LINK BETWEEN AIR POLLUTION AND OBESITY, ASTHMA AND ALLERGIC DISEASES

Results and insights from a comparative study among adolescent school children in Delhi vs Kottayam and Mysuru- 3 cities of India

Study conducted by

LUNG CARE FOUNDATION

PURE
PULMOCARE RESEARCH & EDUCATION FOUNDATION

Supported by

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Report released in partnership with

DOCTORS FOR CLEAN AIR AND CLIMATE ACTION

CLIMATE TRENDS

Health Care Without Harm

ACKNOWLEDGEMENTS

We express our sincere thanks to:

- Shakti Sustainable Energy Foundation, India, for funding the study
- Doctors associated with various stages of this research study
  - Dr G. Siddesh, *Senior Consultant Surgeon, Mysuru*
  - Dr Binni John, *Senior Consultant Surgeon, Kottayam*
  - Dr. Anurag Agrawal, *Director, Institute of Genomics and Integrative Biology (IGIB), CSIR*
  - Dr. Parvaiz Koul, *Professor and Head, Internal and Pulmonary Medicine, Sher-i- Kashmir Institute of Medical Sciences & Editor, Lung India*
- Principals, Teachers, Staff Members, Parents and Children from participating schools in Delhi, Mysuru, and Kottayam
- Dr. M.P. George from Delhi Pollution Control Committee and Officials from pollution control boards at Mysuru and Kottayam for helping with Pollution data from their cities
- Pulmocare Research and Education (PURE) Foundation
  - Dr. Sundeep Salvi, *Director*
  - Sapna Madas
  - Deesha Ghorpade
- Lung Care Foundation
  - Dr. Arvind Kumar, *Founder Trustee*
  - Rajiv Khurana, *Founder Trustee*
  - Dr. Belal Bin Asaf, *Founder Trustee*
  - Abhishek Kumar, *Founder Trustee*
  - Matrushri P. Shetty, *Director- Programs and Strategy*
  - Dr. Harsh Vardhan Puri, *Medical Advisor*
  - Dr. Sukhram Bishnoi, *Medical Advisor*
  - Charu Dhingra, *Director- Medical Programs*
  - Neha Tiwari & Sadhana, *Nursing Officers*
  - Dr. Carmin Uppal, *Program Manager*
  - Hamid Rehman, *Network Manager*
  - Dr. Trao Lenei, *Project Coordinator*
  - Kritika Sharma, *Project Coordinator - BEST Clubs*

Design: Subhashish Roy

For more details:
Lung Care Foundation, C9/9624, Vasant Kunj, New Delhi – 110070
Contact no: +91-7838333985; Email: matrushri@lcf.org.in

www.lcf.org.in • www.dfca.org.in

CONTENTS

01
Introduction
Page 4–5

02
Aim of the Study
Page 6

03
Methodology
Page 7–12

- Study Design
- Sample Selection
- Data Collection
- Data Analysis

04
Key Findings
Page 13–17

05
Unique Features of the Study
Page 18–19

06
Limitations of the Study
Page 20

07
Recommendations
Page 21–22

LINK BETWEEN AIR POLLUTION AND OBESITY, ASTHMA AND ALLERGIC DISEASES

Results and insights from a comparative study among adolescent school children in Delhi vs Kottayam & Mysuru

INTRODUCTION

INTRODUCTION

India is one of the most polluted countries in the world. An estimated 1.67 million deaths were attributed to air pollution in India in 2019, and of these 59% were accounted for by ambient particulate matter air pollution ($PM_{2.5}$ and PM), the levels of which have increased steadily over the last 3 decades. Air pollution related health effects in India have cost an estimated economic loss of 36.8 billion USD, which is around 1.36% of India's gross domestic product, with Delhi reported to have the highest per capita economic loss due to air pollution in India.

Delhi, India's national capital region with a population of over 30 million, including 6 million children, is one of the most polluted cities on earth with annual average ambient PM_{10} and $PM_{2.5}$ levels exceeding the WHO standards by over 15-fold. A large and growing number of motor vehicles, presence of coal powered power plants in the vicinity, growing construction sites and burning of crop stubble in the neighbouring states, supported by weather and wind conditions have contributed to very high levels of ambient air pollution. Despite several dramatic measures to overcome the challenges of air pollution, such as odd-even travel schemes, shutting down of 6000 schools, total ban on all trucks entering the city, temporary shutdown of construction sites and closure of neighbouring coal powered plants, there has been hardly any change in air pollution levels in Delhi.

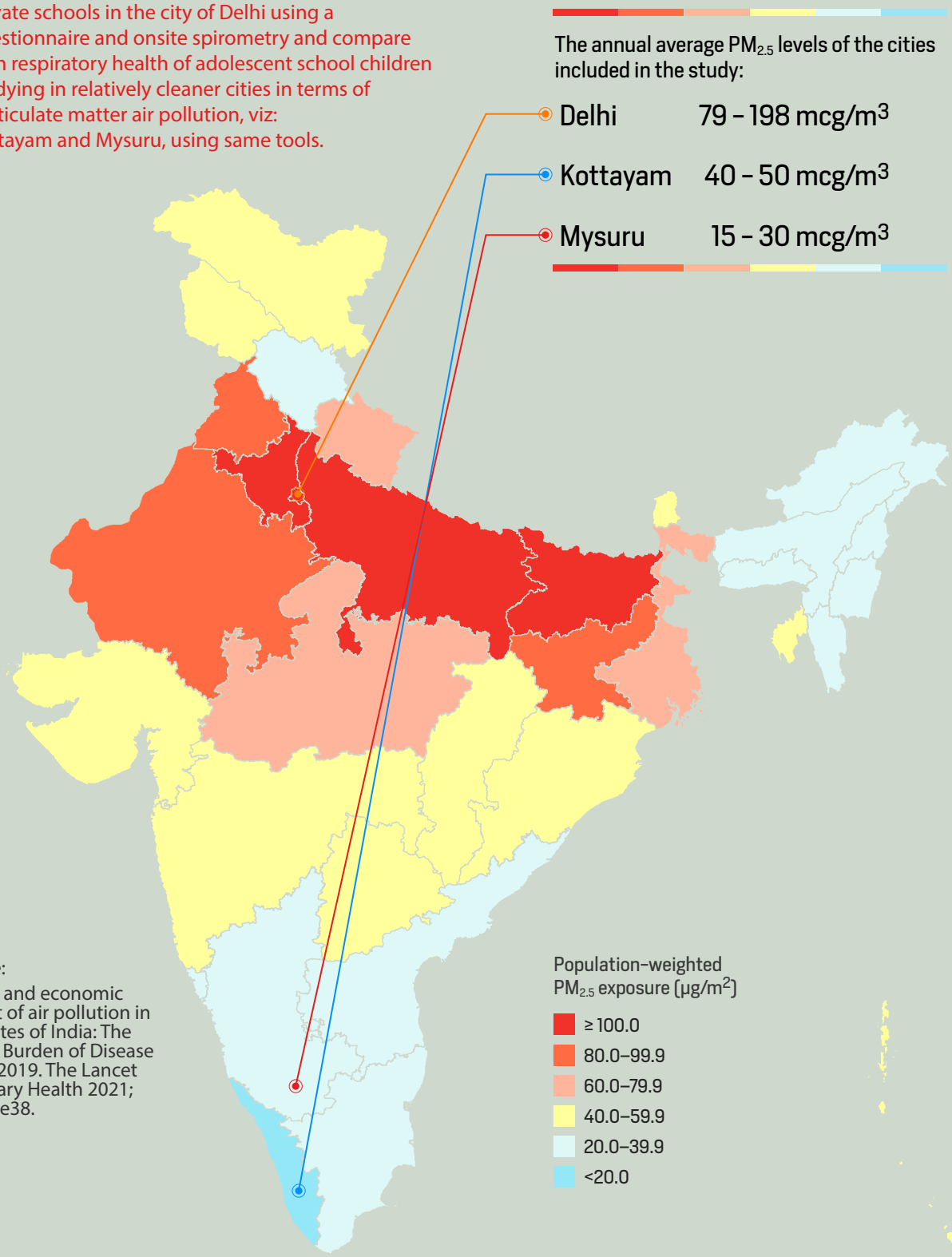
Children are most vulnerable to the harmful effects of air pollution, because they breathe greater volumes of air than adults and many of the pollutants in the inhaled air interfere with the proper growth and development of their lungs. **Chronic exposure to high levels of particulate matter air pollution have been shown to cause stunted lung growth, recurrent respiratory tract infections, asthma, cognition defects and more recently, obesity. Asthma in children has multifactorial etiology, which includes genetic factors, outdoor and indoor air pollution (including smokers in the family).**

Very few studies have examined the lung health of children living in Delhi. Most of them have used a questionnaire-based approach with very little emphasis on objective measures of lung function. Spirometry is the gold standard diagnostic test for lung disorders, especially asthma. However, it is a difficult test to perform and requires trained manpower. There are very few studies on spirometry in school children, not only in India, but across the world.

AIM OF THE STUDY

Lung Care Foundation partnered with Pulmocare Research and Education (PURE) Foundation for formulating the research hypothesis and developing the study design.

The primary aim of the study was to assess the respiratory health of adolescent school children studying in private schools in the city of Delhi using a questionnaire and onsite spirometry and compare with respiratory health of adolescent school children studying in relatively cleaner cities in terms of particulate matter air pollution, viz: Kottayam and Mysuru, using same tools.



Source:
Health and economic impact of air pollution in the states of India: The Global Burden of Disease Study 2019. The Lancet Planetary Health 2021; 5: e25-e38.

METHODOLOGY

STUDY DESIGN

A cross-sectional, case-control study design using quantitative methods, conducted in three cities of India namely – Delhi, Kottayam and Mysuru.

Delhi (henceforth referred to as D) was taken as the **Case**

Kottayam & Mysuru henceforth referred to as K-M) were taken as **Controls**

STUDY POPULATION STUDY POPULATION & SAMPLING METHOD

Adolescent boys and girls aged 13-14 and 16-17 years were chosen from randomly selected private schools in Delhi, Kottayam and Mysuru.

Delhi : 3 schools
Kottayam : 6 schools
Mysuru : 3 schools

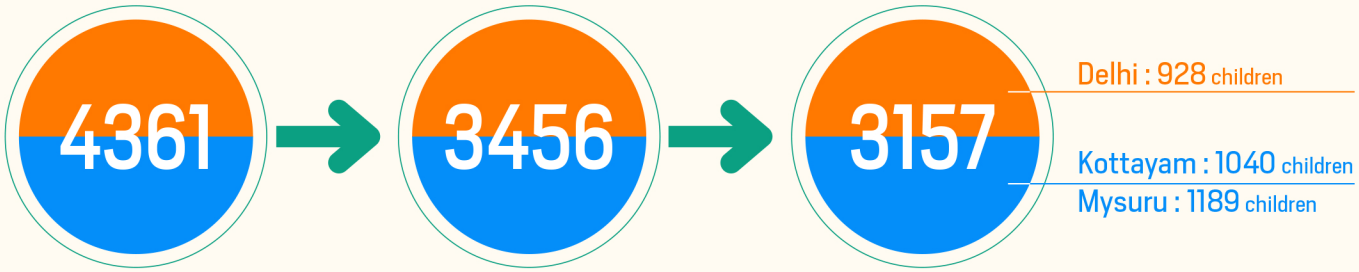
The number of schools selected were based on a minimum sample size of 1000 students required at each site.

Inclusion criteria:

Boys and girls from private schools* belonging to age group between 13-14 (VIII Graders) and 16-17 years (XI Graders) were chosen for the following reasons:

- Lung function of children in this age group is closest to the peak adult lung function
- It is easier to perform spirometry in these children through schools as a research study of this rigour needs good cooperation from children and their parents.

** We chose only private schools in order to minimize the confounding caused by undernutrition, overcrowding and indoor air pollution, risk factors known to be associated with asthma.*



Total no. of children invided to participate in the study

No. of children who consented to participate in the study

3456/4361:
Response rate 79.2%

No. of children who filled up Questionnaire correctly & performed good quality spirometry and finally included in the study

3157/3456:
Success rate 91%

METHODOLOGY

DATA COLLECTION

Tools

Questionnaire

The study questionnaire included demographic details, symptoms suggestive of asthma, allergic rhinitis and eczema and risk factors associated with these diseases. This was based on a standard, validated questionnaire developed by the International Study for Asthma and Allergic Diseases in Children (ISAAC).

Height and Weight Measurement

Measurements for calculating the Body Mass Index (BMI)

Underweight: <18.5 kg/m^2 Normal: 18.5–23 kg/m^2 Overweight: 23–27 kg/m^2 Obese: >27 kg/m^2

(Reference: Haq I, Raja M, Ahmad M. A comparison of the 2015 Indian Academy of Pediatrics, International Obesity Task Force and World Health Organization growth references among 5-18-year-old children. Ann Trop Med Public Health. 2017;10:1814-9.)

Spirometry

Pre-bronchodilator spirometry was performed using the nDD ultrasonic spirometer (Easy one® Air, Switzerland). The predicted values for spirometry were taken from the Global Lung Index 2012 data, which is the only authenticated equation for spirometry in this age group globally.

Process

STEP 01 A **study team** was formed by Lung Care Foundation to carry out the research study.

4 **doctors/ supervisors**




7 spirometry technicians

The Technicians

6 nurses (2 at each site)

The Nurses

STEP 02 All the members of this study team underwent rigorous **training program** at the Chest Research Foundation, Pune on the following parameters :

1. Predefined messaging about the study objectives for communication with the school principals, school teachers, students and their parents.

2. Perform good quality spirometry along with correct way of measuring height and weight. In order to maintain a uniform methodology across the three sites, the same study team travelled to all 3 locations to collect the data.

Onsite team member's training in spirometry by Dr. Salvi at Chest Research Foundation, Pune

STEP 03

The schools in Delhi were contacted by Dr. Arvind Kumar and his team. Doctors who were members of the Doctors for Clean Air and Climate Action Network (DFCA) fromKottayam and Mysuru (Dr. Binni John and Dr. G. Siddesh respectively) contacted the school principals in theirrespective cities.

STEP 04

On receiving the consent from the school principals and respective class teachers, the study team distributed a parent's consent form and the questionnaires to alleligible children in the school. The children took these documents home and those who obtained a written permission from the parents were included in the study.

STEP 05

Selected children who obtained permission from their parents were then asked to fill up the questionnaire. Children were also allowed to fill in the questionnaire at home with the help from parents, if required.

Children filling the study questionnaire

STEP 06 Height and weight of each child included in the sample was measured by the study team in school using validated and accurate tools.

STEP 07 Following this, spirometry was performed on the children according to international standards

Children performing spirometry at Delhi, Mysuru and Kottayam

STEP 08 Quality assurance of spirometry was performed at Chest Research Foundation,Pune the same day from all sites and those children who needed repeat spirometry were again visited the next day and underwent a repeat spirometry, which was again quality assured. Only good quality spirometry tests were included in the analysis.

Dr Sundeep Salvi

Ms Deesha Ghorpade

Ms Sapna Madas

Quality assurance team at Chest Research Foundation, Pune

DATA ANALYSIS

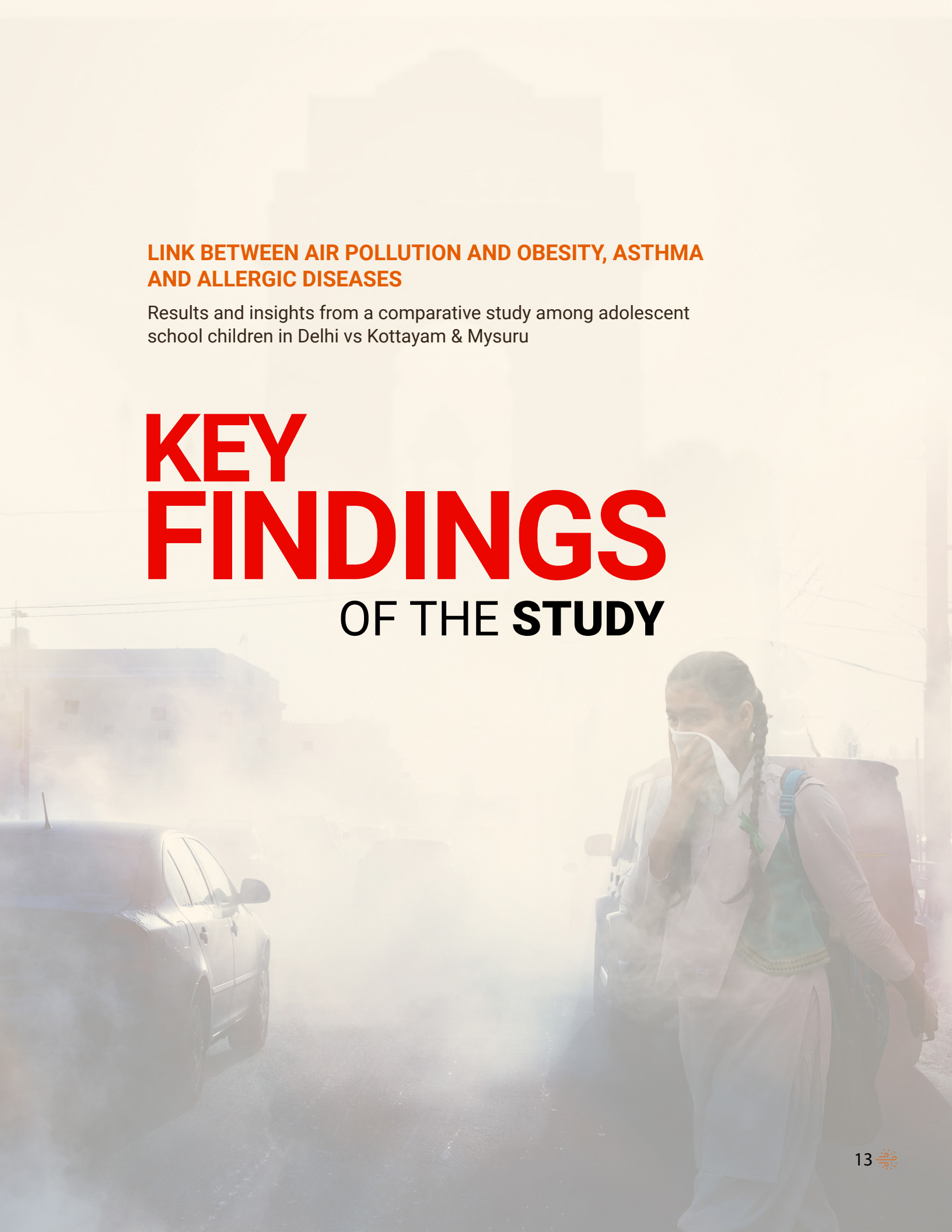
The study data was collected and pooled at Pulmocare Research and Education (PURE) Foundation, Pune (erstwhile Chest Research Foundation, Pune) where data was cleaned. Double data entry was performed to ensure accurate data. Only acceptable spirometry reports and properly filled in questionnaires were included. Clean data was locked for analysis.

Simple descriptive analysis was performed to obtain prevalence rates for different symptoms and diseases. Continuous variables such as age, height, weight were described as mean values ± standard deviation or median (interquartile ranges). Associations between variables were studied using chi square test to obtain odds ratios and confidence intervals. All statistical analyses were performed using the SPSS software ver. 20. The significance levels of all statistical tests were expressed as p values. The results were presented using the appropriate tables and graphs.

LINK BETWEEN AIR POLLUTION AND OBESITY, ASTHMA AND ALLERGIC DISEASES

Results and insights from a comparative study among adolescent school children in Delhi vs Kottayam & Mysuru

KEY FINDINGS OF THE **STUDY**



KEY FINDINGS OF THE STUDY

① The prevalence of asthma and allergic symptoms (on questionnaire) were significantly higher among children from Delhi compared to K-M.

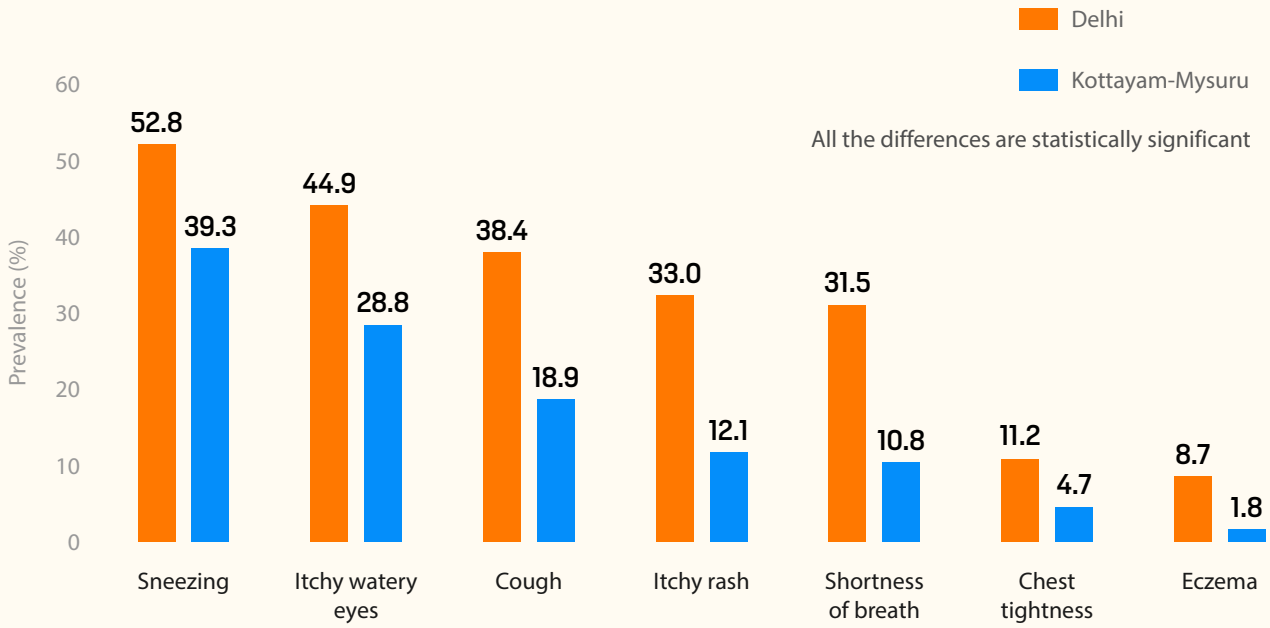


Fig 1 Prevalence (%) of respiratory and allergic symptoms during the last 12 months in children from Delhi and Kottayam-Mysuru (K-M)

- More than half of Delhi children reported significant sneezing.
- More than one-third reported significant cough, shortness of breath and itchy rash.
- Eczema was 4.8 times more prevalent in Delhi than K-M.
- Chest tightness was 2.4 times more prevalent in Delhi than K-M.

Children from Delhi suffer more !!

2 On spirometry, children from Delhi had a significantly higher prevalence of airflow obstruction / asthma as compared to children from K-M.

29.3% DELHI **vs** **22.6%** K-M (Difference highly significant, p<0.0001)

This difference was despite the fact that two factors associated with childhood asthma, namely **family history of asthma (29.8% in Delhi vs 33.7% in K-M, p= 0.03)** and **smoker in the family (13.9% in Delhi vs 18.8% in K-M, p=0.001)** were more prevalent in K-M.

3 Boys were observed to have a two-fold higher prevalence of asthma than girls. This observation was common at all the three sites.

4 Among the 29.3% children observed to have asthma on spirometry in Delhi, only 12% reported to have been diagnosed with asthma and only 3% used some form of inhalers. In contrast, among the 22.6% children observed to have asthma on spirometry in K-M, 27% reported to have been diagnosed and 8% were using some form of inhalers.

Thus, a significant number of asthmatic children are not diagnosed to have asthma and a vast majority do not receive the right treatment. This figure is much higher in Delhi as compared to K-M.

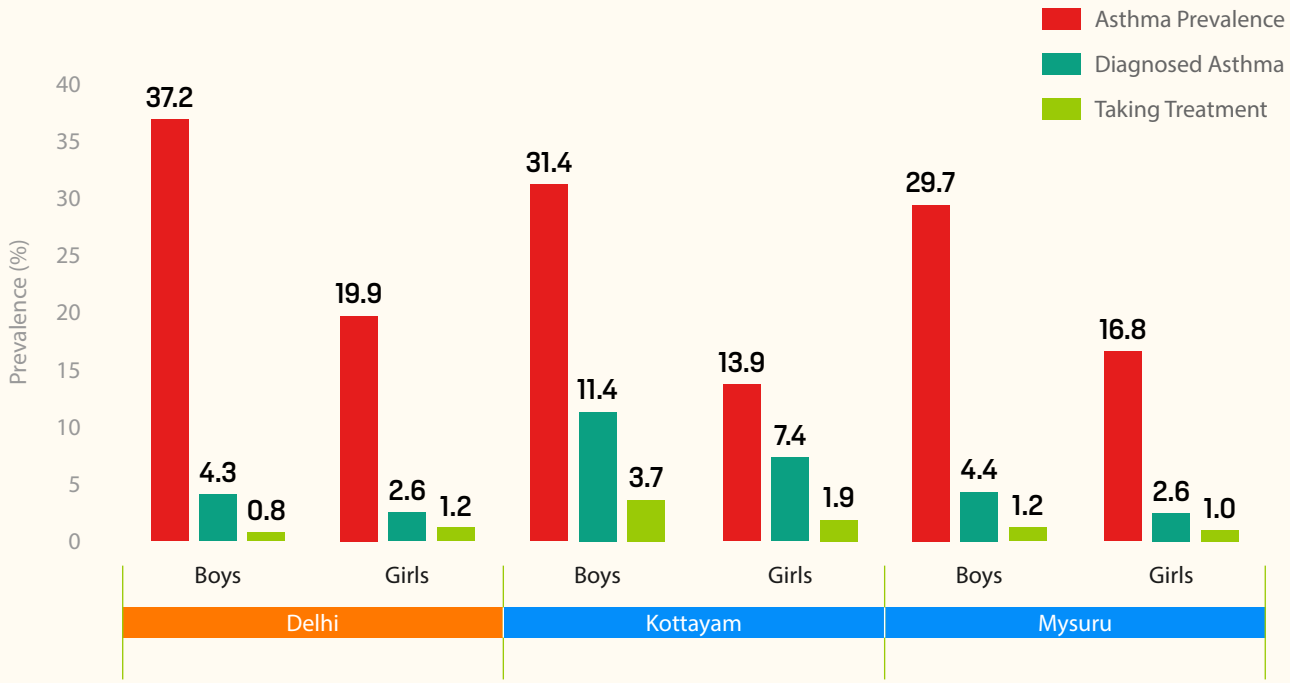


Fig 2 Diagnosis and treatment of Asthma

5 Children from Delhi were more obese and overweight than children from K-M. (39.8% vs 16.4%, p<0.0001).

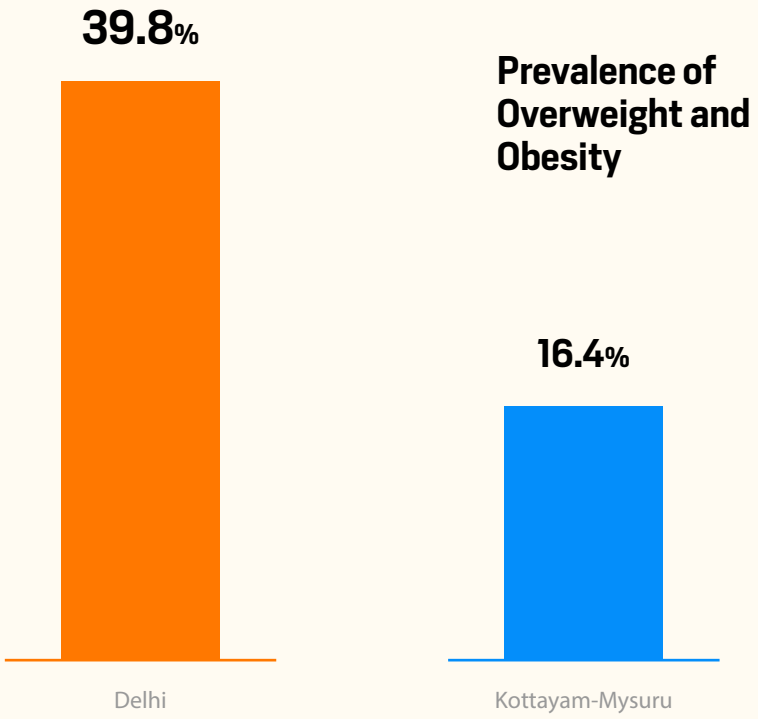
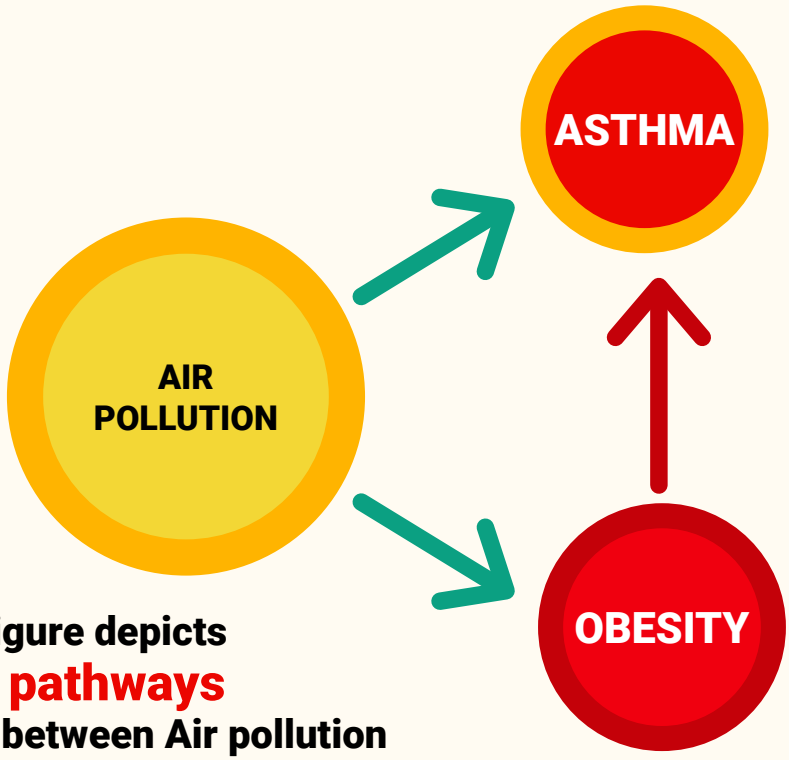


Fig 3 Comparative chart of prevalence of overweight and obesity in Delhi and Kottayam-Mysuru

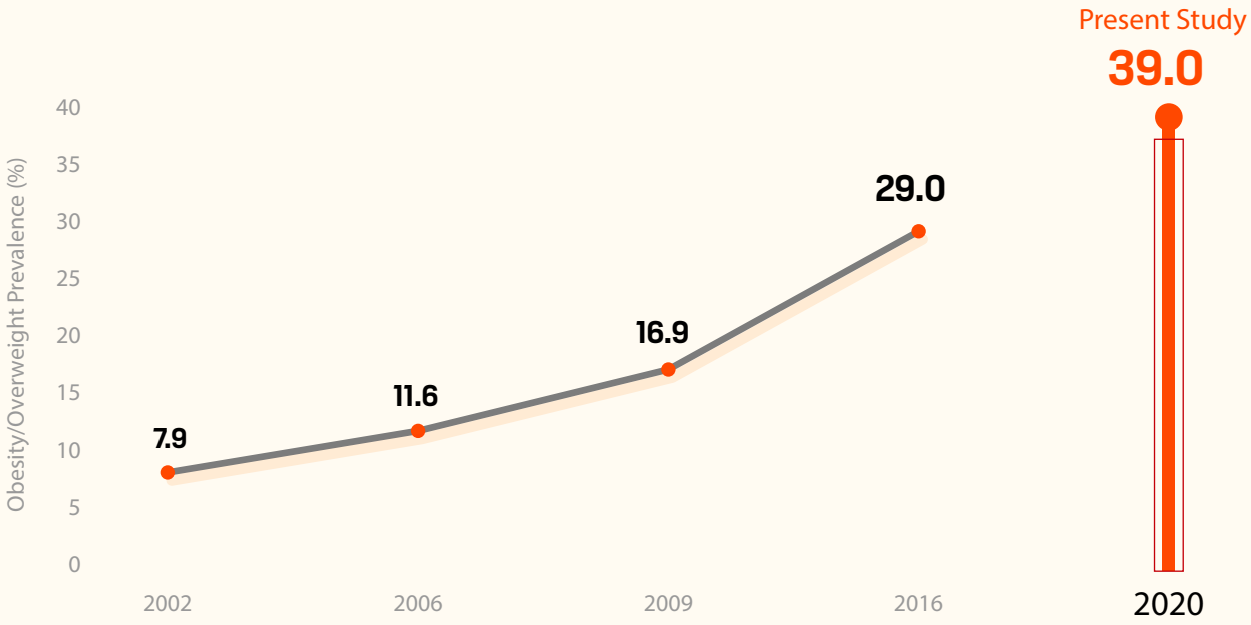
6 Children who were obese and overweight had a 79% greater chance of having asthma on spirometry across all three sites combined. However, overweight and obese children living in Delhi had 38% higher chance of spirometrically defined airflow obstruction than overweight/obese children from K-M.

7 The association between obesity/overweight in children and higher prevalence of asthma is being reported for the first time in any study from India.

Ambient particulate matter air pollution has been implicated as an important cause of obesity/overweight in children in some of the most recent studies. While there could be many causes for obesity/overweight in children from Delhi, we speculate, based on the above mentioned studies that particulate ambient air pollution could be an important contributing factor. The much higher prevalence of overweight/obesity observed in Delhi and much lower prevalence in K-M correlates very well with the reported particulate matter ($PM_{2.5}$ and PM_{10}) levels in these cities.



The figure depicts twin pathways of association between Air pollution and Asthma in Delhi children



Reference: Kapil, U. et al. (2002) 'Prevalence of obesity amongst affluent adolescent school children in delhi', Indian Pediatrics, 39(5), pp. 449–452.

Gupta, D. K. et al. (2011) 'Secular trends in prevalence of overweight and obesity from 2006 to 2009 in urban asian Indian adolescents aged 14-17 years', PloS One, 6(2), p. e17221. doi: 10.1371/journal.pone.0017221.

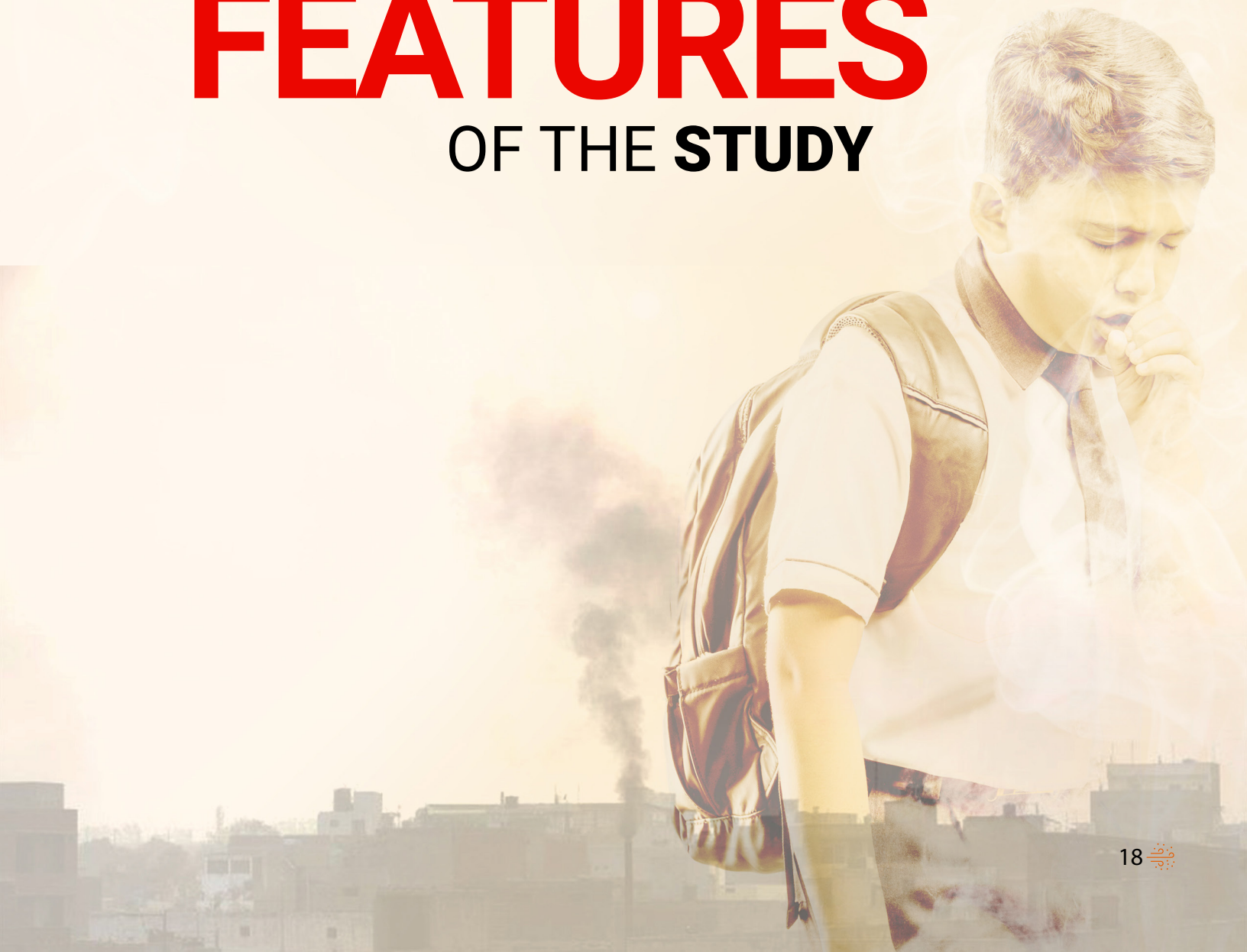
Google Docs. "Latika Bhalla SYBhave Abstract Junk Food .Docx." Accessed August 30, 2021. https://docs.google.com/document/u/0/d/1w3n12Rf9S2CL6zhwqsQAXgV8IkreLEZb/edit?dls=true&usp=gmail_attachment_preview&usp=embed_facebook.

Fig 5 Prevalence of Overweight and Obesity among Delhi children in recent years

LINK BETWEEN AIR POLLUTION AND OBESITY, ASTHMA AND ALLERGIC DISEASES

Results and insights from a comparative study among adolescent school children in Delhi vs Kottayam & Mysuru

UNIQUE FEATURES OF THE **STUDY**



UNIQUE FEATURES OF THE STUDY

- It is the first multicentric study in India that has examined the lung health of over 3000 adolescent boys and girls using ISAAC based questionnaire as well as an ultrasonic flow sensor based spirometry.

- The response rate of 80% in the study matches international standards.

- The exclusion rate due to poor quality spirometry in this study was 8.7%, probably the lowest in any community based spirometry study. It was possible due to the spirometry being administered across all 3 sites by the same team which had undergone rigorous training at a European Respiratory Society (ERS) approved training centre. The spirometry data underwent quality validation at a single location the same evening and poor quality tests were repeated on the children the next day.

- The study included adolescents in the age group 13-14 & 15-16 years. The reason for selecting this age group is that the lung function is close to its peak.

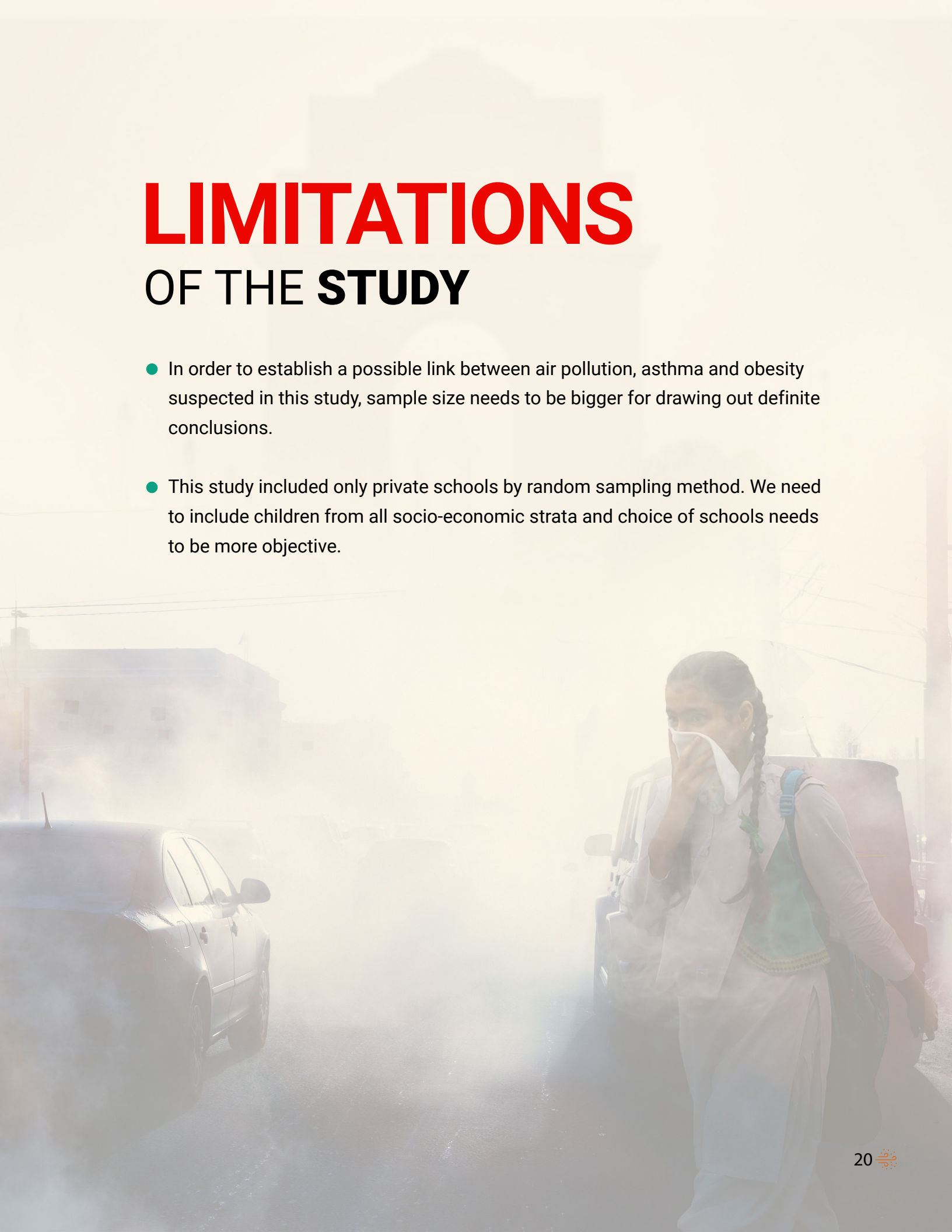
- This study has observed the highest prevalence of allergy symptoms and spirometry detected airflow obstruction/ asthma, ever reported in children from Delhi.

- Additionally, it is the first study that has suggested a possible link between air pollution, obesity and asthma among children in Delhi.

LIMITATIONS
OF THE **STUDY**

- In order to establish a possible link between air pollution, asthma and obesity suspected in this study, sample size needs to be bigger for drawing out definite conclusions.

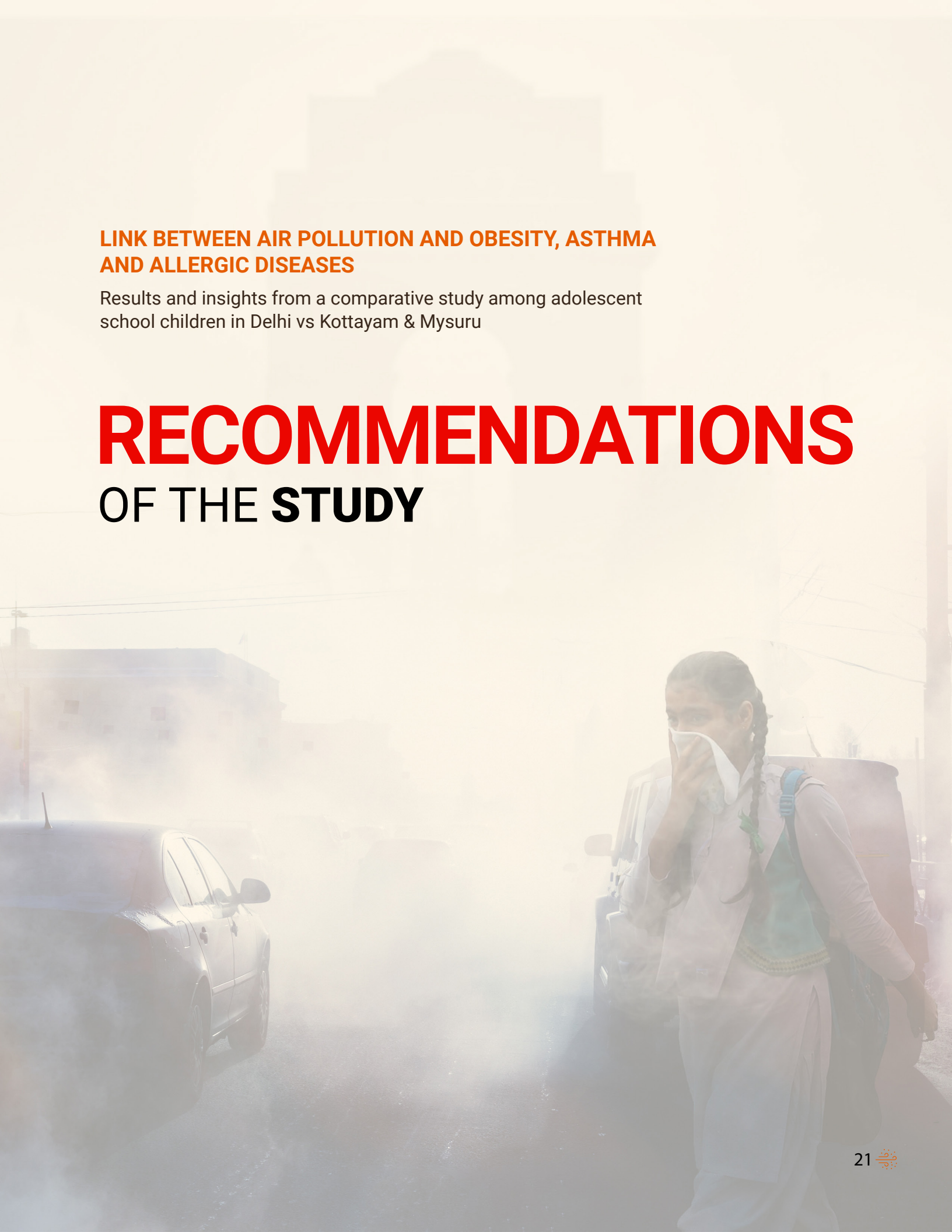
- This study included only private schools by random sampling method. We need to include children from all socio-economic strata and choice of schools needs to be more objective.



LINK BETWEEN AIR POLLUTION AND OBESITY, ASTHMA AND ALLERGIC DISEASES

Results and insights from a comparative study among adolescent school children in Delhi vs Kottayam & Mysuru

RECOMMENDATIONS OF THE **STUDY**



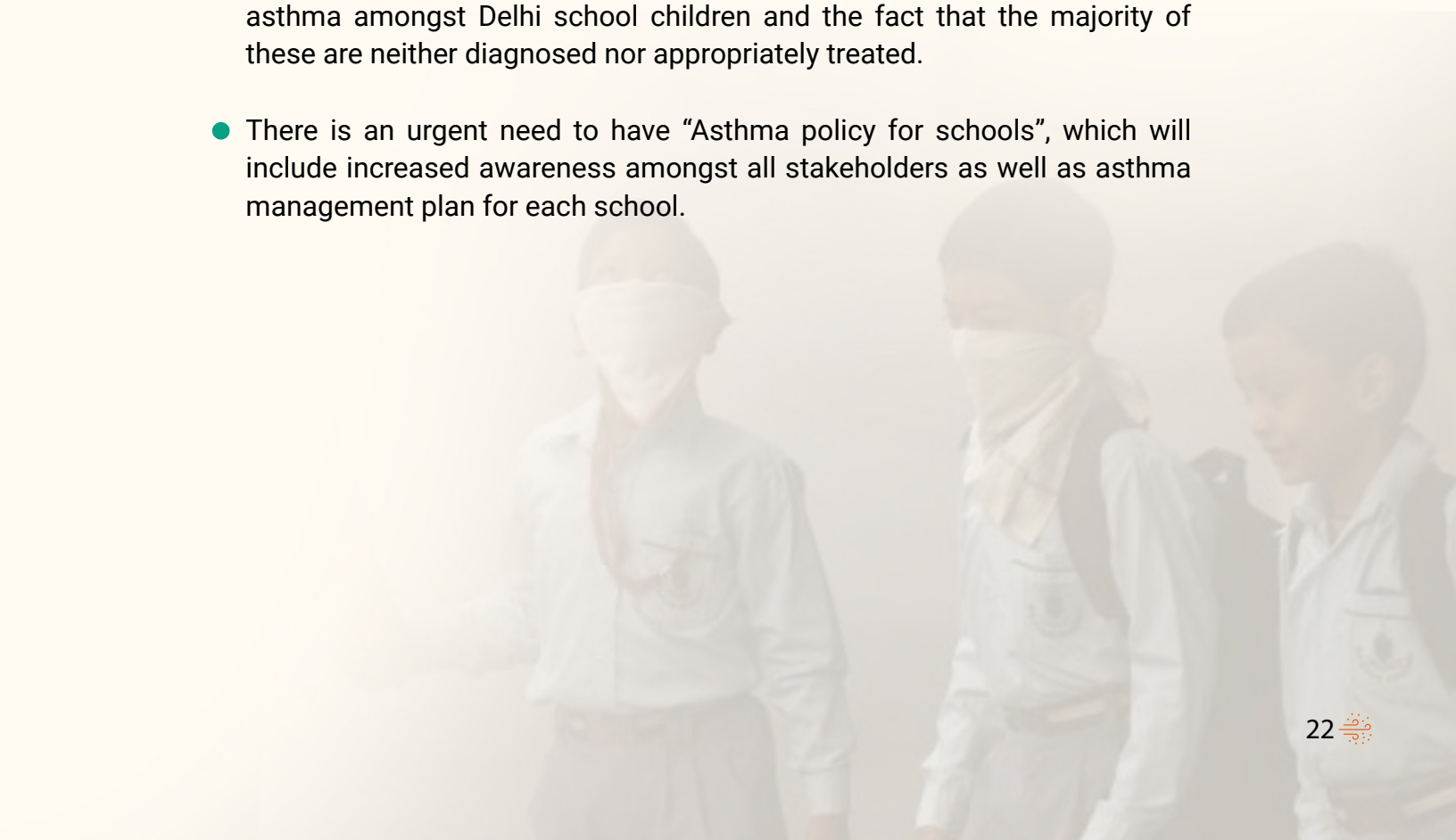
RECOMMENDATIONS OF THE STUDY

- There is an urgent need for a similar large-scale study at a national level which looks at the possible link between air pollution, obesity and asthma eliminating the limitations of this study.

- The policy makers need to be made aware about the potential link between air pollution obesity and asthma and stringent measures need to be taken on an urgent basis to reduce the ambient air pollution as well as obesity in adolescent children.

- All schools and parents need to be sensitized about the high prevalence of asthma amongst Delhi school children and the fact that the majority of these are neither diagnosed nor appropriately treated.

- There is an urgent need to have “Asthma policy for schools”, which will include increased awareness amongst all stakeholders as well as asthma management plan for each school.



“For the millions of children exposed to polluted air every day, there is little time to waste and so much to be gained.”

Dr Tedros Adhanom Ghebreyesus,
Director-General World Health Organization

Source:
Air pollution and child health: prescribing clean air. Summary. Geneva: World Health Organization; 2018 (WHO/CED/PHE/18.01)