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Serbian and Libyan Anthropometric Measurements Data in Contemporary Systems' Design

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ABSTRACT

The aim of this paper is to compare Serbian and Libyan anthropometric measurements, such as foot length, standing height, sitting height, lower leg length, upper leg length, shoulder width, hip breadth, arm length and body weight, on the basis of samples of 1197 Serbians and 400 Libyans which have been collected. Further statistical analysis have been conducted to explore the effect of large mixed data on the anthropometric measurements, and their patterns, which facilitates the interior space design of vehicles and cabins used by both males and females, in order to establish a model that could be fit to multi-users. The measurements of the sample for the Serbian population have more statistically significant correlations than the Libyan sample has. Serbian sample has significant differences only in three measurements while there were reverse results for the Libyan sample. Absolute, significant differences were found between all compared anthropometric measurements at a significance level of $p<0.001$. The mean and median values and z test results show that the Serbian sample has higher values than the Libyan sample, excluding for shoulder width which has very close values.

Keywords: Serbian, Libyan, Anthropometric data, Descriptive statistics, Correlation analysis, *Z*-test

INTRODUCTION

It is very important to determine how, and to what extent, people vary in order to ensure that products and environments are designed to fit as many people as possible (Masson et al., 2015, Lima et al., 2015). The study of the interactions of a person and a machine in a system, in terms of its improvement and further adjustments in order to improve the efficiency of functioning, reduce fatigue, preserve human health and ensure optimum working environment, is still a challenge for designers and constructors as well as other experts who deal with this problem. In contemporary contexts it is even more important is to provide equal consideration of the human along with the hardware and software in the technical and technical management processes for developing systems that will optimize total system performance

and minimize total ownership costs. It is well known that anthropometric measurements depend on gender, race, age, occupation (Zhuang et al., 2010, Beydoun and Wang, 2009), nationality, and nutrition (Castellucci et al., 2019, Fatollahzadeh, 2006; Mandahawi et al., 2008). For instance, a study aimed at updating the aircraft seating standards concluded that there were changes in anthropometric characteristics over time, so seat dimensions need to be reviewed in order to provide adequate accommodation for contemporary frames (Quigley et al., 2001). Quigley et al. (2001) have also provided the percentiles values of anthropometric data of the nationalities of Europe, on the one hand and Japan, China and the U.S., on the other, to show the various differences in the standing height, body weight, etc., between European nationalities, and other nationalities. Consequently, the nationality and gender disparities are recommended to be further studied (Beydoun, and Wang, 2009). With that goal, for instance, Guan et al. (2012) have noted that anthropometric measurements (that represent width) also change over time across a 25-year period. This has also been confirmed by Klarin et al. (2011). Klarin et al. (2011) have shown that the height of drivers has increased, whereas other dimensions, i.e. foot length, shoulder width, and hip width have varied too in this time frame. Therefore, the use of up-to-date anthropometric data is recommended (Brkić et al., 2015, Castellucci et al., 2019, Kim et al., 2017, Maukonen et al., 2018, Dianat et al., 2018) in contemporary design issues, and gender, nationality and occupation also have vital importance in anthropometric measurements analysis and in design as well.

Serbian and Libyan anthropometric data are very rarely available (Brkic et al., 2021, Veljkovic et al., 2020, Essdai et al., 2018, Altaboli et al., 2019), so this study focuses on those data collection and comparison. Accordingly, the aim of this paper is to compare Serbian and Libyan anthropometric measurements, such as foot length, standing height, sitting height, lower leg length, upper leg length, shoulder width, hip breadth, arm length and body weight.

STATISTICAL EXAMINATION OF ANTHROPOMETRIC DATA FOR SERBIAN AND LIBYAN PARTICIPANTS

Samples of anthropometric data of 1197 Serbians and 400 Libyans have been collected. In both samples were both male and female drivers and crane operators. Further statistical analysis is conducted to explore the effect of large mixed data on the anthropometric measurements, and their patterns, which facilitates further anthropometric adaptation of different devices, workplaces etc.

Descriptive Statistics

As can be seen from Table 1 and 2, the mean and median values show that the Serbian sample has higher values than the Libyan sample, excluding shoulder width which has very close values, meaning that the Serbian sample has larger anthropometric measurements than the Libyan sample has.

Table 1. Descriptive statistics for Serbians participants.

Dimension	N	Mean	Med.	Min.	Max.	R	SD	c_v (%)	D	p	SIG.	VT
WEI	1197	83.100	84	45	125	80	13.980	16.82	0.2350	1	*n.s.*	parameter
STH	1197	1789.428	1780	1520	1995	475	84.078	4.70	0.2055	1	*n.s.*	parameter
SIH	1197	908.287	910	560	1020	460	50.969	5.61	0.1527	1	*n.s.*	parameter
LLL	1197	587.329	590	370	770	400	38.476	6.55	0.2372	1	*n.s.*	parameter
ULL	1197	627.950	625	384	800	416	48.519	7.73	0.1923	1	*n.s.*	parameter
SHW	1197	462.367	460	358	630	272	50.106	10.84	0.2013	1	*n.s.*	parameter
HIB	1197	388.409	390	290	590	300	45.522	11.72	0.3028	<0.200	*n.s.*	parameter
ARL	1197	697.601	700	410	830	420	50.757	7.28	0.1821	1	*n.s.*	parameter
FOL	1197	277.578	275	225	321	96	18.013	6.49	0.1879	1	*n.s.*	parameter

Table 2. Descriptive statistics for Libyans participants.

Dimension	N	Mean	Med.	Min.	Max.	R	SD	c_v (%)	D	p	SIG.	VT
WEI	400	81.163	80.0	44	125	81	13.614	16.77	0.139	1	*n.s.*	Parameter
STH	400	1732.785	1740.0	1510	1900	390	68.492	3.95	0.232	1	*n.s.*	Parameter
SIH	400	848.338	850.0	670	970	300	50.198	5.92	0.194	1	*n.s.*	Parameter
LLL	400	538.213	540.0	450	670	220	36.950	6.87	0.159	1	*n.s.*	Parameter
ULL	400	577.675	580.0	490	720	230	38.223	6.62	0.219	1	*n.s.*	Parameter
SHW	400	464.988	467.5	340	640	300	51.083	10.99	0.252	1	*n.s.*	Parameter
HIB	400	370.290	360.0	230	570	340	55.847	15.08	0.157	1	*n.s.*	Parameter
ARL	400	632.265	620.0	450	800	350	70.345	11.13	0.196	1	*n.s.*	Parameter
FOL	400	272.64	275.0	230	300	70	12.374	4.54	0.252	1	*n.s.*	Parameter

Correlation Between Anthropometric Measurement for all Serbian and Libyan Participants

The correlation results show that the measurements of the sample for the Serbian population have more statistically significant correlations than the Libyan sample has, as in Tables 3 and 4.

Comparison of Means Between Anthropometric Measurements of Serbian and Libyan Participants

This comparison was done in order to investigate and verify the effect of the mixed gender and occupation selection on the anthropometric measurements with nationality as the only difference. Absolute, significant differences were again found between all compared anthropometric measurements at a significance level of $p<0.001$, with p-values $= 0$. Body weight showed a strong significance difference at level of $p<0.01$ (p-value $= 0.0052$), and shoulder width again had no significant difference with p-value $= 0.3132$. The test indicates that the Serbian sample has larger anthropometric measurements than the Libyan sample, while there are no significant differences for shoulder

Table 3. The correlations between anthropometric measurements of all Serbian participants.

Comparison			*R*	r^2 (%)	*SIG.*	Comparison			*r*	r^2 (%)	*SIG.*
WEI	vs.	*STH*	0.561	31.47	*	*SIH*	vs.	*LLL*	0.495	24.50	*n.s.*
WEI	vs.	*SIH*	0.403	16.24	*n.s.*	*SIH*	vs.	*ULL*	0.419	17.56	*n.s.*
WEI	vs.	*LLL*	0.443	19.62	*n.s.*	*SIH*	vs.	*SHW*	0.353	12.46	*n.s.*
WEI	vs.	*ULL*	0.463	21.44	*n.s.*	*SIH*	vs.	*HIB*	0.043	0.18	*n.s.*
WEI	vs.	*SHW*	0.569	32.38	*	*SIH*	vs.	*ARL*	0.611	37.33	*
WEI	vs.	*HIB*	0.537	28.84	*	*SIH*	vs.	*FOL*	0.442	19.54	*n.s.*
WEI	vs.	*ARL*	0.435	18.92	*n.s.*	*LLL*	vs.	*ULL*	0.681	46.38	*
WEI	vs.	*FOL*	0.588	34.57	*	*LLLL*	vs.	*SHW*	0.383	14.67	*n.s.*
STH	vs.	*SIH*	0.738	54.46	**	*LLL*	vs.	*HIB*	0.209	4.37	*n.s.*
STH	vs.	*LLL*	0.618	38.19	*	*LLL*	vs.	*ARL*	0.565	31.92	*
STH	vs.	*ULL*	0.572	32.72	*	*LLL*	vs.	*FOL*	0.462	21.34	*n.s.*
STH	vs.	*SHW*	0.415	17.22	*n.s.*	*ULL*	vs.	*SHW*	0.450	20.25	*n.s.*
STH	vs.	*HIB*	0.518	26.83	*	*ULL*	vs.	*HIB*	0.281	7.90	*n.s.*
STH	vs.	*ARL*	0.621	38.56	*	*ULL*	vs.	*ARL*	0.543	29.48	*
STH	vs.	*FOL*	0.644	41.47	*	*ULL*	vs.	*FOL*	0.450	20.25	*n.s.*
ARL	vs.	*FOL*	0.488	23.81	*n.s.*	*SHW*	vs.	*HIB*	0.630	39.69	*
HIB	vs.	*ARL*	0.171	2.92	*n.s.*	*SHW*	vs.	*ARL*	0.452	20.43	*n.s.*
HIB	vs.	*FOL*	0.251	6.30	*n.s.*	*SHW*	vs.	*FOL*	0.413	17.06	*n.s.*

Table 4. The correlations between anthropometric measurements of all Libyan participants.

Comparison			*R*	r^2 (%)	*SIG.*	Comparison			*r*	r^2 (%)	*SIG.*
WEI	vs.	*STH*	0.267	7.13	*n.s.*	*SIH*	vs.	*LLL*	0.320	10.24	*n.s.*
WEI	vs.	*SIH*	0.202	4.08	*n.s.*	*SIH*	vs.	*ULL*	0.302	9.12	*n.s.*
WEI	vs.	*LLL*	0.278	7.73	*n.s.*	*SIH*	vs.	*SHW*	0.130	1.69	*n.s.*
WEI	vs.	*ULL*	0.278	7.73	*n.s.*	*SIH*	vs.	*HIB*	0.039	0.15	*n.s.*
WEI	vs.	*SHW*	0.509	25.91	*	*SIH*	vs.	*ARL*	0.175	3.06	*n.s.*
WEI	vs.	*HIB*	0.375	14.06	*n.s.*	*SIH*	vs.	*FOL*	0.271	7.34	*n.s.*
WE	vs.	*ARL*	0.070	0.49	*n.s.*	*LLL*	vs.	*ULL*	0.692	47.89	*
WEI	vs.	*FOL*	0.395	15.60	*n.s.*	*LLL*	vs.	*SHW*	0.348	12.11	*n.s.*
STH	vs.	*SIH*	0.563	31.70	*	*LLL*	vs.	*HIB*	0.179	3.20	*n.s.*
STH	vs.	*LLL*	0.584	34.11	*	*LLL*	vs.	*ARL*	0.165	2.72	*n.s.*
STH	vs.	*ULL*	0.551	30.36	*	*LLL*	vs.	*FOL*	0.420	17.64	*n.s.*
STH	vs.	*SHW*	0.248	6.15	*n.s.*	*ULL*	vs.	*SHW*	0.241	5.81	*n.s.*
STH	vs.	*HIB*	0.040	0.16	*n.s.*	*ULL*	vs.	*HIB*	0.184	3.42	*n.s.*
STH	vs.	*ARL*	0.146	2.13	*n.s.*	*ULL*	vs.	*ARL*	0.138	1.90	*n.s.*
STH	vs.	*FOL*	0.510	26.01	*	*ULL*	vs.	*FOL*	0.294	8.64	*n.s.*
ARL	vs.	*FOL*	0.020	0.04	*n.s.*	*SHW*	vs.	*HIB*	0.483	23.33	*n.s.*
HIB	vs.	*ARL*	0.243	5.90	*n.s.*	*SHW*	vs.	*ARL*	0.178	3.17	*n.s.*
HIB	vs.	*FOL*	0.001	0.00	*n.s.*	*SHW*	vs.	*FOL*	0.355	12.60	*n.s.*

width, as shown in Table 5. Data also gave opportunity to test gender differences on drivers in both Serbia and Libya, as in Tables 6 and 7, where different pattern could be seen.

Table 5. Comparison between Serbian and Libyan participants.

z test	*p* value	*p*
WEI SR >> WEI LI	0.0052	$p<0.01$
STH SR >>> STH LI	0	$p<0.001$
SIH SR >>> SIH LI	0	$p<0.001$
LLL SR >>> LLL LI	0	$p<0.001$
ULL SR >>> ULL LI	0	$p<0.001$
SHW SR = SHW LI	0.3132	*n.s.*
HIB SR >>> HIB LI	0	$p<0.001$
ARL SR >>> ARL LI	0	$p<0.001$
FOL SR >>> FOL LI	0	$p<0.001$

Table 6. Comparison between Serbian male drivers and Serbian female drivers.

z test	*p value*	*P*
WEI SMD >>> WEI SFD	0	$p<0.001$
STH SMD >>> STH SFD	0	$p<0.001$
SIH SMD >>> SIH SFD	0	$p<0.001$
LLL SMD >>> LLL SFD	0	$p<0.001$
ULL SMD >>> ULL SFD	0	$p<0.001$
SHW SMD >>> SHW SFD	0	$p<0.001$
HIB SMD >>>HIB SFD	0	$p<0.001$
ARL SMD >>> ARL SFD	0	$p<0.001$
FOL SMD >>> FOL SFD	0	$p<0.001$

Table 7. Comparison between Libyan male drivers and Libyan female drivers.

z test	*p value*	*P*
WEI LMD >>> WEI LFD	0	$p<0.001$
STH LMD >>> STH LFD	0	$p<0.001$
SIH LMD >> SIH LFD	0.0037	$p<0.01$
LLL LMD >>> LLL LFD	0	$p<0.001$
ULL LMD >> ULL LFD	0.0068	$p<0.01$
SHW LMD >>> SHW LFD	0	$p<0.001$
HIB LMD <<<HIB LFD	0.0002	$p<0.001$
ARL LMD > ARL LFD	0	$p<0.05$
FOL LMD >>> FOL LFD	0	$p<0.001$

CONCLUSION

The aim of this paper was to compare Serbian and Libyan anthropometric measurements, such as foot length, standing height, sitting height, lower leg length, upper leg length, shoulder width, hip breadth, arm length and body weight, on the basis of samples of 1197 Serbians and 400 Libyans which have been collected. Further statistical analysis have been conducted to explore the effect of large mixed data on the anthropometric measurements, and their

patterns, which facilitates the interior space design of vehicles and cabins used by both males and females, in order to establish a model that could be fit to multi-users. Descriptive statistics included sample sizes, means, medians, minimal and maximal values with their ranges, coefficient of variation and Kolmogorov test for normality. Since all measurements were parametric, this enabled conducting the linear regression and correlation analysis, which include coefficient of correlations, coefficients of determination, as well as significance of regression and correlations. In order to compare anthropometric measurements between different nationalities, for all examined groups of participants, the Z tests for difference of means were conducted between Serbian and Libyan samples. The correlation results show that the measurements of the sample for the Serbian population have more statistically significant correlations than the Libyan sample has. Serbian sample have significant differences only in three measurements while there were reverse results for the Libyan sample. The arm length and lower leg length have no significant differences in either samples, and the standing height in both samples have an absolute difference ($p\ value = 0$). Absolute, significant differences were found between all compared anthropometric measurements at a significance level of $p<0.001$. Body weight showed a strong significance difference at level of $p<0.01$ ($p\text{-}value = 0.0052$) while shoulder width had no significant difference ($p\text{-}value = 0.3132$). The mean and median values and z test results show that the Serbian sample has higher values than the Libyan sample, excluding for shoulder width which has very close values. Also, tested gender differences on drivers in the samples in Serbia and Libya, have shown different patterns.

Since the compatibility of the anthropometric characteristics of the driver/operator of the vehicle and/or machinery with other space dimensions, as well as the dimensions and position of the equipment in the cabin, directly affects the user from the aspect of comfort, health and working ability, results of this study could be useful for its designers in aim to influence the performance, productivity and financial losses as well as safety performance, in a very broad scope. Also, more research on other rarely available anthropometric data on certain other nationalities are needed, due to globalization trends and constant migrations and that is possible avenue for future research.

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