Original Paper

COPD-SQ Positivity and Suspected Asthma Screen Positivity From a Representative, Community-Based Sample in Xishui County, Guizhou Province, China: Cross-Sectional Study

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) and asthma remain underdiagnosed in China, particularly in rural and resource-constrained settings. Questionnaire-based screening may support early risk identification; however, COPD-oriented and asthma-oriented screening approaches may capture different segments of the population. Single-disease screening may fail to identify the broader spectrum of people reporting respiratory symptoms or relevant exposures.

Objective: This study aimed to estimate the weighted proportions and the overlap between Chronic Obstructive Pulmonary Disease Screening Questionnaire (COPD-SQ) positivity and suspected asthma screen positivity in a community-based screening sample from Xishui County, China, and to characterize the demographic, exposure-related, and respiratory profiles of the resulting screening-defined groups.

Methods: We conducted a cross-sectional analysis of baseline screening data collected between June and December 2024 from permanent residents aged 35 years or older across all 26 townships in Xishui County, Guizhou Province, China. Permanent residents were defined as individuals who had lived in Xishui County for at least 3 months before the survey and were expected to remain in the same township within the following year. Screening questionnaires were completed online or with assistance from trained local staff during household visits. Analyses incorporated stratum-specific sampling weights proportional to population-to-sample ratios and accounted for township-level clustering, with linearized SEs. COPD risk was assessed using the COPD-SQ, with a score of 16 or higher indicating high risk. Suspected asthma screen positivity was defined as at least one positive response to a symptom item from the European Community Respiratory Health Survey (ECRHS).

Participants were classified into 4 mutually exclusive groups: both screen-negative, COPD-SQ–positive only, suspected asthma screen-positive only, and dual screen-positive.

Results: Of 44,005 sampled residents, 41,839 completed the baseline screening, and 41,808 were included in the final analysis. The weighted proportions were 66.72% (95% CI 59.89%-73.54%) for both screen-negative, 11.01% (95% CI 8.88%-13.13%) for COPD-SQ–positive only, 10.97% (95% CI 8.92%-13.02%) for suspected asthma screen-positive only, and 11.31% (95% CI 8.27%-14.34%) for dual screen-positive. Overall, 22.31% (95% CI 17.36%-27.27%) were COPD-SQ–positive, 22.28% (95% CI 17.26%-27.30%) were suspected asthma screen-positive, and 33.28% (95% CI 26.46%-40.11%) screened positive on at least one instrument. The 2 screening approaches therefore identified similarly sized but only partly overlapping populations. The dual screen–positive group had the highest cumulative smoking exposure, biomass smoke exposure, prevalence of a family history of respiratory disease, and respiratory symptom burden, although several of these characteristics were components of the screening definitions.

Conclusions: Questionnaire-based COPD risk assessment and asthma symptom screening identified complementary populations in this community-based sample. These findings suggest that digitally enabled, integrated respiratory risk stratification may help organize demand for confirmatory assessment in resource-constrained primary care settings. However, a coherent care cascade pathway that follows screening should be in place to improve population health.

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Introduction

Chronic respiratory diseases (CRDs) usually encompass chronic obstructive pulmonary disease (COPD), asthma, pneumoconiosis, interstitial lung disease, and pulmonary sarcoidosis. An estimated 468.3 million individuals were living with CRDs in 2021 [1]. COPD and asthma are the most common and harmful CRDs in China and are collectively referred to as obstructive lung diseases (OLDs) [2]. The prevalence of COPD was 13.7% among those aged 40 years and above [3], and that of asthma was 4.2% among those aged 20 years and above in the China Pulmonary Health Survey (CPHS) [4]. COPD also imposes an immense health economic burden on China, accounting for INT $1.363 trillion (constant 2017 international dollars, adjusted for purchasing power parity) from 2020 to 2050 [5]. One of the most significant challenges with COPD and asthma is that the prevalence of undiagnosed OLDs may be significantly higher than that of diagnosed cases—recent reviews have estimated that up to 70% of COPD and asthma cases are not diagnosed worldwide [6,7].

Awareness, early detection, and access to appropriate care for COPD and asthma remain limited among both general and high-risk populations in China. A recent study identified substantial unmet health care needs for COPD testing, formal diagnosis, treatment, and control in China, where only 41.0% had previously undergone lung function tests, 17.6% had formally been diagnosed with COPD, 8.5% had received treatment, and less than 5.0% had been controlled [8]. Similar gaps have been observed for asthma, where only 28.8% had been diagnosed with asthma by a physician, 23.4% had reported receiving a lung function test, and only 5.6% had been treated with inhaled corticosteroids [4].

These gaps are particularly pronounced in primary care and community settings, where health professionals may have limited experience, time, personnel, and diagnostic facilities for respiratory disease detection and management. Strengthening awareness and early detection of COPD and asthma at the primary care level is therefore essential. A previous modeling study has shown the cost-effectiveness of population-based COPD screening at the community level [9]. By using the Chronic Obstructive Pulmonary Disease Screening Questionnaire (COPD-SQ), we can identify individuals at high risk of COPD based on 7 items: age, cumulative smoking history, BMI, cough, breathlessness, family history of respiratory diseases, and exposure to biomass. The COPD-SQ has been validated among Chinese populations and has been recommended for COPD screening in primary care settings [10]. Asthma screening in primary care settings is rare because of the complex natural history and heterogeneity of presentations [11,12]. Multiple epidemiological studies have used standardized symptom-based screening questionnaires to identify patients with suspected asthma, and the screening tool used in the European Community Respiratory Health Survey (ECRHS) [13-15] for asthma has been validated in Chinese populations. The ECRHS asthma screening questionnaire has been widely used in prior studies, including the CPHS [4], Global Burden of Disease Study [16], and so on. Both the COPD-SQ and the ECRHS asthma screening questionnaire are feasible in primary care settings to identify individuals at high risk of COPD and patients with suspected asthma [4,9].

Population medicine seeks to maximize population health benefits and advance health equity by extending care beyond the treatment of established disease to prevention, early risk identification, diagnosis, and longitudinal management [17]. In resource-constrained primary care settings, however, screening organized around a single disease may identify only part of the population reporting respiratory symptoms or relevant exposures. An integrated approach that combines COPD-oriented risk assessment with asthma symptom

screening may therefore be more consistent with a population medicine framework, particularly where access to quality-assured spirometry and specialist assessment is limited.

Digital health technologies offer an opportunity to implement such population-level respiratory risk stratification at scale. In the Population Medicine Multimorbidity Intervention in Xishui County (POPMIX) project [18-21], the COPD-SQ and ECRHS-derived asthma symptom items were delivered through a web-based questionnaire accessed by scanning a QR code. Residents could complete the questionnaire using their own mobile devices, while trained local staff provided household-based assistance to those unable to complete it independently. Responses were captured electronically, enabling standardized information on respiratory symptoms and major exposures to be collected across geographically dispersed communities and to be potentially linked to referral, confirmatory assessment, and subsequent management. This study therefore goes beyond a direct comparison of 2 screening tools and examines whether their combined use can inform chronic respiratory risk stratification in a low-resource primary care setting. We aimed to estimate the weighted proportions and overlap of COPD-SQ positivity and suspected asthma screen positivity and to characterize the demographic, exposure-related, and respiratory profiles of the resulting screening-defined groups, with the broader goal of informing tiered allocation of confirmatory assessment.

Methods

Study Design and Setting

This cross-sectional analysis used screening data from the POPMIX project, a population-based community screening and management project conducted in Xishui County, Guizhou Province, southwestern China [18-21]. The POPMIX project was designed to identify and manage residents at high risk of COPD using a population medicine framework. This analysis focused on the screening stage and examined the joint distribution of COPD-SQ positivity and suspected asthma screen positivity.

This study was conducted from June 2024 to December 2024 in Xishui County, Guizhou Province, a mountainous county where access to health care services is usually difficult and where the smoking prevalence of Guizhou Province ranked second among all provinces in China [18-22]. Xishui County is characterized as a resource-limited county, where its gross domestic product per capita was 48% below the national average in 2024; however, it was designated as China's National Comprehensive Primary Care Experimental Area, which created opportunities for public health practice innovations.

Study Participants

The initial screening of the POPMIX project used a government-provided roster of permanent residents aged 35 years or older across all 26 townships in Xishui County. Permanent residents were defined as individuals who had lived in Xishui County for at least 3 months and were expected to remain in the same township for the subsequent year. A total of 208,259 individuals met this definition and constituted the target population.

The sampling procedure was aligned with the cluster-randomized controlled trial design of the POPMIX project [18-21]. Townships were first classified as large or small according to whether their population size was above or below the township average and, combined with trial assignment, were grouped into 4 strata: 4 large intervention townships, 4 large control townships, 9 small intervention townships, and 9 small control townships. Residents were sampled within each stratum for screening. In this initial screening study, eligible participants were included if they (1) were adults aged 35 years or older; (2) were permanent residents in Xishui County; and (3) provided informed consent. Responses completed in 3 minutes or less, or with missing questionnaire items, were excluded from the analysis. For individuals unable to complete the electronic questionnaire independently, trained village doctors administered the questionnaire face to face, with interviews recorded for quality assurance. Stratum-specific sampling weights were applied to obtain estimates representative of permanent residents aged 35 years or older in Xishui County.

The sample size was determined by consensus between the Xishui County government and the academic team. To achieve broad coverage of permanent residents and ensure representativeness, 10,000 individuals were targeted within each stratum. Allowing for an anticipated attrition rate of 10%, 11,000 individuals were sampled per stratum, yielding a proposed total sample of 44,000. The minimum required sample size for the POPMIX trial was 2850 individuals at high risk of COPD and 3988 individuals with suspected asthma, as specified in the published protocols [18,20]. Given an estimated high-COPD-risk prevalence of approximately 25%, screening 44,000 individuals was expected to provide sufficient eligible participants. Thus, this sample size was considered adequate to meet both the POPMIX trial requirements and the local government's population coverage objective. Within each stratum, residents were selected using simple random sampling, with approximately 11,000 residents sampled per stratum based on the cluster randomized controlled trial sample-size calculation. In total, 44,005 residents aged 35 years or older were included in the baseline screening roster.

Of the 44,005 sampled residents, 2166 did not complete the baseline screening or did not provide usable questionnaire data (see *Results* section). Among the 41,839 respondents, 31 were excluded because of missing key items required to determine COPD-SQ or suspected asthma screening status, leaving 41,808 participants in the final analytic sample.

Screening Instruments and Risk Group Definitions

In this study, we used QR codes to scale up the COPD-SQ and ECRHS asthma screening questionnaires in a low-resource setting in Xishui County, Guizhou Province,

China. Participants could use their mobile phones to scan the QR codes and complete the screening questionnaires. This web-based digital screening can be easily scaled up and used to obtain data on risk factor exposures and symptoms in a cost-effective and efficient manner. Data monitoring procedures, including timing and recording, were applied to ensure the accuracy of the collected data. For residents in Xishui County who could not use mobile phones, village doctors administered face-to-face questionnaires to include them in the survey and ensure representation of the target population.

High-COPD-risk status was assessed using the COPD-SQ (ie, COPD-SQ–positive). The COPD-SQ is considered the most suitable questionnaire for the Chinese population. A previous study reported that, at a cutoff score of 16, the sensitivity, specificity, and correct classification rates for COPD diagnosis were 60.6%, 85.2%, and 82.7%, respectively [10]. Thus, a score of 16 or higher was classified as high-COPD-risk status (ie, COPD-SQ–positive), whereas a score below 16 was classified as COPD-SQ negative. Suspected asthma screen positivity was assessed using symptom-based items derived from the ECRHS asthma screening questionnaire. The Chinese version of the ECRHS asthma screening questionnaire has been validated and used in several important nationwide and regional studies. The Chinese version of the ECRHS screening questionnaire has a sensitivity of 94.0% and a specificity of 71.0% if the respondent answers "yes" to any question item and a sensitivity of 86.0% and a specificity of 96.5% if the respondent answers "yes" to the question item of whether they have "wheezed in the past 12 months" [4,20]. Within our study, we defined patients with suspected asthma as participants who responded "yes" to any question and reported the prevalence of the "wheezing symptom" in Table S4 and Figures S1 and S2 in Multimedia Appendix 1.

Based on the combined COPD-SQ and ECRHS screening results, participants were classified into 4 mutually exclusive screening-defined risk groups: both screen-negative, COPD-SQ–positive only, suspected asthma screen-positive only, and dual screen-positive. The both screen–negative group was defined as COPD-SQ negative and ECRHS-negative; the COPD-SQ–positive only group as COPD-SQ–positive and ECRHS-negative; the suspected asthma screen–positive only group as COPD-SQ negative and ECRHS-positive; and the dual screen–positive group as COPD-SQ–positive and ECRHS-positive (see Table S1 in Multimedia Appendix 1). Dual screen positivity was defined solely by positive screening results on both instruments and should not be interpreted as a clinical diagnosis of asthma-COPD overlap.

Ethical Considerations

This study forms an initial component of the POPMIX trials and was approved by the Ethics Committee of the Chinese Academy of Medical Sciences & Peking Union Medical College. The initial approvals were granted under approval numbers CAMS&PUMC-IEC-2024-040 and CAMS&PUMC-IEC-2024-041. Continuing ethical reviews were completed in June 2025 and June 2026, with updated approvals granted under CAMS&PUMC-IEC-2025-061, CAMS&PUMC-IEC-2025-062, CAMS&PUMC-IEC-2026-080, and CAMS&PUMC-IEC-2026-081. The study was conducted in accordance with the Declaration of Helsinki and subsequent amendments. Informed consent was obtained from all participants before enrollment. Participants identified as being at high risk of COPD or having symptoms suggestive of asthma were informed of their risk status through pop-up alerts following the initial screening and were advised to seek professional medical care. All data were stored at the Information Centre of Chinese Academy of Medical Sciences & Peking Union Medical College to ensure data safety. Data access is subject to approval by the study's principal investigator.

Statistical Analysis

Initial sampling weights were calculated as the ratio of the target population size to the sampled population size within each of the 4 strata and were adjusted for inclusion in the analytic sample. Inclusion probabilities were estimated using weighted logistic regression with age group, sex, and township as categorical predictors. Final weights equaled the initial weight divided by the predicted inclusion probability; no trimming or additional calibration was applied.

All primary estimates used the final weights, with sample sizes reported as unweighted counts. Variance estimation accounted for stratification and township-level clustering. Screening proportions and 95% CIs were estimated using Taylor linearization and design-based t critical values. Agreement and Cohen $\varkappa$ were calculated from weighted joint and marginal proportions. Analyses using alternative definitions of suspected asthma used the same weights. Continuous variables were summarized using weighted means and SDs, and categorical variables were summarized using unweighted counts and weighted percentages. Participant characteristics were described overall and across the 4 screening-defined groups. Smoking duration, average packs smoked per day, and pack-years were calculated among ever-smokers only.

Stratum-specific sampling weights were calculated as the ratio of the target population size to the sampled population size within each of the 4 strata. Survey analyses accounted for the 4 sampling strata and township-level clustering, with SEs estimated using Taylor linearization. Weighted proportions and design-based 95% CIs were estimated for each screening-defined group and for the overall prevalence of COPD-SQ positivity, suspected asthma screen positivity, dual screen positivity, positivity on either screening approach, discordant screening results, and identical screening status.

The joint distribution of COPD-SQ and ECRHS-derived symptom screening results was examined using a weighted 2 × 2 cross-tabulation and visualized using a weighted mosaic plot. Weighted observed agreement and Cohen $\varkappa$ were reported descriptively to characterize the degree of overlap between the 2 screening approaches rather than to assess interchangeability.

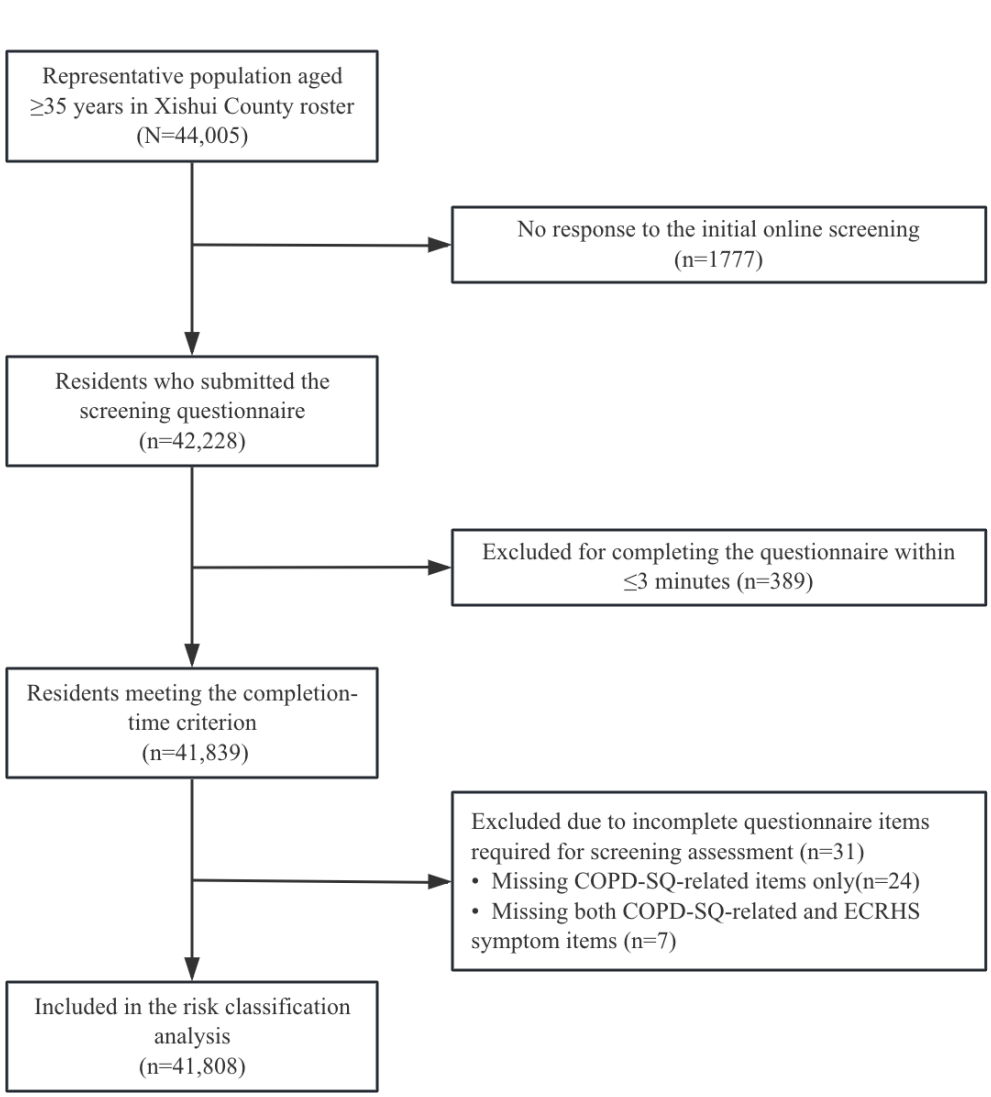
To describe group-specific profiles, selected demographic, smoking-related, environmental exposure, family history, and respiratory symptom variables were summarized across the 4 screening-defined groups. For visualization, each characteristic was standardized across the 4 groups using *z* scores, while the original weighted means or percentages were retained in the heatmap labels. Because several characteristics were components of the COPD-SQ or ECRHS-derived screening definitions, these group differences were interpreted descriptively rather than as independent associations.

As part of a sensitivity analysis, suspected asthma screen positivity was redefined as positive responses to at least 2 ECRHS-derived symptom items, and the weighted proportions of suspected asthma screen positivity, dual screen positivity, and positivity on either screening approach were reestimated. All analyses were conducted using Stata (version 17.0; StataCorp LLC) and R software (version 4.1.2; R Foundation for Statistical Computing).

Results

Among 44,005 permanent residents aged 35 years and older identified from a government-provided community roster in Xishui County, 2166 were excluded because of nonresponse, questionnaire completion time ≤3 minutes, or insufficient information to determine the screening group. We further excluded 31 respondents with missing key COPD-SQ or ECRHS items required for risk classification. Therefore, 41,808 participants were included in the final analytic sample (Figure 1). Of these, 27,542 participants were classified as both screen-negative, 4775 as COPD-SQ–positive only, 4628 as suspected asthma screen-positive only, and 4863 as dual screen-positive. Dual screen positivity was defined by positive results on both screening approaches and should not be interpreted as a clinical diagnosis of asthma-COPD overlap.

Figure 1. Flowchart of participant inclusion and exclusion. Participants were identified from a government-provided roster of permanent residents aged 35 years or older in Xishui County. Individuals who did not respond to the initial online screening had no screening data. Respondents missing key Chronic Obstructive Pulmonary Disease Screening Questionnaire (COPD-SQ) or European Community Respiratory Health Survey (ECRHS) items required for risk classification were excluded from the risk classification analysis. Permanent residents were defined as individuals who had resided in Xishui County for at least 3 months and were expected to remain within the same township for the subsequent year.



The 4 screening-defined groups showed distinct demographic, exposure-related, and respiratory symptom profiles (Table 1). Overall, the weighted mean age of participants was 57.75 (SD 12.86) years, and 50.79% (weighted) and 50.82% (21,247/41,808, unweighted) of participants were male. The COPD-SQ–positive only group was the oldest, with a weighted mean age of 71.11 (SD 8.73) years, and had the highest proportion of males (69.97% weighted and 70.01% unweighted [3343/4775]). By contrast, the suspected asthma screen-positive–only group had a weighted mean age of 54.55 (SD 10.69) years, the lowest proportion of males (41.06% weighted and 40.90% unweighted [1893/4628]), and the highest weighted mean BMI of 24.07 (SD 3.96) kg/m^2.

Table 1. Weighted characteristics of study population by screening-defined risk group.[a]

Characteristics	Overall (N=41,808)	Both screen-negative (n=27,542)	COPD-SQ[b] positive only (n=4775)	Suspected asthma screen-positive only (n=4628)	Dual screen-positive (n=4863)
Age (y), weighted mean (SD)	57.75 (12.86)	54.19 (11.60)	71.11 (8.73)	54.55 (10.69)	68.86 (10.16)
Height (m), weighted mean (SD)	1.61 (0.07)	1.62 (0.07)	1.62 (0.07)	1.60 (0.07)	1.61 (0.07)
Weight (kg), weighted mean (SD)	59.80 (10.39)	60.63 (9.87)	56.08 (9.97)	61.79 (11.36)	56.98 (11.35)
BMI (kg/m^2), weighted mean (SD)	22.90 (3.49)	23.17 (3.24)	21.20 (3.13)	24.07 (3.96)	21.93 (3.89)
Cumulative years of smoking, weighted mean (SD)	24.85 (13.71)	19.01 (10.23)	33.16 (13.95)	20.88 (10.34)	34.14 (13.75)
Average packs smoked per day, weighted mean (SD)	0.95 (0.70)	0.91 (0.66)	0.96 (0.73)	0.99 (0.64)	1.05 (0.77)
Smoking index, pack-years, weighted mean (SD)	23.91 (22.88)	17.63 (16.48)	31.25 (26.80)	20.83 (16.69)	35.15 (29.10)
Sex, n (weighted %)					
Male	21,247 (50.79)	13,128 (47.77)	3343 (69.97)	1893 (41.06)	2883 (59.36)
Female	20,561 (49.21)	14,414 (52.23)	1432 (30.03)	2735 (58.94)	1980 (40.64)
Smoking status, n (weighted %)					
Never smoked	27,966 (66.99)	20,518 (74.35)	1762 (36.81)	3340 (71.99)	2346 (48.14)
Former smoker	4822 (11.48)	2247 (8.21)	1096 (22.95)	486 (10.64)	993 (20.45)
Current smoker	9020 (21.52)	4777 (17.45)	1917 (40.24)	802 (17.37)	1524 (31.41)
Cough without cold, n (weighted %)					
No	37,530 (90.02)	27,119 (98.49)	4066 (85.16)	4073 (88.03)	2272 (46.67)
Yes	4278 (9.98)	423 (1.51)	709 (14.84)	555 (11.97)	2591 (53.33)
Degree of dyspnea, n (weighted %)					
No dyspnea	32,640 (78.56)	25,507 (92.81)	3148 (65.97)	2792 (60.41)	1193 (24.34)
Short of breath when walking normally on level ground	2370 (5.51)	388 (1.35)	513 (10.64)	242 (5.18)	1227 (25.32)
Short of breath when hurrying on the level or walking up a slight hill	6798 (15.93)	1647 (5.83)	1114 (23.40)	1594 (34.41)	2443 (50.35)
Exposure to biomass smoke from cooking or heating, n (weighted %)					
No	34,712 (83.86)	24,685 (90.28)	3503 (73.69)	3480 (76.15)	3044 (63.40)
Yes	7096 (16.14)	2857 (9.72)	1272 (26.31)	1148 (23.85)	1819 (36.60)
Family history of respiratory disease, n (weighted %)					
No	39,340 (94.12)	27,015 (98.03)	4513 (94.43)	4095 (88.31)	3717 (76.42)
Yes	2468 (5.88)	527 (1.97)	262 (5.57)	533 (11.69)	1146 (23.58)
Experienced single or recurrent wheezing, n (weighted %)					
No	37,850 (90.72)	27,542 (100)	4775 (100)	3180 (68.77)	2353 (48.23)
Yes	3958 (9.28)	0 (0)	0 (0)	1448 (31.23)	2510 (51.77)

Characteristics	Overall (N=41,808)	Both screen-negative (n=27,542)	COPD-SQ[b] positive only (n=4775)	Suspected asthma screen-positive only (n=4628)	Dual screen-positive (n=4863)
Often bothered by cough at night, n (weighted %)					
No	38,759 (92.88)	27,542 (100)	4775 (100)	3783 (81.89)	2659 (54.59)
Yes	3049 (7.12)	0 (0)	0 (0)	845 (18.11)	2204 (45.41)
Wheezing, dyspnea, or cough after exercise, n (weighted %)					
No	36,073 (86.59)	27,542 (100)	4775 (100)	2285 (49.70)	1471 (30.23)
Yes	5735 (13.41)	0 (0)	0 (0)	2343 (50.30)	3392 (69.77)
Symptoms after exposure to allergens or polluted air, n (weighted %)					
No	38,311 (91.84)	27,542 (100)	4775 (100)	3075 (66.64)	2919 (60.23)
Yes	3497 (8.16)	0 (0)	0 (0)	1553 (33.36)	1944 (39.77)
Cold symptoms go to the chest or last more than 10 days, n (weighted %)					
No	37,339 (89.53)	27,542 (100)	4775 (100)	2613 (56.50)	2409 (49.57)
Yes	4469 (10.47)	0 (0)	0 (0)	2015 (43.50)	2454 (50.43)

[a]Values are n (weighted %) or weighted mean (SD). Counts are unweighted; percentages and continuous summaries are weighted using sampling weights adjusted for final analytic inclusion using roster age group, sex, and township. Smoking duration, packs/day, and pack-years were calculated among ever-smokers only. Heights outside 1.30-2.05 m, weights outside 25-250 kg, suspected weight-unit errors, and BMI values outside 10-60 kg/m^2 after cleaning were set to missing. COPD-SQ and ECRHS symptom rows are screening items and partly define the risk groups.
[b]COPD-SQ: Chronic Obstructive Pulmonary Disease Screening Questionnaire.

Smoking-related exposures varied across the screening-defined groups. Among ever-smokers, the dual screen–positive group had the highest mean smoking index at 35.15 (SD 29.10) pack-years, compared with 31.25 (SD 26.80) pack-years in the COPD-SQ–positive only group and 20.83 (SD 16.69) pack-years in the suspected asthma screen–positive only group. Current smoking was most common in the COPD-SQ–positive only group (1917/4775, 40.15%, unweighted and 40.24%, weighted), followed by the dual screen–positive group (1524/4863, 31.34%, unweighted and 31.41%, weighted). Exposure to biomass smoke from cooking or heating was most frequent in the dual screen–positive group (1819/4863, 37.40%, unweighted and 36.60%, weighted), followed by the COPD-SQ–positive only group (1272/4775, 26.64% unweighted and 26.31% weighted) and the suspected asthma screen–positive only group (1148/4628, 24.81% unweighted and 23.85% weighted).

A family history of respiratory disease was reported by 23.58% (weighted) and 23.57% (1146/4863, unweighted) of the dual screen–positive group, compared with 5.57% (weighted) and 5.49% (262/4775, unweighted) of the COPD-SQ–positive only group and 11.69% (weighted) and 11.52% (533/4628, unweighted) of the suspected asthma screen–positive only group. The dual screen–positive group also had the highest frequencies of cough, dyspnea, wheeze, nocturnal cough, exercise-related respiratory symptoms, allergen- or polluted air–triggered symptoms, and prolonged chest symptoms after colds. Because age, BMI, smoking exposure, cough, dyspnea, biomass smoke exposure, family history, and ECRHS-derived symptoms were components of the screening instruments, these patterns should be interpreted as descriptive characteristics of the screening-defined groups rather than as independent risk-factor associations.

The COPD-SQ and ECRHS-derived symptom screening identified partially overlapping but nonidentical populations (Figure 2). Among the 41,808 participants included in the analysis, 4775 were COPD-SQ–positive only, 4628 were suspected asthma screen-positive only, and 4863 were dual screen-positive. Overall, 22.31% (95% CI 17.36%-27.27%) were COPD-SQ–positive and 22.28% (95% CI 17.26%-27.30%) were suspected asthma screen-positive (Table 2). Overall, 33.28% (95% CI 26.46%-40.11%) were screened positive on at least one of the 2 screening approaches (Table 2). Cross-classification showed that the corresponding weighted proportions were 11.01% (95% CI 8.88%-13.13%), 10.97% (95% CI 8.92%-13.02%), and 11.31% (95% CI 8.27%-14.34%), respectively. The weighted observed agreement between the 2 screening approaches was 78.03% (95% CI 74.18%-81.87%), with a Cohen κ of 0.366 (see Table S2 in Multimedia Appendix 1). These findings indicate that the 2 approaches identified similarly sized but only partly overlapping populations, with substantial numbers identified by only one approach.

Figure 2. Weighted mosaic plot of Chronic Obstructive Pulmonary Disease Screening Questionnaire (COPD-SQ) and European Community Respiratory Health Survey (ECRHS) symptom screening. Rectangles' areas are proportional to weighted percentages based on sampling weights adjusted for final analytic inclusion. Both screen-negative denotes participants who are negative on both screening tools, and dual screen-positive denotes participants who are positive on both COPD-SQ and ECRHS symptom screening. Dual screen-positive should not be interpreted as physician-diagnosed asthma-COPD overlap.

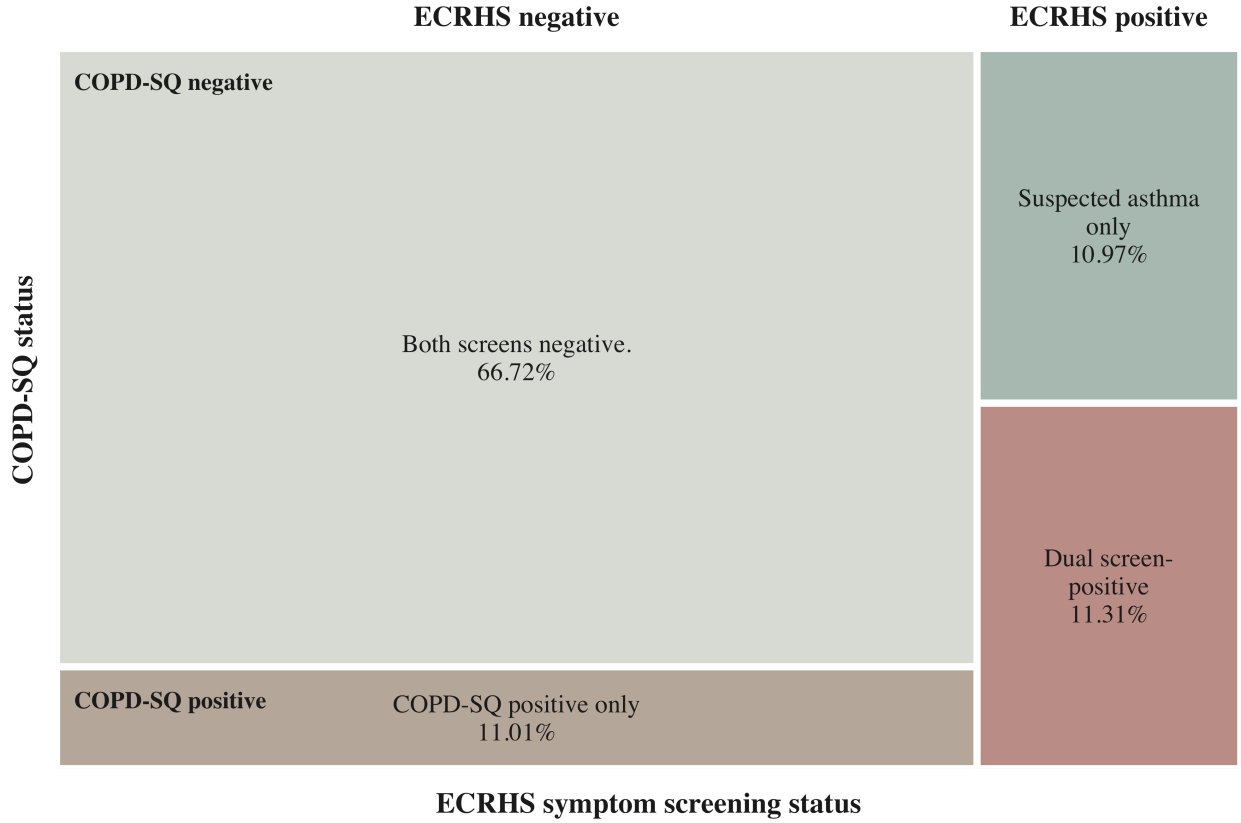


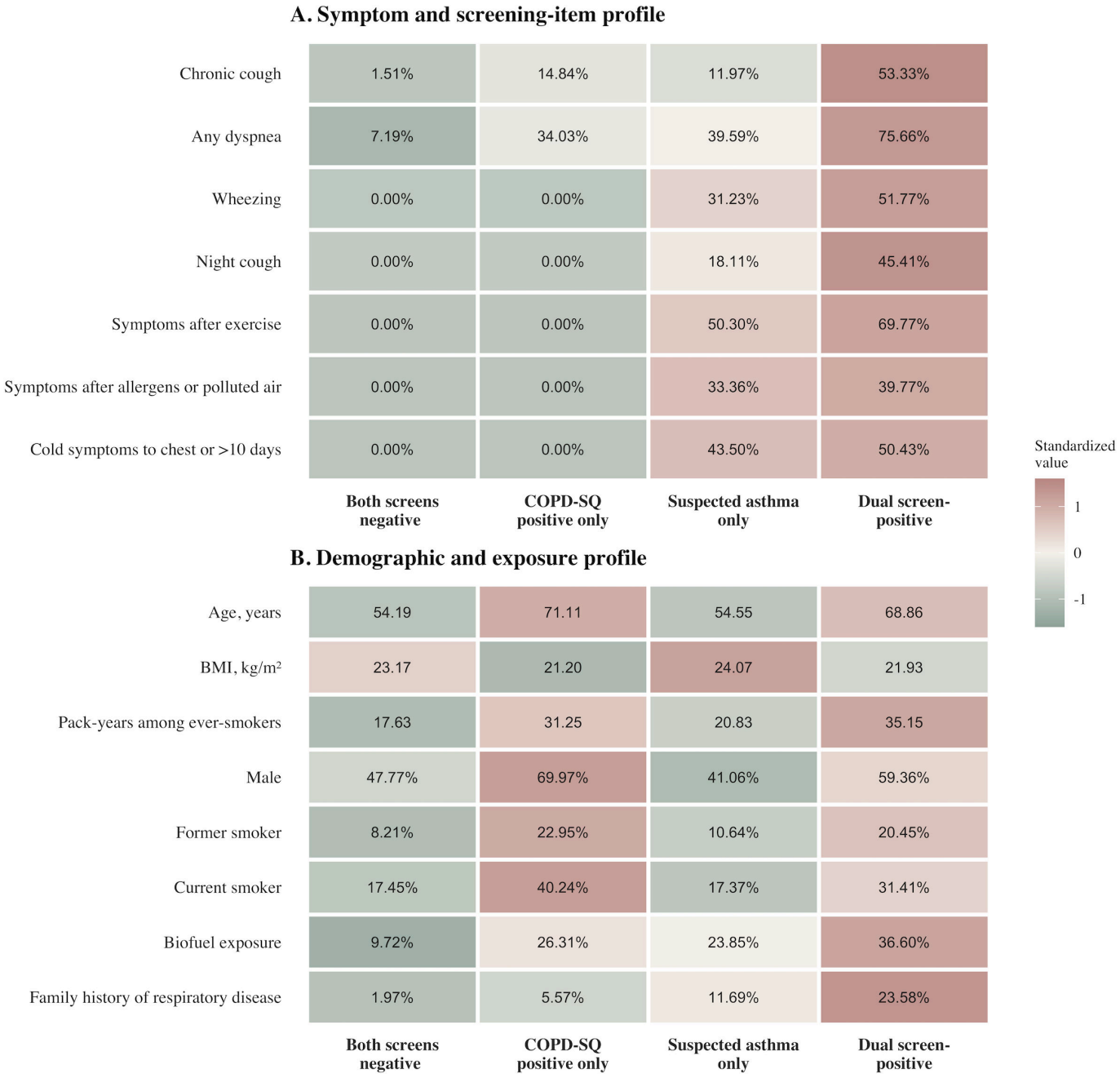
Table 2. Weighted prevalence estimates of Chronic Obstructive Pulmonary Disease Screening Questionnaire (COPD-SQ) and European Community Respiratory Health Survey (ECRHS) screening status.[a]

Estimate	Unweighted n (weighted %; 95% CI [%])
COPD-SQ positive	9638 (22.31; 17.36-27.27)
Suspected asthma screen-positive	9491 (22.28; 17.26-27.30)
Dual screen-positive	4863 (11.31; 8.27-14.34)
Either COPD-SQ or ECRHS screen-positive	14,266 (33.28; 26.46-40.11)
Discordant screen-positive	9403 (21.97; 18.13-25.82)
Same screening status	32,405 (78.03; 74.18-81.87)

[a]Counts are unweighted observed numbers. Percentages and 95% CIs were estimated using sampling weights adjusted for final analytic inclusion and survey linearized SEs.

The heatmap of standardized group characteristics further illustrated the heterogeneity of the 4 screening-defined risk groups (Figure 3). The COPD-SQ–positive only and dual screen–positive groups showed higher values for age, male sex, and smoking-related indicators than did the both screen-negative and suspected asthma screen–positive only groups. The COPD-SQ–positive only group had the highest mean age and highest proportion of men, whereas the dual screen–positive group had the highest smoking index and the greatest prevalence of biofuel exposure and family history of respiratory disease. The suspected asthma screen–positive only group had the highest BMI and lower smoking exposure than the 2 COPD-SQ–positive groups but still had higher biofuel exposure and a family history of respiratory disease than the both screen–negative group. These patterns suggest that the dual screen–positive group was not simply intermediate between 2 single-positive groups but instead had a combined profile of tobacco exposure, environmental exposure, and family history. Because several characteristics were components of the screening instruments, these patterns should be interpreted descriptively.

Figure 3. Weighted profiles of symptoms, screening items, demographic characteristics, and exposures by screening group. Values inside cells are weighted percentages or weighted means. Color intensity represents standardized values across the 4 screening groups, with muted rose indicating relatively higher values and gray sage indicating relatively lower values. Smoking pack-years were calculated among ever-smokers only. Age, BMI, smoking pack-years, chronic cough, dyspnea, biomass smoke exposure, family history of respiratory disease, and all European Community Respiratory Health Survey (ECRHS)–derived symptom items were components of the screening definitions. Accordingly, the between-group patterns for these characteristics are partly definitional and should be interpreted descriptively rather than as independent risk-factor associations. COPD-SQ: Chronic Obstructive Pulmonary Disease Screening Questionnaire.



The weighted proportions with weighted 95% CIs are shown in Table S2 in Multimedia Appendix 1. In a sensitivity analysis using a stricter definition of suspected asthma screen positivity requiring at least 2 positive ECRHS symptom items, the weighted proportion of suspected asthma screen positivity decreased from 22.28% (95% CI 17.26%-27.30%) to 12.56% (95% CI 9.18%-15.94%), dual screen positivity decreased from 11.31% (95% CI 8.27%-14.34%) to 7.74% (95% CI 5.47%-10.02%), and positivity on either screening approach decreased from 33.28% (95% CI 26.46%-40.11%) to 27.13% (95% CI 21.15%-33.12%; see Table S3 in Multimedia Appendix 1). These findings indicate that the estimated overlap was attenuated but not eliminated under the stricter ECRHS definition. In a previous study, a self-reported history of an asthma diagnosis or wheeze symptoms in the preceding 12 months was used to define asthma [4]. Therefore, we redefined suspected asthma screen positivity based on wheeze symptoms and reanalyzed the proportion with suspected asthma screen positivity. The prevalence of wheeze symptom–based suspected asthma was 9.28% (95% CI 6.79%-11.77%). Further details are provided in Table S4 and Figures S1 and S2 in Multimedia Appendix 1. We also

conducted a robustness check to compare weighted screening estimates before and after adjustment for noninclusion in the final analytic sample. The estimates were similar before and after adjustment (see Table S5 in Multimedia Appendix 1).

Discussion

In this large community-based study of 41,808 adults aged 35 years or older in Xishui County in southwestern China, COPD-SQ and the ECRHS asthma screening questionnaire identified similarly sized but partially overlapping populations. Approximately one-third of participants screened positive on at least one of the 2 approaches, and around 1 in 9 were dual screen-positive. The 4 screening-defined groups also differed in demographic, exposure, and symptom characteristics. These findings indicate that screening questionnaires for COPD and asthma symptoms provide complementary information for identifying unmet health care needs related to these 2 major OLDs in a resource-limited rural setting. In settings where spirometry, trained personnel, and specialist services are limited, a brief digital assessment combining COPD-related risk factors with asthma symptoms may offer a pragmatic first step for stratifying respiratory risk across the community and prioritizing confirmatory evaluation. In the *Discussion* section, we interpreted our results in detail from the following perspectives: the implementation of brief respiratory screening tools in a resource-limited setting, characteristics of different types of screen-positive populations, and implications for the health system.

First, brief respiratory screening tools capture different dimensions of risk and have imperfect diagnostic performance when used alone; therefore, the county-wide digital screening approach generated standardized information on respiratory symptoms, smoking, household biomass smoke exposure, and family history across all townships. Such information has value beyond estimating the proportion of questionnaire-positive residents. It can help characterize the distribution of screening-defined respiratory risk, estimate the potential demand for confirmatory assessment, and identify groups for whom limited diagnostic capacity might be prioritized [23-25]. In mountainous and resource-constrained settings, where residents may face substantial barriers to facility-based assessment, an initial community-based risk-stratification step could reduce the number of people required to travel immediately for spirometry while retaining an opportunity to identify individuals who might otherwise remain outside diagnostic and care pathways. The overlap between the 2 screening instruments also has implications for policymaking. In Chinese primary care, questionnaire-based COPD tools were generally less accurate than simple airflow measurements, while combining questionnaires with airflow assessment improved case detection [26]. Multicountry evidence from Nepal, Peru, and Uganda showed that screening performance varied across settings [27], and the CAPTURE (COPD Assessment in Primary Care to Identify Undiagnosed Respiratory Disease and Exacerbation Risk) study demonstrated modest sensitivity for clinically significant COPD in US primary care [28]. Combining questionnaire information with peak expiratory flow also improved discrimination in resource-limited settings [29]. Earlier work in Mexico similarly proposed a sequential strategy in which questionnaire assessment preceded lung-function testing [30]. Our study addresses a different, upstream question: how COPD-related risk and asthma-related symptoms are distributed and overlap before confirmatory testing. The discordance should therefore be interpreted as complementary risk information. These findings illustrate how screening programs organized exclusively around a single disease label may leave distinct groups of people with respiratory symptoms or exposure-related risks outside the initial assessment pathway [31]. An integrated approach to chronic respiratory risk assessment may therefore be more appropriate than parallel screening programs organized around separate diagnostic labels. Such an approach could link initial risk identification with smoking cessation, reduction of household air pollution, vaccination, confirmatory testing, clinical referral, and subsequent disease-specific management.

Second, the 3 screen-positive subgroups showed different characteristics and should be prioritized in the early detection of COPD and asthma. Participants with dual screen positivity were mostly smokers, were exposed to biofuels, had a family history, or had respiratory symptoms. The COPD-SQ–positivity group was primarily characterized by older age, male predominance, and a higher prevalence of current smoking. The suspected asthma group was characterized by symptoms after exercise, chest symptoms with colds, dyspnea, and wheezing. These characteristics were aligned with previous studies in questionnaire-based screenings. Rural Ugandan evidence highlights both biomass and tobacco consumption as important COPD-related exposures [32]. Smoking and household biomass exposure were associated with clinically defined asthma-COPD overlap [33]. However, several of these characteristics contribute directly to our screening algorithms, so between-group differences are partly determined by classification and should remain descriptive. Clinically characterized asthma-COPD overlap has instead been defined using objective features such as persistent airflow obstruction together with asthma- and COPD-related characteristics [34,35], consistent with broader clinical reviews. Without spirometry or clinical phenotyping, dual positivity is viewed as a potential marker for further assessment rather than a diagnosis or distinct phenotype.

Symptom-based asthma screening via the ECRHS asthma questionnaire is easy to implement but cannot be considered diagnostic. Thus, 2 sensitivity analyses to alter the working definition of suspected asthma were applied, that is, requiring either 2 “yes” answers to the ECRHS items or wheezing symptoms over the past 12 months. Requiring at least 2 ECRHS-derived symptoms reduced the screen-positive proportion, and using wheeze alone produced a still lower estimate of 9.28% (95% CI 6.79%-11.77%), showing that prevalence depends on the operational threshold, even though a possible working definition of asthma is based on reporting wheezing symptoms over the past 12 months. Symptom-based tools have likewise been used to

identify people warranting further asthma assessment without treating questionnaire positivity as a diagnosis; the Childhood Asthma Risk Tool (CHART) provides 1 example in children, although that population is not directly comparable with ours [36]. Ongoing primary-care asthma case-detection research in Uganda similarly evaluates symptom screening together with feasibility, acceptability, and cost-effectiveness [37]. Thus, our 22.28% (95% CI 17.26%-27.30%) estimate should be interpreted as symptom-based screen positivity, not asthma prevalence. The appropriate threshold will depend on the balance between sensitivity and downstream demand.

The principal implication is that early detection and risk stratification may help organize demand for confirmatory assessment where capacity is constrained. Sequential approaches have previously used questionnaire assessment before physiological testing [26,29,30]. A proactive primary-care e-visit combining COPD screening with smoking-cessation support achieved substantially higher completion of home spirometry than laboratory pulmonary-function testing, while also revealing attrition between screening and definitive testing [38]. In China, an Internet-of-Things–enabled program linked electronic questionnaire screening with spirometry and subsequent COPD management [39]. These examples support evaluating a tiered pathway from risk identification to objective assessment. At the same time, the updated US Preventive Services Task Force (USPSTF) evidence review found no direct evidence that screening asymptomatic adults for COPD improves health outcomes [40]. Our findings therefore inform symptom- and exposure-based prioritization for confirmatory assessment.

An important implication for the health system regarding early detection of CRDs in the primary care setting is that improvements in population health depend more on whether formal diagnoses, treatment, and control follow the initial screening. In the POPMIX series of studies, the COPD-SQ and the ECRHS asthma screening questionnaire were used as the initial screening process. Participants with positive screening results in the intervention arm were invited to the village gathering place for in-depth interviews and physical examinations. In the Undiagnosed COPD and Asthma Population (UCAP) randomized trial, identification of adults with previously undiagnosed symptomatic asthma or COPD followed by pulmonologist-directed treatment reduced respiratory health care use and improved several clinical measures [41]. By contrast, a cluster-randomized CAPTURE implementation trial found that providing screening scores to primary-care clinicians did not significantly improve the prespecified composite of downstream COPD assessment and management actions [42]. These studies suggest that identification alone is insufficient unless connected to an effective care cascade pathway. Digital technologies can support different components, from computed tomography–based deep-learning case finding [43] to electronic questionnaires and remote monitoring. However, scalability should not be equated with effectiveness: asthma e-screening research has identified workflow, clinician, and patient barriers [44], while a pragmatic trial of between-visit digital asthma monitoring showed limited overall improvement in asthma-related quality of life [45]. The initial screening approach in Xishui demonstrates operational feasibility for standardized data collection, but broader scalability, equity, effectiveness, and cost-effectiveness require prospective evaluation.

This study has several strengths. It included a large community population drawn from all townships in Xishui County and collected standardized information on both symptoms and major respiratory exposures. The application of 2 screening approaches allowed us to examine populations that would have been overlooked by a single-disease framework. The QR codes demonstrated the feasibility of standardized respiratory risk assessment across a geographically dispersed population in a mountainous region. The resulting profiles provide locally relevant information for planning confirmatory services and exposure-reduction interventions in a setting that is underrepresented in respiratory epidemiology.

Several limitations should be considered. First, neither spirometry nor clinical assessment was available for the present analysis; thus, the screening categories cannot be interpreted as clinical diagnoses or used to estimate the prevalence of COPD, asthma, or asthma–COPD overlap. Second, several characteristics, including age, BMI, smoking exposure, cough, dyspnea, biomass smoke exposure, family history, and ECRHS-derived symptoms, were components of the screening instruments. Their distributions across the screening-defined groups were therefore partly determined by the classification rules and should not be interpreted as independent risk-factor associations or evidence of disease severity. Third, the primary definition of suspected asthma screen positivity required only one positive ECRHS-derived symptom item and may therefore have limited specificity. Although the main patterns persisted in 2 sensitivity analyses requiring at least 2 positive symptom items and the presence of wheezing symptoms, diagnostic accuracy could not be assessed. Fourth, although the study was designed to provide broad geographic coverage within Xishui County, findings from a county might not be generalizable to other rural or resource-constrained settings. We also did not directly measure travel barriers, spirometry capacity, workforce availability, or the cost of implementing a tiered screening strategy.

In conclusion, community-based screenings may be more informative when they move beyond separate COPD- and asthma-labeled screening pathways and consider complementary patterns of symptoms and exposures. A digitally enabled, integrated risk-stratification strategy may help identify complementary screening-defined risk groups and support tiered allocation of confirmatory spirometry and clinical assessment. In resource-constrained primary care settings, its potential value lies in linking community-based screenings and early detection to spirometry, clinical assessment, referral, preventive interventions, and longitudinal management. Prospective studies should determine whether an integrated, tiered pathway improves diagnostic yield, access, equity, clinical outcomes, and efficiency compared with disease-specific or usual-care approaches.

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Generative AI Use

The authors declare the use of generative AI (GenAI) in the research and writing process. According to the GAIDeT taxonomy (2025), the following tasks were delegated to GenAI tools under full human supervision: proofreading and editing, adapting and adjusting emotional tone, reformatting, and quality assessment. The GenAI tools used were ChatGPT 5.6-Thinking (OpenAI) and DeepSeek. Responsibility for the final manuscript lies entirely with the authors. GenAI tools are not listed as authors and do not bear responsibility for the final outcomes.

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Data Availability

The datasets used or analyzed in this study are available from the principal investigator (CW) upon reasonable request.

Authors' Contributions

CW (wangchen@pumc.edu.cn) and SC (chensimiao08@icloud.com) are the joint corresponding authors, and Y Liu is the first author. SC, Y Liu, and TB conceived the study idea. Y Liu and SZ contributed to the methodology. Y Liu and SZ contributed to the data analyses. Y Liu, SZ, ZZ, QL, KH, YW, TZ, Y Luo, and XL contributed to data collection and fieldwork. Y Liu wrote the original draft. TB, SC, PG, KH, TY, and CW edited and improved the original draft. CW, SC, and TY provided resources and supervised the study. All authors contributed to the study and agreed to the final submission draft.

Conflicts of Interest

None declared.

Multimedia Appendix 1

Screening classifications, weighted prevalence estimates, and sensitivity analyses.
[DOCX File (Microsoft Word File), 307 KB-Multimedia Appendix 1]

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Abbreviations

CAPTURE: COPD Assessment in Primary Care to Identify Undiagnosed Respiratory Disease and Exacerbation Risk
CHART: Childhood Asthma Risk Tool
COPD: chronic obstructive pulmonary disease
COPD-SQ: Chronic Obstructive Pulmonary Disease Screening Questionnaire
CPHS: China Pulmonary Health Survey
CRD: chronic respiratory disease
ECRHS: European Community Respiratory Health Survey
OLD: obstructive lung disease
POPMIX: Population Medicine Multimorbidity Intervention in Xishui County
UCAP: Undiagnosed COPD and Asthma Population
USPSTF: US Preventive Services Task Force

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