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SHORT COMMUNICATION

A PRELIMINARY INVESTIGATION INTO MAXIMAL EXPIRATORY PRESSURES IN SOME VILLAGE CHILDREN

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Abstract : A clinical mercury sphygmomanometer was used to measure Maximal Expiratory Pressure (MEP) in 29 boys (mean age 8 ± 1.4 yr) and 21 girls (mean age 7.6 ± 1.5 yr) of a village in interior Maharashtra. The values of 70.6 ± 13.4 mmHg SD for the boys and 61.9 ± 18.9 mmHg for the girls were quite comparable to the respiratory pressures reported elsewhere in literature, even though the subjects were apparently poorly nourished. There was no statistical difference between the MEPs of boys and girls. The MEP was positively and significantly ($P<0.01$) correlated to height ($r=0.51$) and weight ($r=0.05$) in the boys. The MEP denoting respiratory muscle strength also correlated positively with handgrip power used to represent non-respiratory muscle strength ($r=0.34$) ($P>0.05$). The simple, reproducible method of measuring MEP as described may be useful for measuring this important physiological parameter at the bedside in children whose respiratory muscle function needs to be evaluated.

Key words : BMI hand grip max respiratory effort respiratory pressures

INTRODUCTION

Respiratory pressure measurements have been used as indicators of respiratory muscle strength in adults and in children (1). The Maximum Expiratory Pressure (MEP) has been correlated with height, weight, BMI, age, sex, degree of fitness and non-respiratory muscle strength (1, 2, 3), The values of this parameter as reported in the various studies vary considerably because of wide age range of subjects, different types of instruments used to make the measurements (4, 5), and the possible differences in the method used for making the measurements.

Poor nourishment has been associated with generation of low respiratory pressures (6). During a field health survey exercise in

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a village in the north west region of Maharashtra, about 60 Km from Pune, we noticed a group of village (tribal) children who apparently appeared to be poorly nourished. We report here our findings of MEP measured in the field with a standard clinical mercury sphygmomanometer in these 50 children aged 6–10 yrs.

METHODS

The MIMER Medical College Standing Ethical Committee approved the non invasive investigation which included a clinical examination that formed a part of the Depart of Preventive and Social Medicine health survey exercise. We also obtained prior approval for measuring maximum expiratory pressures in these children. These village children appeared to be malnourished. In the absence of the parents of the children, the school master of their single class-room school gave consent for the non-invasive study in 50 apparently normal children (29 boys, 21 girls; age 6–10 years). The school master was responsible for the welfare of the children under his care. None of the procedures were invasive or risky, and were easily comprehended by the children who were screened clinically with a general physical examination before the test.

Body Mass Index (BMI) was calculated from the measured height and weight.

Measurement of the MEP. The children were trained to inspire maximally, and then to breath out forcefully and maximally into a calibrated, standard clinical Hg spygmomanometer through a cylindrical mouth piece (dead space 40 ml). Average of the three highest pressures attained on the manometer was taken.

We also measured maximum force generated (Kg) with a handgrip dynamometer (HGD) (Anand Agency, Pune) using the dominant hand as derived from the Lateral Preference Inventory (7). Average of two best efforts was taken. This represented the non-respiratory muscle strength parameter of our subjects.

MEP was recorded in 34 adult males (non smokers), and 25 adult females (all young and healthy) of our Medical College using the same sphygmomanometer. These measurements were made with a small leak in the mouth piece (8), as also without the leak.

Statistics :

Unpaired 't' test was used to compare differences if any between boys and girls for the variables recorded. Correlations of the MEP with the BMI, height, weight, and HGD force were made using Pearson's correlation test. The r-values were calculated for these correlations The MEP values with and without leak at the mouth measured in adult males and females were compared independently using paired 't' test (9). Level for significant difference was fixed at a P value of <0.05.

RESULTS

The findings of this study are tabulated as Table I, and the r values with their statistical significance are given in Table II. The highest MEP recorded amongst boys was 98 mmHG (age 10 yr; BMI 13.2) while the

TABLE I : Mean ± SD values of MEP (mmHg) measured in 50 children and 59 adults along with their physical attributes. HGD was not done for adults. NS: statistically not significant. Leak stands for leak given in the mouth piece.

	Age (yr)	*Ht (m)*	*Wt (kg)*	*BMI*	*MEP mmHg*		*HGD kg*
Boys n=29	8.0±1.4	1.19±0.6	18.9±3.2	13.3±1.0	70.6±13.4		1.3±0.8
Girls n=21	7.6±1.5	1.18±0.6	17.9±2.6	12.9±1.1	61.9±18.9		0.9±0.7
Significance	NS	NS	NS	NS	NS		NS
Pooled data boys+girls	7.8±1.4	1.18±0.62	18.5±2.9	13.1±1.0	67.0±16.3		
					No Leak	*Leak*	
Adult Males n=34	21.6±5.9	1.71±0.1	63.2±8.6	21.0±1.9	93.2±22.7	88.7±21.9	
					NS		
Adult Females n=25	20.7±1.5	1.60±0.1	52.3±9.0	21.2±3.0	67.4±17.3	62.6±17.3	
					NS		

lowest was 47 mmHg (7 yr; BMI 13.1). Amongst the girls, it ranged from 100 mmHg in an 8 yr old with a BMI of 14.6, to 38 mmHg (6 yr; BMI 12). The MEPs of adult females and female children fell quite close to one another.

TABLE II : Correlations (r values) between the MEP and physical parameters in children. Significant values are marked with an * for P<0.05, and ** for P<0.01 df is degrees of freedom.

	BMI	*Ht*	*Wt*	*HGD*
Boys	0.32	0.51** t=3.1 df 27	0.5** t=2.99 df 27	0.30
Girls	0.30	–0.01	0.19	0.40
Pooled data for boys and girls	0.34	0.3	0.37* t=2.76 df 48	0.39

DISCUSSION

We made measurements of maximal expiratory pressures in young village children using a clinical mercury spygmomanometer The advantages of this method were (i) its simplicity of use; (ii) ease of transportation for field work; (iii) ease of calibration (whenever indicated) and maintenance; (iv) highly satisfactory and reproducible results. One disadvantage of the method is that maximal inspiratory pressure (MIP) could not be measured with this technique.

The MEPs recorded in our subjects (Table I) were quite comparable with values reported in literature (Table III). The age group in Tomalak's study (7–14 yr) (1) was closest to our study (6–10 yr). It is difficult to compare values of MEP of our children with the other quoted references because the means reported by these workers envelope subjects over a wide age range, which included adolescents as well as adults. Inverse correlation between age and MEP has been demonstrated in adults (8, 10, 11). Some of the studies have reported a significant +ve correlation of respiratory pressure and age amongst children (1, 12, 13). Tomalak et al's 144 boys were in the age range 7–14, bordering on to adolescence

TABLE III : MEP values as measured in this study are tabulated with MEPs found in other studies. The nos. in brackets in the 2nd column are reference nos. of papers quoted in this paper.

Sr. No.	*Study*		*Age yr.*	*MEP mmHg*			
				Boys	*Girls*	*Adult males*	*Adults females*
1.	Present study		6–10	70.6±13.4	61.9±18.9	93±23	67±17
2.	Tomalak et al	(1)	7–14	60.0±17.0	53.0±14.0		
3.	Wagener et al	(2)	8–17	105±30 (Boys+girls)			
4.	Choudhuri et al	(3)	16.3	71.3±12.8			
5.	Smyth et al	(4)	adolescents	84±26	63±16		
6.	Fiz et al	(5)	27–28			81	60
7.	Black & Hyatt	(8)	20–74			171–136	111–94
8.	Karvonen et al	(11)	<25			113±52	72±34
			>50			94±34	55±28

TABLE IV : Comparative physical attributes of boys and girls in this study vis-à-vis Indian standards for mean age 8 yr. Mean heights and weights for standard Indian data taken from ref. 14. Standard BMI calculated from these values.

	Mean Ht cm.		*Mean Wt kg*		*Mean BMI*	
	Present study	*Indian standard*	*Present study*	*Indian standard*	*Present study*	*Indian standard*
Boys	119±6	124	18.9±3.1	23.5	13.3±1.0	15.3
Girls	118±6	123	17.9±2.6	23.0	12.9±1.1	15.2

(1). We did not test for this relationship because of a relatively small number of subjects who were mostly in the 6–8 year range. Szeinberg et al (12), did not find a difference in the respiratory pressures between boys and girls who were between 8–10 yrs of age. Our subjects were between 6–10 yrs of age, and hence difference in muscle strength between the two sexes did not affect power generation by the respiratory muscles. Various factors such as minor variations in technique, physical variables, may have accounted for the wide range of normal values of maximal respiratory pressures reported by various workers (4, 5, 8). Subject motivation and coordination also play a part in generation of respiratory pressures.

Our subjects visually conveyed the impression of being poverty ridden, and in a poor state of general health. A few had pallor, while most had superficial skin infections. We did not measure their haemoglobin as it would have required pricking of fingers which may be considered unethical. The mean height, and weights of these children fitted into the 10th percentile and the 25th percentile respectively of available norms for Indian children (14). Their mean BMIs also were close to those calculated for Indian children from mean height and weight (Table IV). Therefore, contrary to expectations, our subjects, though apparently thriving poorly, were well within the normal standards of physical development. As such, the respiratory pressures generated by children including those under report, are relatively high when compared with adult pressures because in children the pressures are generated over a less surface area of the lungs, giving a relatively high pressure per unit area. This may counteract to an extent the non availability of greater muscle mass (15). It is possible that our subjects found adequate nourishment in whatever they consumed, including natural resources containing essential nutrients. By necessity, these children have to be highly active physically to thrive from day to day. These factors may have helped in generation of relatively high respiratory pressures in them, contrary to what had been predicted. Regulated physical activity helped adolescents who were residents of a military school, to develop higher MEPs compared with their colleagues who were non residents at the same school (3). The resident students were taller (150 cm vs 140 cm) and heavier (37 kg vs 32 kg). Perhaps in the cohort under study, this factor of physical endurance in a rural environment helped in the generation of adequate pressures.

It has been recommended that a slight leak be placed in the mouth piece to prevent additional pressure generation by facial muscles in some subjects when the respiratory pressures are being measured (8). Facial muscle activity contributes mostly to the generation of inspiratory pressures (11). We measured only the expiratory pressure in our field study. Therefore we did not find it necessary to use a leak in the mouth piece for measuring the pressures in this field study. Further, the MEPs measured in our adult subjects with and without the mouth piece leak did not show any difference (Table I). This vindicated our not using a leak at the mouth in the measurements on our children in the field setting. Black and Hyatt (8) developed a twin diaphragm gauge instrument for recording MEP at the start of the forceful expiratory effort near about the TLC, and the MIP near the residual volume. Others used cylindrical tubes (5, 6), mechanical mouth pressure meters (10), and membrane manometer (11). Smyth et al (4) had used a water manometer to make their measurements of these pressures in adolescents. The findings of this study substantiate the fact that the simplicity of the method used here should make it a convenient clinical investigation tool whenever indicated.

Respiratory pressures may not correlate well with physical parameters (10). But the BMI in both girls and boys in our cohort was positively, though not significantly related to the respiratory pressure ($P>0.05$). In the boys, height and weight showed a significant positive correlation with the MEP generated (Table II) This apparent discrepancy may have occurred because BMI is a ratio, with different weightages given to height and weight. Wagener et al (2) and Wilson et al (13) also found that the height and MEP in children were positively and significantly related.

Non-respiratory muscle strength

Respiratory muscle strength, as represented by the MEP generated (1) correlated with non-respiratory muscle strength as measured from upper arm muscle circumference (2). This would be expected because both groups involve use of striated muscle. Handgrip strength was used by us as an indicator of non-respiratory muscle strength. The positive correlation was significant only for pooled data for boys and girls (Table II). It is possible that the relatively small number of subjects (29 boys and 21 girls) obscured statistical significance. Respiratory pressures have been shown to correlate significantly with peak expiratory and inspiratory flow rates (1). This is expected, as both these variables are effort dependent, and the recording of the MEP and MIP are done at the start of forced expiration, and at the beginning of forced inspiration respectively (8), stages at which there is maximum activation of concerned respiratory muscles.

Conclusions

MEP measurement may be done easily and reproducibly using a clinical mercury nanometer. Using this simple method, we demonstrated that MEPs of village children belied their apparently poorly nourished state. It is possible that though apparently malnourished, the life style of these children may be such that they may be ingesting enough essential and other nutrients to help them thrive well in the face of adversity.

It is also felt that this simple and effective bedside test should be used in patients with respiratory problems for physiological assessment towards more effective clinical management.

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