

## **DIFFERENCES IN ANTHROPOMETRIC MEASUREMENTS BETWEEN LIBYAN AND SERBIAN PASSENGER CAR DRIVERS AND CRANE OPERATORS**

**Vesna Spasojevic Brkic<sup>1</sup>, Zorica Veljkovic<sup>1</sup>, Ahmed Ali Essdai<sup>1</sup>, Aleksandar Brkic<sup>2</sup>**

<sup>1</sup>University of Belgrade, Faculty of Mechanical Engineering, Serbia

<sup>2</sup>Innovation center, Faculty of Mechanical Engineering, Serbia

*This paper is a part of ongoing research on passenger car drivers' and crane operators' anthropometric measurements data collected in aim to make comparison, explore ergonomic adaptation and finally improve safety. It represents one of the rare explorations containing the Libyan male drivers and crane operators' data, and accordingly it is one of the first researches in anthropometric field on Libyan population. Herein, statistical analysis on Libyan 300 male drivers and 50 crane operators collected data shows that male drivers are taller, and have higher sitting height as well as upper leg length values, while crane operators have slightly wider shoulders and hips. Both Libyan groups have the same arm and foot lengths. Apart of Libyan male car drivers and crane operators, research includes also and Serbian car drivers (921 Serbian male drivers) compared with crane operators (83 crane operators). Obtained data show that Serbian male car drivers have significantly larger standing height and upper leg length values, while foot length is significantly lower for drivers than for crane operators. Passenger vehicle and crane cabins designers can benefit from this survey.*

*Key words: Passenger car drivers, Crane operators, Anthropometric measurements, Weight, Comparison*

### **INTRODUCTION**

Ergonomic adaptation results in better users' accommodation and their better performances when executing certain tasks. Therefore, anthropometric measurements, together with ergonomic principles have to be considered in aim to achieve effective ergonomic adoption of workplaces.

There are significant measurements differences on Anthropometric measurements between different nationalities, gender, age, race, occupation and nutrition patterns [1], [2], [3]. Anthropometric measurements also change over time, causing a constant need for their updating in order to achieve comfortable and safe vehicles or cabins interior design [2], [4], [5], [6], [7].

In surveys [8], [9], [10] [11], [12], [13], [14], [15], [16], [17], [18] the importance of the ergonomics issues solution in the crane cabin design has been considered with aim to increase crane operators safety and improve their working conditions, safety and efficiency. Occupational fatalities, injuries and risks caused by the operation of cranes pose a serious public problem that till today has not been solved although it produces also huge cost implications [8], [19], [20], [21], [22]. The ergonomic design of crane cabin is vital to improve operators comfort and consequently crane operation safety, which should be achieved through a better understanding of the anthropometric characteristics of crane operators [11], [14], [18], [23], [24], [25], [26].

Similarly, driving can causes musculoskeletal disorders and surveys such as [1], [2], [3], [4], [5], [6], [7] emphasize that further studies are needed in the field of interi-

or space of a passenger vehicle. Vehicle interior space modeling includes aspects of seat comfort, human interactions, visual displays of location, pedal controls, reaches etc., that have to be modeled depending on fresh anthropometric data [27]. Klarin et al. [6] point out the need for continual evaluation of interior vehicle space design and modeling, with different approaches such as the algorithm model, that could be used to quantify and determine the parameters related to the interior vehicle space modeling. Also, authors in [5], [6], [7] analyze an adaptation of the passenger car to driver, including the limits of anthropometric measurements and technical limitations of the car, in order to improve the comfort, safety, and efficiency of vehicle operation.

Anthropometric measurements on Libyan population, till now are rarely collected and considered [28], [29], [30]. When those data are available they are in the field of drivers [31], while crane drivers in Libya are considered only from economic/workforce aspect, since numerous number of cranes operates there in petrol industry [32], [33].

This paper presents one of the first seriously conducted researches concerning Libyan male passenger car drivers and crane operators, comparing their anthropometric characteristics and statistically testing their similarities and differences, together with our surveys given in [11], [31]. It also covers Serbian samples of male passenger car drivers and crane operators with its fresh anthropometric measurements.

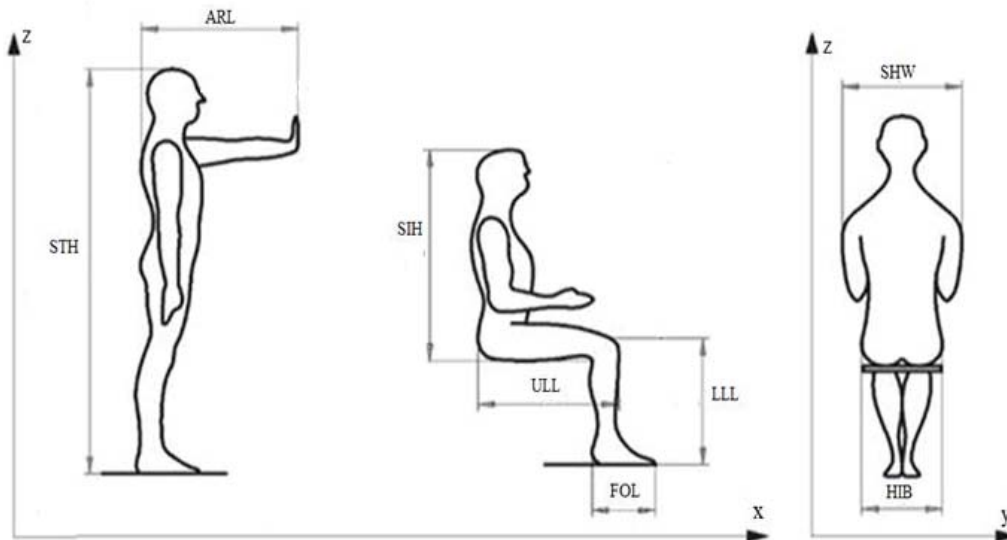


Figure 1: Body dimensions as anthropometric measurements

### METHODOLOGY OF EXPERIMENTATION

For all groups - Libyan and Serbian male car drivers and crane operators nine anthropometrics were measured - standing height - STH, sitting height - SIH, lower leg length - LLL, upper leg length - ULL, shoulder width SHW, hip breadth - HIB, arm length - ARL and foot length - FOL (as given in Figure 1).

For collected data statistical analysis were conducted. It included descriptive statistics for determination of means, medians, standard deviations and coefficients of variations. Based on those data adequate Kolmogorov tests for normality were applied in order to determine type of further examination. In the second step, in order to compare data between car drivers and crane operators, adequate systems of hypothesis were tested and conclusions were drawn for every variable, based on the following criteria, with annotations according to [34]:

- If  $p > 0.05$  no significant difference (n.s.)
- If  $p < 0.05$  low difference (<)
- If  $p < 0.01$  strong difference (<<)
- If  $p < 0.001$  absolute difference (<<<).

### DATA ANALYSIS

#### Libyan male car drivers and crane operators

For Libyan car drivers collected sample sized 300 respondents and 50 crane operators. Based on values from descriptive statistics (Table 1), i.e. coefficients of variation that showed homogenous data for all variables in both groups, Kolmogorov tests for normality were conducted, leading to conclusion that all variables are parametric. Based on conclusion that all data were parametric variables, adequate z test for difference of means were conducted between Libyan car drivers and crane operators. Test are presented at Table 2.

Data in Tab. 2 show that there are no statistical differences on lower leg length, arm length and foot length, while other measures show significant differences. Differences on standing height, sitting height and upper leg length are significant on  $< 0.001$  level, that means that there is absolute difference, while other measurements show low differences.

### SERBIAN DATA ANALYSIS

Descriptive statistics on Serbian male drivers and crane operators is given in Tab. 3. Data include 931 Serbian male drivers and 83 crane operators.

According to descriptive statistics it is evident that coefficients of variation are small ( $< 30\%$ ) and that therefore data are homogeneous, which enables further usage of Kolmogorov tests for normality which has been proven that all anthropometric measurements are parametric for both examined groups.

Comparison of anthropometric measurements between Serbian male drivers and crane operators for Z test of difference of means are presented at Tab 4. It can be noticed that there are no differences on sitting height, lower leg length, shoulder width, hip width and arm length, while existing differences have absolute differences.

### DISCUSSION

Visual presentation of mean differences for absolutely differences between anthropometric measurements between Libyan male drivers and crane operators are presented at Fig. 2.

Significant number of anthropometric measures (one third) is statistically absolutely greater for Libyan male drivers than for crane operators in range from 2.83% to 4.25%, as it shown at Fig. 1.

Table 1: Descriptive statistics for Libyan male drivers and crane operators

Dimension	N	Mean	Me	SD	cv(%)	D	p	SIG.	VT
STH LMD	300	1749.517	1750.000	63.104	3.61	0.1871	1	n.s.	parameter
SIH LMD	300	855.483	860.000	43.493	5.08	0.1919	1	n.s.	parameter
LLL LMD	300	543.050	540.000	34.425	6.34	0.1516	1	n.s.	parameter
ULL LMD	300	582.767	580.000	37.166	6.38	0.2407	1	n.s.	parameter
SHW LMD	300	471.350	470.000	45.440	9.64	0.1661	1	n.s.	parameter
HIB LMD	300	365.620	360.000	59.192	16.19	0.2018	1	n.s.	parameter
ARL LMD	300	633.053	610.000	72.291	11.42	0.2220	1	n.s.	parameter
FOL LMD	300	275.833	275.000	9.115	3.30	0.2126	1	n.s.	parameter
STH LCO	50	1701.40	1700	58.554	3.44	0.3050	1	n.s.	parameter
SIH LCO	50	829.40	840	47.827	5.77	0.1812	1	n.s.	parameter
LLL LCO	50	534.60	530	36.545	6.84	0.2222	1	n.s.	parameter
ULL LCO	50	559.00	560	32.779	5.86	0.1908	1	n.s.	parameter
SHW LCO	50	489.00	470	53.918	11.03	0.1590	1	n.s.	parameter
HIB LCO	50	382.00	370	49.652	13.00	0.2375	1	n.s.	parameter
ARL LCO	50	642.40	650	82.054	12.77	0.1565	1	n.s.	parameter
FOL LCO	50	273.70	270	9.248	3.38	0.1901	1	n.s.	parameter

Table 2: An anthropometric measurements' comparisons between Libyan male drivers and crane operators

	z	p-value	significance
STH LMD >>> STH LCO	5.319	0	<0.001
SIH LMD >>> SIH LCO	3.615	0.0003	<0.001
LLL LMD = LLL LCO	1.526	0.127	n.s.
ULL LMD >>> ULL LCO	4.653	0	<0.001
SHW LMD < SHW LCO	-2.189	0.0286	<0.05
HIB LMD < HIB LCO	-2.097	0.0359	<0.05
ARL LMD = ARL LCO	-0.758	0.4485	n.s.
FOL LMD = FOL LCO	1.513	0.1303	n.s.

Differences between means of Serbian male car drivers and crane operators are graphically shown at Fig. 3.

From Fig 3. and Table 4. statistically absolute mean differences between two groups vary from 2.44 to 5.32%.

**CONCLUSIONS**

Comparison between Libyan male passenger car drivers and crane operators leads to the following conclusions:

- drivers have significantly higher standing and sitting sitting high, as well as upper leg length than crane operators;
- shoulder width and hip breath are slighter smaller for male drivers and

- drivers and crane operators have the same arm length and foot length (there are no statistically significant differences).

From comparison between anthropometric measurements between Serbian male drivers and crane operators the following conclusions can be drawn:

- there no differences between sitting heights, lower leg lengths, shoulders width, hip breadths and arm lengths between analyzed populations;
- standing height and upper leg length are significantly larger for passenger car drivers then for crane operators and
- foot length is significantly larger for crane operators then for passenger car drivers.

Table 3: Descriptive statistics for Serbian male drivers and crane operators

Dimension	N	Mean	Med.	SD	cv(%)	D	p	SIG.	VT
STH SMD	921	1811.26	1800	74.657	3.86	0.1668	1	n.s.	parameter
SIH SMD	921	917.218	920	47.064	6.25	0.1551	1	n.s.	parameter
LLL SMD	921	593.613	600	35.754	6.84	0.1615	1	n.s.	parameter
ULL SMD	921	636.228	635	45.544	5.88	0.204	1	n.s.	parameter
SHW SMD	921	471.356	470	46.728	10.14	0.1535	1	n.s.	parameter
HIB SMD	921	391.097	390	43.749	14.61	0.2434	1	n.s.	parameter
ARL SMD	921	706.488	700	46.213	7.22	0.1882	1	n.s.	parameter
FOL SMD	921	281.612	275	12.577	4.21	0.1765	1	n.s.	parameter
STH SCO	83	1768.193	1765	68.210	3.86	0.2694	1	n.s.	parameter
SIH SCO	83	907.313	910	56.749	6.25	0.2134	1	n.s.	parameter
LLL SCO	83	587.169	585	40.176	6.84	0.2441	1	n.s.	parameter
ULL SCO	83	618.229	615	36.350	5.88	0.1894	1	n.s.	parameter
SHW SCO	83	478.349	480	48.520	10.14	0.2718	1	n.s.	parameter
HIB SCO	83	401.313	395	58.629	14.61	0.2785	1	n.s.	parameter
ARL SCO	83	704.554	700	50.892	7.22	0.1843	1	n.s.	parameter
FOL SCO	83	297.422	296	12.524	4.21	0.3668	1	n.s.	parameter

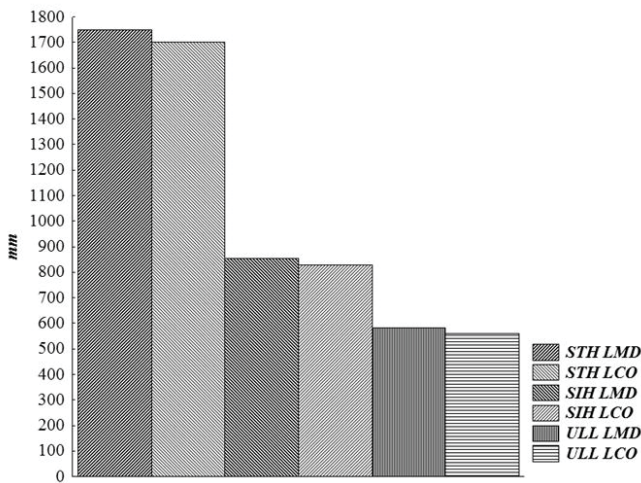


Figure 2: Anthropometric measurements for Libyans, where male drivers have absolutely larger values than crane operators

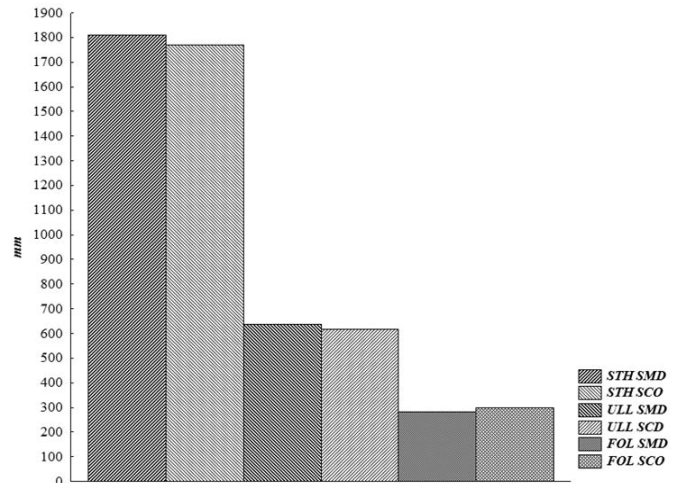


Figure 3: Anthropometric measurements for Serbians, where absolutely differences between male drivers and crane operators exists

Table 4: Comparisons of anthropometric measurements between Serbian male drivers and crane operators

	z	p-value	Significance
STH SMD >>> STH SCO	5.465	0	<0.001
SIH SMD = SIH SCO	1.543	0.1228	n.s.
LLL SMD = LLL SCO	1.412	0.1589	n.s.
ULL SMD >>> ULL SCO	4.222	0	<0.001
SHW SMD = SHW SCO	-1.261	0.2072	n.s.
HIB SMD = HIB SCO	-1.549	0.1214	n.s.
ARL SMD = ARL SCO	0.334	0.738	n.s.
FOL SMD <<< FOL SCO	-11.011	0	<0.001

**NOMENCLATURE**

Abbreviation	Definition	Unit
STH	standing height	mm
SIH	sitting height	mm
LLL	lower leg length	mm
ULL	upper leg length	mm
SHW	shoulder width	mm
HIB	hip breadth	mm
ARL	arm length	mm
LMD	Libyan male drivers	
LCO	Libyan crane operators	
N	sample size	
Med.	median	
SD	standard deviation	
D	Kolmogorov statistics	
p	p-value	
SIG.	significance	
n.s.	not significant	
VT	variable type	
z	z test for difference of means	

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