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Normative Values of Maximal Inspiratory and Expiratory Pressures in Healthy Children of the Age 8-16 Years in a City of Western Maharashtra

Krishma Solanki, Shreya Dhake,

Intern, D.E.S Brijlal Jindal College of Physiotherapy, Pune.
Associate Professor, D.E.S Brijlal Jindal College of Physiotherapy, Pune.

Corresponding Author: Krishma Solanki

ABSTRACT

Objective: To find normative values of Maximal respiratory pressures in children of the age 8-16 years in Pune City.
Materials and methodology: 572 subjects were selected through cluster sampling. Healthy, school going children were selected. Demographic and anthropometric data like weight, height, age, body mass index was recorded. Maximal inspiratory Pressure (MIP) and Maximal expiratory pressure (MEP) was measured with the help of a portable respiratory pressure meter (Micro RPM).
Results: The study population was divided into different age groups and the mean value was found out.
GIRLS:
MIP: 60.54 (± 14.38) cmH2O to 77.90 (±18.83) cmH2O
MEP: 54.9 (± 10.11) cmH2O to 70.18 (± 11.25) cmH2O
BOYS:
MIP: 59.76 (±13.46) cmH2O to 88.2 (±23.11) cmH2O
MEP: 57.78 (±11.21) cmH2O to 80.31 (±14.29) cmH2O
The values showed an increase with age. It was seen that boys had higher values of maximal respiratory pressures than girls.
Conclusion: The age group wise obtained values of MIP and MEP can be used as reference values for assessing respiratory muscle strength in diseased population. Rehabilitation can be planned from these values these values can be used for diagnosis, prognosis and for identifying respiratory muscle weakness.

Key words: Maximal respiratory pressures, children, MIP, MEP, normative values.

INTRODUCTION

It is of great importance to find out the strength of the respiratory muscles in order to adequately carry out pulmonary assessment. [1] The ability of respiratory muscles to generate the required amount of force should be noted for adequate functioning of the lungs and to identify and recognise weakness of the respiratory muscles in healthy as well as sick population. [1]

Evaluation, monitoring of respiratory functions have improved in children. [1] Technological advances, more reliable studies and recognition of the importance of monitoring in clinical practice have all contributed to better understanding of lung function in paediatric age group.[1] It is difficult to assess respiratory muscle functioning since the muscles have complex attachments (origins and insertions) [3] The pressure generated

within the thoracic cavity, depends on the coordinated action of many muscles. [4]

There are various methods available for testing the respiratory muscle strength. Measurement of maximal static inspiratory and expiratory pressure is a volitional test. Maximal respiratory pressures are simple, convenient and non invasive indices of respiratory muscle strength. [5] Maximal inspiratory pressure(MIP) is a measure of inspiratory muscle strength, maximal expiratory pressure (MEP) is a measure of the strength of abdominal and intercostal muscles. [8] Measuring MRP (Maximal Respiratory Pressures) requires subject's full cooperation which could underestimate the values of Maximal Respiratory Pressures,even in absence of muscle weakness. [4] An increase in the load on the muscles of respiration can lead to weakness. [9] Respiratory muscle weakness can be detected more sensitively by maximal static pressures; therefore, it can become a clinical parameter for treatment of respiratory problems. [6] Maximal Respiratory Pressures are useful in determining weakness of the respiratory muscles and quantifying severity of certain diseases. It can be helpful for the management as well as follow up of neuromuscular diseases and lung disorders like asthma, cystic fibrosis, especially in the paediatric population. These values are also useful for monitoring rehabilitation programmes. [8]

Measurement of respiratory muscle strength has proven to be an efficient tool in school population. [8] ATS recommends consideration of various factors like age, sex, height and physical activity for the values of respiratory pressures. [4] The normative values of MIP and MEP are widely based on Western population. [2] Standard values cannot be used worldwide, significant values have been found between western and Asian population. Hence it is important to find separate normative values in different populations. [6] In order to correctly interpret the measurements of MIP and MEP, comparison of data from the individual child, with those of healthy children is necessary. These values will help clinicians and provide information about respiratory muscle function and can be used to interpret individual test results using them as reference values.

Measuring respiratory pressures can contribute to evaluation of respiratory system in school going children. However, the absence of reference values for specific populations makes it difficult to interpret these finding. [10] Generation of normal values could help in better evaluation and follow up of children and adolescents with alterations of respiratory muscle functioning. We aim to determine standard values of MIP and MEP, which could become the criteria of respiratory rehabilitative treatment in patients with neuromuscular disorders.

MATERIALS AND METHODS

The design of the study was a cross-sectional type of study. Study setting was schools and study population was school going children. The sample size was 572.

Inclusion criteria: Normal healthy children from the age group of 8-16 years.

Exclusion criteria: Subjects who were athletes, obese or with any history of previous cardiopulmonary, neuromuscular or orthopaedic disorders involving the thorax.

Procedure:

Statistical Analysis:

Data was analysed using Graphpad, Prism 8. The anthropometric data like age, height, weight, BMI, MIP and MEP was summarised to find out the mean and standard deviation with the help of Google Sheets.

RESULTS

Total data of 572 subjects was collected. The values (mean ± standard deviation) for MIP and MEP in all subjects was found out.

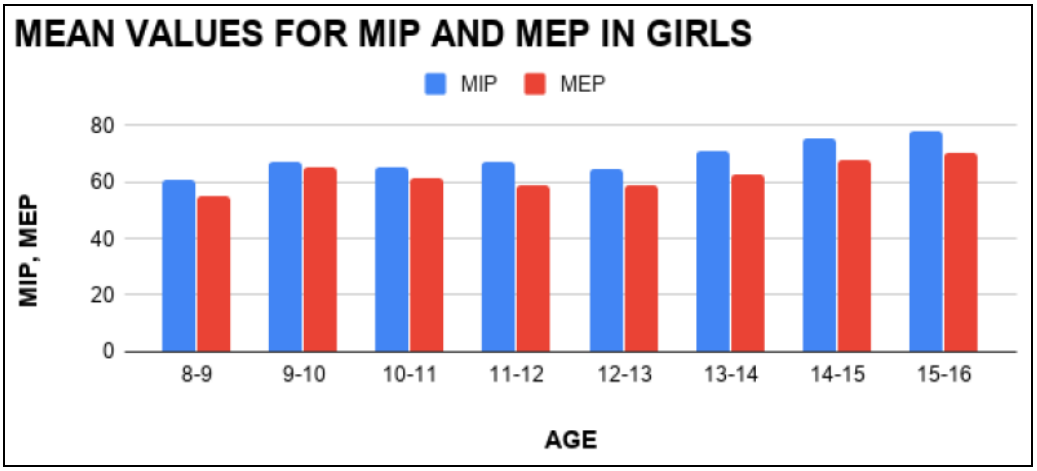
The mean values ± standard deviation according to age group is shown in Table 1. for boys and Table 2. for girls

Table 1: shows the mean and standard deviation for all the age groups in boys for MIP and MEP.

AGE (years)	MIP (cmH_2o)	SD	MEP (cmH_20)	SD
8-9	59.76	13.46	57.78	11.21
9-10	69.65	14.12	65.4	9.68
10-11	78.9	21.11	67.16	14.38
11-12	79.93	19.06	71.02	13.83
12-13	82.63	21.32	69.88	15.33
13-14	86.7	27.2	72.98	16.39
14-15	94.45	24.78	83.55	13.18
15-16	88.2	23.11	80.31	14.29

Table 2: shows mean and standard deviation for all the age groups in girls for MIP and MEP

AGE (years)	MIP (mmHg)	SD	MEP (mmHg)	SD
8-9	60.54	14.38	54.9	10.11
9-10	67.187	14.34	65.4	9.59
10-11	64.94	16.968	61.2	17.72
11-12	66.96	17.379	58.89	11.504
12-13	64.48	19.93	59.07	12.322
13-14	70.92	15.32	62.73	12.01
14-15	75.34	16.46	68	12.56
15-16	77.909	18.83	70.18	11.25



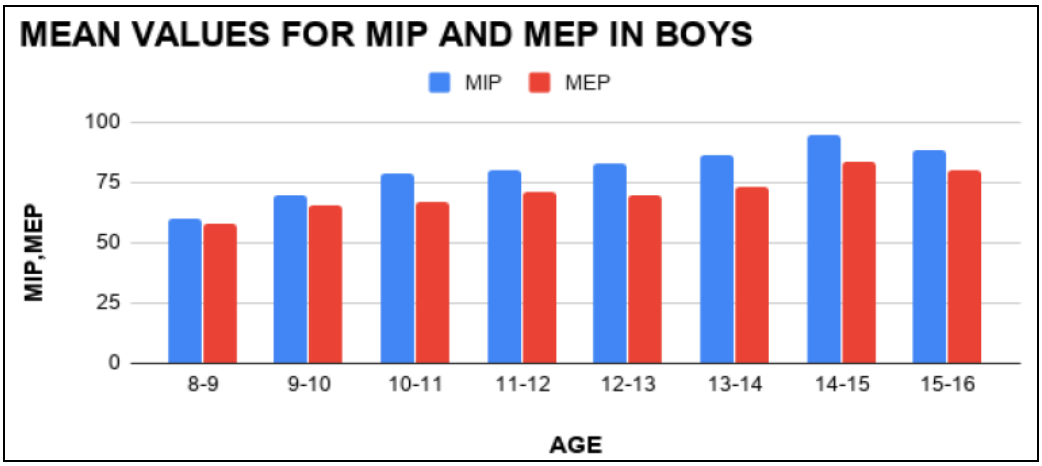
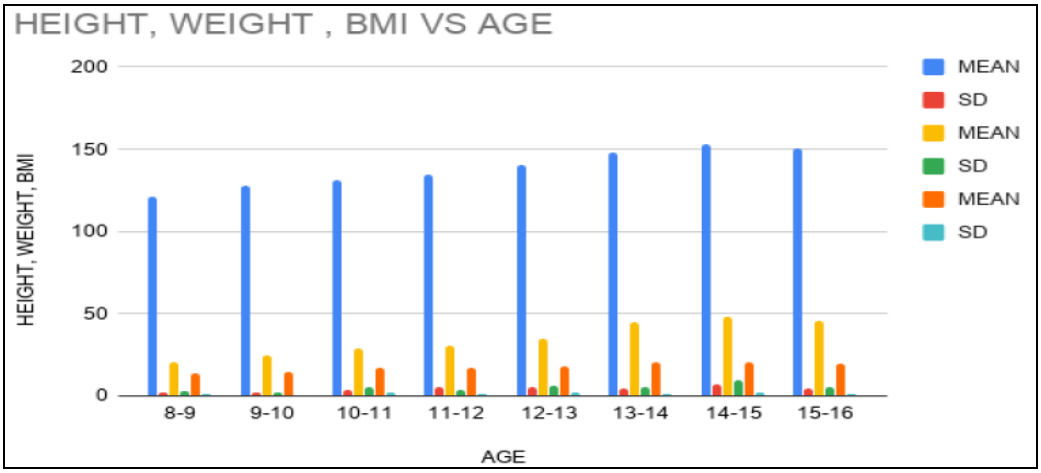
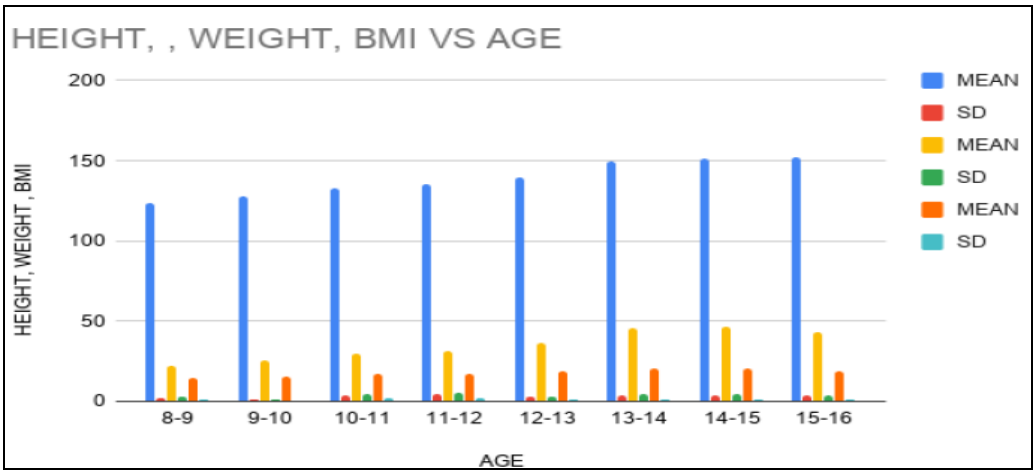


Table 3 and Table 4: shows the mean height, weight and BMI ± standard deviation for boys and girls respectively.

AGE	HEIGHT (cm)		WEIGHT (kg)		BMI (kg/m^2)	
	MEAN	SD	MEAN	SD	MEAN	SD
8-9	121.31	1.84	20.82	2.82	14.11	1.62
9-10	127.65	1.67	24.51	1.67	15.02	0.72
10-11	131.26	4.01	29.3	5.1	16.89	1.9
11-12	134.24	5.36	30.26	4.04	16.74	1.47
12-13	140.75	5.81	35.15	6.14	18.13	2.09
13-14	148.35	4.24	44.64	5.14	20.2	1.35
14-15	153.3	7.5	48.42	9.32	20.37	2.04
15-16	150.689	4.93	45.58	5.68	19.98	1.41

AGE	HEIGHT (cm)		WEIGHT (kg)		BMI (kg/m^2)	
	MEAN	SD	MEAN	SD	MEAN	SD
8-9	123.42	1.67	21.9	2.5	14.28	1.32
9-10	127.68	1.58	25.25	1.56	15.47	0.62
10-11	132.8	4.07	29.65	4.61	16.73	1.68
11-12	135.02	4.59	31.66	5.18	17.28	1.98
12-13	139.74	2.96	36.03	3.3	18.41	1.01
13-14	149.47	3.81	45.78	4.7	20.43	1.21
14-15	151.53	4.04	46.34	4.96	20.11	1.19
15-16	152	3.5	42.77	4.1	19.23	1.26



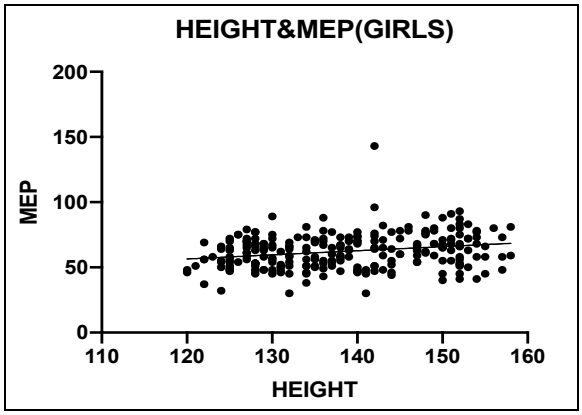


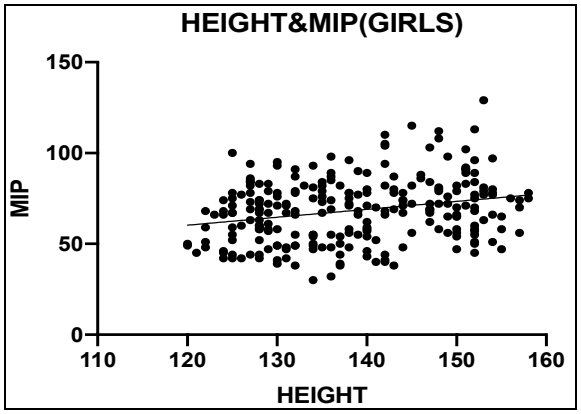
The above graphs are graphical representation of Table.3 and Table.4.

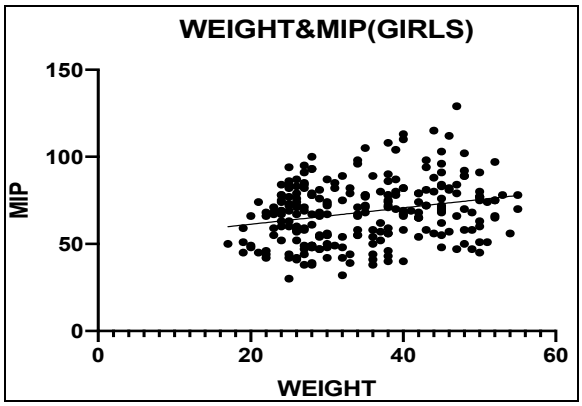
GIRLS:

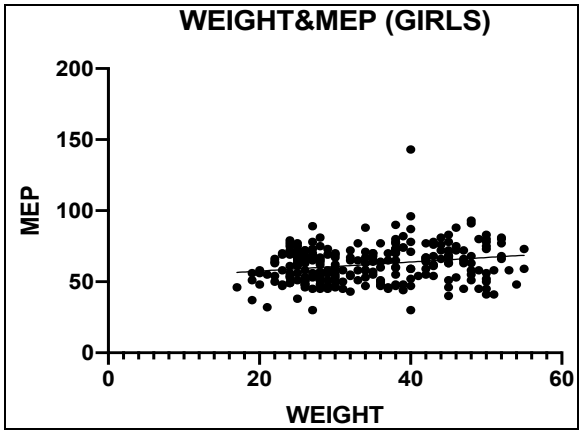
Table 5: shows the value of the correlation coefficient (r), value of p and N being the number of pairs correlated for Girls.

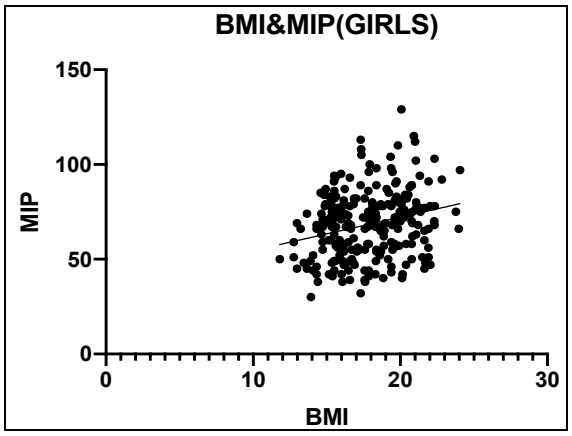
		MIP	MEP
HEIGHT	r	0.25	0.23
	p	<.001	<..001
	N	249	249
WEIGHT	r	0.25	0.22
	p	<.001	<..001
	N	249	249
BMI	r	0.25	0.19
	p	<.001	<..001
	N	249	249

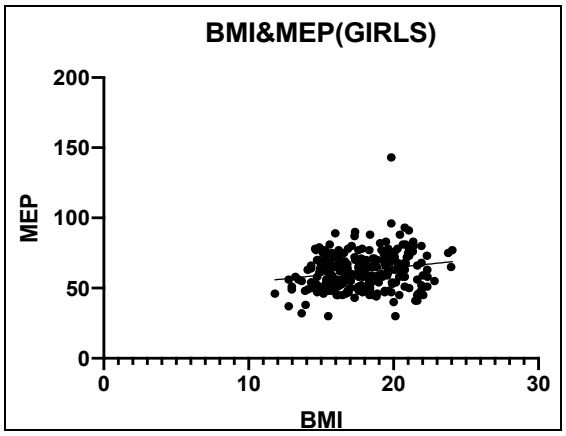


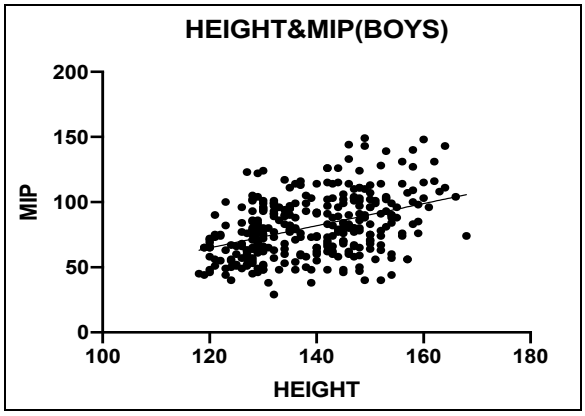


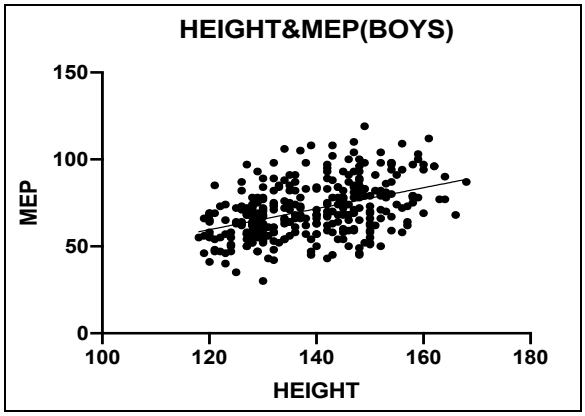


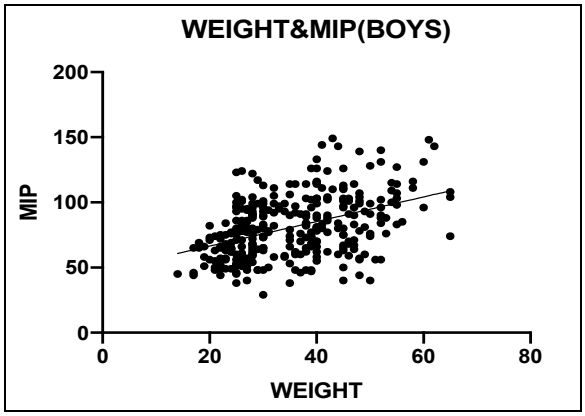


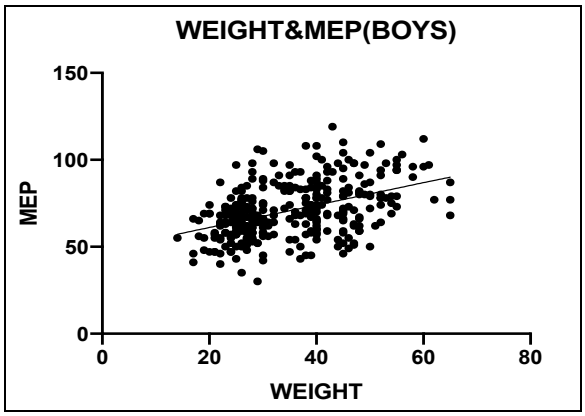






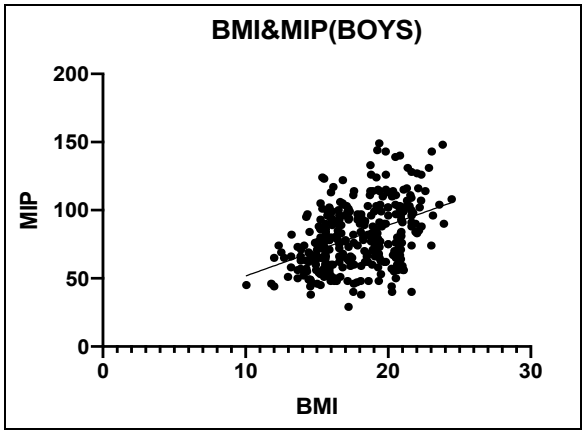


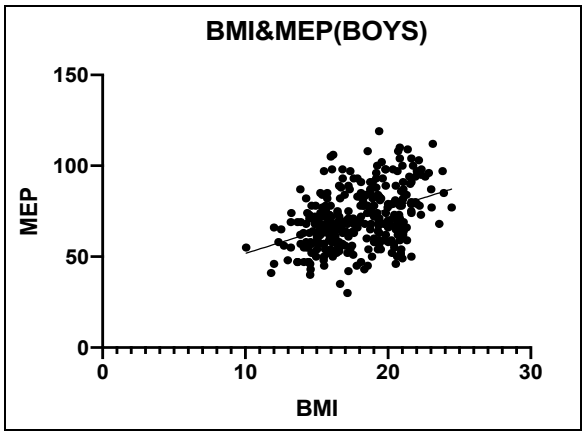




BOYS:

		MIP	MEP
HEIGHT	r	0.41	0.43
	p	<.001	<.001
	N	323	323
WEIGHT	r	0.43	0.43
	p	<.001	<.001
	N	323	323
BMI	r	0.43	0.41
	p	<.001	<.001
	N	323	323





DISCUSSION

The study population was divided into different age groups and the mean values were found for each of them.

The mean values for the entire age group was found to be:

GIRLS:

MIP: 60.54 (± 14.38) cmH2O to 77.90 (±18.83) cmH2O

MEP: 54.9 (± 10.11) cmH2O to 70.18 (± 11.25) cmH2O

BOYS:

MIP: 59.76 (±13.46) cmH2O to 88.2 (±23.11) cmH2O

MEP: 57.78 (±11.21) cmH2O to 80.31 (±14.29) cmH2O

The values of MIP and MEP were found to increase with an increase in age. With an increase in age there is an obvious increase in weight and height. Muscle mass increases with age and so does the cross-sectional area. Previous studies have reported that strength is proportional to the cross-sectional area of the muscle. [15] Hence, as cross-sectional area increases with age the strength of the muscles increases as well.

Similar studies done in different countries like Japan, Korea, Brazil, Navajo and Caucasian population have also shown an increase in pressures with age in both genders and were more in boys than in girls. [6-8,10,16] We also found correlation between MIP, MEP and height, weight, BMI and age. MIP and MEP showed a positive correlation with height, weight and BMI in boys and girls. The values found in our study were found to be higher than of the Korean and Japanese children, [6,8] both being short statured than Indian children supports our finding that MIP and MEP correlates with height positively. A fair correlation is seen between height and weight with MEP in Boys. (r=0.41, r=0.43).

Domenech et al reported that height and weight related to expiratory muscle pressures in boys. [14]

Joao et al reported that gender is an important factor in prediction of respiratory muscle pressure. [16] In our study, boys showed to have higher values of both MIP and MEP than girls. Studies have shown that percent of lean body mass is higher in boys. Fat free mass index is also seen to be higher in boys than in girls. Another study has proved a positive correlation between fat free mass index and lung functions and pressures. [15]

A large variability was seen between the different age groups, this can be attributed to difference in growth in the subjects which may in return affect the correlations between height, weight, MIP and MEP. [6]

CONCLUSION

RMS was found to be higher in boys as compared to girls in this study. Age wise obtained values of RMS can be used as reference value for doing RM assessment. These can be used for diagnosis, prognosis and will be an important measure in rehabilitation. Also it can play an important role in presurgical fitness, weaning from ventilator and children involved in sports.

The age group wise obtained values of MIP and MEP can be used as reference values for assessing respiratory muscle strength in diseased population. Rehabilitation can be planned from these values.

These values can be used for diagnosis, prognosis and for identifying respiratory muscle weakness. Can be used for training children involved in sports. Important parameter for pre-surgical fitness and weaning from ventilators.

The younger age groups had difficulty performing the manoeuvres. The study does not account for the different levels of physical activity of the children across the sample size.

A correlation can be done between the physical activity levels of the child and their MIP & MEP.

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