Ergonomic Posture for Motorcycle Riding.

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***Abstract* — Motorcycle is widely used by commuters which consist of college going students. Motorcycle is preferred mode of transport within city limits as it is economical, more manoeuvrable and needs less space for parking. It is considered as a constrained workstation for users of different sizes to fit on the same workstation i.e. persons with different anthropometry, some ergonomic problems should be taken into consideration when designing a motorcycle. This study aims at finding the problems associated with motorcycle riding posture. Questionnaire was prepared to identify body parts which are mostly affected.**

***Keywords* — motorcycle, students, constrained workstation, anthropometry, riding posture.**

I. INTRODUCTION

The International Ergonomics Association defined ergonomics as a scientific discipline to design and optimize human well-being while interacting with industrial product. The fundamental aim of ergonomics is to eliminate the discomfort symptom which causes low job satisfaction, activity limitation and long term disability [4].

The motorcycle presents an interesting problem to ergonomists in that it is, a constrained workstation in which there is very limited available adjustment to suit the different needs of riders [1]. Literature review has highlighted that, there is high frequency of car drivers exposed to discomfort during their driving process which leads to the musculoskeletal symptom on their body parts. In motorcycle, this can be related to the biomechanical aspect of the riders seating condition [4]. Given the constrained nature of the scooter as a workstation, riding comfort is relevant to the physical fit and riding posture of a rider.

This study considers all the body dimensions concerned with motorcycle riding to estimate an ergonomic riding posture.

The subjective measurements are one of the important methods in measuring the discomfort or comfort level in the respective user. There is a variety of measuring scale for discomfort and comfort levels such as using continuous scale (moving from the extreme comfort to the extreme discomfort) and by considering the two extremities as different discrete states (defined as presence or absence of comfort). The most common subjective method to assess discomfort is using a body map. Generally, the participants are required to rate their discomfort (scale from no discomfort to extreme discomfort) level on the given body map [4].

Anthropometry is a research method of ergonomics dealing with the measurement of the dimensions and certain physical characteristics of the human body. Anthropometric data can be used in ergonomics to specify the physical dimensions of workspaces, workstations, and equipment as well as applied to related product design.

Robertson and Minter (1996) undertook an anthropometric survey with 140 UK motorcyclists and found that the population of motorcycle riders (both male and female) in the UK was significantly taller than the general population. They further noted that there was a wide variation in the forward position of a rider's knee while riding a motorcycle.

Motorbike riders are relatively more exposed to sitting posture hazard compared to car drivers. Ergonomic principles are valuable in providing basic scientific information, regarding unsupported back-leaning seating posture among motorbike riders. Motorbike riders are normally associated with sitting posture during riding the bike. Studies shows that for sitting without lower back support will generate pain in lower back and sitting without back support will generate pain in central back. Back pain occurring in adults with high recurrence rates is most common in musculoskeletal disorders (MSDs). Intradiscal pressures in lumbar region of spine can actually be greater while seated than standing [3].

II. PROBLEM IDENTIFIED

Most of the motorcycles available in the Indian market are not designed with ergonomic viewpoint. They are designed keeping a specific group of people in mind. Some bikes are designed to attract younger generation, some are designed to attract people who want to have a good fuel economy, some want the bike to lift load. However, human being is going to use the product and hence his comfort should be the top most priority. Therefore, the bike design should be ergonomic one. Also vehicles are designed mostly on the basis of American dimensions or European dimensions. Anthropometric dimensions of Indian people are different [6] [8].While riding a motorcycle, factors that affect comfortable sitting posture are:

- ✓ How rider sits while riding?
- ✓ What are his / her body dimensions?
- ✓ What is the quality of seat cushion?
- ✓ How is weight and pressure distributed while riding?
- ✓ For how long does the rider would sit in same position?
- ✓ How comfortable the rider is while operating various controls?

Following approaches for the study are used:

1) Subjective Approach:

A questionnaire is prepared for subjective analysis. Questionnaire helps to identify problems associated with motorcycle riding and complaints of different age group as experience of riding the motorcycle increases.

2) Anthropometric Approach:

Anthropometry deals with the measurement of the dimensions and certain other physical characteristics of the body such as volumes, center of gravity, inertial properties, and masses of body segments.

There are two primary types of body measurement:

A. Static dimensions,
B. Dynamic dimensions.

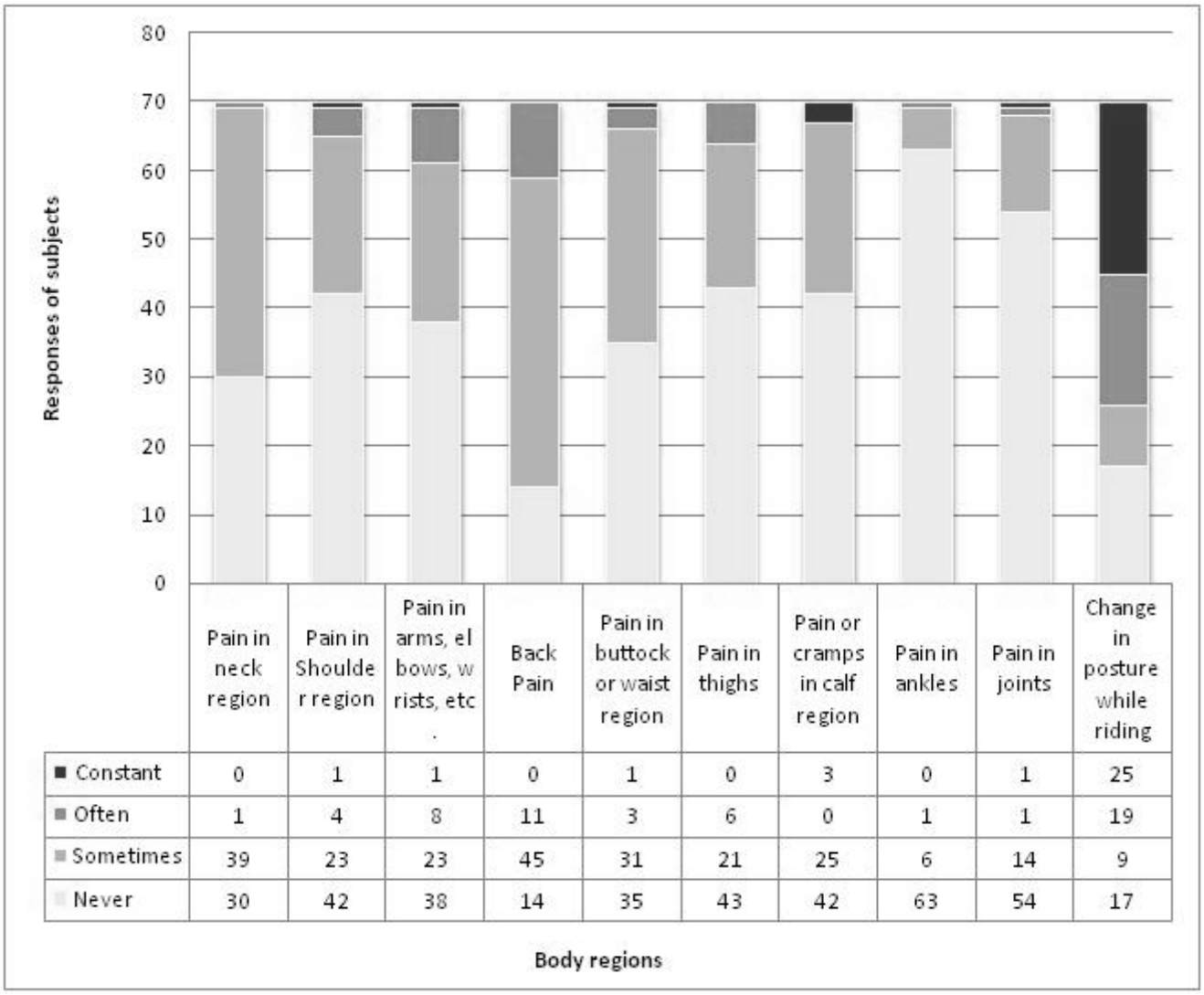
While riding a motorcycle, the posture of rider is static for long period and his dynamic movement occurs when motorcycle stops and he touches his leg down on the ground to balance.

Different dimensions are identified based on response given by subjects' on the questionnaire provided to them. The identified dimensions are studied in detail for their contribution to the comfort level as perceived by the subjects.

III. Data Collection Approach

I. Subjective Approach:

A questionnaire consisting of 19 questions related to man-machine interface was prepared and response was taken from 70 motorcyclists. The subjects belonged to 18-25 age group and are mostly college going students. The questionnaire formed the basis for determining problem areas mostly affected with motorcycle riding. Following is the analysis of questionnaire. It consisted of 10 objective questions and 9 subjective questions.



	Pain in neck region	Pain in Shoulder region	Pain in arms, elbows, wrists, etc.	Back Pain	Pain in buttock or waist region	Pain in thighs	Pain or cramps in calf region	Pain in ankles	Pain in joints	Change in posture while riding
Constant	0	1	1	0	1	0	3	0	1	25
Often	1	4	8	11	3	6	0	1	1	19
Sometimes	39	23	23	45	31	21	25	6	14	9
Never	30	42	38	14	35	43	42	63	54	17

Fig. 1 Questionnaire Analysis

II. Anthropometric Approach:

Anthropometric data was collected for the dimensions identified as relevant to comfort sitting on motorcycle. Following dimensions were recorded for the purpose of identifying variance between anthropometric dimensions [8].The dimensions are given along with their required percentiles and values, mean and standard deviation.

TABLE I
DIMENSIONS AND THEIR VALUES ALONG WITH PERCENTILES

Sr. no.	Dimension	Percentile and values	Mean	Std. deviation
1	Acromial height	95^{th} , 1448	1325	80
2	Crotch height	50^{th} , 760	762	63
3	Ball of foot length	50^{th} , 244	244	17
4	Foot breadth	50^{th} , 92	93	9
5	Buttock height	95^{th} , 911	832	51
6	Buttock knee length	95^{th} , 911	832	51
7	Buttock-Poplitieal length	50^{th} , 451	453	35
8	Elbow rest height	50^{th} , 210	211	36
9	Forearm-forearm breadth (closed)	95^{th} , 479	398	52
10	Forearm-forearm breadth (relaxed)	95^{th} , 632	501	74
11	Forearm hand length	50^{th} , 239	261	26
12	Shoulder-forearm length	50^{th} ,309	311	24
13	Hand length	50^{th} , 184	178	12
14	Knee height (sitting)	75^{th} ,534	511	33
15	Poplitieal height	75^{th} , 439	420	33

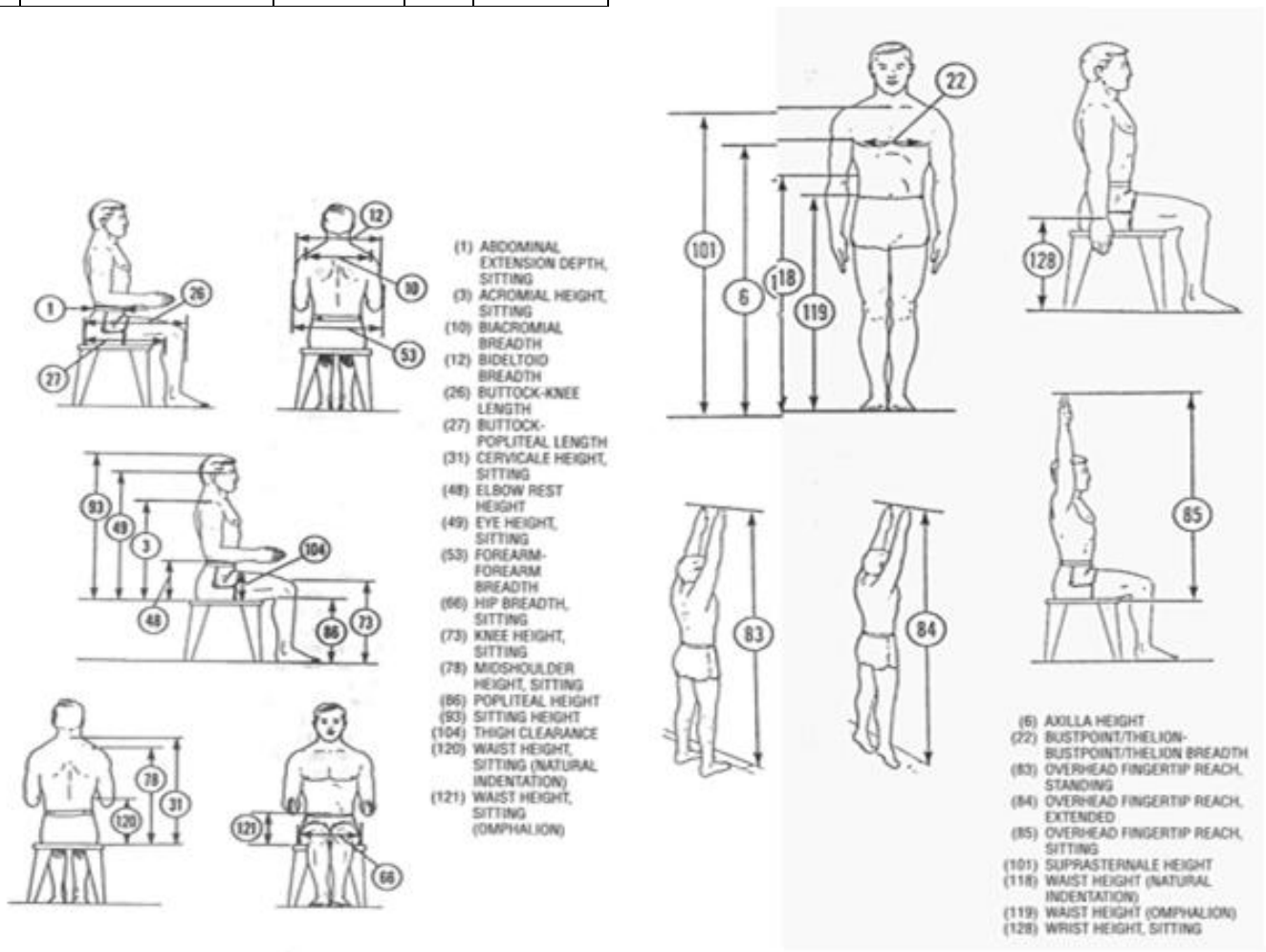


Fig. 2 Anthropometric Dimensions

III. Percentiles:

Percentiles correspond to the value of a variable below which a specific percentage of the group falls. For example, the 5th percentile standing height for males is 162 cm. This means that only 5 percent of males are smaller than 162 cm. The 95th percentile is 185 cm i.e. 95 percent of males are shorter than this height. The concept of percentile is especially important in using anthropometric data for designing objects, workstations, and facilities [5] [7].

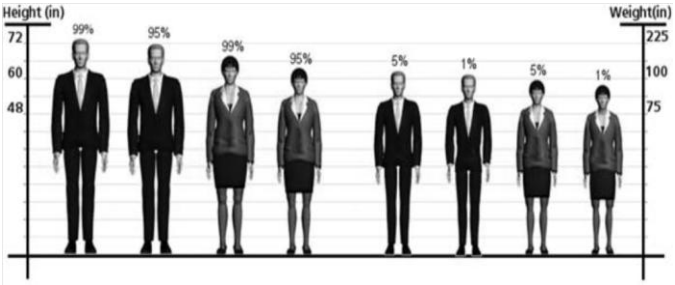


Fig.3 Percentile difference between male and females.

TABLE III
DIFFERENCE BETWEEN INDIAN AND AMERICAN DIMENSION FOR GIVEN PERCENTILE

Dimension	Percentile	Indian	American
Acromial height	95th	1448	1548
Crotch height	50th	760	835
Ball of foot length	50th	244	195
Foot breadth	50th	92	100
Buttock height	95th	911	966
Buttock knee length	95th	613	665
Buttock-Poplitieal length	50th	451	500
Elbow rest height	50th	210	234
Forearm-forearm breadth	95th	479	621
Forearm hand length	50th	239	482
Hand length	50th	184	193
Knee height (sitting)	75th	534	577
Poplitieal height	75th	439	450

IV. RESULTS AND DISCUSSION

From the analysis of questionnaire, it was found that motorcyclists change their posture for most of the time during riding. The only reason for this is discomfort experienced while sitting on the motorcycle.

Also, back pain is prominent among motorcyclists as during riding they cannot maintain proper ergonomic posture and hence the musculoskeletal disorder arises.

Pain in arms, elbows and wrist and pain in thighs are also reported by the respondents. These points to cramped position while driving the motorcycle and hence justified the point that it is a constrained workstation with minimum adjustment possible.

Anthropometric data shows the variation in values which should be ideally considered and values which are considered while designing a motorcycle. As motorcycle is a constrained workstation, the design should be user focused and not universal. Little variations in dimensions of motorcycle should be made possible to facilitate rider adjust the riding position according to his needs.

Anthropometric data also reveals the difference between Indian and American dimensions. Machines designed with American anthropometric dimensions are not comfortable of Indian population and hence need to design motorcycle with Indian anthropometric dimensions.

Percentile shows that there is difference between male and female dimensions for same percentile. As the population of females using motorcycle is increasing there is a need to take into consideration female dimensions also.

Also, some type of customization should be provided as there is no relation between different dimension of human body as well as humans has different morphology, which is also a factor when we talk about comfort. Some humans are short and fat, while some are tall and slim, but it cannot be generalised as there are slim and short person. Lifestyle of a person also affects the perseverance of comfort.

V. CONCLUSION

The results indicate that majority motorcyclists experienced discomfort in their body parts during their riding process. The results also indicated that the motorcyclist mainly experienced discomfort on their upper body parts (neck or head, shoulder, upper back, arm and hand, low back and buttock) and whereas majority expressed no discomfort in their lower body part (knee, calf leg below knee and ankle and feet).

As the age group of respondents is 18-25 years, the experience of discomfort will increase with increasing age and increasing years of riding as healing power of body decreases as age increases if an injury is sustained.

Therefore, these study findings can be useful for the designers in the automobile (motorcycle) industry in order to enhance the ergonomic relationship between the human (riders) and motorcycle.

This study used a relatively small sample and clearly further work is required to obtain more detailed anthropometric data and sitting position studies need to be undertaken, particularly with respect to differences between the different styles of motorcycle and the static and dynamic situations.

REFERENCES

[1] Robertson S.A. and Minter A. 1996. *"A study of some anthropometric characteristics of motorcycle riders"*. Journal of Applied Ergonomics.

[2] Jyh-Rong Chou, Shih-Wen Hsiao, 2005. *"An anthropometric measurement for developing an electric Scooter"*. International journal of Industrial Ergonomics.

[3] Karmegam K., Ismail M. Y., Sapuan S.M., Ismail N. 2008. *"Conceptual design and prototype of an ergonomic back-leaning posture support for motorbike".* Journal of scientific and industrial research.

[4] Karmegam K., Ismail M. Y., Sapuan S.M., Ismail N., Bahri Shamsul M.T., Shuib S. and Seetha P. 2009. *"A study on motorcyclist's riding discomfort in Malaysia".*

[5] Mark S. Sanders and Ernest J. McCormick. *"Human factors in engineering and design".*

[6] K.N.Dewangan, G.V.Prasanna, Kumar,P.L.Suja, M.D. Choudhury,2005. *"Anthropometric dimensions of farm youth of the north eastern region of India"*. International Journal of Industrial Ergonomics.

[7] Sarah M. Donelson and Claire C. Gordon 1996."*1995Matched anthropometric database of U.S. marine corps personnel: Summary statistics"*.

[8] Debkumar Chakrabharti. *"Indian Anthropometric Dimensions"*.