# Sanya climatic-treatment cohort profile: objectives, design, and baseline characteristics

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**Background:** The prevalence of allergic diseases has increased globally, climate and environment also have important effects on respiratory or allergic diseases. However, population-based studies investigating the impact of tropical climates and environments on migratory-bird old people (MBOP) are lacking.

**Methods/Design:** For this prospective cohort study, we recruited 756 participants from the community in Sanya City, Hainan Province, China. In addition to the completed baseline survey, a follow-up survey will be conducted during the periods of October−December and March−April for the next 3 years of MBEPs from northern China who spend the winter in Sanya. We will continue to record the height, weight, and blood pressure of all participants, as well as lung function for those with asthma and chronic obstructive pulmonary disease (COPD). Venous blood at baseline and urine samples will be collected during follow-up.

**Results:** A total of 756 volunteers were recruited. Their average age is 66.1 years; 32.1% of them have high-school educations, while 37.3% have graduated from college or done undergraduate studies. The top five diseases in this cohort are allergic rhinitis (57.9%); eczema, urticaria, or dermatitis (35.6%); bronchitis and bronchiectasis (35.6%); asthma (14.7%); and emphysema (11.7%). Compared with their symptoms while at their summer places of residence, rates of remission reported by participants while living in Sanya were 80.4% for allergic rhinitis, 82.3% for bronchitis and emphysema, 85.2% for asthma, 96.0% for COPD ($P < 0.001$).

**Conclusions:** The baseline survey has been completed. The preliminary findings support that a tropical climate may relieve the symptoms of allergic diseases in migratory-bird old people.

## Introduction

The prevalence of allergic diseases has increased globally in recent decades (1, 2). According to the World Health Organization's (WHO) 2019 report, approximately 262 million people worldwide suffered from asthma at the time, resulting in 455,000 deaths. Allergic diseases, including allergic rhinitis and eczema, together constitute a major global public-health burden (3). China is also facing this issue: according to epidemiological surveys, the prevalence of allergic diseases (4, 5) such as asthma (6, 7), allergic rhinitis (8), and eczema are increasing in China. Influencing factors include climate change (9), air pollution (10), environmental temperature (11), meteorological factors (12), and allergens (13).

Current studies on allergic diseases mainly focus on the effects of climate and environmental factors. There are reports on the treatment and relief of asthma in alpine environments (14, 15). However, population-based research is lacking on the effect of tropical climate and environment on migratory-bird old people (MBOP). Sanya, China has a unique tropical climate, with a minimum temperature of >15°C in winter; by contrast, the minimum winter temperature in northern China is below −40°C (16). Therefore, many MBEPs relocate from northern China to Sanya for the winter. It is reported that more than 1 million people spend the winter in Sanya every year (17).

In addition to drug treatment, climate, and environment also have important effects on respiratory or allergic diseases. In Europe, cave therapy is widely used to treat chronic airway diseases. Some studies have shown that exercise in winter combined with cave therapy can improve the quality of life (QoL) and allergic symptoms of adults with allergic rhinitis and/or asthma (18, 19). A systematic review showed that high-altitude climate therapy improved the lung function of adult asthma patients (15, 20). However, there is no relevant evidence that symptoms and climate-related factors of allergic diseases improve in MBEPs who move from high latitudes to low ones. The establishment of this cohort will help us better study the effect of Sanya's tropical climate on respiratory or allergic diseases, clarify risk factors related to these diseases, and determine whether such a climate effectively mitigates these diseases in MBEPs.

## Cohort description

### Study design, setting, and participants

This is a prospective cohort study whose subjects were recruited from the community in Sanya City, Hainan, the southernmost province in China from 2022 to 2025. We will conduct a follow-up survey focused on allergic diseases in MBEPs from northern China who move to Sanya for the winter (Figure 1). Northern China includes three northeastern provinces (Heilongjiang, Jilin,

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Abbreviations: WHO, World Health Organization; MBOP, Migratory bird's old people; FEV1, Forced expiratory volume in 1 s; COPD, Chronic obstructive pulmonary disease; FVC, Forced vital capacity; AQLQ, Asthma quality of life questionnaire; SGRQ, Saint George respiratory questionnaire.

and Liaoning), five northern provinces (Beijing, Tianjin, Hebei, Shanxi, and the Inner Mongolia Autonomous Region), and five northwestern provinces (Xinjiang Uygur Autonomous Region; Ningxia Hui Autonomous Region; and Qinghai, Gansu, and Shaanxi Provinces). The subjects of this study are MBEPs who travel from northern China to Sanya in autumn, stay for the winter, and return to northern China in spring. The sample size was estimated by forced expiratory volume in 1 s (FEV$_1$) (15), which was 92.8% ± 23.1 and 86.5 ± 26.2 for the trial and control groups, respectively. A type I error α = 0.05, β = 0.10, and loss of follow-up rate of 20% for 3 years, requiring 775 participants.

For easier follow-up, we recruited participants from communities of mainly MBEPs, who own apartments in Sanya and spend the winter there for many years. Inclusion criteria were as follows: (a) age 50–80 years; (b) suffering from allergic rhinitis, asthma, eczema, urticaria, or chronic obstructive pulmonary disease (COPD); (c) previous or winter residence in northern China; (d) willingness to participate in the study and be followed up on at the designated location for the subsequent 3 years; and (e) no difficulty in communication. Exclusion criteria were (a) other respiratory diseases and (b) communication barriers or unwillingness to cooperate with the requirements of the study.
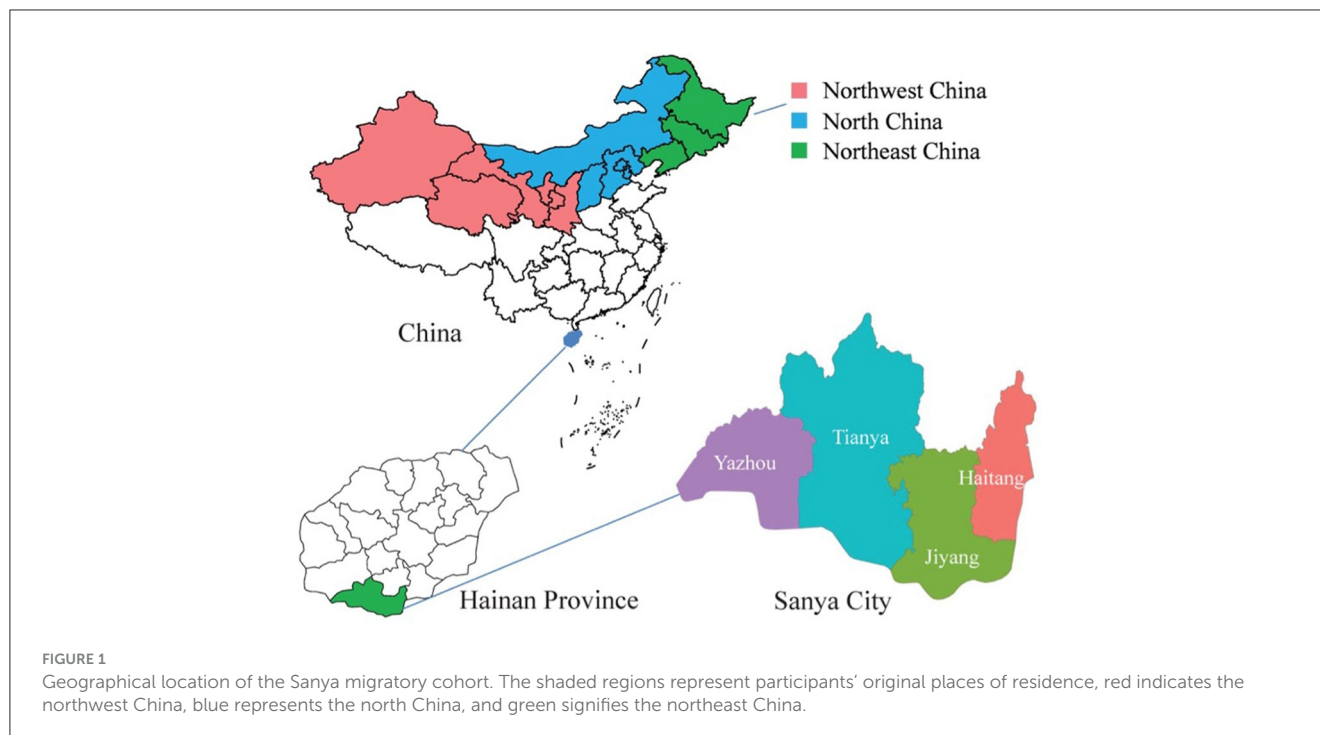
Diagnosis of allergic rhinitis, asthma, eczema, urticaria, or COPD was based on self-reported disease history in face-to-face interviews at recruitment. Allergic rhinitis was defined as an affirmative response to the question "Do you have any nasal allergies, including hay fever?" according to the Allergic Rhinitis and Its Impact on Asthma guidelines (8). Asthma was defined as a self-reported history of asthma, diagnosis by a physician, or wheezing during the preceding 12 months (6). Eczema or urticaria was defined as self-reported history and/or diagnosis by a physician (21, 22). Atopic dermatitis was diagnosed by an affirmative response to the question "Have you had an itchy rash at any time in the past 12 months?" (8). COPD was defined as post-bronchodilator FEV$_1$/forced vital capacity (FVC) < 0.7 according to the 2017 Global Initiative for Chronic Obstructive Lung Disease guidelines (23). Chronic bronchitis was defined as self-reported phlegm production for at least 3 months each year over 3 successive years (24).

## Data collection

### Demography and outcomes

A paper questionnaire was used to collect a range of basic information in march 2022. After obtaining informed consent, trained investigators collected relevant information in face-to-face interviews. The questionnaire covered demographic data, socioeconomic status, clinical disease characteristics, living habits, and past medical history (Table 1). Participants with asthma and COPD were evaluated using the Asthma Quality of Life Questionnaire (AQLQ) (25) and Saint George Respiratory Questionnaire (SGRQ) (26), respectively; SGRQ assesses the quality of life of participants with COPD. The primary outcome was the effect of Sanya's tropical climate

FIGURE 1
Geographical location of the Sanya migratory cohort. The shaded regions represent participants' original places of residence, red indicates the northwest China, blue represents the north China, and green signifies the northeast China.

TABLE 1 Data collected from participants in the Sanya migratory cohort.

| Category | Data |
|---|---|
| Demographics/socioeconomic factors | Date of birth, ethnicity, educational level, working status, sex, previous location of residency, and location and duration of current residency |
| Physical examination | Height, weight, BP, and lung function |
| Lifestyle | Diet, smoking, exercise, sleep, work, and living environments |
| Medical history | Allergic history, and family history of respiratory and allergic diseases |
| QoL evaluation | AQLQ and SGRQ |

BP, Blood pressure; QoL, quality of life; AQLQ, Asthma Quality of Life Questionnaire; and SGRQ, Saint George Respiratory Questionnaire.

on MBEPs with allergic or respiratory diseases, including symptoms evaluated by questionnaires, for example, frequency of mitigations and exacerbations. Potential confounding factors included the psychological effects of living in this famous tourist city.

## Physical examination

We used a unified measuring tool for physical examination. After calibration, we measured the height, weight, and blood pressure of all participants, and in those with asthma and COPD, we also measured lung function. Participants were asked to take off their shoes and coats before their heights and weights were measured.

## Collection and measurement of biological samples

Nurses from local hospitals traveled to the community, collected 5–10 mL of patients' venous blood, and then transferred the samples to the laboratory at Sanya Women and Children's Hospital (SWCH) for centrifugation and subpackaging. Whole blood was used for routine blood tests; serum was used to test for liver and kidney function, blood sugar, blood lipids, and allergen. Some samples were stored in a freezer at −80°C. Table 2 lists the types of samples and main tests using these samples.

## Quality control

All investigators received unified training. Two investigators independently input the results of all questionnaires into database using EpiData 3.0 software (EpiData, Copenhagen, Demark). A Portion of the data underwent double entry, and in cases where inconsistencies arose, a third researcher reviewed and resolved them to guarantee data accuracy.

We adopted various policies to retain participants in the cohort. Health consultation was and will be provided during recruitment and follow-up, and free health examinations were and will be provided during baseline and follow-up. We are following up on participants in the spring (March–April) and autumn (October–December) every year for the next 3 years and providing them with timely reminders to take advantage of the free health examinations.

TABLE 2 Collection of biological samples from participants in the Sanya migratory cohort.

| Biological samples | Clinical examinations | Specific tests |
|---|---|---|
| Venous blood | Routine blood | White blood cell (WBC), red blood cell (RBC), hemoglobin concentration (HGC), platelet count (PLT), neutrophil percentage (NEU%), lymphocyte percentage (LYM%), monocyte percentage (MPN%), eosinophil percentage (EOS%), and basophil percentage (BAS%) |
| | Liver function | Total protein (TP) level, albumin (ALB) level, globulin/white cell ratio (A/G), glutamic pyruvic transaminase (GPT), glutamic oxaloacetic transaminase (GOT), aspartate transaminase (AST)/alanine transaminase (ALT) ratio, total bilirubin (TBIL), direct bilirubin (DBIL), and indirect bilirubin (IBIL) |
| | Blood lipids and sugar | Glucose (Glu); total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and blood glucose (BG) |
| | Allergens | Animal allergens (cat, horse, cow, and dog dander); house dust (household dust, dust mites, and cockroaches); food allergens (milk, eggs, soybeans, peanuts, cod, wheat, and millet); plant allergens (grass, French chrysanthemum, dandelion, plantain, *Chenopodium* [goosefoot], and a yellow flower); mycoallergens (*Penicillium punctatum*, *Aspergillus fumigatus*, *Polydendrosporium*, *Candida albicans*, *Alternaria alternata*, and *Helminthosporium longum*) |
| Urine | Routine urine | Environmental-pollution exposure |

## Statistical analysis

Baseline characteristics of participants who stayed in or withdrew from the cohort, and loss of follow-up, were described. All missing data were noted. We analyzed classification data using a $\chi^2$ test and continuous data using Student's $t$ test. All analyses were conducted using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered to indicate a statistically significant difference.

## Ethical approval

The research protocol and informed-consent form of this study were reviewed and approved by the Ethics Committee of Sanya Women and Children's Hospital (Approval No. SYFYIRB2022009). All participants signed their informed consent before participating.

TABLE 3 Baseline characteristics of the Sanya migratory cohort.

| Characteristics | Recruited for cohort (N) | Proportion (%) or Mean |
|---|---|---|
| Gender | | |
| Male | 231 | 33.3 |
| Female | 462 | 66.7 |
| Age (years) | 693 (50–80) | 66.1* |
| Height (cm) | 671 | 162.0* |
| Weight (kg) | 670 | 64.5* |
| BMI (kg/m$^2$) | 670 | 24.1* |
| Educational level | | |
| Junior high school or lower | 185 | 26.7 |
| High school or technical secondary school | 223 | 32.1 |
| Undergraduate or junior college | 258 | 37.3 |
| Postgraduate or higher | 9 | 1.3 |
| Respiratory/allergic disease | | |
| Asthma | 102 | 14.7 |
| COPD | 77 | 10.6 |
| Allergic rhinitis/pharyngitis | 401 | 57.9 |
| Eczema/urticaria/dermatitis | 247 | 35.6 |
| Food/drug allergy | 60 | 8.7 |
| Bronchitis/bronchiectasis | 247 | 35.6 |
| Emphysema | 81 | 11.7 |
| Hypertension | 165 | 23.8 |
| Diabetes | 92 | 13.3 |
| Other | 51 | 7.4 |
| The original location of residence | | |
| Heilongjiang province | 280 | 40.9 |
| Jilin province | 71 | 10.4 |
| Liaoning province | 82 | 12.0 |
| Inner Mongolia Autonomous Region | 40 | 5.8 |
| Xinjiang Uygur Autonomous Region | 21 | 3.1 |
| Gansu province | 6 | 0.9 |
| Shanxi province | 6 | 0.9 |
| Beijing | 48 | 6.9 |
| Hebei province | 51 | 7.4 |
| Tianjin | 10 | 1.4 |
| Shaanxi province | 26 | 3.8 |
| Other | 28 | 4.0 |
| Sanya, > 5 years | 15 | 2.2 |

BMI, Body mass index; COPD, chronic obstructive pulmonary disease; * Mean.

TABLE 4 Data collected from participants in the Sanya migratory cohort.

| Participants' data | Baseline and follow-up | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | 2022 | | 2023 | | 2024 | | 2025 |
| | Baseline | Autumn | Spring | Autumn | Spring | Autumn | Spring |
| **Demographics/Social** | | | | | | | |
| Date of birth | ✓ | | | | | | |
| Ethnicity | ✓ | | | | | | |
| Educational level | ✓ | | | | | | |
| Marital status | ✓ | | | | | | |
| Gender | ✓ | | | | | | |
| The original location of residence | ✓ | | | | | | |
| Current location and duration of residence | ✓ | | | | | | |
| **Physical examination** | | | | | | | |
| Height | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Weight | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| BP | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Pulmonary function[#] | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Biological samples** | | | | | | | |
| Blood | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Urine | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Lifestyle** | | | | | | | |
| Diet | ✓ | | | | | | ✓ |
| Smoking/passive-smoking status | ✓ | | | | | | ✓ |
| Exercise | ✓ | | | | | | ✓ |
| Sleep habits | ✓ | | | | | | ✓ |
| Living environment | ✓ | | | | | | ✓ |
| **Medical records** | | | | | | | |
| Respiratory or allergic diseases | ✓ | | | | | | |
| Past allergic history, family history, and disease symptoms | ✓ | | | | | | |
| Medical history | ✓ | | | | | | |
| Family medical history | ✓ | | | | | | |
| Clinical test results | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| **Assessment of respiratory and allergic diseases** | | | | | | | |
| SGRQ | ✓ | | ✓ | | ✓ | | ✓ |
| AQLQ | ✓ | | ✓ | | ✓ | | ✓ |

BP, blood pressure; [#] for participants with COPD or asthma; SGRQ, Saint George Respiratory Questionnaire; and AQLQ, Asthma Quality of Life Questionnaire.

# Findings to date

## Baseline characteristics

The baseline survey was completed in March 2022 among the 756 volunteers who were recruited from the community (Table 3). After performing quality control, we excluded missing and unqualified participants, ultimately including a total of 693 in the cohort. These included 231 men (33.3%) and 462 women (66.7%), with an average age of 66.1 years. In terms of educational level, 26.7% have not completed junior high school, 32.1% have completed senior high school, and 37.3% are college graduates or undergraduates. Compared with their symptoms in their original places of residence, the initial rates of remission reported by the

participants in Sanya were 80.4% for allergic rhinitis, 82.3% for bronchitis and emphysema, 85.2% for asthma, 96.0% for COPD ($P < 0.001$). The top five diseases in this cohort are allergic rhinitis (57.9%); eczema, urticaria, or dermatitis (35.6%); bronchitis and bronchiectasis (35.6%); asthma (14.7%); and emphysema (11.7%). The top five original regions of residence are Heilongjiang Province (40.9%), Liaoning Province (12.0%), Jilin Province (10.4%), Hebei Province (7.4%), and Beijing (6.9%). The first follow-up, of 682 participants, was conducted by telephone from October to December 2022. The loss of follow-up does not make sure since COVID-19.

## Biological-sample collection

During the baseline survey, we collected venous blood for detection of allergen, routine blood, liver function, blood lipids and sugar, which is close linked to the allergic and immune diseases during March 2022; the collection rate was 100%. We have continued to collect venous blood and urine samples from all 693 participants for detection during the ongoing follow-up (Table 4).

## Strengths and limitations

Sanya is located in the southernmost region of China, which is tropical and has a warm winter. Many MBEPs migrate from northern China to Sanya for the winter. This provides a unique opportunity to observe the effect of tropical climate and environment on allergic diseases and helps follow up with the general population. To the best of our knowledge, this is the world's first study on the effects of tropical climate and environmental factors on respiratory and allergic diseases in MBEPs. The biological samples collected will provide objective evidence of such effects. In the future, we will further explore the relationship between the climatic environment and allergic diseases in children.

However, this study has several limitations. The main disadvantage is that the volunteers recruited are migratory-bird middle-aged or old people, who have relatively high educational levels and socioeconomic status and are therefore not representative of the general population. This limits the generalization of our findings. In addition, MBEPs return to their original residences in spring, and the effect on participants living in northern regions during the spring and summer will be difficult to assess. Notably, such potential confounding variables were not adjusted for statistical adjustments, such as the psychological impact of living in a famous tourist city. If possible, we will perform further research into this aspect in the future.

## Collaboration

This is an ongoing prospective cohort study. Preliminary findings demonstrate the beneficial impact of tropical climate on allergic diseases in migratory-bird old people.

## Data availability statement

The data supporting the conclusions of this article will be made available by reasonable request.

## Ethics statement

The studies involving humans were approved by the Ethics Committee of Sanya Women and Children's Hospital (Approval No. SYFYIRB2022009). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants.

## Author contributions

HG: Data curation, Formal analysis, Investigation, Methodology, Project administration, Writing–original draft, Writing–review and editing. GY: Investigation, Methodology, Project administration, Resources, Writing—review and editing. JG: Investigation, Project administration, Resources, Writing—review and editing. XL: Formal analysis, Investigation, Project administration, Writing–review and editing. CL: Formal analysis, Investigation, Project administration, Writing—review and editing. HR: Data curation, Investigation, Writing–review and editing. DC: Investigation, Writing–review and editing. LZ: Investigation, Writing–review and editing. QH: Formal analysis, Investigation, Writing–review and editing. YH: Formal analysis, Investigation, Writing–review and editing. YZ: Project administration, Resources, Writing–review and editing. ST: Conceptualization, Methodology, Supervision, Writing–review and editing. ZL: Funding acquisition, Project administration, Resources, Writing–review and editing. SL: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing—original draft, Writing—review and editing. DW: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Writing—review and editing.

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# Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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