





# Prevalence and Risk Factors of Asthma and Allergy-Related Diseases among Adolescents (PERFORMANCE) study: rationale and methods

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**ABSTRACT** Despite a considerable number of international reports on allergic diseases among children, information about the prevalence and risk factors of asthma and allergy-related diseases among Indian adolescents is relatively sparse. The Prevalence and Risk Factors of Asthma and Allergy-Related Diseases among Adolescents (PERFORMANCE) study has been conceived to study the aetiology of asthma and allergic diseases including rhinoconjunctivitis, atopic eczema and food allergies among adolescents in West Bengal, India, using standardised methods and collaborations. The aims of the study are: 1) to estimate the prevalence and risk factors of asthma and allergic diseases among the adolescents residing in rural, suburban and urban areas of West Bengal; 2) to obtain information about the possible role of lifestyle factors (smoking, diet and physical activity) on the disease prevalence; and 3) to create a network for further investigation on social, environmental and genetic factors affecting the diseases. The PERFORMANCE study comprises two phases. The phase I study will investigate the prevalence and possible contributing factors of asthma and allergic diseases in a defined population. The phase II study will be performed as a follow-up of phase I to assess the incidence of asthma and allergic diseases.



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## Background

Childhood allergy and asthma are among the chronic diseases on which action is imperative [1–3], and they have increasing prevalence across the world [4–14]. In the last two decades, extensive clinicoepidemiological studies have been conducted, mostly in North America and Europe, to obtain a global picture of the disease pattern along with identification of its potential risk factors. The International Study of Asthma and Allergy in Childhood (ISAAC) reports demonstrated a wide range of potential factors, including outdoor and indoor air pollution and exposure to environmental tobacco smoke [15–20]. Along with these environmental factors, migration [21, 22] has also been found to link with allergy and asthma morbidity. Recently, the ISAAC Indian collaborators reported that maternal smoking also contributed to the development of asthma symptoms among children of 6–7 years of age [23]. However, the report included children mainly from urban areas; therefore, the prevalence in the suburban and rural areas remains obscure.

Apart from the well-established environmental risk factors, childhood asthma is also modulated by social and behavioural cues. Childhood obesity has emerged as a major risk factor for asthma among young adults [24–28]. At the same time, poverty is a contributing factor for aggravated asthma symptoms among children [29, 30]. Behavioural aspects such as chronotype and sleep pattern are the new additions to the list of asthma modulators [31, 32]. Asthma symptoms are synergistic to circadian rhythm; that is, the symptoms get worse in the last part of the night or in the early morning compared to the rest of the day [33, 34]. It has been observed that the evening chronotype was associated with the increased propensity for nocturnal asthma [35]. Another recent report indicated a significantly higher disruption of circadian behaviour among patients with chronic rhinosinusitis, shifting them towards a later chronotype that could lead to abnormal metabolic function and other organ system effects [36]. However, sufficient epidemiological evidence on such associations is still not available.

In this study, we aim to investigate these social, environmental and behavioural attributes that could have a potential influence on the prevalence of asthma and allergy-related diseases among adolescents residing in West Bengal, India.

## Rationale of the PERFORMANCE study

In spite of several published national and international studies on the prevalence of childhood asthma and allergic diseases, the enigma of symptomatic abundance among some children rather than all remains poorly understood, even today. Although the numbers of epidemiological reports on the prevalence of allergy and asthma among children and adolescents in India are very few, most of them, including those of the ISAAC Indian collaborators, recruited participants from urban areas only and thus, information about the prevalence of these diseases among children of rural and suburbs areas is lacking. Most importantly, the majority of the studies have focused on air pollution and exposure to second-hand smoke as principal contributing factors to childhood asthma among Indian children; however, there are recent reports that have demonstrated more potentially important risk factors such as indoor air quality and damp in homes and/or schools [37–39]. In addition, childhood obesity has now arisen as one of the major concerns in developed and developing countries as a result of altered dietary patterns and reduced physical activity [40–42]. Asthma in children and adolescents has been found to associate with increased body weight and reduced physical activity; however, there are still not enough reports of childhood obesity and asthma in the industrially developing countries.

Chronotype or circadian behaviour has been shown to be linked with asthma; however, there is no report of whether the trend is similar in case of the adolescents. The chronotype of an individual refers to the personal choice of sleep–wake time, and can be classified into morning, intermediate and evening chronotypes. People with the morning chronotype tend to wake up early in the morning, are both physically and mentally more active during the early part of the day, and go to bed early in the evening. Evening types are exactly opposite to morning types, with a late bed and wake up time, and they achieve their highest physical and mental activity during the later part of the day. Individuals between these two extreme chronotypes are referred to as the intermediate type. Chronotype assessment through questionnaire scores has been validated among adolescents and provide substantial information of the circadian behaviour of the individual [43]. For the first time, we aim to determine the association between circadian behaviour and allergy and asthma response among adolescents. The assessment of chronotype distribution among teenagers as a function of asthma prevalence is of major importance in the context of the present study. The predominance of occurrence of asthma timing in different chronotypes may have potential implication in asthma medication and thus cope up with such diseases. Moreover, we assume that there could be many other social, behavioural and biological determinants that could also potentially modulate allergy and asthma among children and adolescents.

We have purposefully selected the state of West Bengal as the location of this study. The state (area ~89000 km<sup>2</sup>) is located in the eastern part of the country, and is surrounded by sea in the south and

mountains in the north; this geographical orientation creates a dynamic weather system across the state characterised by an average temperature of 26–43°C during summer and 11–19°C during winter, tropical savannah in the south and east, a humid subtropical climate in the north and a dry subtropical climate in the west. This climatic variation within a single union territory is unique and differs from the other states of the country, and from European and North American countries. Another important reason is that the state harbours an ethnically (Bengalese, Bhutanese, Nepalese, people from other states, *etc.*), culturally (food habits, festivals, ceremonies, *etc.*) and socially mixed population (lifestyle, family, societal situation, *etc.*). All these attributes may have substantial impacts on various health conditions including allergies and asthma. Moreover, none of the Indian reports on childhood allergy and asthma had data from the eastern zone of India; thus, the prevalence of these diseases in West Bengal has remained unknown. Therefore, the Prevalence and Risk Factors of Asthma and Allergy-Related Diseases among Adolescents (PERFORMANCE) study has been developed to investigate these potential issues.

## Objectives of the study

### Primary objective

The primary objective of the PERFORMANCE study is to estimate the prevalence of asthma and allergic diseases among the adolescents (13–14 years) residing in rural, suburban and urban areas of West Bengal.

### Secondary objectives

- To identify the socioenvironmental (socioeconomic conditions, indoor and outdoor air pollution, exposure to second-hand smoke and hygiene), lifestyle (physical activity, food habits and sleeping patterns) and biological (family history of disease, obesity and chronic illness) risk factors of asthma and allergic diseases among the adolescents.
- To estimate the association between circadian behaviour (chronotype) and asthmatic response among the adolescents.
- To develop a network of clinicians, allied health professionals and health workers for following up on the potential study of incidence.

## Organisations, collaborators and locations

The PERFORMANCE study group will consist of a three-stage organisational hierarchy: the executive committee, coordinating centres and collaborating centres.

- The executive committee will be responsible for recruiting coordinators, planning and implementation of the study, and performing the analysis and publication of data. The executive committee, consisting of the principal investigator and the coprincipal investigators, will coordinate the study on a regular basis.
- The coordinating centres have been identified based on location, related area of interest, and available expertise and resource persons. They will be responsible for identifying and recruiting collaborating centres, coordinating the study, and providing guidance, training and necessary assistance to the collaborating centres. The coordinating centres will also manage the raw data that will be obtained from the collaborating centres and provide a “clean” dataset to the executive committee.
- We aim to incorporate at least one collaborating centre from each of the 23 districts of the state. Collaborating centres will carry out the PERFORMANCE study as per the instructions of the executive committee and the coordinating centres, adhere to the coordinating centres throughout the course of the study, and provide “raw” datasets to the coordinating centres for quality check and management. The collaborating centres are required to obtain the necessary ethical clearance from their respective human research ethics committee and other documents as applicable.

The study will be performed in three habitation settings (rural, suburban and urban) across multiple locations in West Bengal. All coordinating and collaborating centres are allowed their own capacity building, independent collaborations and arrangement of financial support. The collaborating centres need to submit an initial set of data by mid-2018, which will be scrutinised by the coordinating centres for accuracy and quality, based on which the final selection of the collaborating centres will be made.

## Methodologies

### Design of the study

PERFORMANCE is a multicentre, prospective study with an aim to investigate the prevalence and incidence of asthma and allergy-related diseases in defined geographical location (West Bengal) of India. The study has been planned primarily in two phases. Phase I assesses the prevalence and severity of asthma and allergy-related diseases (rhinoconjunctivitis and atopic eczema), and their potential risk factors among adolescents. Phase II: investigates the incidence (trend) of these diseases after 10 years.

### ***Selection of subjects***

The population of interest is school children within a specified geographical area (West Bengal), aged between 13 and 14 years (estimated population of adolescents within the specific age group is ~3 million). The standard questionnaire modules that have been applied to almost all the studies of childhood allergy and asthma, including the ISAAC studies, were designed for age groups 13–14 and 6–7 years. We have specifically selected only the upper age group as reliable participants to reflect the period when mortality from asthma is more common, and to enable the use of both a self-completed questionnaire and a video questionnaire. >90% of students in this age group attend schools in the state of West Bengal [44]. Although this percentage may differ between geographical areas, especially in rural areas, this is unlikely to cause any bias as we aim to recruit an equal proportion of students from rural, suburban and urban areas.

The coordinating centres and the collaborators will identify schools from their respective localities, and will randomly shortlist schools based on feasibility and accessibility. The schools will be contacted for access and those that respond will be selected. All adolescent students (both male and female) of the specific age group, who are able to read, write and understand Bengali or English will be included in the study. A participation rate of  $\geq 80\%$  is expected [23]. It is our primary concern that many children (especially females of rural areas) suffering from these diseases may not be willing to disclose these; therefore, the investigators of the coordinating and collaborating centres will need to make preliminary visits to the selected schools for general introduction and discuss the importance of the study with the students before the scheduled visits. Many students may opt out from participating in this study due to religious or social restrictions; however, to obtain maximum respondents, the schools will be requested to send letters to the parents asking them to allow their children to participate in this study. The questionnaires will be completed by the students at the school with the instructions given to them by the interviewer. If, any absent student wishes to participate in the study, a questionnaire will be posted to the address of the student with prepaid return mailing.

### ***Ethical approval and informed consent***

The study has been ethically approved by the Clinical Research Ethics Committee of the Allergy and Asthma Research Centre, Kolkata, India. If required, the participating coordinators and collaborators can also obtain ethical approval from their respective institutional ethical committees; however, multiple ethical approvals are not mandatory for this study.

The participants in this study are minors; therefore, signed informed consents will be obtained from their parents. The parents will be informed about the study by the schools and the informed consent forms will be given to the parents prior to the scheduled date of visit. On the scheduled date, the signed informed consent forms will be collected from the participants. In some cases, where parents or legal guardians of the participants lack primary education, the signed informed consents will be obtained from the heads of the attending schools on their behalf.

### ***Sample size***

Sample size estimations suggested that 351 participants would have to be recruited to obtain the previously reported prevalence of rhinitis of 24% [23], with a precision of 5%, accepting an alpha risk of 0.05 in a two-sided test, and anticipating a nonresponse rate of 20%. Since we want to provide prevalence for three zones (rural, suburban and urban) and two genders, we aim to recruit 2100 participants.

Accepting an alpha risk of 0.05 and a beta risk of 0.2 in a two-sided test, and assuming a common standard deviation of 3.2% of the body fat percentage, a total of 180 male participants will be randomly selected for somatotyping in order to recognise a statistically significant difference  $\geq 3$  units in body fat percentage [45]. Similarly, a total of 240 female participants will be randomly selected with an assumption of a common standard deviation of 2.5% of the body fat percentage [46].

### ***Questionnaire for wheezing, rhinitis and eczema***

The ISAAC phase III questionnaire modules developed by the ISAAC collaborators will be used for assessing wheezing, rhinitis and eczema among the participants [47]. The main questionnaire comprises a video questionnaire and a core questionnaire module. The questionnaire has already been validated and applied in several studies across the world as well as in India [48–51]. The exact wording of the questions will be followed to the best possible extent to minimise any alteration in the subjective response. The ISAAC video questionnaire will be obtained from the ISAAC coordinator with permission to use and will be adapted directly without any modification. The video contains a 3-min clip with five scenes. The participants will be shown the video first and a question-cum-response sheet will be given to them to mark as per the instructions. The core questionnaire contains sections for wheezing, rhinitis and eczema.

The core questionnaire will be given to the participants always after the video questionnaire is completed to maximise the probability to perceive the symptoms by the participants.

An English-to-Bengali back-translated version of all the questionnaires will be used for the students of Bengali-medium schools. Although the Bengali version of the core questionnaire is not available, the ISAAC core questionnaire has already been translated and validated in Hindi, and the specific medical terms are very similar in both the languages; therefore, a formal Bengali translation is not required. However, although medical practitioners often use some common terms for the diagnosis, utmost care will be taken so that the terminology do not differ much from the original clinical terminology.

#### ***Demographic and environmental questionnaire***

The demographic questions including name, age, school, sex and domicile will appear on the first page of the questionnaire. These details will be verified from the school records. Another set of questions related to family size, education, socioeconomic status, family history of allergy or asthma and social habits has been included in the questionnaire. These questions have been adapted from the European Community Respiratory Health Survey (ECRHS) Main-II questionnaire [52], which has been tested previously in an Indian context [53–56]. Although the Bengali version of the ECRHS Main-II questionnaire has not been formally validated, an English-to-Bengali back-translated version of the questionnaire has been used in previous studies [53–56].

An environmental questionnaire containing items on the quality of the indoor environment at home and school (adequacy of sunlight and air movement, presence of damp, *etc.*), construction material of the house (clay or concrete), cooking medium used in the house, pets (including poultry), exposure to second-hand smoke at home, and proximity to an industry that emits fumes/gases *etc.*, has been compiled from the ECRHS Main-II questionnaire to seek information on the indoor and outdoor environment.

#### ***Chronotype assessment questionnaire***

Chronotype of the participants will be assessed using the reduced version of the Morningness–Eveningness Questionnaire (rMEQ) [57], which was derived from the 19-item original version of the HORNE and ÖSTBERG [58] Morningness–Eveningness Questionnaire. rMEQ is a five-item questionnaire that asks participants about their preferred wake-up time, the degree of tiredness during first half hour after waking up in the morning, sleep time at night, peak personal efficiency time and self-estimation of chronotype. Chronotype assessment based on the rMEQ scores has already been validated among adolescents [43] and is influenced by other modulating factors, such as the timing of school and tuition, or influence of the family, *etc.* The rMEQ score ranges from 4 to 25 and is calculated by summing up the scores of each of these five questions. Participants that score >18, 11–18 and <11 are recognised as morning, intermediate and evening types, respectively. The rMEQ has been established to be quick and reliable measure with good psychometric properties and convergent validity [43, 57, 59–61], and hence we have chosen it to evaluate the chronotype of the participants. The validity of the Bengali-translated version of the rMEQ will be tested before applying it in the study.

#### ***Questionnaire for physical activity***

To assess the physical activity of the participants, the Fels Physical Activity Questionnaire (Fels-PAQ) will be used [62]. The Fels-PAQ is an eight-item questionnaire asking for information on activity and leisure of the participants, and has been shown to be a reliable tool to assess physical activity among children. The validity of the questionnaire has been found to be satisfactory and acceptable for children of elementary and high school standards; however, it is more reliable for the high school students when the total activity score of the sports is calculated (the sport index had the highest validity for the high school participants with a correlation value of 0.34,  $p=0.002$ ). The Fels-PAQ is not exhaustive and does not contain any specific medical terminology that is difficult to understand. Therefore, we will make an English-to-Bengali back-translated version for this study.

#### ***Measurement of body composition***

Height and weight will be measured using an anthropometric rod (Desco Medical, New Delhi, India) and an electronic weighing scale (Omron, Gurugram, India), respectively. Body density and fat percentage will be calculated from skinfold measurements by means of a skinfold calliper (Bharat Medical Systems, Chennai, India), according to the formula proposed by JACKSON and POLLOCK [63] and SIRI [64]. The anthropometric Heath–Carter method of somatotyping will be used to estimate the shape and composition of the body, and will be expressed as endomorphy (relative fatness), mesomorphy (relative musculoskeletal robustness) and ectomorphy (relative linearity or thinness) [65].

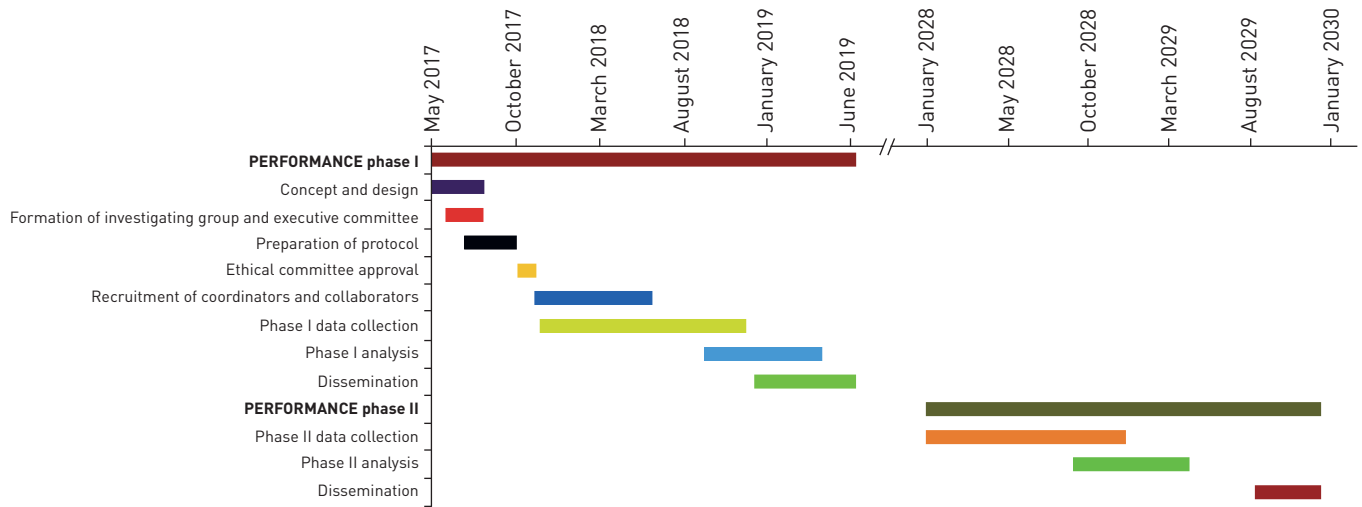


FIGURE 1 Gantt plot of the timeline of the project. PERFORMANCE: Prevalence and Risk Factors of Asthma and Allergy-Related Diseases among Adolescents.

### Timeline, data collection, distribution and usage

Phase I will be conducted throughout the year 2018 and is expected to achieve the targeted sample size by end of 2018. Phase II is expected to start by the beginning of 2028. The timeline of the project is presented in figure 1.

All data will be primarily collected as paper files and will subsequently be converted into electronic files using appropriate data managing software, and all data must be stored in both formats. For long-term storage, electronic data will be stored in hard drives or compact discs.

The coordinating centres and the collaborators will need to submit all data to the executive committee in electronic format every week until the end of phases I and II; however, they can also store data on their repository (both as paper copies and electronic files).

Dissemination of the results of this study will be carried out solely at the discretion of the executive committee. The coordinating centres may use the regional data for publication in scientific journals, conferences, scientific meetings and in other formats (monographs, newsletters, etc.) with prior approval from the executive committee; however, all communications must bear the signature of “PERFORMANCE Study” and appropriate credentials must be given to the committee. Collaborating centres are not allowed to use the data for dissemination except as joint ventures with the coordinating centres.

Conflict of interest: None declared.

Support statement: The study will be supported primarily by the internal research support scheme of the Allergy and Asthma Research Centre. However, coordinating centres and collaborators are encouraged to arrange their own funding resources through grants and/or informal research support from private agencies or from their own institutions.

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