Pulmonary function of adolescents from Tripura, a North-eastern state of India

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ABSTRACT

Objective: Spirometric evaluation of pulmonary function has been evolved as clinical tool in diagnosis, management, and follow-up of respiratory disorders. There are very few studies on normative reference values of pulmonary function parameters for adolescents from Tripura, a North-eastern state of India. The present study was aimed to evaluate pulmonary function and their predictors in male and female adolescents of Tripura. Materials and Methods: A total of 640 (320 from tribal and 320 non-tribal) healthy, non-smoking male and female school children (age 10-14 years) from four different districts of Tripura were randomly sampled for the study. The pulmonary function parameters analysed included forced vital capacity (FVC), forced expiratory volume in 1 second (FEV₁), peak expiratory flow rate (PEFR), forced expiratory flow between 25% and 75% expired volume (FEF₂₅‑₇₅%), ratio of FEV₁/FVC and maximum voluntary ventilation (MVV). Results: The results revealed that body weight, body mass index (BMI), PEFR, FEF₂₅‑₇₅%, and MVV are significantly high among male tribal children in comparison to non-tribal children. Height, weight, waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), PEFR and MVV were found to be significantly more in tribal girls. In case of adolescents from Tripura, most of the pulmonary function parameters correlated with anthropometric parameters of the subject like height, weight, BMI, WHR, and WHtR. Conclusion: From the present study, it can be concluded that both anthropometric and pulmonary function status of tribal and non-tribal adolescents from Tripura are comparable. The computed regression norms may be used to predict pulmonary function of adolescents from Tripura by using anthropometric indices.

KEY WORDS: Anthropometric indices, correlation, prediction equation, pulmonary function, tribal and nontribal adolescents

INTRODUCTION

Spirometric evaluation of pulmonary function is the most important tool for clinical assessment of respiratory functions in individuals. Population specific reference values are necessary for maintaining the reliability of pulmonary function evaluation. Till now, several studies have reported reference values for pulmonary function from different corners of the world, including India. There is significant difference in these values owing to genetic, environmental and ethnic differences of the population studied. The normal standards for pulmonary function measurements among the tribal adolescents of Tripura, a North eastern state of India is not reported yet. Moreover, the difference between tribal and nontribal adolescents residing in Tripura is also not reported. Since, ethnicity and environment plays important role in influencing pulmonary function, and in view of paucity of pertinent data, evaluation of pulmonary function of adolescents from Tripura seemed important.

The present study was, therefore, aimed to evaluate pulmonary functions of both tribal and non tribal adolescents from Tripura. The study also aimed to evaluate association of pulmonary function parameters with various physical and anthropometric parameters of the subject from both the groups.

MATERIALS AND METHODS

This cross sectional study was conducted among adolescents from eight schools covering four different
districts of Tripura. From each district one rural and one urban school was included for the study. The study was conducted between February to June 2013. Total number of subjects included in the study were six hundred and forty (640). Out of which 320 were from tribal and another 320 were from nontribal community of the state. In each group equal number of male (160) and female (160) were included for the study. The sample size was calculated according to World Health Organisation method for sample size calculation in health studies taking 95% confidence.[11]

All the students with in the age group of 10-14 years were requested to participate in the study, irrespective of their sex, ethnicity or socioeconomic status. A pre validated questionnaire that was used in INSEARCH studies across India was administered to the parents to identify children with any respiratory symptoms.[12] One hundred and eighty seven (187) subjects having the history or existing pulmonary disorders were excluded from the study. Informed consent to participate in the study was obtained from the parents of each children. The study protocol was approved by the Human Ethical Committee of the University.

Demographic information of the subject including age, sex, and ethnicity were recorded.[13] Anthropometric parameters like weight, height, chest circumference, hip and waist circumference were recorded using standardized procedure.[14] Height was measured with subject standing barefoot on a stadiometer (Bio + Plus R. Sl. No. 51392) and rounded to the nearest 10th of a centimetre. Weight was recorded with the subjects wearing school uniforms to an accuracy of ± 0.1 kg by using a standard spring balance (Libra, India). Waist circumference was measured at the level of umbilicus and hip circumference was measured across the greater trochanter with legs and feet together by using a tailors measuring tape. The body mass index and waist hip ratio were calculated.[10]

A complete spirogram was performed according to American Thoracic Society (ATS) guidelines[15] by using an expiograph (Helios 702, RMS, India). The test was carried out in a private and quiet room in a standing position with the nose clip held in position on the nose. Data from two hundred and fifty three (253) subjects were not included for analysis as they could not perform spirometry according to ATS standard. The flow, volume/timed graph were taken out in accordance to the criteria based on the ATS. The subject was instructed to take a deep breath until the lung were full and then blow out through mouth as forcibly and as fast and as long as possible till the maximum capacity, sealing the lips tightly around a clean mouth piece. Best of the three acceptable curves was selected as the recording.

Spirometric parameters recorded for analysis were forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), FEV1/FVC ratio, peak expiratory flow rate (PEFR), forced expiratory flow FEF25-75%. The maximum voluntary ventilation (MVV) was determined by fast, deep breathing for a 10 second period and reported as liters/minute.

Statistical analysis was performed using SPSS 16.0 (statistical Program for the Social Sciences) for Windows. Continues variables (e.g. age) were reported as mean ± standard deviation (SD). The mean for age, height, weight, BMI, WHR, FVC, FEV1, PEFR, FEF25-75% and MVV were stratified by gender and ethnicity. The t-test was used to test for the difference in measurements between various groups at the level of significance P < 0.05. Pearson’s correlation coefficients between spirometric parameters (FVC, FEV1, FEV1/FVC, PEFR, FEF25-75% and MVV) and age, height, weight, BMI and WHR were calculated. Linear regression analysis was performed to establish the relationship between pulmonary function parameter and physical parameters.

RESULTS

Table 1 shows the comparison of mean values for anthropometric and pulmonary function characteristics between tribal and non tribal male subjects. Among different anthropometric and pulmonary function parameters mean values for weight, BMI, PEFR, FEF25-75% and MVV were found to be significantly higher in tribal male than their non-tribal counterpart.

Table 2 represents anthropometric and pulmonary function parameters in female subjects. Mean values for WHR, WHR, PEFR, and MVV of the subjects were significantly higher in tribal female and mean values height and weight were found to be higher in non tribal female subjects.

Table 3 represents comparison of various pulmonary function parameters recorded in different groups of Indian children recently.[16-20] It shows that various parameters recorded in our study is comparable with that from other groups of children. The variations in values may be due

| Parameters | Tribal (160) | Non-tribal (160) | P value |
|------------|-------------|-----------------|---------|
| Age (years) | 11.99±1.26 | 11.95±1.23 | 0.8051 |
| Height (cm) | 143.41±8.78 | 143.64±8.63 | 0.8154 |
| Weight (kg) | 35.40±3.97 | 32.76±3.39 | <0.0001*** |
| BMI | 17.20±1.14 | 15.95±1.78 | <0.0001*** |
| WHR | 0.44±0.04 | 0.44±0.04 | 0.2798 |
| WHR | 0.89±0.06 | 0.88±0.06 | 0.1781 |
| FVC (L) | 1.69±0.07 | 1.69±0.07 | 0.8941 |
| FEV1 (L) | 1.51±0.10 | 1.52±0.09 | 0.6584 |
| FEV1/FVC % | 89.72±5.99 | 89.95±5.82 | 0.7315 |
| PEFR (L/sec) | 4.57±0.79 | 4.22±0.90 | 0.0003*** |
| FEF25-75% | 2.93±0.46 | 2.70±0.44 | <0.0001*** |
| MVV (L/min) | 61.34±10.81 | 57.55±11.83 | 0.0030** |

Values are in mean±SD, “*”significant P values. BMI: Body mass index, WHtR: Waist-to-height ratio, WHR: Waist-to-hip ratio, FEV1/FVC: Forced expiratory volume in 1 second/Forced vital capacity, PEFR: Peak expiratory flow rate, MVV: Maximum voluntary ventilation, **Strongly Significant, ***Moderately Significantly
variation in age group included and method and sensitivity of study protocol employed.

In male subjects PEFR and FEF\textsubscript{25-75}\% is correlated positively with age of the subject. Height of the subject correlated positively with FEV\textsubscript{1}/FVC\%, PEFR, FEF\textsubscript{25-75}\% and negatively with FVC. Weight of the subjects shows significant positive correlation with PEFR, FEF\textsubscript{25-75}\%, and negative correlation with FVC of the subject. BMI of the subjects positively correlated with FVC, PEFR, and MVV and negative correlation was found between BMI and FEV\textsubscript{1}/FVC\% of the subjects. WHR of the subject correlated negatively with FEV\textsubscript{1}/FVC\%, and positively with FVC, and MVV of the subjects. WHR of the subjects exhibited significant positive correlation with FVC, MVV and negative correlation with FEV\textsubscript{1}/FVC\% of the male subjects [Table 4].

Table 2: Recording of anthropometric and pulmonary function parameter of tribal and nontribal female subject

| Parameters          | Tribal (160) | Non-tribal (160) | P value |
|---------------------|--------------|------------------|---------|
| Age (years)         | 11.84±1.29   | 11.97±1.29       | 0.3757  |
| Height (cm)         | 137.1±7.71   | 140.67±9.01      | 0.0002*** |
| Weight (kg)         | 32.36±3.37   | 33.53±3.91       | 0.0042  |
| BMI                 | 17.26±1.77   | 16.99±1.70       | 0.1527  |
| WHR                 | 0.47±0.04    | 0.44±0.04        | <0.0001*** |
| WHR                 | 0.90±0.06    | 0.88±0.06        | <0.0001*** |
| FVC (L)             | 1.70±0.08    | 1.69±0.07        | 0.1335  |
| FEV\textsubscript{L} | 1.51±0.09    | 1.51±0.09        | 0.9951  |
| FEV\textsubscript{FVC} % | 88.51±6.06   | 88.97±7.07       | 0.5281  |
| PEFR (L/sec)        | 4.74±0.63    | 4.36±0.87        | <0.0001*** |
| FEF 25-75\%         | 2.81±0.43    | 2.75±0.43        | 0.1938  |
| MVV (L/min)         | 64.28±11.79  | 58.68±11.15      | <0.0001*** |

Values are mean±SD; *significant P values. BMI: Body mass index, WHR: Waist-height ratio, WHR: Waist-to-hip ratio, FEV\textsubscript{1}/FVC: Forced expiratory volume in 1 second/Fixed vital capacity, PEFR: Peak expiratory flow rate, MVV: Maximum voluntary ventilation, FEF: Forced expiratory flow, ***Strongly significant, **Moderately significant.

Table 3: Recent reports on pulmonary function measurements by different authors

| Author’s Name        | Subjects | Age range (years) | FVC (L) | FEV\textsubscript{1} (L) | FEV\textsubscript{1}/FVC\% | PEFR (L/sec) | FEF 25-75\% | FEF 50\% | MVV (L/min) |
|----------------------|----------|-------------------|---------|--------------------------|---------------------------|---------------|-------------|----------|-------------|
| Singh et al. (2014)  | Boys (n=109) | 10-14             | 2.53    | -                        | -                         | 5.80          | -           | -        | -           |
|                     | Girls (n=158) | 10-14             | 2.31    | 2.18                      | 5.29                      | -             | -           | -        | -           |
| Thakare et al. (2014)| Rural boys (n=110) | 5-15             | 1.89±0.93 | 1.752±0.805                | -                         | 3.96±1.762    | -           | -        | -           |
|                     | Urban boys (n=110) | 5-15             | 1.44±0.737 | 1.353±0.657                | -                         | 3.16±1.708    | -           | -        | -           |
|                     | Rural girls (n=110) | 5-15             | 1.60±0.666 | 1.586±0.622                | -                         | 3.95±1.496    | -           | -        | -           |
|                     | Urban girls (n=110) | 5-15             | 1.39±0.635 | 1.240±0.548                | -                         | 3.47±1.312    | -           | -        | -           |
| Tahere et al. (2010) | Boys (n=408) | 8-14              | 2.01±0.46 | 1.76±0.38                 | 4.74±0.96                 | -             | -           | -        | -           |
|                     | Girls (n=247) | 8-14              | 1.91±0.47 | 1.688±0.403                | 4.47±1.15                 | -             | -           | -        | -           |
| Vijayan et al. (2000) | Boys (n=246) | 7-19              | 2.05    | 1.79                      | -                         | 3.64          | -           | 2.32     | 68.0        |
|                     | Girls (n=223) |                   |         |                          |                           |               |             |          |             |
| Budhiraja et al. (2010)| Male (n=57.1% of 600) | 6-15        | 2.16 | 1.95                     | -                         | 3.663         | -           | 2.68     | 72.91       |
|                     | Female (n=42.9% of 600) | 6-15       | 1.80 | 1.66                     | 3.056                    | -             | -           | 2.37     | 62.97       |
| Present study       | Tribal (rural and urban n=320) | 10-14     | 1.70±0.08 | 1.51±0.09 | 88.51±6.06 | 4.74±0.63 | 2.81±0.43 | 64.28±11.79 | -           |
|                     | Non-tribal (rural and urban n=320) | 10-14 | 1.69±0.07 | 1.51±0.09 | 88.97±7.07 | 4.36±0.87 | 2.81±0.43 | 58.68±11.15 | -           |

FEV\textsubscript{1}/FVC: Forced expiratory volume in 1 second/Fixed vital capacity, PEFR: Peak expiratory flow rate, MVV: Maximum voluntary ventilation, FEF: Forced expiratory flow

Table 4: Pearson’s correlation coefficient between different anthropometric and pulmonary function parameter of male subject

| Parameters          | Age (years) | Height (cm) | Weight (kg) | BMI | WHR | WHR |
|---------------------|-------------|-------------|-------------|-----|-----|-----|
| R                   | P           | R           | P           | R   | P   | P   |
| FVC (L)             | -0.068      | 0.222       | -0.280**    | 0.000 | -0.139* | 0.198** | 0.000 | 0.256** | 0.000 |
| FEV\textsubscript{L} | 0.066       | 0.237       | 0.035       | 0.536 | 0.020 | 0.725 | -0.040 | 0.471 | -0.047 | 0.405 | -0.092 | 0.099 |
| FEF/\text{FVC%}     | 0.102       | 0.069       | 0.198**     | 0.000 | 0.100 | 0.074 | -0.156** | 0.005 | -0.195** | 0.000 | -0.241** | 0.000 |
| PEFR (L/sec)        | 0.159**     | 0.005       | 0.115*      | 0.040 | 0.241** | 0.000 | 0.133* | 0.017 | -0.044 | 0.431 | 0.065 | 0.243 |
| FEF\textsubscript{25-75}\% | 0.375**     | 0.000       | 0.228**     | 0.000 | 0.338** | 0.000 | 0.098 | 0.082 | -0.046 | 0.408 | 0.056 | 0.314 |
| MVV (L/min)         | 0.073       | 0.193       | -0.052      | 0.355 | 0.103 | 0.066 | 0.179** | 0.001 | 0.123* | 0.029 | 0.122* | 0.029 |

FVC: Forced vital capacity, FEV\textsubscript{1}: Forced expiratory volume in one second, FEV\textsubscript{1}/FVC\%: Forced expiratory volume in 1 sec as percentage of FVC, PEFR: Peak expiratory flow rate, FEF\textsubscript{25-75}\%: Mid expiratory flow rate, MVV: Maximum ventilator volume, FEF: Forced expiratory flow, *P<0.05; **P<0.01; ***P<0.001
The regression equation for FVC, FEV_{1}, FEV_{FVC\%}, PEF, and MVV based on weight, BMI, WHR, and WHR are presented in Table 6 for male subjects and Table 7 for female subjects. A comparison of recently reported regression equations among Indian children is represented in Table 8.[17-22] Most of these equations used age, height, weight of the subject as predictors of pulmonary function. Pulmonary function in our subjects showed positive correlation with age, weight, BMI, WHR, and WHR. The regression equation showed significant correlation with WHRR. However, the waist to hip ratio (WHR), BMI, and MVV for tribal children were found to be higher. The waist to hip ratio (WHR) and waist to height ratio (WHtR) of tribal female were significantly higher.

The tribal population of the country is generally at risk of under nutrition owing to different factors affecting their health status.[23] Most of the earlier studies have reported poor health condition of tribal children.[24] Comparable nutritional status of tribal children from Tripura indicates improved health status of the children owing to improved health care and other facilities.[25]

The lung function parameters like PEF, PEF50%, and MVV were found to be significantly higher in tribal children than the non-tribal children. Other lung function parameters like FVC, FEV_{1}, FEV_{FVC\%} were found to be comparable between the children of both the groups. Singha and Nag also reported a higher value of FVC, FEV_{1}, among the urban male tribal children of Tripura than the non-tribal children.[26] PEF recorded by them was less in tribal male than non-tribal male children. Gupta et al. reported a better peak expiratory flow rate for children living at high altitude than the lowlanders.[27]

However, Kasayp et al. did not find any difference in PEFR values between highlander tribal children and children from West or lowlanders urban North Indian children.[28] Comparable nutritional status of tribal children might improve their health and nutrition status. The lung function measurements of the present study indicate that the tribal children of Tripura have better lung function parameters than the non-tribal children. Therefore, more research is required to understand the factors affecting the lung function of tribal children of Tripura.

### DISCUSSION

In the present study, we evaluated pulmonary function and their anthropometric predictors in school children 10-14 years of age from Tripura, a North eastern state of India. The pulmonary function and anthropometric parameters of ethnic tribal children and non-ethnic Bengali children residing in the state of Tripura, evaluated in our study, are found to be comparable. The bodyweight and BMI of tribal children were significantly higher. Both height and weight of non-tribal female were found to be higher. The waist to hip ratio (WHR) and waist to height ratio (WHtR) of tribal female were significantly higher.

### Table 5: Pearson’s correlation coefficient between different anthropometric and pulmonary function parameter of female subject

| Parameters | Age (years) | Height (cm) | Weight (kg) | BMI | WHR | WHtR |
|------------|-------------|-------------|-------------|-----|-----|-------|
| FVC (L)    | 0.149**     | 0.008       | 0.087       | 0.120 | 0.145** | 0.009 | 0.053 | 0.345 | 0.149** | 0.008 | 0.350** | 0.000 |
| FEV (L)    | 0.331**     | 0.000       | 0.363**     | 0.000 | 0.251** | 0.000 | -0.189** | 0.000 | -0.306** | 0.000 | -0.201** | 0.000 |
| FEV/FVC%   | 0.212**     | 0.000       | 0.292       | 0.000 | 0.206** | 0.000 | -0.138** | 0.014 | -0.329** | 0.000 | -0.337** | 0.000 |
| PEF (L/sec)| 0.262**     | 0.000       | 0.072       | 0.198 | 0.221** | 0.000 | 0.140*   | 0.012 | -0.032   | 0.571 | -0.002   | 0.975 |
| FEF 25-75% | -0.008      | 0.892       | 0.124       | 0.026 | -0.002 | 0.971 | -0.159** | 0.004 | -0.023   | 0.683 | 0.068    | 0.222 |
| MVV (L/min)| -0.115*     | 0.040       | -0.137*     | 0.014 | -0.043 | 0.440 | 0.106     | 0.059 | 0.196** | 0.000 | 0.191**  | 0.001 |

FVC: Forced vital capacity, FEV_{1}: Forced expiratory volume in one second, FEV_{FVC\%}: Forced expiratory volume in 1 sec as percentage of FVC, PEF: Peak expiratory flow rate, FEF: Forced expiratory flow, MVV: Maximum voluntary ventilation, WHR: Waist hip ratio, WHtR: Waist height ratio, BMI: Body mass index, *P<0.05; **P<0.01; ***P<0.001

### Table 6: Multiple regression norms for the prediction of pulmonary function measurements in male adolescent of Tripura

| Dependent variable | Sex      | Regression equation | R   | R²  | P value |
|--------------------|----------|---------------------|-----|-----|---------|
| FVC (L)            | Male     | FVC (L)=1.576+0.01881*BMI−0.8585*WHR+0.4981*WHR−0.007627*Weight | 0.3466 | 0.1201 | <0.001*** |
| FEV (L)            | Male     | FEV (L)=1.595−0.01202*BMI+1.006*WHR−0.5681*WHR+0.005260*Weight | 0.1531 | 0.0234 | 0.1119 |
| FEV/FVC%           | Male     | FEV/FVC%=100.57−1.729*BMI+108.46*WHR−61.821WHR+0.7257*Weight | 0.3395 | 0.1152 | <0.001*** |
| PEF (L/sec)        | Male     | PEF (L/sec)=−1.261+0.00870*BMI−7.474*WHR+4.955*WHR+0.02096*Weight | 0.2862 | 0.0819 | <0.001*** |
| FEF 25-75%         | Male     | FEF 25-75%=−0.05245+0.1052*BMI+5.496*WHR−0.07909*Weight | 0.4003 | 0.1608 | <0.001*** |
| MVV (L/min)        | Male     | MVV (L/min)=18.963−0.1146*BMI+76.117*WHR−14.309*WHR+0.6350*Weight | 0.2127 | 0.0453 | 0.005*** |

FEV/FVC: Forced expiratory volume in one second/Forced vital capacity, PEF: Peak expiratory flow rate, MVV: Maximum voluntary ventilation, FEF: Forced expiratory flow, BMI: Body mass index, WHR: Waist hip ratio, WHtR: Waist height ratio, *P<0.05; **P<0.01; ***P<0.001

### Table 7: Multiple regression norms for the prediction of pulmonary function measurements in female adolescent of Tripura

| Dependent variable | Sex      | Regression equation | R   | R²  | P value |
|--------------------|----------|---------------------|-----|-----|---------|
| FVC (L)            | Female   | FVC (L)=1.166−0.415*XWeight+0.002807*BMI−0.9983*WHR+1.048*WHR | 0.4495 | 0.2021 | <0.001*** |
| FEV (L)            | Female   | FEV (L)=1.576+0.01093*Weight−0.1980*BMI+0.5109*WHR−0.3641*WHR | 0.3933 | 0.1547 | <0.001*** |
| FEV/FVC%           | Female   | FEV/FVC%=-109.90+0.8649*Weight−1.415*XBMI+93.416WHR−76.212*WHR | 0.4234 | 0.1792 | <0.001*** |
| PEF (L/sec)        | Female   | PEF (L/sec)=−2.634+0.05266*Weight+0.01147*BMI+2.240*WHR−1.164*WHR | 0.2343 | 0.0549 | 0.0013 |
| FEF 25-75%         | Female   | FEF 25-75%=−2.404+0.009159*Weight−0.05583*BMI−0.3821*WHR+1.352*WHR | 0.2219 | 0.0492 | 0.0031 |
| MVV (L/min)        | Female   | MVV (L/min)=−28.926−0.02856*Weight+0.2116*BMI+24.094*WHR+21.305*WHR | 0.2023 | 0.0409 | 0.0103 |

FEV/FVC: Forced expiratory volume in one second/Forced vital capacity, PEF: Peak expiratory flow rate, MVV: Maximum voluntary ventilation, FEF: Forced expiratory flow, BMI: Body mass index, WHR: Waist hip ratio, WHtR: Waist height ratio, *P<0.05; **P<0.01; ***P<0.001
Table 8: Predictive equation derived from different recent studies

| Author          | Subject | Respiratory parameter studied | Anthropometric variable studied | Predictive equation derived                  |
|-----------------|---------|-------------------------------|---------------------------------|---------------------------------------------|
| Thakare et al.  | Rural   | FVC, FEV<sub>1</sub>, PEFR    | Age, height, weight, arm span, BSA | FVC = −0.546+0.208 (age)+0.001 (height)+0.04 (weight)+0.016 (arm span)=1.99 (BSA) |
|                 | Urban   | FVC, FEV<sub>1</sub>, PEFR    | Age, height, weight, arm span, BSA | FEV = −0.759+0.175 (age)+0.007 (height)+0.006 (arm span)=1.052 (BSA) |
|                 |         |                               |                                 | PEFR = −1.577+0.359 (age)+0.024 (height)+0.031 (weight)+0.018 (arm span)=2.206 (BSA) |
|                 |         |                               |                                 | FVC = −0.388+0.159 (age)+0.023 (height)+0.04 (weight)+0.016 (arm span)=1.99 (BSA) |
|                 |         |                               |                                 | FEV = −0.255+0.147 (age)+0.018 (height)+0.04 (weight)+0.011 (arm span)=2.151 (BSA) |
|                 |         |                               |                                 | PEFR = −0.989+0.361 (age)+0.031 (height)+0.026 (weight)+0.031 (arm span)=1.496 (BSA) |
| Budhiraja et al.| FVC, FEV<sub>1</sub>, PEFR, MVV | Age, sex, height, weight         | FVC = −2.891+0.0254 (Age years)+0.1257 (Sex)+0.0271 (Ht (cm))+0.0172 (Wt (kg)) |
| et al. (2010)   |         |                               |                                 | FEF = −2.366+0.021 (Age years)+0.0906 (Sex)+0.0236 (Ht (cm)) |
|                 |         |                               |                                 | PEFR = −214.587+3.2039 (Age years)+17.451 (Sex)+2.2489 (Ht (cm))+1.1375 (Wt (kg)) |
|                 |         |                               |                                 | MVV = −90.2014+2.3332 (Sex)+0.966 (Htt (cm))+0.5332 (Wt (kg)) |

FVC: Forced vital capacity, FEV<sub>1</sub>: For ery expiratory volume in one second, PEFR: Peak expiratory flow rate, FEF: Forced expiratory flow, MVV: Maximum voluntary ventilation, WHR: Waist hip ratio, WHtR: Waist height ratio, BMI: Body mass index

contribute to better pulmonary function status among the tribal children from Tripura.\[20\]

Variables like ethnicity, age, weight, and height, are reported to be the prime predictors of lung function in different groups of population.\[19,20\] In our study, parameters like height, weight, BMI, WHR and WHtR correlated positively in different groups of subjects. Meng-chiao Tasi, et al. observed that standing height was the factor with highest correlation with the pulmonary function parameters in growing children aged 6-11 years in Tiawn city.\[21\] Ya-Nan Ma, et al. recently developed predictive equation of lung function for 9-15 years of age, height, and weight.\[22\] Doctor et al. in their study with Gujarati school children of age of 8-14 years of age found, for FVC and FEV highest correlation was presented with age in girls and height in boys. For FEV1% significant negative correlation was found with age and height in both sexes, but positive correlation was found with surface area. Similarly, PEF showed highest correlation with surface area in boys and girls.\[23\] Various earlier studies on children from India mostly used age, height, and weight as predictor for pulmonary function.\[24-26\]

Number of recent studies have observed that pulmonary function shows an inverse relationship with various markers of obesity and fat distribution in children and adolescent.\[27-29\]

Markers of both general and visceral obesity like BMI, WC, WHR are reported to influence pulmonary function in children and adolescent.\[30,31\] Some of the recent studies showed that respiratory mechanics can be affected by fat distribution pattern and central obesity, estimated by WC and WHR, independent of BMI. In view of these findings and depending on results of correlation analysis we utilized marker of obesity like weight, BMI, WHR, and WHtR in multiple regression analysis for prediction of pulmonary function measurements in both male and female adolescents from Tripura.

The study included both ethnic and non ethnic population of the state for comparison. This provides overall picture of pulmonary function of different groups of children in the state. However cross sectional nature of the study is a limitation. Longitudinal studies are needed to investigate the effect of various anthropometric predictors on pulmonary function of the studied subjects.

CONCLUSION

In conclusion, our study determined the normative values for pulmonary function parameters in children from Tripura and proposed predictive equation with anthropometric markers like BMI, WHR, WHtR. These normative reference values can be utilized for evaluating pulmonary function of children living in Tripura.
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