DIFFERENCES ON ANTHROPOMETRIC MEASUREMENTS OF THE HAND BASED ON LATERALITY IN SERBIAN CONTEXT

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DIFFERENCES ON ANTHROPOMETRIC MEASUREMENTS OF THE HAND BASED ON LATERALITY IN SERBIAN CONTEXT

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Anthropometric data are essential for designers of products, while hand anthropometric measurements are of special importance due to the fact that grasp enables different manipulation tasks. Literature review shows that differences on anthropometric characteristics of the hand based on laterality in Serbian context have not been examined till now, so this study tested it on the sample containing 110 subjects - 23 left-handed and 87 right-handed. Hand anthropometric measurements include 30 anthropometric dimensions measured on each examined participant. Dimensions are taken by capturing the imprints of the subjects' outstretched hands. Collected data were subjected to descriptive statistics, t-test, Kolmogorov test and Mann-Withney U* tests. Also, 5th and 95th percentiles are calculated on all dimensions. Results show that there are no statistically significant differences based on laterality in Serbian context. Accordingly, hand tools and many other equipment, which are controlled by means of Serbian operator could be designed in the same manner both for workers whose dominant hand is left and right. Also, percentiles values are calculated and should be taken into account in design processes. It is recommended, in future research to enlarge sample, repeat statistical testing and analyze hand grasp possible issues.

Key words: hand, anthropometric measurement, left-handed, right-handed, statistical analysis

INTRODUCTION

Anthropometric data are essential for designers of products which fulfill users special needs, since it is well known that if users experience discomfort, accidents and injuries could appear [1,2]. Human laterality is very important issue which has to be examined in ergonomics field and in the hand tool design [3].

The human hand is very important executor of locomotor function, especially in tasks of manipulation. Hand has specific configuration of the bones and muscles which enables opposition of the pulp surface of the thumb to the surfaces of the other four finger tips in a firm grasp. Hand discomfort, disorders and injuries are very frequent - hand disorders account around 30% of all injuries at work, 25% of lost work time, and 20% of permanent disabilities [4]. Hand discomfort and injuries are provoked by task which requires a hand strength that exceeds the worker's capability, awkward posture, and repetitive task [5].

Accordingly, anthropometric dimensions and hand grip strength are critical parameters that need to be considered when designing ergonomic products and the aim of this paper is to check if there are significant differences between left handed and right handed persons' hand anthropometric dimensions. This paper is structured as follows. After topic introduction in this section, literature, which is scarce, review is given in the next section, while in section 3 methodology is described, implemented and results are given, while the last, forth section gives discussion and conclusions.

LITERATURE REVIEW

Available literature on differences between hand anthropometric measurements between left and right handed users is scarce and just touches topic of interest. Kawaguchi et al. emphasize importance of hand anthropometry for the grasp, such as stability, easiness and fitness of the grasp, for certain products [6]. Boz et al. have analyzed relationship between the body mass index (BMI), wrist index and hand anthropometric measures and come to conclusion that differences in the hand length/height ratio were not statistically significant between female and male study participants [7]. Barut et al. have compared hand anthropometric measurements and grip strength between different sports professions and found statistically significant differences for right and left hand width, right finger index, right hand, length/height, left hand length/height values between basketball, handball and volleyball players [8]. Kulaksiz & Gözili investigated hand preference based on seven parameters of hand anthropometric measurements and concluded that there are no differences between sex, while influential factors such on hand preference are hand activity, hormones, and brain asymmetry [9].

On other side, numerous studies on hand grip strength have been carried till today. Data are usually divided into age and gender sub-groups and it evident that the highest hand grip strength have male persons in forties [10,11]. Also, certain research claim positive relationship between hand grip strength and BMI, while other do not find significant between subjected parameters [12].
One of rare studies which compare left and right hand anthropometric dimensions is done by Cakit et al. on sample consisting of of 92 male and 73 female students at dentistry faculty in Turkey [13]. Authors Cakit et al. have found that the mean values of fingerbreadths, finger circumferences, and hand depths are significantly larger in the right hand when compared with the left hand while the mean value of handgrip strength is significantly larger in the right and when compared with the left hand [13]. Mohammad has examined 200 male and female participants in Jordan and found significant differences in hand dimensions and hand performance between left- and right-handed individuals, but without statistical hypothesis testing and based on obtained percentiles values [3]. This study is aimed to check if there are statistically significant differences between left and right hand in Serbian population.

**METHODOLOGY AND RESULTS**

**Methodology of measurements**

Anatomy of the hand is shown at Fig. 1, while dimensions measured in experiment are shown at Fig. 2. Dimensions are taken by capturing the imprints of the subjects’ outstretched hands. Hand anthropometric measurements shown at Fig. 4 are obtained by combining several sources – 30 anthropometric dimensions are taken [14-17].

Participants for this study were randomly selected from the general population. Subjects selected were chosen from 19 to 50 years of age, similar to study by Mohammad [3]. The techniques of measurements were as per guidelines in NASA-1024 [19].

**Measurement results and data analysis**

In the first step is conducted descriptive statistics. It's includes number of subjects identification of the dominant hand (R - right, L - left), N number of all 110 subjects, 26 left-handed and 87 right-handed, Mean values of all measurements (see Fig. 2), Median, difference between mean and median, 5 and 95 percentile, standard deviations $SD$ and Coefficient of variation in percentages $cv$ [20].

Finger lengths are calculated as follows, according to Fig 1.:

$$A = A_1 + A_2, \quad B = B_1 + B_2 + B_3,$$
$$C = C_1 + C_2 + C_3, \quad D = D_1 + D_2 + D_3,$$
$$E = E_1 + E_2 + E_3. \quad (1)$$

Descriptive statistics of all measures for all subjects is shown at Tab. 1. Since coefficients of variation are all smaller than 30%, data are homogeneous. Also, differences between means and medians are small (less than 1 mm) it can be concluded that data are symmetrical. Thus it can be assumed that all measured data are normally distributed.

In order of further comparisons measured hand dimensions are divided on left-handed users and right-handed users Tables 2 and 4. Parametric variables indicate that parametric methods for comparisons are used, i.e. t-test, since number of left-handed users is smaller than 30.

In the case of left-handed users differences between mean and median for measurements $B$, $C$, $E$, $G$, $I$, $L$ and $M$ (see Fig. 4) are greater than 1 mm, and for them Kolmogorov test for normality is conducted, since all data are homogeneous, i.e. values of coefficient of variation are smaller than 30%. Obtained results are shown in Table 3.

Conducted Kolmogorov test for normality shows that all measures except $L$, in spite differences larger than 1 mm
In the case of right-handed users, differences between their mean and median are parametric, while measurements for left-handed users is nonparametric measurement, as well as a hand length, which can be explained by measurement of dimension $K$, and positioning of middle finger at the imprints.

According Tab. 2 and Tab. 4 for comparisons of the measurements $E$, $L$ and $N$ is conducted by use of Mann-Whitney U* tests. Otherwise for comparisons t-tests for independent samples are used.

Comparison between left and right hand measurements using student t-test is presented in Table 6., while measurements where Mann-Whitney U* test is used are presented at Tab. 7.
Both types of comparisons, using parametric and non-parametric methods (Tab. 6 and Tab. 7) show that there are no statistically significant differences between measurements that consider dominant hands within group of 110 subjects, 23 left-handed and 87 right-handed.

**CONCLUSION**

This is first study of hand anthropometric measurements for Serbian population. This study examined hand anthropometric measurements on the sample containing 110 subjects - 23 left-handed and 87 right-handed. Therefore:

- Extended statistical analysis was conducted for all 30
measured dimensions, that include additional measurement such as difference between mean and median, and also 5th and 95th percentiles are calculated;

- Same descriptive statistics was conducted for all of 23 left-handed and 87 right handed users;
- Depending of hand, for some measures difference between mean and median was larger than 1 mm, and for them was conducted Kolmogorov test for normality was conducted resulting with one of 7 measures for left-handed and 2 of four measures right-handed users had non-normal distribution;
- In the cases of the comparisons of the normal distributions, t-test for independent samples were used, otherwise non-parametric Mann-Whitney U* test was conducted (3 comparisons);
- All results show no statistically significant difference between measures.

According to this study, using parametric and non-parametric methods, there are no evidenced statistically significant differences between subjects, so hand tools and other equipment which are controlled by means of Serbian operator hand could be designed in the same manner both for workers whose dominant hand is left and right. In those tasks, obtained percentiles values have to be taken into account when designing tools.

It is recommended, in future research to enlarge sample and repeat statistical testing. Also, hand grasp laterality issues are possible future research avenue.

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