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RESEARCH ARTICLE

PREDICTING EQUATIONS FOR MEASURING VITAL CAPACITY OF THE RAJSHAHI UNIVERSITY STUDENTS.

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Abstract

Objectives: The purpose of the present study was to predict vital capacity for the students of Rajshahi University.
Materials and Methods: This study was performed on 862 students (578 males and 284 females) who were selected through stratified random sampling technique from the University of Rajshahi, Bangladesh. The variables used in this study were stature, weight, vital capacity (VC), sitting height, pulse rate, systolic blood pressure, diastolic blood pressure, oxygen saturation and chest circumference those were measured accordingly and analyzed using the software IBM SPSS Statistics 20 and STATISTICA 8. Forward stepwise ridge regression method was used for prediction purpose.
Results: Two easily accessible predicting equations for measuring vital capacity of the male and female students were proposed. Only, height, sitting height and chest circumference for the equation of male students and height, sitting height and weight for the equation of female students were essential. The proposed two equations were highly robust with small standard error of the estimate.
Conclusion: To assess the expensive body parameter, vital capacity, the student of Rajshahi University as well as the students of other universities can use the proposed equations for measuring their vital capacity.

Introduction:-

Lung function tests were used to evaluate how well the lungs work, by determining how much air the lung can hold and how quickly air moves in and out of the lungs (Alghadira et al., 2011; Balasubramaniam et al., 2014; Budhiraja et al., 2010; Mohammad et al., 2015; Nepal et al., 2014; Vijayan et al., 1990). Lung function in health might be influenced by a number of factors like height, weight, sitting height, chest circumference, systolic blood pressure, diastolic blood pressure, oxygen saturation, pulse rate as so on (Ali Z, 2018). Researchers are interested to use the predicting equations for achieving rare event(s) using easily accessible variables (Ali MA, 2000; Ali et al. 2004; Rahman et al. 2004; Shahin et al. 2013; Ali Z, 2018).

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Vital Capacity (VC), the volume of air breathed out after the deepest inhalation, is also an expensive event. It costs about BD Tk1000 per test. On the other hand, for measuring vital capacity the recent instrument Chestgraph HI-101 spirometer uses some predicted equations of VC those were developed from different data base of other country(Operation Manual, ND). Predicted equation should be constructed from its own data base.

On the basis of admission process of the universities, Rajshahi University students (about 34000) may be a representative part of the university students of the country. Thus, this study initiates to develop predicted equations of VC for the students of Rajshahi University as well as for other universities.

Materials and Methods:-

Subjects:-

Almost, there are about 34000 students who study in Rajshahi University. There are 57 departments under 9 faculties. Among these faculties, two are selected at random and they were namely Faculty of Science and Faculty of Arts. Fifty percent of the departments from the selected two faculties were further considered and they were namely department of Mathematics, Chemistry, Statistics and Pharmacy from the Faculty of Science, and the department of Philosophy, Bengali, Fine Arts, Islamic Studies and Islamic history & Culture from the Faculty of Arts. Twenty five percent students from each academic year of the selected departments were randomly selected. This consist of a sample of size 862 (578 males and 284 females) students (who completed the lung function test). The ethical clearance was achieved (for details, please see Zulficar et al., 2018).

Measurements:-

Stature and sitting height were measured (without shoes) with the nearest half of a centimeter using a portable Stadiometer. Weight was measured (in lightweight covering, empty pockets and while not shoes on) employing a Stadiometer balance scale that was renowned to the adjacent half of a kilogram. Other anthropometric variables were measured accordingly. The Chestgraph HI-101 was used for measuring vital capacity and other lung related variables. All tests were conducted by the trained technicians. Every measurement was taken at least three times and their average value was considered as the final measurement.

Method:-

Linearity among the study variables were tested using correlation matrix scattered plot. Simple linear regression model can be adopted in case of linear relationship. Otherwise, a polynomial regression would be considered. In case of inter correlation among the predictors, ridge regression method should be considered to avoid multicollinearity problem. To screening most important predictors, forward stepwise regression method would be applied (Ali 2000, Rahman and Ali, 2003; Ali and Ohtsuki, 2001; Ali et al., 2004; Rahman et al., 2004; Shahin, 2015). Statistical Software IBM SPSS 20 and STATISTICA were used. The significance of the parameters will be tested using t-test. Percentages of explanation by the explanatory variables were assessed by R^2 and adjusted R^2. The validity and stability of the fitted equations were confirmed by cross-validity-predictive power (Stevens, 1996; p-96; Ali 2000, Rahman and Ali, 2003; Ali and Ohtsuki, 2001; Ali et al., 2004; Rahman et al., 2004; Shahin, 2015 p-94). The cross validity predictive power, denoted by ρ_{cv}^2, is defined as:

$$\rho_{cv}^2 = 1 - \frac{(n-1)(n-2)(n+1)}{n(n-k-1)(n-k-2)}(1-R^2)$$

where n is the sample size, k is the number of predictors in the regression equation and the cross validated R is the correlation between observed and predicted values of the dependent variable. Using the above statistic, it can be concluded that if the prediction equation is applied to many other samples from the same population, then (ρ_{cv}^2x100)% of the variance on the predicted variable would be explained by the regression equation (Stevens, 1996; p-100).

Results:-

Linearity among the study variables were shown in figure 1 and 2. These tables imply the linearity of vital capacity with other study variables for both male and female. Therefore, simple linear regression model was applicable and as well as considered here for both male and female students. As the study variables are inter correlated (Table 1) for both sex, to avoid multicollinearity problem ridge regression method was applied.

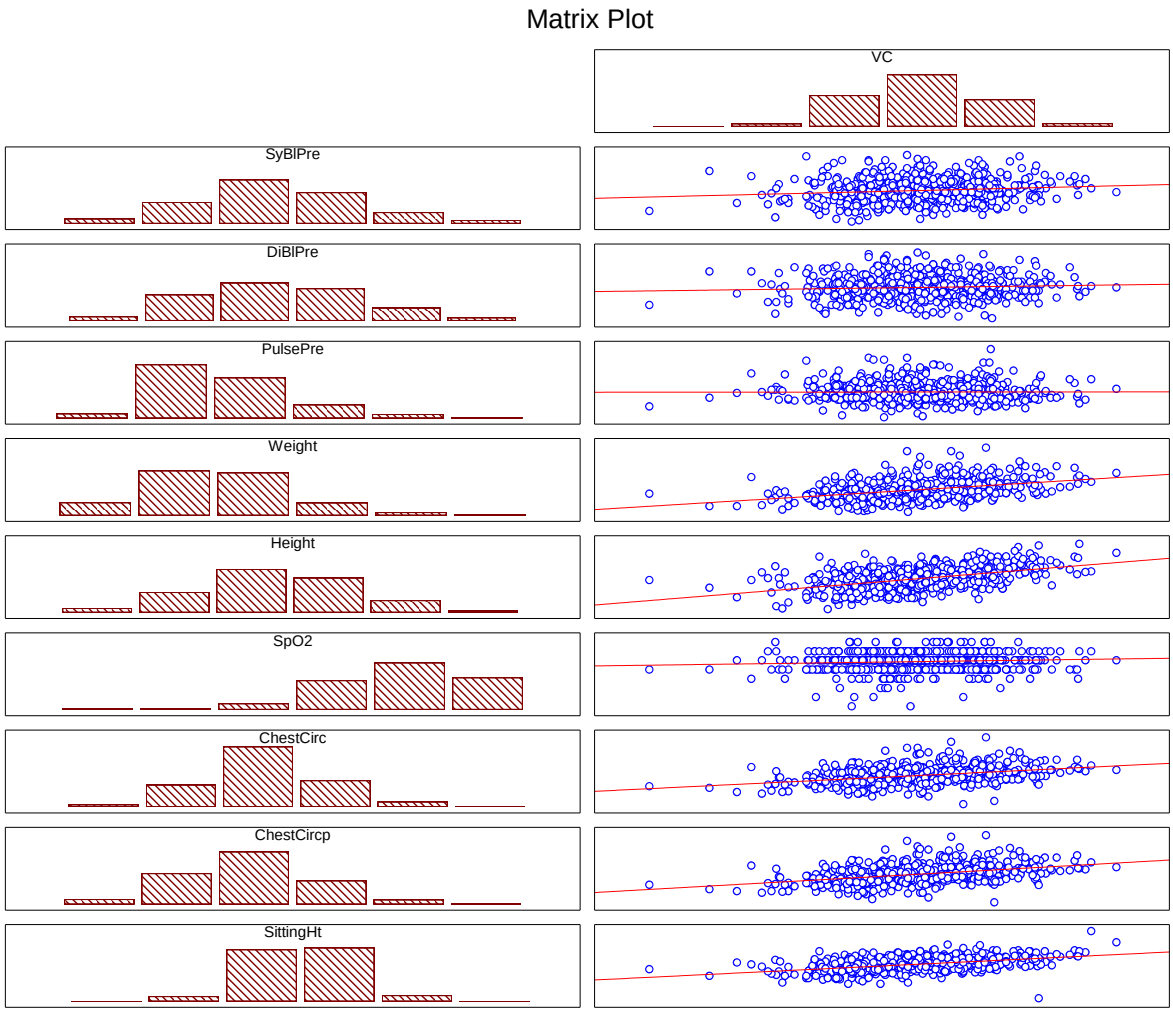

Fig. 1:-For checking linearity of Vital Capacity (VC) with other variables of Male Students.

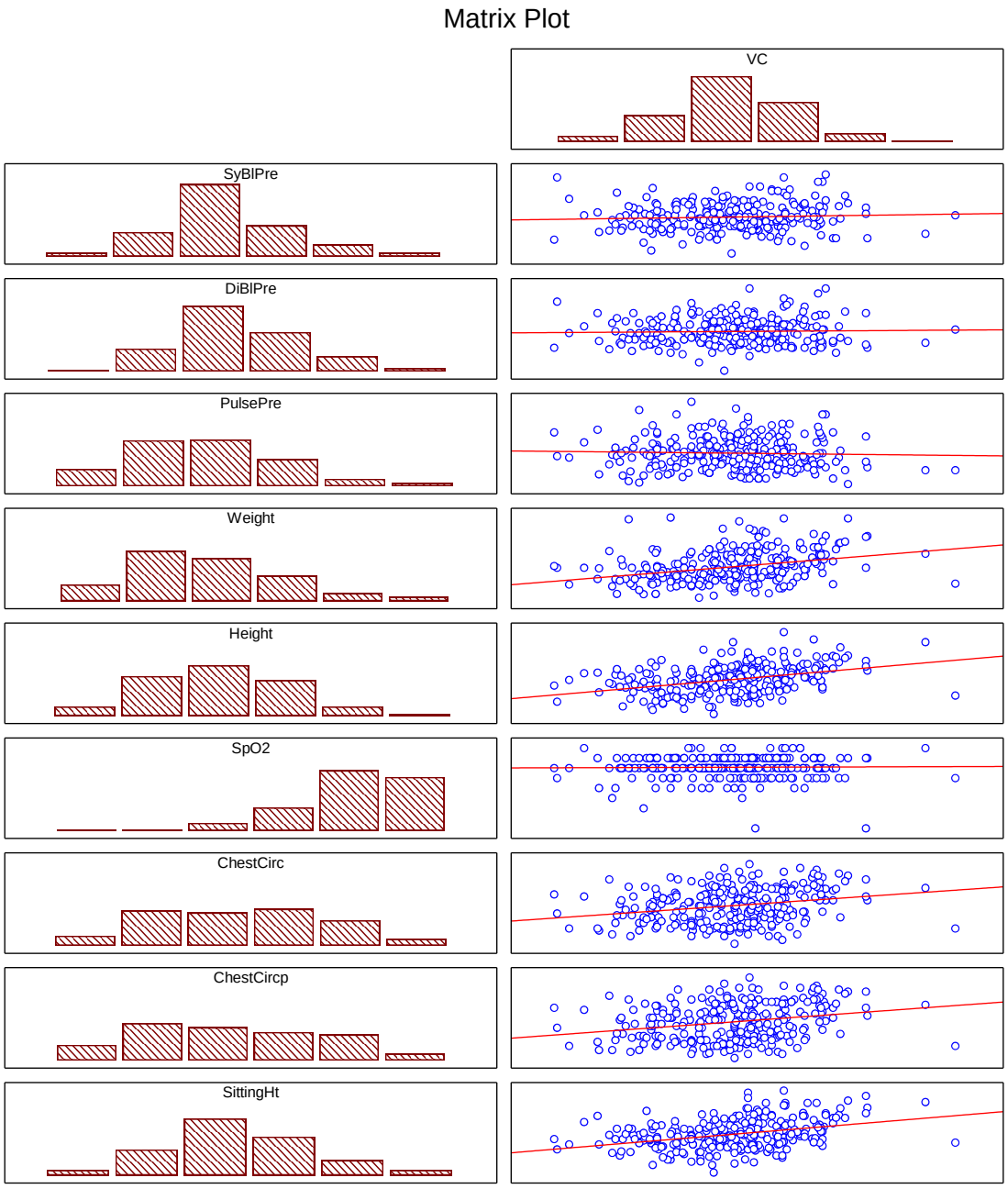

Fig. 2:-For checking linearity of Vital Capacity (VC) with other variables of Female Sudents

Table 1:-Correlation between the study variables. The values in the upper triangle is for males and that in the lower triangle is for females

	Height	Sitting Height	Weight	Pulse Rate	Systolic BP	Diastolic BP	Mean Absolute Pressure	Oxygen Saturation	Chest Circumference	Vital Capacity
Height	1	.648**	.418**	-.018	.045	-.007	.006	.126**	.203**	.476**
Sitting Height	.691**	1	.430**	.034	.101*	.019	.032	.170**	.283**	.446**
Weight	.369**	.404**	1	.086*	.244**	.131**	.154**	-.022	.869**	.393**

Pulse Rate	.005	.031	-.116	1	.166**	.408**	.366**	.082	.100*	.003
Systolic BP	.005	.031	.152*	.233**	1	.696**	.772**	.071	.267**	.128**
Diastolic BP	.068	.009	.032	.374**	.687**	1	.925**	.116**	.197**	.069
Mean Absolute Pressure	.030	.000	-.005	.407**	.744**	.903**	1	.118**	.214**	.102*
Oxygen Saturation	.110	.055	.065	.045	.077	.082	.088	1	-.040	.088*
Chest Circumference	.187**	.181**	.588**	-.124*	.057	-.018	-.072	.001	1	.354**
Vital Capacity	.380**	.360**	.324**	-.040	.062	.030	.029	-.008	.252**	1

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

Intercept term was omitted from the regression equation because for the absence of predictors vital capacity would not be appeared. Therefore, forward stepwise ridge regression with zero intercept method was applied for predicting vital capacity of the Rajshahi University students and the results shown below.

For Male

$$Vital\ Capacity = 0.319154 * Height + 0.322081 * chest\ circumference + 0.318056 * sitting\ height$$
$$(p = 0.0000) \qquad (p = 0.0000) \qquad (p = 0.0000)$$
$$R^2 = 0.95, \quad Adjusted R^2 = 0.95, \qquad Overall\ Significance\ Level, p = 0.0000$$

For Female

$$Vital\ Capacity = 0.327057 * Height + 0.325635 * sitting\ height + 0.306252 * weight$$
$$(p = 0.0000) \qquad (p = 0.0000) \qquad (p = 0.0000)$$
$$R^2 = 0.95, \quad Adjusted R^2 = 0.95, Overall\ Significance\ Level, p = 0.0000$$

In both male and female, the estimated coefficients of predictors are highly significant (p=0.0000). The value R^2 and *adjusted* R^2 are good enough and they indicate 95% variation of vital capacity can be explained by the predictors. Averages of the observed, predicted, residual, and standard error (SE) of predicted equations of vital capacity based on easily accessible variables for male and female students of Rajshahi University are shown in Table 2. The normality of the residual are shown in figure 3 and 4.

Table 2:-Averages of the observed, predicted, residual, and standard error (SE) of predicted equations of vital capacity based on easily accessible variables for male and female students of Rajshahi University.

Sample Size (n)	Observed VC (L/s)	Predicted VC (L/s)	Residual (L/s)	SE of Prediction (L/s)
		Male Students		
578	3.50	3.40	0.107	0.03
		Female Students		
284	2.49	2.41	0.08	0.04

VC is stands for Vital Capacity and L/s is for Liter per second.

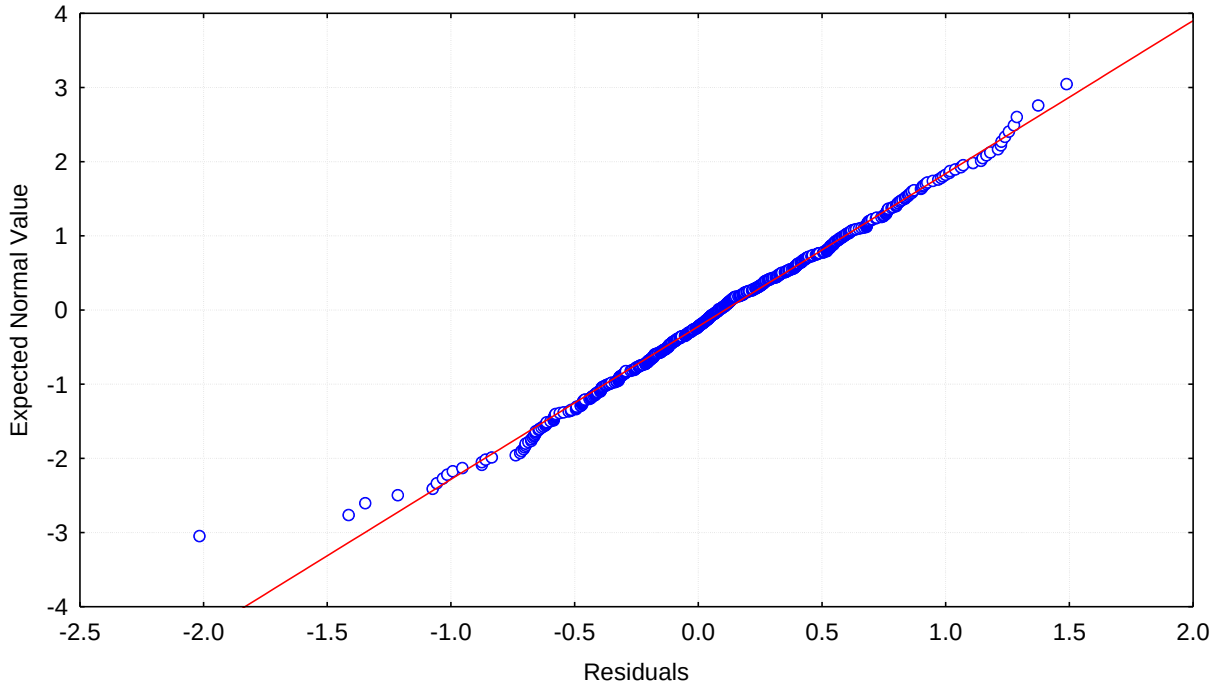

Fig. 3:-Normal Probability Plot of Residuals for Male Students

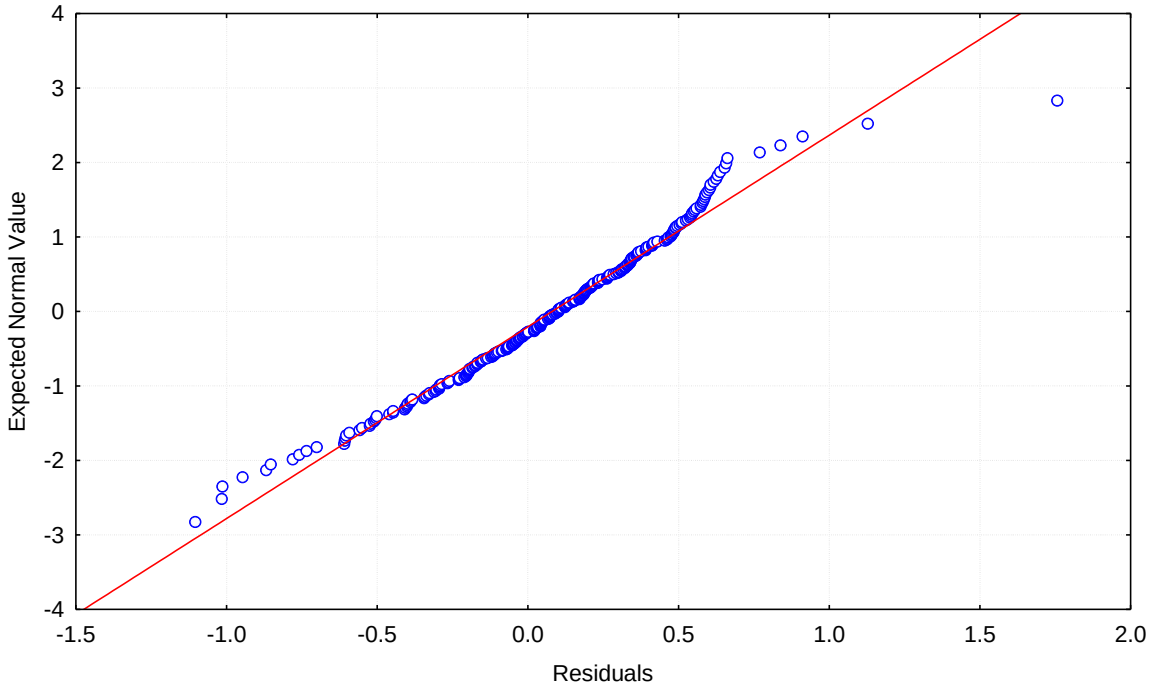

Fig. 4:-Normal Probability Plot of Residuals for Female.

Discussion:-

The volume of air breathed out after the deepest inhalation is called vital capacity. The testing instrument Chestgraph HI-101 Spirometer has been being used in hospital and clinics in many countries as well as in Bangladesh for assessing spirometry system, especially vital capacity (Operation Manual, ND). Measuring vital capacity is clinically expensive. Thus, prediction equations are helpful there. The main focus of the present study is to provide the expensive vital capacity measurement using only height, weight, sitting height, and chest circumference. The difference between observed and predicted values of vital capacity is very negligible. On

average, it is 0.10 L/sec for males and 0.08 L/sec for female with very small predicted standard error of the estimate (Table 2). Moreover, the normality plot shows in favor of the post prediction test for good fitting (Fig. 3 and 4).

The proposed predicted equations to predict the vital capacity of male and female students were cross validated by the cross validity predictive power. Estimated cross validity predictive power of the predicted equations for male and female students were shown in Table 3. This table indicates that the predicting equations are stable and highly robust i.e., if the prediction equation is applied to many other samples from the same population, then 95% of the variance on the predicted variable would be explained by the predicted equation. Therefore, the predicted equations for male and female were highly cross validated. As on the same issue this kind of prediction is rare in Bangladesh, further discussion is kept limited.

Table 3:-Estimated cross validity predictive power of the predicted equations of vital capacity for male and female.

n	k	R^2	ρ_{cv}^2
Male Students			
578	3	0.95	0.94939
Female Students			
284	3	0.95	0.94939

Conclusion:-

The predicted equations might be used by the researchers as well as by the doctors in their hospitals and clinics.

Acknowledgement:-

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