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Factors influencing back Strength and the Changes due to Age of the Oraon Agricultural Labourers of Jalpaiguri District, West Bengal

Muscle strength is a major component of successful performance in almost every activity of daily living and it is critical to health and well-being. Anthropometric, blood pressure and strength measurements were taken from Oraon agricultural labourers of Jalpaiguri district of West Bengal. The data were analyzed to find out the differences between high and low back strength groups of both sexes in different traits of the parameters mentioned above. Secondly, identifying the peak age of muscle strength in both sex and the declining ages. Thirdly, the influencing factors which, affect the back strength. The results show that high back strength groups have higher mean values of most of the anthropometric traits compared to low back strength groups and the differences are significant in case of males, but females show significant differences in few traits. Blood pressures are relatively low in high back strength groups compared to low back strength groups in both sexes. The peak age for higher back strength seems to be within the age of 24 years for males and 20 years for females. The predictive variables for males were found to be grip strength and subscapular skinfold thickness, but females show grip strength, BMI, biceps girth, bicondylar diameter of humerus. The differences in influencing factors between males and females have been sorted out from sociocultural practice of the population.

Key words: Oraon, Strength, Anthropometry, Blood pressure, Age change

Introduction

Strength is basic to performance in activities. Strength tests are one of the most practical measures to evaluate physical fitness of the people, who earns their livelihood through physical labour. Strength can be defined as the maximum force which can be exerted against an immovable object (static or isometric strength), the heaviest weight which can be lifted or lowered (dynamic strength), or the maximal torque which can be developed against a pre-set rate-limiting device (isokinetic strength) (Thompson, 1994). Muscle strength is a major component of successful performance in almost every activity of daily living. It is vital to the maintenance of upright posture, ambulation, and the accomplishment of simple tasks such as eating and dressing (Barne and Levy, 1983).

A number of studies reveal that muscle strength is critical to health and well-being (Kraus and Hirschland, 1953, McDonangh and Davies, 1984, Astrand and Rodahl, 1986). Several external [altitude (Ruff and Strughold, 1942), position of exerting strength (Teraoka, 1979), diet (Keys et al., 1950) etc.] and internal [age, sex (Mathiowetz, 1985), height, weight (Schmidt and Toews, 1970), etc.] factors influence the maximum force that

can be exerted by a muscle (Berne and Levy, 1983). Lack of sufficient muscular activity not only means insufficient emotional release, but at the same time it decreases muscular strength, a person's maximal strength decreases with increasing age (Frontera et al.,1988, Lexell et al., 1988). The decline in muscle strength may have important functional consequences. The decline in strength in muscles of the lower extremities may be associated with gait disorders, falls, and hip fractures. A reduction in upper body strength increases the risk of accidents in activities, which require lifting, pushing, or pulling maneuvers (such as housekeeping, cooking, and eating). Weakness of low back muscles may be related to problems such as disk herniation and chronic low back pain of soft tissue origin. Thompson (1994) suggested that the age-related deterioration of skeletal muscle observed may actually be a result of inactivity, rather than age itself. Muscle strength appears to be relatively well maintained up through 50 years of age. A 15% loss in muscle strength per decade occurs between the ages of 50 and 70 years of age.

In view of these, the present study was undertaken among the Oraon agricultural labourers of Madarihat anchal of Jalpaiguri district, West Bengal. The objective of the present study was to find out the following: (1) what are the differences between low and high back strength group in respect of different variables. (2) What is nature of age changes in regards to back strength. (3) What are the different variables, which influence the back strength of the individuals.

Material and Methods

A total of 197 Oraon agricultural labourers/workers were investigated out of which 113 were males and 84 were females, and all of them were selected from Rangali Bazna Anchal of Madarihat Police Station, Jalpaiguri district, West Bengal.

The Oraons are a Dravidian-speaking tribal population with its major concentration in the Chotanagpur plateau in Bihar. They are believed to have migrated to northern West Bengal from Bihar about the end of the last century (Choudhury, 1978). The Oraon population is inhabiting this area for a long time and practising their traditional occupation agriculture, although a sizable proportion of the Oraons are working as tea garden labourers. The subjects for the present study were all adults, aged between 20 and 60 years. Only one ethnic group was chosen in order to avoid the possible ethnic/genetic effects in respect of the variables under study.

Harvesting of paddy in the Jalpaiguri area of West Bengal and most of the agricultural sectors in India are done manually and individuals of both sexes participate in the job. The productive output data (termed in the present study as "stocks") is primarily the harvesting data. The data have been collected through counting the number of stocks of paddy each individual is harvesting per hour. In the absence of better method of measuring the productive output of the agricultural labourers, the above method of measuring the rate of harvesting or clearing the land, was adopted (Roy and Pal, 2000).

Anthropometric measurements were done using standard methodology and standard instruments (Weiner and Lourie, 1981 A single investigator (SKR) took the anthropometric measurements.

Strength data in terms of handgrip strength and back strength have been collected through battery operated automatic hand grip dynamometer and back dynamometer, using standard instruments made by Tekai Scientific Instruments Co. Ltd, Japan and standard test protocols (Mathews, 1973).

The subject was instructed to squeeze the dynamometer as tightly as possible, using the musculature of the hand. No part of his/her upper or lower arm or hand may push against any object or against any other part of the body. The force exerted has been read from the dial of the dynamometer and the data have been recorded for the best one, after three successful attempts.

For testing back strength, the subject was instructed to stand upright on the base of the dynamometer with feet shoulder-width apart, arms straight, and fingers extended downward as far as possible on the fronts of the thighs. The bar was then attached to the chain so that it was 1 to 2 inches below one's fingertips. Then were asked to bent forward slightly and grasp the bar. The correct position was with back bent forward slightly at the hips and keeping legs straight. Head held upright, and looking straight ahead. Lifted steadily, keeping the legs straight and feet flat on the base of the dynamometer. The tests were done consecutively three times with a short interval between each attempt and the best performance result was recorded.

Systolic (SBP) and diastolic (DBP) blood pressure measurements were measured after 15 minutes rest period, in a sitting position, on the upper arm by the auscultatory method using an inflatable calf and mercury sphygmomanometer. SBP was determined at the point when the Korotkoff sound completely ceased (Rose et al., 1980), pulse rate was also measured.

No statistical sampling was attempted because of obvious difficulties in the field but the subjects were included in the sample without any conscious bias. The subjects who volunteered themselves and could be persuaded to participate in the study were only taken in the sample. In the absence of systematic written records for age in most of the individuals, the ages were estimated by reference to local important events and cross-checked with elderly individuals and compared with the ages of individuals for whom age records existed.

Classification of high and low back strength individuals was done on the basis of median points of the back strength values in each sex separately, since there is no standard value of back strength for individuals. Therefore, the males were classified on the basis of $\leq$116.5 (median) as low back strength group and >116.5 as high back strength group, in case of females the cut-off point is $\leq$63.5 (median) as low back strength group and >63.5 as high back strength group.

To identify which of the various variables (i.e. anthropometric measurements, blood pressure measurements, and pulse rate) are significantly related to back strength and are useful for predicting it, we carried out a multiple regression analysis. Firstly, we build a multiple regression model to predict Back Strength in a stepwise manner by entering and/or removing one variable at a time from a list of potential predictors. The regression

model fitted to the data $y= \beta_0 + \beta_1\chi_1+\beta_2\chi_2+ .....+ \beta_n\chi_n + e$, where y= dependent variable, $x_1....x_p$ = independent variable(s), $\beta_1.....\beta_p$ = regression coefficients, β_0 = intercept and e= error with mean zero. The aim was to select a good set of predictor variables under study i.e. to separate the more important variables from those that are less necessary. In this analysis, the variables were included in a stepwise manner by entering the variable whose addition would increase R^2 most at each step.

All the participants in the present study belong to the more or less similar socioeconomic condition. The samples were classified into 5-yearly age groups (≤20, 21-24, 25-29, 30-34, 35-39 & 40+) because of the small number of samples in each age. The sample size of the older age group (i.e. 45+) was very few in number, therefore, the group was also merged with the previous age group (i.e. 40+). In order to find out the age changes in respect of Back Strength, firstly, we have calculated the descriptive statistics of the variable for each age cohorts and then plotted mean values of Back Strength for each age cohorts.

Results

Table 1 shows the descriptive statistics of both low and high back strength groups of both sexes. As has been mentioned earlier that the low and high back strength group has been separated simply by determining the median values for both sexes. Now, table shows that the high back strength groups of both sexes are from lower age groups and the differences between groups are significant. In respect of anthropometric measurements, both the sexes show some significant differences in common in few traits [e.g. biacromian diameter, chest girth (inh.), fat, height, sitting height, weight and wrist diameter (R)] and that is due to higher mean values of high back strength groups in all the traits. In respect of grip strength, high back strength groups of both the sexes show higher mean values in both hands and the t-values are significant. Beside these, there are few anthropometric traits, where males only show significant difference [e.g. bicondylar diameter of femur, biceps girth, biiliac diameter, body mass index, calf girth, chest girth (exh.), skinfold thickness (subscapular) and wrist diameter (L)] and that is also due to higher mean values of the high back strength males. In blood pressure traits, low back strength males show higher mean values in all the traits but the differences are significant only in systolic BP and pulse pressure. In respect of actual work output (termed here as stocks), high back strength groups of both sexes show higher mean values comapared to low back strength groups but the difference is significant only in males.

Table1. Descriptive statistics of low and high back strength groups of both sexes

Sex		Male					Female				
Group		Low Back Strength. (N-57)		High Back Strength (N-56)		t-value	Low Back Strength (n-42)		High Back Strength (n-42)		t-value
Variables		Mean	Sd	Mean	Sd	df-111	Mean	Sd	Mean	Sd	df-82
Age	Yr	37.47	14.23	28.23	8.28	4.21*	34.38	10.93	29.79	10.62	1.95*
Height	Cm	159.69	5.29	165.73	5.91	5.73*	149.05	6.31	152.42	4.72	2.77*
Sitting Height	Cm	81.85	3.13	85.25	3.12	5.79*	76.67	3.19	78.04	2.27	2.26*
Weight	Kg	45.01	4.10	51.26	4.87	7.38*	39.20	4.49	41.14	3.59	2.19*
Body Mass Index		17.64	1.25	18.66	1.45	4.02*	17.62	1.46	17.72	1.44	0.32
Biceps Girth	Cm	21.44	1.46	23.16	1.41	6.37*	20.35	1.67	20.94	1.37	1.77
Calf Girth	Cm	28.01	2.24	29.64	1.88	4.18*	26.48	2.02	27.03	1.37	1.47
Chest Girth (exh.)	Cm	78.02	3.71	80.60	3.10	4.02*	70.01	5.91	71.47	8.54	0.91
Chest Girth (inh.)	Cm	80.10	3.77	82.90	3.65	4.02*	72.60	3.44	74.99	3.69	3.07*
Biacromial Diam.	Cm	35.86	1.68	37.03	1.61	3.78*	32.08	1.51	33.01	1.14	3.19*
Bicond.Diam. Femur	Cm	8.75	0.35	9.03	0.38	4.08*	7.88	0.41	7.94	0.26	0.80
Bicond. Diam Humerus	Cm	6.48	0.26	6.58	0.34	1.79	5.65	0.32	5.69	0.27	0.73
Biiliac Diam.	Cm	25.43	2.22	26.28	1.26	2.50*	25.45	1.11	25.52	1.16	0.28
Wrist Diam. (L)	Cm	4.97	0.59	5.46	0.68	4.14*	3.65	0.55	3.77	0.55	1.03
Wrist Diam. (R)	Cm	5.06	0.50	5.55	0.66	4.45*	3.76	0.52	3.99	0.51	2.02*
Skinfold (Biceps)	Mm	3.09	0.54	3.28	0.56	1.80	4.05	1.48	4.04	1.25	0.05
Skinfold (Calf)	Mm	4.60	1.22	4.99	1.37	1.60	6.66	1.88	7.53	2.39	1.85
Skinfold (Subscapular)	Mm	8.44	1.72	9.13	1.53	2.28*	8.81	2.19	9.44	3.11	1.08
Skinfold (Suprailiac)	Mm	5.70	1.36	6.00	1.69	1.04	6.45	2.52	6.80	2.83	0.59
Skinfold (Triceps)	Mm	5.04	1.19	5.17	1.44	0.53	7.65	2.30	8.62	3.00	1.67
Fat	Kg	4.31	0.77	4.97	1.01	3.93*	4.84	1.30	5.50	1.64	2.01*
Diastolic Blood Pressure	Mm	87.79	13.70	84.50	8.95	1.51	87.14	15.62	85.67	15.04	0.44
Systolic Blood Pressure	Mm	136.35	25.33	126.73	11.12	2.61*	126.33	20.01	126.05	20.57	0.06
Pulse Pressure	Mm	48.56	15.68	42.23	9.56	2.59*	39.19	11.24	40.38	9.50	0.52
Grip Strength (L)	Kg	28.09	5.25	36.51	5.40	8.40*	19.88	3.55	23.45	2.71	5.18*
Grip Strength (R)	Kg	27.74	5.39	36.35	5.36	8.51*	20.46	3.32	24.70	3.15	5.99*
Stocks	N	3613.0	1365.0	4425.0	1580.0	2.92*	2811.9	1196.3	3150.6	1050.4	1.38

* Significant at 5% level

Table 2 shows the means and standard deviations of back strength separately for 6 age cohorts and for both sexes. In males, the 2nd group (21-24) shows the highest mean value and the 6th (40+) group shows the lowest mean value in comparison with all other five groups. Females, on the other hand, show highest mean value in the 1st (≤20) group and lowest in the 6th (40+) group in comparison with all other groups. Plotting the mean values against each age cohort and connecting the values with a line drawing is depictable in Figure 1, which is clear enough to understand the age changes in respect of back strength.

Table 2. Descriptive statistics of back strength in different age cohorts

		Male			Female		
Group	Age cohorts	N	Mean	Sd	N	Mean	Sd
1	< 20	16	120.406	28.227	13	71.677	11.524
2	21-24	18	134.783	22.044	12	67.000	14.777
3	25-29	23	131.891	21.515	15	61.433	12.358
4	30-34	11	126.864	19.015	12	62.875	12.503
5	35-39	14	110.857	20.482	11	63.818	07.511
6	40+	31	100.029	30.397	21	58.190	13.341

Comparison between/ among age groups in respect of back strength have been done using t-statistic. Table 3 shows the t-values and level of significance. Among 6 male age groups, the mean value of group 6 (i.e. 40+) is significantly lower in comparison with all other 4 groups (1-4) except group 5 (i.e. 35-39). The mean value of groups 5 is significantly lower in comparison with group 3 and 4. Females on the other hand, show that group 1 has significantly higher mean values compared with group 3 and group 6.

Table 3. t-statistic of back strength between /among age cohorts of both sexes.

Age Gr.	Male			Female		
	T_values	df	Sig.	T_values	Df	Sig.
Gr1 Vs Gr2	1.665	32	.106	.886	23	.385
Gr1 Vs Gr3	1.442	37	.158	2.256*	26	.033
Gr1 Vs Gr4	0.661	25	.515	1.832	23	.080
Gr1 Vs Gr5	1.047	28	.304	1.937	22	.066
Gr1 Vs Gr6	2.164*	45	.036	3.011*	32	.005
Gr2 Vs Gr3	0.423	39	.675	1.067	25	.296
Gr2 Vs Gr4	0.987	27	.333	0.738	22	.468
Gr2 Vs Gr5	3.14**	30	.004	0.641	21	.528
Gr2 Vs Gr6	4.166**	47	.000	1.755	31	.089
Gr3 Vs Gr4	0.660	32	.514	0.300	25	.767
Gr3 Vs Gr5	2.936*	35	.006	0.566	24	.577
Gr3 Vs Gr6	4.206**	52	.000	.0741	34	.464
Gr4 Vs Gr5	2.001	23	.057	0.217	21	.831
Gr4 Vs Gr6	2.671*	40	.011	.992	31	.329
Gr5 Vs Gr6	1.144	43	0.259	1.290	30	.207

* Significant at 5% level

** Significant at 1% level

Table 4 shows the results of step-wise regression analysis. Males show that 3 traits out of 29 traits are significantly influencing the back strength trait. In males, back strength is dependent on grip strength (both right and left) and skinfold thickness (subscapular). Females on the other hand show 4 traits significantly influencing the back strength i.e. grip strength (right), body mass index, biceps girth and bicondylar diameter of humerus. But both body mass index and bicondylar diameter have negative relation with back strength because of the negative beta values of those two traits.

Table 4. Summary results of step-wise regression analysis

SEX = MALE

Coefficients

		Unstandardized		Standardized	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	16.335	7.754		2.107	.037
	Grip Strength (Right)	3.209	.237	.789	13.547	.000
2	(Constant)	9.103	7.767		1.172	.244
	Grip Strength (Right)	1.886	.467	.464	4.043	.000
	Grip Strength (Left)	1.536	.473	.373	3.246	.002
3	(Constant)	-7.631	10.672		-.715	.476
	Grip Strength (Right)	1.820	.459	.448	3.963	.000
	Grip Strength (Left)	1.552	.465	.376	3.338	.001
	Skinfold Thickness(Subscapular)	2.090	.932	.124	2.242	.027

a Dependent Variable: Back Strength

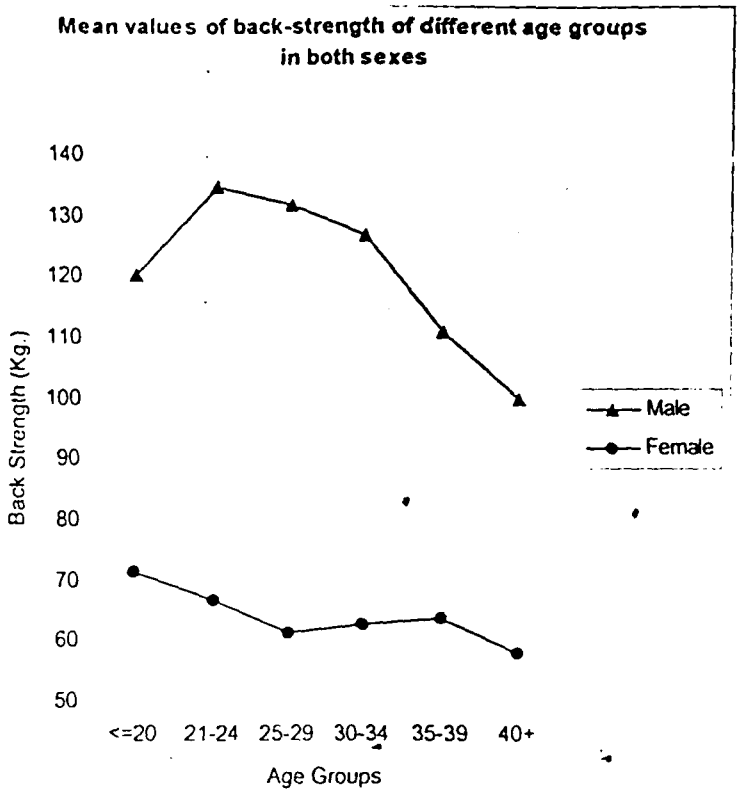
SEX = FEMALE

Coefficients(a,b)

		Unstandardized		Standardized	t	Sig.
Model		B	Std. Error	Beta		
1	(Constant)	13.684	6.289		2.176	.032
	Grip Strength (Right)	2.207	.275	.664	8.038	.000
2	(Constant)	52.112	12.208		4.269	.000
	Grip Strength (Right)	2.628	.282	.790	9.316	.000
	Body Mass Index	-2.713	.755	-.305	-3.591	.001
3	(Constant)	36.065	13.174		2.737	.008
	Grip Strength (Right)	2.527	.274	.760	9.211	.000
	Body Mass Index	-4.608	1.011	-.518	-4.559	.000
	Biceps Girth	2.510	.929	.303	2.701	.008
4	(Constant)	68.969	19.523		3.533	.001
	Grip Strength (Right)	2.654	.274	.798	9.698	.000
	Body Mass Index	-4.470	.988	-.502	-4.523	.000
	Biceps Girth	2.748	.913	.332	3.010	.004
	Bicondylar Diam.Humerus	-7.607	3.397	-.176	-2.239	.028

a Dependent Variable: Back Strength

Figure 1



In order to see the leaner relationship between back strength and other variables, correlation coefficients have been computed and presented in table 5. The values of correlation coefficient show that out of 25 traits 20 traits are significant and 5 traits are not significant. A few traits show very high significant values e.g. height, sitting height, weight, biacomian diameter, wrist diameter of both hands, bicondylar diameter of femur and humerus, grip strength of both hands. A few traits also show significant negative correlation values e.g. age, skinfold thickness (biceps, calf and triceps).

Table 5. Correlation values of between Back Strength and other variables

HEIGHT	0.75**	BICONDYLAR DIAMETER OF FEMUR	0.74**
SITTING HEIGHT	0.75**	BICONDYLAR DIAMETER OF HUMERUS	0.71**
WEIGHT	0.74**	SKINFOLD THICKNESS (Biceps)	-0.25**
AGE	-0.26**	SKINFOLD THICKNESS (Calf)	-0.35**
BIILIAC DIAMETER	0.19**	SKINFOLD THICKNESS (Triceps)	-0.43**
BIZYGOMATIC BREADTH	0.60**	SKINFOLD THICKNESS (Suprailiac)	-0.12
BICEPS GIRTH	0.59**	SKINFOLD THICKNESS (Subscapular)	0.03
CALF GIRTH	0.57**	GRIP STRENGTH (Left)	0.88**
CHEST GIRTH (Exh.)	0.56**	GRIP STRENGTH (Right)	0.86**
CHEST GIRTH (Inh.)	0.69**	DIASTOLIC BLOOD PRESSURE	-0.08
BIACROMIAN DIAMETER	0.74**	SYSTOLOC BLOOD PRESSURE	-0.04
WRIST DIAMETER (Left)	0.74**	PULSE RATE	-0.09
WRIST DIAMETER (Right)	0.76**		

** significant at 5% level

Discussion

In the present study, although the labourers were from the same ethnic origin, the socioeconomic conditions of all the labourers were more or less similar. They shared the same habitat for throughout their lives and engaged in the agricultural job for at least from childhood onward. While the test protocols for data collection were also similar for all individuals, there were intra-individual differences in back strength. The differences may be due to several factors, including age. There seems to be more old age people are in the low back strength group in both sexes, although there are young individuals also and the comparison of mean values show significant difference (see table 1). When age was regressed out from work output, there were still biological differences between the high and low back strength groups (tables were not presented).

However, the mean values of height, sitting height and weight of the high back strength groups are higher compared to low back strength groups of both sexes, and the differences are significant in either sex. The results of the present study corroborate with the study of Roberts et al. (1959), Laubach and McConville (1969) and Schmidt and Toews (1970). Both Biceps girth (Upper arm circumference) and Calf girth trends toward higher mean values in high back strength groups of both the sexes compared to low back strength groups but significant difference is observed only in males. Because the muscle mass of those region are generally very low in females compared to males and the minor variations within females are difficult to observe. The observation supports the findings of Nordgren (1972). Chest girth (Chest circumference) both inhalation and exhalation seems to be one of the important variables. Higher mean values have been observed in high back strength groups of both sexes, but significant differences for both the traits are

found only in males and females show significant difference only in inhalation. In most of the anthropometric traits considered for the present study (e.g. diameter measurements and fat fold measurements) high back strength groups show comparatively higher mean values than low back strength groups in both sexes. To our knowledge there is no literature which deals directly on all of these observations.

Blood pressure parameters show relatively lower mean values of both systolic and diastolic pressures in high back strength groups of both sexes compared to low back strength groups, and the only significant difference is in systolic BP and in males only. The result suggests that a good number of individuals in low back strength groups of both sexes are hypertensive, which is an indicator of poor health status. The pulse rate is also low in high output groups of both sexes compared to low output groups.

Physical fitness, measured by grip strength of both hands, is significantly high, in high back strength groups, for both sexes, compared to low back strength groups. It indicates that grip strength is one of the fundamental criteria for high back strength. Actually back strength trait shows highly significant correlation with most of the anthropometric traits under study, except few skin fold measurements.

The mean values of back strength in six age cohorts show that the back strength increases upto a certain age and then declines. Because of the small sample size in each specific age, it was difficult to calculate specific peak age for back strength in the present population. The age groups for peak back strength and the point of declining differs between sexes. However, the back strength reaches its maximum peak before the age of 24 in both sexes, and the observation corroborate with the findings of Prokopec (1987) and Roy & Pal (1999).

Finally, the predictive variables for back strength in males are grip strength of both hands and subscapular skin fold thickness. Females on the other hand, show grip strength of right hand, body mass index, biceps girth and bicondylar diameter of humerus, which are also the indicators of strength. The explanation at this moment as to why female's predictor of back strength is different than males may be looked into the sociocultural factors of the population. Females in this society got married at the age of puberty and start-bearing child before the age of 20 and the birth spacing is very small, on the other hand, they works hard with the male counterpart therefore, the strength and health of the females deteriorate at an early age.

In sum, the variables used in the present study and the effort to find the relationship with back strength proved that a few of the variables are useful predictors and others are not. Therefore, future studies should be oriented toward keeping sensitive variables in mind and adding further variables to find out suitable predicting parameters of back strength in other populations.

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