Study on Selected Strength Parameters of Women from Different Ethnic Groups of Sikkim for Design Consideration of Agricultural Tools and Equipment

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Paper Received on November 01, 2018, Accepted on December 01, 2018 and Published Online on January 01, 2019

ABSTRACT

The inhabitants of Sikkim, the Bhutias, the Lepchas and the Nepalese have their interesting characteristic features. While the Lepchas of Sikkim have their own food habits, attire, language, script, culture and traditions, the Bhutias too have their own culture, rituals and traditions. There are many castes among the Nepali community, namely the Bahuns, the Chettris, the Newars, the Rais, the Limboos, the Tamangs, the Gurungs, the Mangars, the Sunuwars, the Kamis, the Damais etc. It was felt necessary to compare some of their strength parameters necessary to operate the hand tools and equipment so that it can be ensured that whether size of tools designed based on the strength data of whole population would be suitable for all the women from different ethnic groups. Aiming to this, the 79 body dimension and 16 strength parameters of 284 farm women and 320 farmers from 30 villages of all the four district of Sikkim were collected. This data base would be useful for designing of appropriate tools and equipment suiting to their anthropometry and strength data.

Some of the important strength parameters namely hand grip strength both left and right, push strength with both hands in standing posture and pull strength with both hands in standing posture were considered in the study and these were compared amongst the Bhutia (N= 42), Chettri (N= 40), Lepcha (N= 56), Rai (N = 26), Sherpa (N= 07) and Tamang (N = 12) farm women of Sikkim. The descriptive statistic and t-test were applied to test the Null hypothesis "There is no strength difference in various ethnic groups of farm women". In general, it was observed that at 5% confidence, there was no significant different in hand grip strength, push and pull strength among all the ethnic group. Therefore, study concluded that same size of the tool from the power required point of view shall be suitable for all women in Sikkim.

Key words: *Lepchas; Nepalese; Sikkim; Habits; Language; Script; Culture; Traditions;*

Sikkim belongs to Eastern Himalayan Zone. The state being hilly, the agro-climatic condition ranges from sub-tropical in the lower valley to alpine in the upper reaches. The state has been divided in three agro-climatic zones; (1) Sub Tropical Hills: Parts of East and West Sikkim (1000-1500 MSL) (2) Temperate Alpine: Parts of North, West and East Sikkim (1500-3500 MSL) and (3) Alpine Zone: Northern Parts of North Sikkim and West Sikkim, Parts of East Sikkim (more than 3500 MSL).

The inhabitants of Sikkim, the Bhutias, the Lepchas and the Nepalese have their interesting characteristic features. While the Lepchas of Sikkim have their own food habits, attire, language, script, culture and traditions, the Bhutias too have their own culture, rituals and traditions. There are many castes among the Nepali community, namely the Bahuns, the Chettris, the Newars, the Rais, the Limboos, the Tamangs, the Gurungs, the Mangars, the Sunuwars, the Kamis, the Damaisetc (*www.snowlinenews.com*).

More and more hand tools, implements and machines are being developed, manufactured and used for different farming operations. All of those are either operated or controlled by human workers. Therefore, to achieve better work efficiency with more human comfort it was felt necessary to design the implements

considering the operator's capabilities and limitations (*Agrawal, et.al. 2010*). Use of anthropometric and strength data in design of agricultural implements would be one step in the direction. Agricultural mechanization in Sikkim is increasing due to state Government interventions under Sub-Mission on Agricultural Mechanization (SMAM). The anthropometric and strength data bank of Sikkim was created as per the mandate given under All India Coordinated Research Project on Ergonomics and Safety in Agriculture to the College of Agricultural Engineering and Post Harvest Technology (CAEPHT) Gangtok Centre.

The objective of the study was to ensure whether the strength parameters of female farm workers of different ethnic group of Sikkim necessary to operate the hand tools and equipment are significantly different so that it can be ensured that the size of tools designed based on strength data of would be suitable for all the women workers.

METHODOLOGY

The 79 body dimension and 16 strength parameters of 284 farm women from 30 villages of all the four district of Sikkim (10 villages from East Sikkim, 7 from West Sikkim, 7 from North Sikkim and 6 from South Sikkim) were measured.While random selection of the villages and subjects, due consideration on climatic zones, districts, population, total number of villages and the ethnicity group was given.

The human strength measurement set up developed by CIAE, Bhopal was used for the collection of data. The human strength measurement set up mainly consisted of strain gage type load cell with indicator, different load cell fixtures for measurement of push-pull force and cranking torque are provided in the set up. The setup has height adjustable seat to suit the reach of the subjects.

Before the data collection, permission from the village head (Panchayat) was obtained. The data of healthy female agricultural workersage between 17 to 65 (mean value 37.3 years) were collected. Subjects were told the purpose of data collection and only enthusiastic subjects were selected. They were advised to be relaxed. The data collection team comprises of 2 female trained staff. ISO 7250:1996 standard (Basic human body measurements for technological deign), NASA anthropometric source book (*reference publication no.1024*) and *Gite and Chaterjee, 2000* was followed for data collection.

First the data was analyzed using descriptive statistics. The mean, standard deviation (SD), range, 5th and 95th percentile was calculated. The 5th and 95th percentile were calculated by using the formula given in NASA, 1978a as below;

$$5^{th} \text{ percentile} = \text{Mean} - (1.645 \times \text{SD})$$

$$95^{th} \text{ percentile} = \text{Mean} + (1.645 \times \text{SD})$$

The Null hypothesis "there is no difference in strength data between different ethnic group of female agricultural workers of Sikkim" was assumed. To test the significant difference, t-test (*www. socscistatistics. com* and *www.usablestats.com*) as described below was used.

$s^2 = SS/(N - 1)$

ss= " $(X-M)^2$

$s^2_p = ((df_1/(df_1 + df_2)) * s^2_1) + ((df_2/(df_2 + df_2)) * s^2_2)$

$s^2_{M1} = s^2_p/N_1$

$s^2_{M2} = s^2_p/N_2$

$t = (M_1 - M_2)/" (s^2_{M1} + s^2_{M2})$

Where,

ss = Sum of square of difference between population and mean

M = Mean

X = Population

N = Number of population

RESULTS AND DISCUSSION

The selected strength data collected in the study were subjected to descriptive statistical analysis for mean, standard deviationand percentile values and is given in Table 1.

To test the hypothesis "there was no difference in strength data between different ethnic group female agricultural workers of Sikkim", the data were subjected to test the significance Table 2 to 6). The t test showed that;

i. Hand grip strength (right hand) of women from Chettri race was significantly different than the women of Bhutia race.
ii. Hand grip (left hand) of women from Chettri and Rai races were significantly different from Bhuita.
iii. Hand grip torque of Rai ethnic group was significantly different from Bhutia.

Table 1. Descriptive statistics of selected strength data of all females (284) of Sikkim
(All measurements from are in N unless mentioned)

Dimensions	Mean	S.D.	Percentile	
			5th	95th
Hand grip strength (right)	241	62	149	344
Hand grip strength (left)	231	56	143	329
Push strength with both hands in standing posture	123	46	77	213
Pull strength with both hands in standing posture	203	48	130	297
Right hand push strength in sitting posture	44	21	22	86
Right hand pull strength in sitting	105	23	62	131
Torque strength of both hands in sitting posture, N-m**	39	11	21	59
Torque strength of both hands in standing posture, N-m*	31	9	23	50
Hand grip torque, N-m**	4	1	2	6

*Lever arm length was 0.26 m. ** Lever arm length was 0.21 m

Table 2. t-test for hand grip strength(right) in N

	Bhutia	Chettri	Bhutia	Lepcha	Bhutia	Rai	Bhutia	Sherpa	Bhutia	Tamang
N	42	40		56		26		7		12
Mean	410.6	382.12		411.11		393.62		401.29		409.58
SD	84.63	104.74		95.73		133.18		16.65		115.84
SS	235076.12	164820.38		267759.36		65656.15		15523.43		75036.92
s^2	5733.56	4226.16		4868.35		2626.25		2587.24		6821.54
s^2_p		4998.71		5237.87		2626.25		5331.91		5963.71
s^2_M	119.02	124.97	124.71	93.53	108.49	175.25	126.95	761.7	141.99	496.98
t		1.82		-0.03		1.01		0.31		0.04
p(0.05)		0.036044*		0.486215		0.158561		0.3781		0.484111

Table 3. t-test for hand grip strength(left) in N

	Bhutia	Chettri	Bhutia	Lepcha	Bhutia	Rai	Bhutia	Sherpa	Bhutia	Tamang
N	42	40		56		26		7		12
Mean	408.69	367.58		393.46		375.35		362.57		382.5
SD	98.50	55.49		89.48		85.32		13.18		72.84
SS	209258.98	142633.78		243151.93		55813.88		23459.71		82393
s^2	5103.88	3657.28		4420.94		2232.56		3909.95		7490.27
s^2_p		4398.66		4712.61		4016.26		4951.46		5608.69
s^2_M	104.73	109.97	112.21	84.15	95.63	154.47	117.89	707.35	133.54	467.39
t		2.81		1.09		2.11		1.61		1.07
p(0.05)		0.003148*		0.139969		0.019395*		0.05755		0.145139

Table 4. t-test for push strength with both hands in standing posture in N

	Bhutia	Chettri	Bhutia	Lepcha	Bhutia	Rai	Bhutia	Sherpa	Bhutia	Tamang
N	42	40		56		26		7		12
Mean	178.67	184.1		193.7		195.73		209.29		165.67
SD	103.36	39.54		0.69		1.39		63.12		21.50
SS	146649.33	17913.6		233799.84		106117.12		30483.43		33240.67
s^2	3576.81	3023.43		4250.91		4244.68		5080.57		3021.88
s^2_p		3307.04		3963.01		3829.79		3768.78		3459.42
s^2_M	78.74	82.68	94.36	70.77	91.19	147.3	89.73	538.4	82.37	288.29
t		-0.43		-1.17		-1.1		-1.22		0.68
p(0.05)		0.335025		0.122525		0.136591		0.113956		0.251257

Table 5. t-test for pull strength with both hands in standing posture in N

	Bhutia	Chettri	Bhutia	Lepcha	Bhutia	Rai	Bhutia	Sherpa	Bhutia	Tamang
N	42	40		56		26		7		12
Mean	289.79	274.65		287.64		280.19		302.14		286.58
SD	29.83	56.88		34.68		32.60		73.53		139.43
SS	104279.07	87403.1		214944.86		85046.04		16560.86		50552.92
s^2	2543.39	2241.11		3908.09		3401.84		2760.14		4595.72
s^2_p		2396.03		3325.25		2868.56		2571.06		2977.54
s^2_M	57.05	59.9	79.17	59.38	68.3	110.33	61.22	367.29	70.89	248.13
t		1.4		0.18		0.72		-0.6		0.18
p(0.05)		0.082749		0.427964		0.23771		0.276703		0.429202

Table 6. t-test for hand grip torque (N-m)

	Bhutia	Chettri	Bhutia	Lepcha	Bhutia	Rai	Bhutia	Sherpa	Bhutia	Tamang
N	42	40		56		26		7		12
Mean	5.5	5.32		6.04		4.5		4.86		5.75
SD	1.75	1.02		1.46		1.46		1.46		3.64
SS	112.5	104.78		243.93		40.5		10.86		42.25
s^2	2.74	2.69		4.44		1.62		1.81		3.84
s^2_p		2.72		3.71		2.32		2.62		2.98
s^2_M	0.06	0.07	0.09	0.07	0.06	0.09	0.06	0.37	0.07	0.25
t		0.48		-1.36		2.63		0.97		-0.44
p(0.05)		0.31604		0.088187		0.005279*		0.168018		0.329897

CONCLUSION

In general, the strength parameters considered in this study were not significantly different for women from various ethnic groups taken in this study. Therefore, common strength value can be taken for designing any tools and implements suitable for women workers. However, for designing any machine for hand grip, it may be different for women of Chettri and Rai ethnic group.

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