

Normative values for maximal respiratory pressures in an Indian Mangalore population: A cross-sectional pilot study

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ABSTRACT

Objective: The objective of the pilot study is to obtain normal maximal inspiratory and expiratory pressures for individuals in the age group 20-70 years in the Mangalore population and to predict normal values according to age, sex, height, and weight using the regression equation. **Materials and Methods:** Two hundred and fifty subjects were selected through a convenient method of sampling. Fifty subjects each were enrolled in the following age groups: 20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 to 70. Each group had 50 subjects (males-25 and females-25). Baseline data such as height, weight, body mass index were recorded. Maximal inspiratory pressure (PI) and expiratory pressure (PE) were determined following standardized protocol. **Result:** With regard to PI max and PE max, the measured values were significantly lower than those recorded in previous studies for both males (30%) and females (20%). We found that age served as the best factor for the prediction of PI max and PE max in both genders. **Conclusion:** The results of this study can be used to predict respiratory muscle strength in healthy adult subjects, and the strategy employed in this study will serve as a useful, simple, reproducible, rapid assessment of respiratory muscle function and also aid the planning of treatment.

KEY WORDS: Maximal respiratory pressures, normal values, adult

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INTRODUCTION

Maximal inspiratory and expiratory pressures (PI max and PE max) produced at the mouth during static efforts are regarded as a reflection of respiratory muscle strength.^[1-3] Clinically, respiratory muscle strength is measured as PI max and PE max^[1,2] The relationship of these maximal pressures to age, sex, and general muscular development has been described.^[1,3] Normal values have been reported for the relationship of maximal respiratory pressures to age and gender and these are most frequently derived from the regression equations of Black and Hyatt.^[1-3]

The functions of the respiratory muscles are difficult to

study directly since the muscles have complex origins and insertions.^[4,5] Furthermore, their product, which is the pressure generated within the thoracic cavity, depends on the coordinated action of many muscles, the individual functions of which may be difficult to distinguish in life.^[4-6] The respiratory muscle pump is vital for the movement of air to the level of gas exchange in the respiratory system. The respiratory muscles include the diaphragm as the major muscle of inspiration along with the intercostals and the scalene muscles. It is possible to assess both the strength and endurance of the respiratory muscles separately.^[4-7] PI max is a measure of inspiratory muscle strength, whereas PE max measures the strength of abdominal and intercostal muscles.^[7]

Impairment of the respiratory pump compromises ventilation, gas exchange and tissue respiration. In a condition where the load on the respiratory muscles is increased or the capacity of the respiratory muscles is decreased, muscle weakness can occur.^[2,6]

Respiratory muscle weakness increases the relative load for breathing. This can lead to clinical consequences such

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as dyspnea, impaired exercise performance, ineffective coughing, respiratory insufficiency, weaning failure, and death.^[6]

In the modern world there has been a great increase in pulmonary disease. This has raised an interest in the assessment and treatment of respiratory dysfunction.^[6] Dysfunction of the respiratory muscles is observed in several conditions, such as chronic obstructive pulmonary disease, asthma, cystic fibrosis, and neuromuscular disorders resulting from spinal cord injury, congestive heart failure and various critical illnesses.^[6]

Respiratory muscle assessment is required in order to individually tailor and design pulmonary rehabilitation programmes for the optimization of physical and social performance.^[8]

The available studies that report reference values of PI max and PE max, however, shows wide variability, not only between individuals but also between studies, because of the small numbers surveyed and the selection of subjects in these studies.^[1,2,7] The normal values for maximal inspiratory and expiratory pressures are based on a Western population.^[2,3,7,9] However, these values are not very suitable for our clinical assessment in an Indian population. Therefore it is essential that normal values for the same be predicted through our study. Misri Z. K. carried out a study on maximal mouth pressure estimation as a parameter of respiratory muscle function in healthy medical students including 100 males and 100 females between 18-25 years of age.^[10] The average expiratory pressure PE max and inspiratory pressure PI max values in both males and females were found to be lower than those obtained from Western studies.^[10] The objective of the pilot study is to obtain normal maximal inspiratory and expiratory pressures in the age group of 20-70 years in a Mangalore population and to predict the normal values according to age, sex, height, weight and body mass index (BMI) using the regression equation.

METHODOLOGY

The present study was conducted in the Kasturba Medical College and Hospital, Mangalore. Ethical clearance was obtained from the institutional ethical committee. An advertisement in a local newspaper invited volunteers to avail themselves of free assessment of respiratory muscle function, under the guidance of a physician, at the K.M.C Hospital. Two hundred and fifty subjects were selected using a convenient method of sampling. Fifty subjects each were enrolled in the following age groups: 20 to 29, 30 to 39, 40 to 49, 50 to 59 and 60 to 70. There were 50 subjects in each age group, 25 males and 25 females.

Each subject underwent a formal evaluation program, including pulmonary function tests (PFTs), prior to the

study. Pulmonary function testing was performed in accordance with the standards outlined by the American Thoracic Society.^[11-13] Baseline data such as height, weight and BMI was recorded.

The inclusion criteria were normal, non-smoker subjects of both genders, of the age group 20-70 years, having BMI between 18.0 to 29.5 kg/m². Each subject was examined by a physiotherapist. Subjects without any history of pulmonary, cardiac, neuromuscular or endocrine disease, and with normal spirometric results were included in the study.

Procedure

Patients were selected on the basis of inclusion criteria and written, informed consent was taken from the subjects prior to the test. Maximal inspiratory pressure and expiratory pressure was measured with Morgan P max monitor [P.K Morgan ltd. ME8 7ED].^[14]

The subjects remained seated with the trunk at an angle of 90° to the hip, and feet on the ground. Subjects used a nasal clip in all maneuvers. A nose clip was worn with normal mouthpiece and it was ensured that there was no leak around the mouthpiece. For measurement of PI max the subjects were asked to make a maximal inspiratory effort starting from residual volume [RV] whereas for PE max, a maximal expiratory effort, starting from total lung capacity [TLC] was elicited.^[7] All the subjects performed at least three reproducible maneuvers, each maintained for at least one second, until three technically adequate efforts had been made. One minute of rest was ensured between efforts. For data analysis the highest value was recorded, provided that it did not exceed the second highest value by 10%.^[2,7]

Statistical analysis

Statistical analysis was performed using the SPSS software for Windows (Version 14.0). In all the subjects the values for the maximal respiratory pressures were plotted against the four variables measured (age, height, weight, BMI), a stepwise linear and multiple regression analysis being used. This analysis was used to obtain prediction equations for maximal respiratory pressures. The four variables were included in the multiple regression analysis for all groups but a variable was included in the prediction equation only if multiple correlation coefficients were significant ($P < 0.05$).

RESULTS

The anthropometric data of the study sample, mean and standard deviation for PI max and PE max, are presented in Tables 1 and 2, and Figures 1 and 2, for males and females in all age groups. Pearson's correlation coefficient was used to determine which variables would better explain the respiratory pressure values. In males, PI max and PE max values correlated positively with height, weight and BMI [Tables 3-5]. However, PI max and PE max negatively

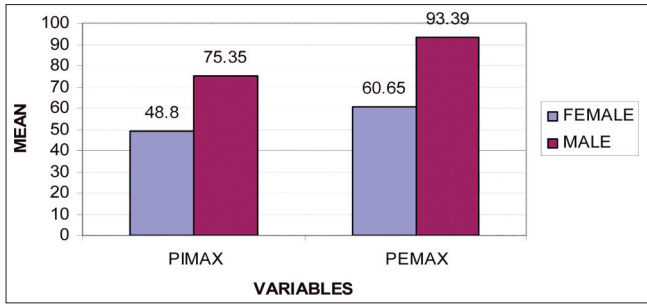


Figure 1: Measured PI max and PE max for males and females

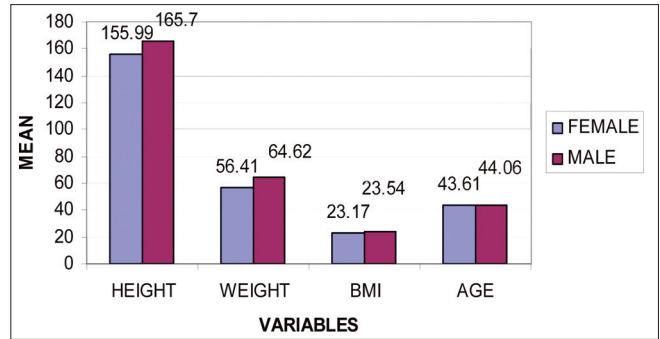


Figure 2: Anthropometric data of the study sample by gender and age

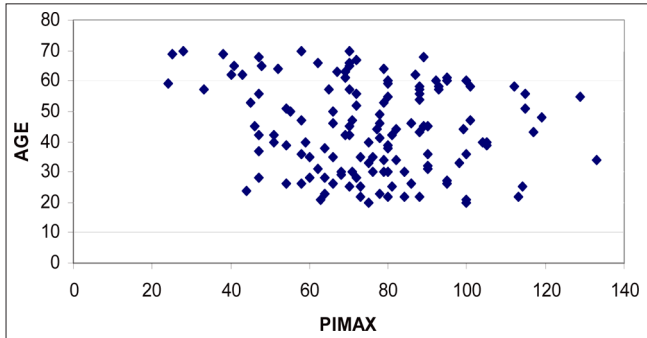


Figure 3: Male scatter diagram for PI max and age

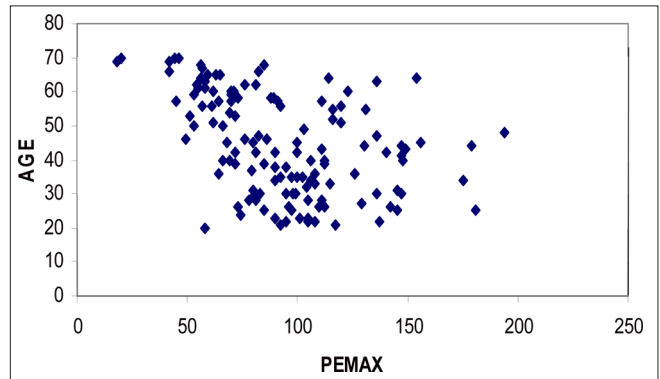


Figure 4: Male scatter diagram for PE max and age

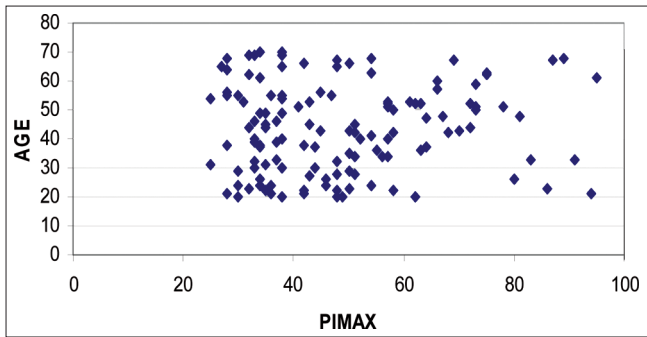


Figure 5: Female scatter diagram for PI max and age

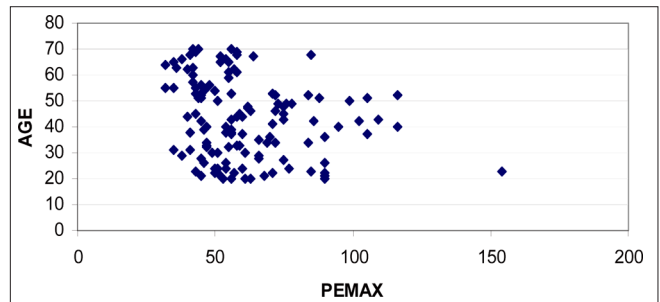


Figure 6: Female scatter diagram for PE max and age

Table 1: Anthropometric data of the study sample by male and age bracket, maximal respiratory pressure

		PI max	PE max	Height	Weight	BMI
All	Mean	-75.35	93.39	165.70	64.62	23.54
ages	SD	20.89	33.08	7.56	9.73	3.21
20-29	Mean	-76.03	102.14	167.82	63.28	22.44
	SD	18.05	27.12	7.19	10.54	3.28
30-39	Mean	-78.57	103.64	169.03	64.00	22.42
	SD	17.40	24.17	8.17	10.84	3.49
40-49	Mean	-78.75	109.25	164.28	66.75	24.65
	SD	19.84	37.44	7.89	11.64	3.45
50-59	Mean	-78.36	83.28	164.04	64.64	24.02
	SD	26.05	25.22	7.27	7.83	2.53
60-70	Mean	-65.35	67.57	163.14	64.42	24.22
	SD	20.91	31.48	5.75	7.16	2.61

Table 2: Anthropometric data of the study sample by female and age bracket, maximal respiratory pressure

		PI max	PE max	Height	Weight	BMI
All	Mean	-48.80	60.65	155.99	56.41	23.17
ages	SD	16.91	20.28	5.81	9.90	3.89
20-29	Mean	-46.89	65.51	156.31	51.96	21.18
	SD	16.45	23.04	6.72	9.06	2.89
30-39	Mean	-46.84	59.00	156.08	55.80	22.91
	SD	16.28	16.07	4.67	8.72	3.47
40-49	Mean	-49.32	70.08	153.60	57.16	24.24
	SD	14.63	19.90	6.98	9.60	3.97
50-59	Mean	-51.20	58.12	157.04	58.16	23.59
	SD	16.73	22.92	5.54	10.13	4.04
60-70	Mean	-50.08	49.80	156.88	59.72	24.27
	SD	20.82	11.86	4.25	10.82	4.41

correlated with age [Table 6] [Figures 3 and 4]. For females PI max and PE max showed positive correlation with height, weight, and BMI [Tables 7-9] and a moderately negative correlation with age [Table 10] [Figures 5 and 6].

Since age was the variable with the best predictive power in relation to maximal respiratory pressures, it was considered in a simple regression analysis model in order

Table 3: Correlation and linear regression of PI max and PE max with height variables for males

Height	Age	F-value	r-value	Regression equation	Result
PI max	All ages	0.193	0.038	58.07 + 0.104X	0.661 <i>P</i> >0.05, NS
	20-29	1.186	0.209	-11.977 + 0.52X	0.286 <i>P</i> >0.05, NS
	30-39	5.901	-0.430	233.4 - 0.916X	0.022 <i>P</i> >0.05, NS
	40-49	2.54	0.298	-44.53 + 0.75X	0.123 <i>P</i> >0.05, NS
	50-59	0.059	-0.050	107.96 - 0.18X	0.811 <i>P</i> >0.05, NS
PE max	All ages	0.109	0.028	72.78 + 0.12X	0.741 <i>P</i> >0.05, NS
	20-29	0.740	-0.166	207.47 - 0.62X	0.397 <i>P</i> >0.05, NS
	30-39	4.429	-0.381	294.3 - 1.12X	0.045 <i>P</i> >0.05, SIG
	40-49	1.394	0.226	-66.59 + 1.07X	0.248 <i>P</i> >0.05, NS
	50-59	0.600	-0.159	173.92 - 0.55X	0.447 <i>P</i> >0.05, NS
60-70	0.123	-0.069	128.78 - 0.375X	0.729 <i>P</i> >0.05, NS	

Table 4: Correlation and linear regression of PI max and PE max with weight variables for males

Weight	Age	F-value	r-value	Regression equation	Result
PI max	All ages	0.903	0.081	64.04 + 0.175X	0.344 <i>P</i> >0.05, NS
	20-29	1.225	0.212	53.04 + 0.363X	0.278 <i>P</i> >0.05, NS
	30-39	0.001	0.006	77.92 + 0.00002X	0.975 <i>P</i> >0.05, NS
	40-49	1.335	0.221	53.61 + 0.377X	0.258 <i>P</i> >0.05, NS
	50-59	0.131	-0.242	107.96 - 0.18X	0.811 <i>P</i> >0.05, NS
PE max	All ages	2.042	0.122	66.5 + 1.07X	0.155 <i>P</i> >0.05, NS
	20-29	0.131	0.071	90.61 + 0.182X	0.720 <i>P</i> >0.05, NS
	30-39	0.007	0.016	101.36 + 0.0003X	0.936 <i>P</i> >0.05, SIG
	40-49	5.075	0.404	22.53 + 1.29X	0.033 <i>P</i> >0.05, NS
	50-59	2.216	-0.296	144.9 - 0.954X	0.150 <i>P</i> >0.05, NS
60-70	0.412	0.125	32.2 + 0.54X	0.527 <i>P</i> >0.05, NS	

Table 5: Correlation and linear regression of PI max and PE max with BMI variables for males

BMI	Age	F-value	r-value	Regression equation	Result
PI max	All ages	0.450	0.058	66.52 + 0.37X	0.503 <i>P</i> >0.05, NS
	20-29	0.438	0.129	60.15 + 0.70X	0.514 <i>P</i> >0.05, NS
	30-39	1.906	0.261	49.39 + 1.301X	0.179 <i>P</i> >0.05, NS
	40-49	0.115	0.066	69.33 + 0.382X	0.737 <i>P</i> >0.05, NS
	50-59	0.409	0.132	45.71 + 1.35X	0.529 <i>P</i> >0.05, NS
PE max	All ages	1.495	0.105	68.02 + 1.07X	0.224 <i>P</i> >0.05, NS
	20-29	0.803	0.173	70.03 + 1.43X	0.378 <i>P</i> >0.05, NS
	30-39	1.865	0.259	63.53 + 1.789X	0.184 <i>P</i> >0.05, NS
	40-49	3.245	0.333	20.11 + 3.61X	0.083 <i>P</i> >0.05, NS
	50-59	1.256	-0.228	137.6 - 2.26X	0.274 <i>P</i> >0.05, NS
60-70	0.412	0.125	32.2 + 0.549X	0.527 <i>P</i> >0.05, NS	

to establish the equations for PI max and PE max. On the basis of a linear regression model, considering gender and age as predictive variables, the following equations for PI max and PE max are proposed for the Mangalore Indian population:

Males:

- PI max: All ages = 83.36 - 0.25 × age
- PE max: All ages = 133.36 - 0.907 × age

Females:

- PI max: All ages = 45.98 + 6.47 × age
- PE max: All ages = 74.85 - 0.32 × age

Table 6: Correlation and linear regression of PI max and PE max with age variables for males

Age	Age	F-value	r-value	Regression equation	Result
PI max	All ages	4.4319	-0.176	83.36 - 0.25X	0.040 <i>P</i> >.05, SIG
	20-29	3.646	-0.351	134.16 - 2.38X	0.067 <i>P</i> >0.05, NS
	30-39	0.175	-0.082	294 - 1.128X	0.680 <i>P</i> >0.05, NS
	40-49	0.577	0.147	30.92 + 1.09X	0.454 <i>P</i> >0.05, NS
	50-59	0.302	0.114	21.199 + 1.03X	0.588 <i>P</i> >0.05, NS
PE max	All ages	26.259	-0.404	133.36 - 0.907X	0.000 <i>P</i> >.05, SIG
	20-29	0.512	0.139	67.54 + 1.418X	0.481 <i>P</i> >0.05, NS
	30-39	2.581	-0.300	181.88 - 2.306X	0.120 <i>P</i> >0.05, NS
	40-49	0.044	0.042	84.17 + 0.57X	0.836 <i>P</i> >0.05, NS
	50-59	0.124	-0.073	118.83 - 0.645X	0.728 <i>P</i> >0.05, NS
60-70	0.863	0.179	15.34 + 2.15X	0.361 <i>P</i> >0.05, NS	

Table 7: Correlation and linear regression of PI max and PE max with height in females

Height	Age	F-value	r-value	Regression equation	Result
PI max	All ages	12.66	0.301	-87.856 + 0.87X	0.001, <i>P</i> <0.5, SIG
	20-29	1.39	0.221	-37.78 + 0.54X	0.248, <i>P</i> >0.05, NS
	30-39	5.93	0.453	-119.6 + 1.57X	0.023 <i>P</i> >0.5, SIG
	40-49	2.28	0.300	-47.296 + 0.62X	0.145 <i>P</i> >0.05, NS
	50-59	9.78	0.546	-207.8 + 1.65X	0.005 <i>P</i> >0.5, SIG
PE max	All ages	3.45	0.163	-27.9 + 0.56X	0.065 <i>P</i> >0.05, NS
	20-29	1.24	0.21	-46.7 + 0.71X	0.225 <i>P</i> >0.05, NS
	30-39	0.56	0.155	-24.1 + 0.53X	0.460 <i>P</i> >0.05, NS
	40-49	2.07	0.288	-55.7 + 0.81X	0.163 <i>P</i> >0.05, NS
	50-59	1.84	0.272	-118.7 + 1.12X	0.188 <i>P</i> >0.05, NS
60-70	1.59	0.255	-61.5 + 0.71X	0.220 <i>P</i> >0.05, NS	

Table 8: Correlation and linear regression of PI max and PE max with weight in females

Weight	Age	F-value	r-value	Regression equation	Result
PI max	All ages	23.59	0.396	10.68 + 0.67X	0.000 <i>P</i> >0.5, SIG
	20-29	19.9	0.651	-14.52 + 1.18X	0.000 <i>P</i> >0.5, SIG
	30-39	3.29	0.354	9.98 + 0.66X	0.083 <i>P</i> >0.05, NS
	40-49	0.001	0.003	49.01 + 0.00002X	0.987 <i>P</i> >0.05, NS
	50-59	7.05	0.484	4.66 + 0.8X	0.014 <i>P</i> >0.5, SIG
PE max	All ages	10.19	0.273	29.18 + 0.55X	0.002 <i>P</i> >0.5, SIG
	20-29	12.57	0.564	-8.91 + 1.43X	0.001 <i>P</i> >0.5, SIG
	30-39	0.14	0.079	50.9 + 0.14X	0.708 <i>P</i> >0.05, NS
	40-49	3.60	0.348	28.18 + 0.72X	0.088 <i>P</i> >0.05, NS
	50-59	3.90	0.381	8.007 + 0.86X	0.060 <i>P</i> >0.05, NS
60-70	3.81	0.377	25.12 + 0.41X	0.063 <i>P</i> >0.05, NS	

Multiple-regression equations

Males:

- PI max: 278.53 - 1.23 × H + 1.60 × W - 3.80 × BMI - 0.27 × age
- PE max: 566.98 - 2.85 × H + 3.29 × W - 7.13 × BMI - 1.04 × age

Females:

- PI max: 379.62 - 2.34 × H + 4.67 × W - 9.83 × BMI - 0.00 × age
- PE max: 178.49 - 0.88 × H + 2.19 × W - 3.65 × BMI - 0.42 × age

Table 9: Correlation and linear regression of PI max and PE max with BMI variables for females

BMI	Age	F-value	r-value	Regression equation	Result
PI max	All ages	10.628	0.287	20.84 + 1.2X	0.001 $P>0.5$, SIG
	20-29	24.53	0.690	-36.14 + 3.92X	0.000 $P>0.5$, SIG
	30-39	0.76	0.179	27.57 + 0.84X	0.391 $P>0.5$, NS
	40-49	0.64	-0.16	64.04 - 0.61X	0.430 $P>0.5$, NS
	50-59	1.86	0.276	24.44 + 1.13X	0.185 $P>0.5$, NS
	60-70	3.18	0.349	10.13 + 1.64X	0.088 $P>0.5$, NS
PE max	All ages	6.10	0.214	34.81 + 1.11X	0.015 $P>0.5$, SIG
	20-29	14.35	0.589	-33.71 + 4.68X	0.001 $P>0.5$, SIG
	30-39	0.010	0.021	56.82 + 0.0009X	0.922 $P>0.5$, NS
	40-49	1.23	0.226	42.68 + 1.13X	0.278 $P>0.5$, NS
	50-59	1.69	0.262	23.06 + 1.48X	0.206 $P>0.5$, NS
	60-70	2.190	0.295	30.5 + 0.79X	0.052 $P>0.5$, NS

Table 10: Correlation and linear regression of PI max and PE max with age variables for females

Age	Age	F-value	r-value	Regression equation	Result
PI max	All ages	0.432	0.058	45.98 + 6.47X	0.512 $P>0.5$, NS
	20-29	0.034	-0.035	51.67 - 0.20X	0.850 $P>0.5$, NS
	30-39	0.044	-0.044	55.23 - 0.244X	0.835 $P>0.5$, NS
	40-49	0.074	-0.057	61.63 - 0.27X	0.787 $P>0.5$, NS
	50-59	3.052	-0.342	184.7 - 2.5X	0.094 $P>0.5$, NS
	60-70	2.44	-0.309	186.1 - 2.06X	0.133 $P>0.5$, NS
PE max	All ages	8.042	-0.244	74.85 - 0.32X	0.005 $P>0.5$, SIG
	20-29	0.537	-0.140	91.88 - 1.12X	0.470 $P>0.5$, NS
	30-39	1.43	0.242	13.22 + 1.32X	0.243 $P>0.5$, NS
	40-49	0.468	-0.141	111.67 - 0.94X	0.501 $P>0.5$, NS
	50-59	7.761	-0.502	326.4 - 5.02X	0.011 $P>0.5$, SIG
	60-70	0.67	0.168	7.54 + 0.64X	0.421 $P>0.5$, NS

DISCUSSION

Maximal respiratory pressures reported in several studies showed a wide range of variation. We studied the age group between 20 to 70 years to set predicted values among the Mangalore population; PE and PI max was used to assess respiratory muscle function in adults. The reported mean value for PI max in males is (75 ± 20 cm H₂O) and for PE max is (93 ± 33 cm H₂O) and for PI max in females is (48 ± 16 cm H₂O) and for PE max is (60 ± 20 cm H₂O).

Compared to previous studies^[2,3,7,9] our study has shown lower mean values for adults. The probable reasons could be geographical variations, poor motivation in our subjects, and deliberate leak in the mouthpiece of the apparatus.

Several factors contribute to the wide range of values described for adults in previous studies. The first concern was, measurement of PI max and PE max may vary markedly with the response characteristics of the pressure-measuring device and diameter of the orifice.^[1,2,7,15] This might have resulted in overestimated values due to undesired contraction of the buccinator muscles, since the activation of these muscles can generate a pressure that interferes with that produced by the respiratory muscles.^[7]

Secondly, air leaks at the nose and mouth can produce inaccuracy during forced expiratory maneuvers. In the

majority of our subjects, detectable air leaks were clearly apparent during initial trial studies, but were readily corrected with careful instruction.^[15]

Thirdly, forced respiratory maneuvers are influenced by motivation, and finally, the number of trials used to measure PI max and PE max may affect the maximal pressures recorded. It has been shown that maximal values recorded may increase over ten attempts. Thus, Ringqvist,^[16] using ten or more trials, reported higher maximal pressures than Black and Hyatt^[3] or Leech *et al.*,^[17] who used two and three trials, respectively, to determine their normal values. Normal values based on a small number of trials may be a more appropriate choice for the clinical laboratory, where repeated trials may be impractical or impossible in patients.^[2] However, if one is dealing with possible methodological differences in terms of data collection, this hypothesis must be considered with caution.^[2,7,18,19]

In the correlation of the variables with the maximal respiratory pressures, our results showed statistically significant correlation of PE max with age for male and female subjects ($P<0.05$), and PI max with age for male subjects ($P<0.05$). However, there was no correlation of PI max with age for female subjects ($P>0.05$).

We agree with Black and Hyatt^[3] that respiratory muscle strength decreases with age. Our study also showed decreased respiratory muscle strength in male subjects. Several factors may affect respiratory muscle strength in adults and account for inter-subject variability in maximal respiratory pressures. Variable changes may occur in skeletal muscle itself, in the elastic recoil of the lungs and chest wall, and increase in residual volume (RV). These effects differ in individuals and likely contribute to variability in respiratory muscle strength with ageing.^[1,2,7]

Increase in RV occurs with age and this may lead to an altered Force-Length relationship of the diaphragm and diminished static outward recoil of the chest wall, resulting in decreased PI max at RV.^[1,2] This increased RV is not uniform in all persons and may contribute to differing PI max values in subjects of the same age. Thus, many factors affect respiratory muscle strength with increasing age, but the relative importance of each is unknown.^[1,2,7,9]

Our study also showed decreased PE max in both male and female subjects, the probable reasons could be, loss of lung recoil and an increase in lung compliance in the elderly, which would tend to decrease the PE max. Changes also occur in the thoracic wall involving calcification and stiffening of the articulations of the rib cage together with changes in the spinal curvature, making the chest wall less compliant. These factors may contribute to large inter-individual variations.^[1,2,7,9]

Our results showed that respiratory pressures in men are related to age. For women, however, a significant

relationship was shown with height, weight and BMI. This may be explained by the fact that decreased muscle mass and strength fall with increasing age in men.^[1,2] There is approximately 8-10% decline per decade and their peak decline being in the second and third decade of life, while in women overall strength may not be related to age.^[7] Weight could affect the diaphragm mass, exerting an influence on respiratory muscle performance.^[7]

Regression analysis was used to obtain the prediction equation for the maximal respiratory pressures. The equations were derived using age, height, weight and BMI as variables. And in our study there was no significant relationship between height, weight, BMI and respiratory pressure in males. In females there was a significant relationship between height, weight, age and BMI and respiratory pressures, except PI max with age and PE max with height. Hence equations were derived using age as a variable which had higher coefficient of correlation.

The measurement of maximal respiratory pressures allows a simple, reproducible, and rapid assessment of respiratory muscle function which is extremely useful in following the progression of respiratory weakness in patients.

Future studies are required to predict regressive equations for the Indian population through a multicentric trial.

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