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CUSTOMIZED HELMETS FOR TWO-WHEELER USERS: AN ANTHROPOMETRIC STUDY

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ABSTRACT ■ One of the important causes of alarmingly high number of accidents due to two-wheelers is non-usage of helmets, and enforcing laws alone will not ensure safety. Studies have indicated that poor design of helmets leading to discomfort is one of the reasons why two-wheeler riders refuse to wear helmet while on road. In order to address such a problem, designing helmets on the basis of ergonomic principles specifically anthropometric dimensions of individuals of varied ethnicity was employed. A study has been carried out on adult males to design 'customized' helmets using regression modelling.

Key words: Motorcyclists, RTI, Discomfort, Anthropometry, Customized-Helmet

INTRODUCTION

Two-wheeler riders are considered a group of unprotected road users representing 23% of the global Road Traffic Injury (RTI) burden (Pinnoji, 2010). Existing data (GoI, 2014) suggests that in India, the total number of persons killed in RTI was around 1, 41,526 of which, two-wheelers accounted for the highest share (Pinnoji, 2010). Deaths due to two-wheeler related RTI is mainly because of head and neck injuries and the likelihood and severity of such injuries may be reduced on wearing helmets. Helmet is thus, the most essential equipment while riding a motorcycle or bicycle as it reduces the rate of head injuries, by lowering the collision impact for head and body (Deck, 2003). Therefore, increasing helmet use among two-wheeler riders may be encouraged to improve road safety. Enforcing laws, for usage of helmet, alone will not serve the purpose (Attewell, 2001). The design criterion of a helmet is based on its protective ability (Head Injury Criterion), comfortability, stability and fit (Newman, 1975). Studies have indicated that wearing ill-fitted helmet increases the likelihood of head injury compared to properly filled helmet (Rivara, 1999). Another study carried out on Asian people indicated a poor Helmet Fit Index (HFI) score of helmets designed for human heads of varied shapes (Alemany, 2012).

Earlier studies have suggested that poor design of helmets leading to discomfort is one of the reasons why two-wheeler riders refuse to wear helmet while on road (Yu, 2011). The

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human head shape has been classified into four types on the basis of Cephalic Index or CI (ratio of head breadth to head length) - Dolichocehalic (CI value <0.74), Mesocephalic (CI value 0.75–0.79), Brachycephalic (CI value 0.8–0.84), Hyperbrachycephalic (CI value > 0.85) (Standring, 2005). Earlier studies have indicated that the shape of human head is influenced by factors like gender, race, ethnic background and like (Swan, 1965). Therefore, to improve the designing of helmet in terms of comfort and fit, the influence of previously mentioned factors on cephalic dimensions may be included. Earlier studies reported that anthropometric parameters like stature, standing and sitting heights bearing significant correlation with cephalic dimensions like head length, head breadth, and cephalic index may be considered to facilitate proper stability and fit of helmets (Standring, 2005). Studies have indicated that the existing range of sizes of commercially available helmets might not fit the varied range of human head dimensions and shapes (Joshi, 2009). In this backdrop, a study has been conducted on adult Indian males permanently inhabiting North India to design 'customized' helmets on the basis of anthropometric data using regression modelling.

METHODOLOGY

The data were collected from 60 adult males (age range 21- 45 years), permanently inhabiting North India and these data represented as data of Group 1. After getting the initial consent from the study participants, study requirements explaining elaborately. Individuals who were on medication for stature enhancement or had some musculoskeletal problem (self reported) excluded from the study purview. Age in year was recorded in pre designed schedule. Stature in cm, was measured using anthropometric measurement set and the cephalic dimensions - head length (HL) and head breadth (HB) in cm, were measured using spreading calliper (Agnihotri, 2008, Williams, 1995).HB was measured as the maximum biparietal diameter, i.e. the distance between the most lateral points of parietal bones (euryon) and HL was measured as the straight distance from the glabella (the prominence on the forehead between the eyebrows, just above the nose) to the opisthocranion (the farthest occipital point) (Williams, 1995, Martin, 1957). Cephalic Index (CI) was calculated from the ratio of HB to HL (Raveendranath, 2010). The same measurements were obtained from 33 consenting adult Bengalee males of similar age range and socio economic stratum and these data represented as data of Group 2. Obtained data were statistically analyzed. Arithmetic mean (AM), standard deviation was calculated. P value lower than 0.05 ($P<0.05$) was considered as significant.

RESULTS

In Table 1 values of Group 1 study participants' anthropometric parameters along with coefficient of correlation has been presented. In the present study, significant ($P < 0.05$) positive correlation has been found between stature and HB in case of Group 1 study participants and therefore, regression equation; with standard error being 0.48 to predict HB has been computed using stature (X) as the predictor.

The regression equation for HB (Y) estimation using stature (X) as the predictor is as follows:

$$\hat{Y} = 0.022 * X + 10.482$$

Table 1. Values of Group 1 study participants' anthropometric parameters and coefficient of correlation

Parameters	Data
Sample size	60
Stature (X) in cm	169.8 ± 6.36
HL in cm	19.2 ± 0.89
HB (Y) in cm	14.2 ± 0.45
CI	0.74 ± 0.04
r_{xy}	0.30*

Values in AM± SD, *P<0.05

DISCUSSION

The findings of the present study in terms of stature (cm) and body weight (kg) of the study participants was in tune with the findings of earlier studies. The values of somatometric indicator, BMI indicated that, the participants were in 'normal weight' category as per the classification given by WHO (WHO, 2000). This finding was in consonance with the findings of earlier studies (Banerjee 2015a; 2015b, Mukherjee 2014a; 2014b, Bhattacharjee 2014,; Kundu 2014; Mukherjee 2013; Mukherjee 2012).

Despite helmet being essential protective equipment for two wheeler riders, people generally refuse to wear it while on road. Apart from the helmet weight, improper fit and discomfort are other two important issues that restrain the user from wearing helmets frequently (Yu, 2011). Studies carried out on size, fit and stability of a helmet have shown that the existing range of sizes of the commercial helmets may not be appropriate due to wide variations in cephalic dimensions among humans of different ethnicity and race (Joshi, 2009, Kumar, 2013, Gupta, 2013, Yagain, 2012). As RTI due to non-usage of helmets while riding two wheelers is increasing rapidly, encouraging helmet use is quite challenging. Initiatives have been taken by governmental and non-governmental organizations to design different strategies and safety campaigns but to get satisfactory results the underlying cause of the problem needs to be addressed (Mondal, 2015, Banerjee, 2015c). Discomfort either in the form of a large space between the inner liner and the head or low coverage of the skull area with significant unprotected regions of the headis probably the chief reason for riders refusing helmet use while on road (Yu, 2011). To abate this problem, incorporating techniques to design 'customized' helmets by considering the influence of race, gender, ethnicity on human head shape may be adopted (Yagain, 2012). Stature bears a correlation between different anthropometric parameters; therefore estimation of cephalic dimensions from stature of an individual may prove to be promising in reducing the discomfort rate of the wearer (Krishan, 2007). Cephalometry is a powerful tool and is widely used in physical anthropology, forensic science, genetics and like (Kumar, 2013, Franco, 2013).

In the present study, in case of Group 1 participants' stature was found to be significantly correlated ($P < 0.05$) with HB. Earlier studies carried out among different ethnic groups and populations (Krishan, 2007, Kpela, 2016, Ukoha, 2015, Wankhede, 2015) have found a similar trend of result which reports stature was found to be significantly correlated ($P < 0.05$) with HL. It has already been reported, that the type of human head shape is influenced by ethnicity, race, genetic interaction, nutritional status and gender and this is the reason why vast anthropometric variations exist among various castes and sub-castes of same region (Ozaslan, 2003). In

view of the results presented and discussed, it may therefore be stated that it is possible to estimate the cephalic dimensions from stature, e.g. HB in adult males permanently inhabiting North India. Validation study has indicated almost similar HB values. However, in case of Bengalee Brahmin males due to the size of the sample being small so far possibly because of usual increase in number of inter-caste marriages in recent times, no such conclusion could be drawn. In order to improve the existing range of sizes of the commercially available helmets designing 'customized' helmets like that of tailored-fit dresses, on the basis of cephalic dimensions of an individual predicted from his/her stature, may prove to be effective (Alemany, 2012, VV, 2009, Bharati, 2005). Since it has already been mentioned that proper fit and stability of helmet is not just important for maintaining comfort level of the wearer but also from the perspectives of a helmet's protective ability, improving helmet design in terms of size and proper fit is therefore, essential and in turn may encourage helmet use among two-wheeler riders (Attewell, 2001).

CONCLUSION

From the present study it may be concluded that in case of adult males (i.e. study participants belonged to Group 1) inhabiting North India stature bears a significant positive correlation with HB and therefore, stature may be used to estimate the HB by employing regression equation model. It may also be concluded that to improve comfort and fit of a helmet, modification of the existing range of sizes of the commercially available helmets by including the influence of gender, ethnicity and like on cephalic dimensions may be effective. Therefore, to encourage helmet use among two-wheeler users in order to reduce the number and impact of RTI, employing techniques to design 'customized' helmets on the basis of cephalic and other anthropometric dimensions may prove to be fruitful.

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