Abstract: There are only a few studies that have established reference standards for pulmonary function of Indian children. Reference standards for pulmonary function that are reported for Indian children are mainly from particular area or parts of the country. There is a paucity of data on pulmonary function in normal school going Indian children residing near cement plants located in various parts of the country. Therefore, pulmonary function tests (spirometry and peak expiratory flow rates) were carried out in 491 children between 8-18 years of age to derive regression equations to predict pulmonary function. The correlations of forced vital capacity (FVC) and forced expiratory volume in one second (FEV1) as well as peak expiratory flow rates were established through regression analysis by preparing various models. The functions were regressed over all possible combinations of regressor variables, i.e. between independent variables (like AQI & Exp.Duration) and dependent variables (various indices). It would give a direct relation between damage severity of lungs and pollutants.

Key words: Pulmonary functions, Regression equations, Prediction equations.

I. INTRODUCTION

There are only a few studies that have established reference standards for pulmonary function of Indian school going children residing near cement plants. However, more than 100 reference standards are published for pulmonary function in children of different origin. The prevalence of childhood pulmonary diseases especially bronchial asthma is increasing worldwide and this necessitates the need for establishing regression equations for predicting damage in pulmonary functions in school children studying in schools near cement plants in different parts of the country. The reference standards for pulmonary function that are reported for Indian school going children are mainly from particular parts of the country and there is a paucity of data on pan India basis on pulmonary function in normal Indian children residing near operating cement plants. Pulmonary function is known to vary with various factors and changes in pulmonary functions can occur between children of different origin and children of other regions. Therefore, it is essential to have normal pulmonary function data for children residing near cement plants to interpret accurately the damage in pulmonary functions due to exposure to cement plants pollutants for different exposure duration.

A Research study was, therefore, planned to evaluate the pulmonary function changes due to exposure to cement plant pollutants in school children.

II. MATERIALS AND METHODS

Pulmonary function studies in children were carried out under relevant protocols approved. Informed consent was obtained from parents and from children. The procedure to be performed was explained in the local language to each child. Prior to pulmonary function testing, each child has assessments and investigations that included detailed history, physical examination through a well developed questionnaire to ascertain that children were free from respiratory symptoms at least three months before testing. Children were excluded from the study if they had structural deformity of the thoracic cage and were suffering from any acute or chronic respiratory or cardiac disease. Although the study population was not truly random, attempts were made to obtain a true representative cross section of normal subjects of school going children and to have a study population representative for the common socio-economic status. To achieve this, children were selected from the local area schools near cement plants. All study subjects were non-smokers. All tests were carried out in the morning after breakfast.

III. PULMONARY FUNCTION TESTS

Pulmonary function tests were carried out in 491 school going children between 8-18 years of age. The tests were carried out in the sitting position and a nose clip was applied. All pulmonary function tests were carried out on a dry-rolling spirometer (Transfer Test model C, P.K. Morgan Ltd., U.K.) and print outs were obtained from a computer. The equipment was calibrated every day. The coefficient of variation was less than 1% for forced vital capacity (FVC) and forced expiratory volume in one second (FEV1), less than 3% for peak expiratory flow rate (PEFR), forced midexpiratory flow (FMF) and forced expiratory flow at 25% of FVC (FEF25%FVC), less than 5% for forced expiratory flow at 50% of FVC (FEF50%FVC), and 10% for forced expiratory flow at 75% of FVC (FEF75%FVC).

IV. SPIROMETRY

The subject was asked to loosen tight clothing and was seated comfortably. The subject was instructed to take a full breath in, then close the lips around the mouth piece and blow out as hard and fast as possible. Inspiration should be full and unhurried and expiration once begins should be...
continued without a pause. A minimum exhalation time of 6
seconds was applied to obtain maximal FVC results. The
technique was demonstrated to every subject and the result
was expressed in litres in body temperature pressure
saturated (BTPS). A minimum of three acceptable forced vital
capacity (FVC) manoeuvres were obtained. Forced vital
capacity and forced expiratory volume in one second (FEV1)
of the best 2 of 3 acceptable tracings should not vary by more
than ± 5% of reading or 100 ml whichever is greater. The
largest of three acceptable FVC and FEV1 volumes were
recorded, even if the two values did not come from the same
curve. The ratio of FEV1 to FVC was expressed as
percentage.

V. MAXIMAL EXPIRATORY FLOW RATES
Maximal expiratory flow-volume loops were recorded by
asking the subject to take a deep breath until he breathed in to
total lung capacity (TLC) and to wrap his mouth tightly
around a mouth piece, and on a given signal to breath out to
residual volume, and finally suck it all back again as fast as
possible to TLC, taking care to keep his back against the
chair-back all of the time. At least three such flow-volume
loop (F-V loop) manoeuvres were obtained from each
subject. The highest value obtained from any of the three
tracings was used for calculation of peak expiratory flow rate
(PEFR). Values of forced expiratory flow, FEF25%/FVC,
FEF50%/FVC and FEF75%/FVC were derived from the single
best test and the best test was defined as the one with the
largest sum of FEV1 and FVC.

VI. STATISTICAL ANALYSIS
The entire data from the schools, school going children were
pooled to cover a wide range of variability, if any, and thus,
enhance applicability of the results, particularly the
prediction equations, to general population of children
exposed to similar cement plant pollutants for different
exposure duration. Each study variable was analyzed
separately. Significance of difference in various study
characteristics between different exposure duration was
tested by applying ‘t’ test after ascertaining homogeneity of
variances and normality separately for each segment of
exposure. Overall effect of pollutants on these variables was
tested by applying analysis of variance (two way
classification) after adjusting sum of squares for non-
orthogonality due to varying sample size in different
exposure category groups of school going children residing
near cement plants. Correlations were calculated between the
study variables both dependent and independent and the
physical characteristics separately for subjects. Their
significance from zero was tested by applying ‘t’ test. All the
study variables (regressor/dependent variable) were
thereafter regressed using least square principle. All possible
combinations of regressor (independent) variables were
considered to propose prediction equations and those with
simplicity, maximum amount of regressee variables sum of
squares explained (Rsq) by the equation and least standard
deviation from regression Sy-x in order of preference, were
taken to be the criteria to be proposed for predicting expected
study variables. In order to compare our regression equations
for FVC and FEV and PEF with those recently published
studies, expected values of these variables were determined
def mean exposure duration and Air quality index.
The conventional levels of probability, P=0.05 and P=0.01
were taken to be those being significant and highly
significant respectively.

VII. RESULTS
Of the 491 children surveyed, technically valid results were
obtained from 478 children. The data from schools, children
and cement plants were pooled to cover a wide range of
socio-economic strata and thus provide a broader
applicability of the prediction equations proposed in this
study. There was definite evidence of significant (P<0.01)
interaction shown by analysis of variance results thus
indicating diverse trend in different exposure duration under
different cement plant pollutants. Different regression
models, to establish the relation between independent
variables (like air quality index and exposure duration) and
dependent variables ie various indices, to give a direct
relation between damage severity of lungs and pollutants are
shown in regression models 1, 2 and 3.

Regression Analysis for IFVC
Regression Model 1

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Model Summary

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Model

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a. Predictors: (Constant), AQI, Exdur
b. Dependent Variable: IFVC

Coefficient

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a. Dependent Variable: IFVC

Regression Analysis for IPEF
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a. Predictors: (Constant), AQI, Exdur
b. Dependent Variable: IFVC

Coefficient

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a. Dependent Variable: IFVC
Regression Analysis for IFEV

Regression Model 2

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a. Predictors: (Constant), Expdur, AQI

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a. Predictors: (Constant), Expdur, AQI

REFERENCES