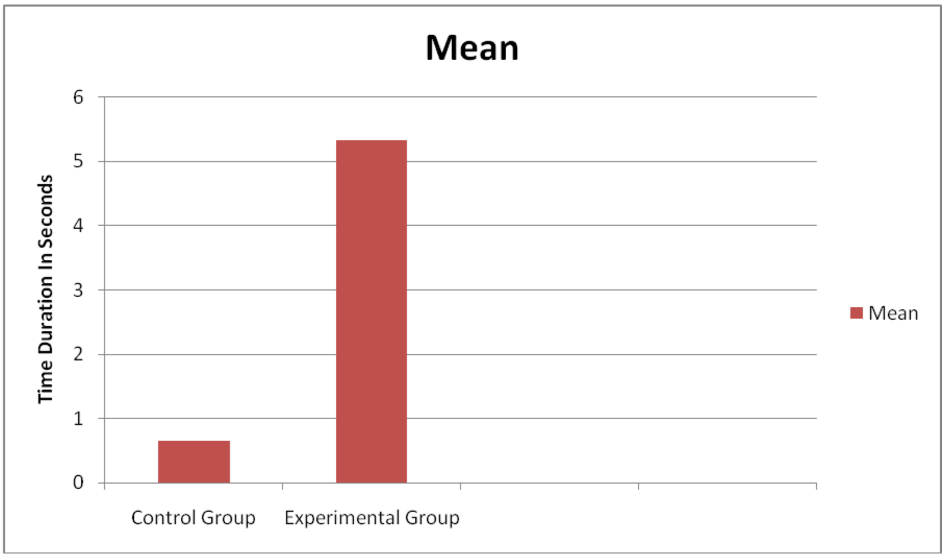


The above graph (J) shows that the total duration of contact (in seconds) is more in experimental group as compared to control group.

15. The below table shows Duration of contact in 4.00mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	0.95	2.61	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.13	0.37	

L)

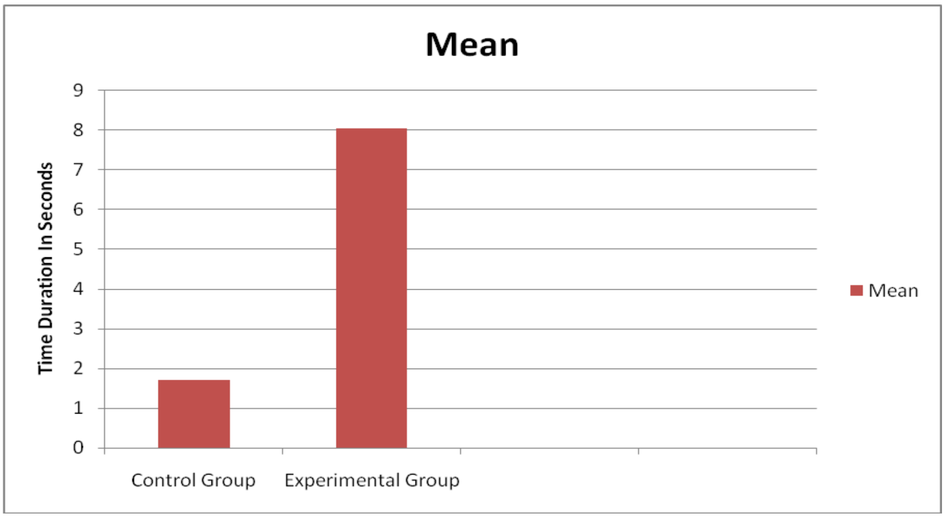


The above graph (L) shows that the total duration of contact (in seconds) is more in experimental group as compared to control group.

16. The below table shows Duration of contact in 3.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	1.50	2.04	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.21	0.29	

M)

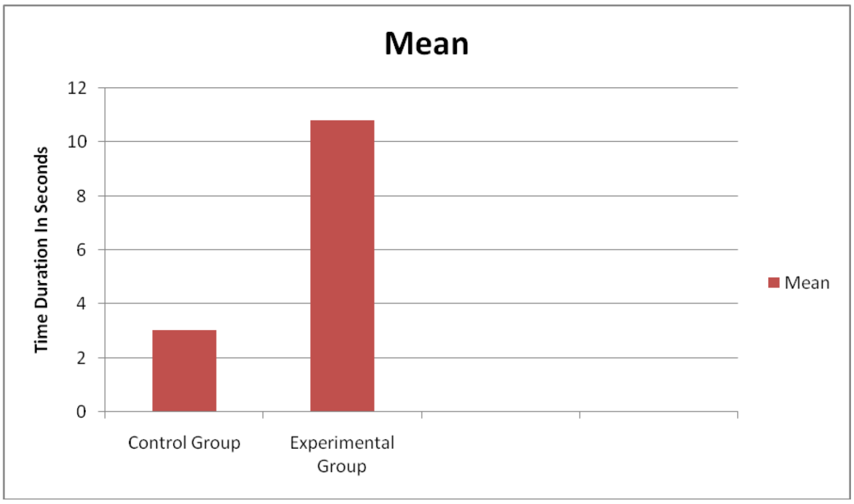


The above graph (M) shows that the total duration of contact (in seconds) is more in experimental group as compared to control group.

17. The below table shows Duration of contact in 3.00mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	2.04	3.63	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.29	0.51	

N)

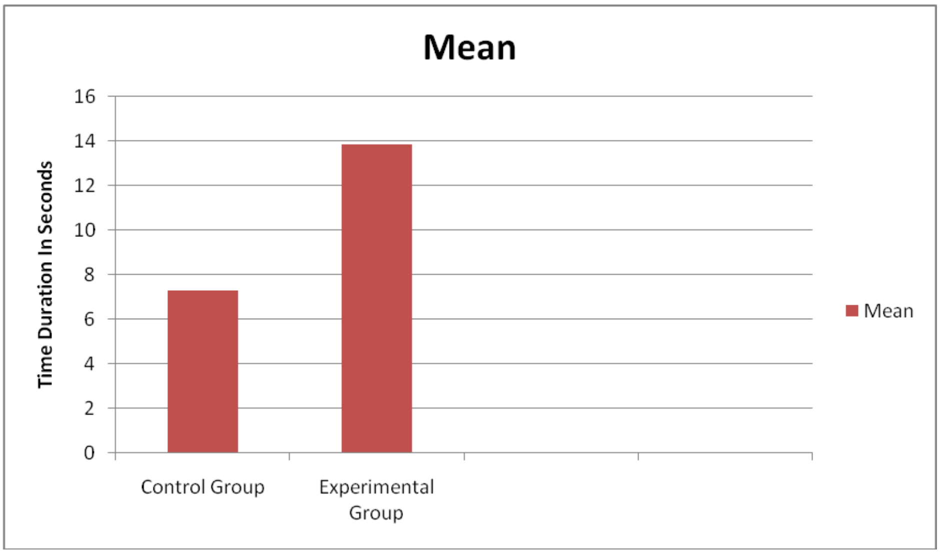


The above graph (N) shows that the total duration of contact (in seconds) is more in experimental group as compared to control group.

18. The below table shows Duration of contact in 2.5mm diameter hole.

Variables	Control Group	Experimental Group	P Value
Standard Deviation	1.87	3.77	P value is 0.0001 which is <0.05 hence statistically significant
Standard Error	0.27	0.53	

O)



DISCUSSION

This study assessed the effect of vibration on hand steadiness in delivery boys riding geared bikes using 9 hole steadiness test kit. A sample size of 100 was taken, age ranging from 25-35 years. The sample was divided into two groups, group A of 50 normal individuals and group B of 50 delivery boys. 9 hole steadiness test was performed on both the groups. The data was collected and analyzed using Man Whitney test and it was found out that the hand steadiness was affected in group B as compared to group A, the data was highly significant with P value of P<0.0001.

Previous studies states that, a person who is using motorcycle for more than four hours per day, could have risk of getting hand arm vibration syndrome. [4] Shivkumara BS et al, conducted a study, in this study hand arm vibration (HAV) and whole body vibration (WBV) of different motorcycles was measured using a software, results showed that he Rms values of HAV and WBV is above likely health risk considering 8 hours of exposure also vibration transmitted to hand should be monitored on riders who are using bike for more than 2 hours a day. [1] RMS (Root Mean Square) value is useful because it is directly related to the energy content of the vibration profile and thus the destructive capability of the vibration.

In a study conducted by Farhad Forouhamajd et al, 12 male workers working in motorcycle chassis production firm were exposed to vibration less than the recommended vibration limits. The subjects were then tested for motor control problem, tactile problems, skin temperature changes using 9 hole steadiness test, V-Pieron test, two point threshold test and precision thermometer respectively. A significant decrease in hand function was noted after exposure to vibration. [2]

JR Simon conducted a study on 32 subjects; he performed a steadiness task before and immediately after 3 minutes of exposure to localized vibration which showed a significant decrease in hand steadiness. [7]

In this study we saw that, as the diameter of hole decreased, number of contacts and duration of contacts increased in group B as compared to group A which shows a significant reduction in hand steadiness in group B. There was significant increase in number and duration of contacts in 5.0mm, 4.5mm, 4.0mm, 3.5mm, 3mm and 2.5mm diameter of hole in both groups A as well as B. As the diameter decreases, number and duration of contacts increases most being in 3.0mm and 2.5mm. The number and duration of contacts was higher in group B as compared to group A which shows group B being more affected in hand steadiness.

This study shows that hand steadiness is affected by exposure to vibration transmitted through handle of bike. The factors that influence the effect of vibration on hand are how hard the worker grasps the vibrating equipment (grip force), operator’s control of tool, position of hand and arm relative to the body and individual susceptibility to vibration.

Hand steadiness being an integral part of our day to day lives which is required for doing small as well as big task with precision. So we recommend bike riders to use protective gears such as gloves which will absorb vibration to some extent. It is advisable to have regular medical check ups and awareness should be given about harmful effects of prolonged exposure to vibration. Frequent breaks should be taken in between and servicing of bikes should be done regularly. Also hand and grip strengthening exercise can be taught.

CONCLUSION

The present study concluded that hand steadiness is affected in delivery boys riding geared bikes due to the exposure to vibration as compared to normal individuals.

Clinical Implication:

This study highlights the effect of vibration on hand steadiness which reduces in delivery boys riding geared bikes. Thus protective aids such as hand gloves or padding on bike handles can be done so that some amount of vibration gets absorbed by these layers before reaching the hands directly. Grip strengthening can be given to this population to reduce the effect of vibration. Also taking frequent breaks in between his/her work to reduce load on hands should be advised.

AKNOWLEDGEMENTS

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