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Diagnosis and management of COPD in primary care in China: a nationwide cross-sectional survey

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Abstract

This survey aimed to assess the current capacity of primary healthcare (PHC) institutions in China to diagnose and treat Chronic obstructive pulmonary disease (COPD), based on respondents' reports. An online questionnaire covering professional staffing, diagnostic testing, equipment and medication availability, screening implementation, long-term patient management and smoking cessation services was distributed through the Peking University General Practice Research Network, the Chinese General Practice Research Network, and the Standardized Respiratory Care System and Capacity-Building Project from January to July 2025. The questionnaire respondents in this study were drawn from PHC institutions, secondary hospitals, and tertiary hospitals. Because tertiary hospitals differ considerably from PHC institutions and secondary hospitals, tertiary hospitals were excluded from the present analysis. A total of 918 questionnaires were collected. After excluding 8 questionnaires from institutions that could not be identified and 116 questionnaires from tertiary hospitals, 794 questionnaires remained for analysis. Of these, 762 (96.0%) were from PHC institutions and 32 (4.0%) were from secondary hospitals. The 794 valid questionnaires were completed by respondents from 357 institutions: 328 PHC institutions and 29 secondary hospitals. Among respondents from PHC institutions, 58.0% reported that their institution had personnel able to perform spirometry, 44.0% reported availability of portable or handheld spirometers and 59.1% reported provision of spirometry, but the median reported number of tests performed during the preceding 12 months was only 6. Several long-acting combination inhalers were less frequently reported as available by respondents from PHC institutions than by those from secondary hospitals. COPD screening was reported by 70.3% of respondents from PHC institutions; among these respondents, the median reported number of cases identified during the preceding 12 months was 20. A COPD specialty outpatient clinic was reported by 20.6% of respondents from PHC institutions, while the median reported numbers of newly diagnosed and managed patients were 1 and 30, respectively. A foundation has been laid for COPD diagnosis and treatment at PHC institutions in China; however, screening and medication availability need to be further strengthened to improve the quality of COPD management in PHC institutions.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is one of the most common chronic respiratory diseases and is characterized primarily by chronic respiratory symptoms, including dyspnea, cough, and sputum production[1]. COPD is the third leading cause of death worldwide and affects millions of people, with a particularly substantial disease burden in low- and middle-income countries. By 2050, the number of COPD cases in low- and middle-income countries is projected to be more than twice that in high-income countries[2]. China has a large population of individuals with COPD, estimated at nearly 100 million. The reported prevalence of COPD among adults aged 40 years and older is 13.7%[3]. Primary healthcare (PHC) institutions play a vital role in COPD diagnosis and treatment. In recent years, the Chinese government has introduced a series of policies aimed at strengthening COPD diagnosis and treatment capacity in primary care. In 2024, COPD was incorporated into the National Basic Public Health Service Program,

which explicitly requires PHC institutions to provide health services for patients with COPD[4]. Understanding the current capacity for COPD diagnosis and treatment in PHC institutions will facilitate the effective implementation of this policy. This study aimed to investigate the current status of COPD diagnosis and treatment capacity in PHC institutions across China based on staff reports about their institutions. The assessment covered COPD-related resources and services, including the availability of trained healthcare professionals, respiratory diagnostic services such as spirometry, therapeutic medications, the implementation of COPD screening, long-term patient management, and smoking cessation interventions. The findings are expected to provide evidence for evaluating current COPD diagnosis and treatment capacity in primary care, identifying priorities for future capacity building, and strengthening COPD management in PHC institutions.

METHODS

Questionnaires were distributed to medical institutions in China through online platforms, primarily to survey primary healthcare institutions. This study was part of the project entitled “Implementation science–based strategies to facilitate implementation of Chronic Obstructive Pulmonary Disease screening in primary care in China: a stepped-wedge cluster randomized study,” which was approved by the Ethics Committee of Peking University First Hospital (2025R0104-0002). As this was an online study, participants did not provide written informed consent; however, the informed consent and privacy protection terms were displayed on the first page of the electronic questionnaire.

Study design and survey content

Based on respondents’ reports about their institutions, this study used an online, self-administered questionnaire to assess resources and COPD management in primary healthcare (PHC) settings by comparing them with secondary hospitals. The unit of analysis was the respondent. The survey was conducted from 1st, January to 30th, July 2025. The questionnaire was developed based on the study aims, the research team’s previous work, and a review of the relevant literature. The draft was reviewed and revised by experts in general practice and respiratory medicine. It was then tested in a small pilot survey and further revised before wider distribution. The questionnaire was distributed through the Peking University General Practice Research Network, the Chinese General Practice Research Network, and the Standardized Respiratory Care System and Capacity-Building Project for Primary Healthcare Institutions. Participation was voluntary. To improve data quality, the online questionnaire included checks on data types and allowed numerical ranges. All questions had to be completed before submission.

The questionnaire covered the following areas: 1. Basic institutional characteristics and respondents’ professional roles. 2. Staffing, including the numbers of spirometry operators, physicians and nurses who had received structured training, and healthcare professionals able to diagnose and treat COPD or provide smoking cessation counseling. 3. Availability of common diagnostic tests for respiratory diseases, and the numbers and funding sources of spirometers. 4. Numbers of spirometry and

bronchodilator reversibility tests performed during the preceding 12 months. 5. Availability of medications for COPD treatment, including nebulized, inhaled, and oral or systemic medications. 6. Provision of COPD screening, screening tools used, and populations covered. 7. Numbers of dedicated COPD clinics in PHC institutions, newly diagnosed COPD patients, COPD patient visits, patients with COPD registered as of the survey date. 8. Provision of smoking cessation services.

The following definitions were used in this survey: 1. Large spirometers: A fixed, non-portable desktop pulmonary function testing device located in a dedicated examination room. It could perform a range of assessments, including forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), maximum voluntary ventilation (MVV), diffusing capacity, and bronchodilator reversibility testing; 2. Portable spirometer: A movable pulmonary function testing device, usually connected to a laptop or tablet and equipped with a standard 3-L calibration syringe for daily volume calibration; 3. Handheld spirometer: A small, factory-calibrated handheld device that should not be calibrated daily by the user[5]; 4. Screening device: A simple device, such as the COPD-6, used for preliminary screening. It measures indices such as $FEV_1/FEV_6$to identify individuals who require further diagnostic assessment. Positive screening results require confirmation with standard diagnostic spirometry, including post-bronchodilator measurements[6]; 5. Nebulized medications: Liquid medications converted into an aerosol by a jet, ultrasonic, or vibrating mesh nebulizer and inhaled through the mouth or nose to act on the airways; 6. Inhaled medications: Medications delivered through devices such as pressurized metered-dose inhalers, dry-powder inhalers, or soft mist inhalers for maintenance or as-needed treatment[7]; 7. Oral and systemic medications: Medications that enter the systemic circulation through oral administration or intravenous, intramuscular, or subcutaneous injection; 8. Reported provision of COPD screening: The percentage of respondents who reported that their institution conducted COPD screening among all respondents in the corresponding institution-type group.

Study respondents

The questionnaire respondents included staff from PHC institutions, secondary hospitals, and tertiary hospitals. Given differences in institutional functions, the present analysis focused primarily on staff working in PHC institutions and secondary hospitals across China. Institutions were classified according to national standards based on their functions, responsibilities, service coverage, and technical capabilities[8–10]. PHC institutions included community health service centers, township health centers, and community health service stations. Secondary hospitals mainly included county- or district-level general hospitals and hospitals of traditional Chinese medicine.

Respondents were classified into four professional groups: institution managers, physicians, nurses, and technical staff. Each respondent was counted in only one group. Those who held both a managerial and a clinical or technical role were classified as institution managers. Tertiary hospitals were mainly general hospitals at the municipal level or above.

Statistical analysis

Statistical analyses were performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Categorical variables are presented as frequencies (*n*) and percentages (%). Between-group comparisons were performed using Pearson's chi-square test. When the expected frequency in any cell was less than 5, a Monte Carlo exact test based on 10,000 samples and a 99% confidence interval was used to calculate the *P* value. Non-normally distributed continuous variables are presented as medians with the 25th and 75th percentiles. Comparisons between two groups were performed using the Mann–Whitney U test. All tests were two-sided, and $P < 0.05$ was considered statistically significant.

RESULTS

Characteristics of participating institutions and respondents

Survey responses were received from 25 provincial-level administrative regions across China: Hubei, Tianjin, Shandong, Sichuan, Guangdong, Beijing, Liaoning, Hunan, Zhejiang, Fujian, Jiangsu, Hainan, Henan, Chongqing, Shanxi, Hebei, Yunnan, Shanghai, Jiangxi, Anhui, Guizhou, Shaanxi, Heilongjiang, Inner Mongolia, and Gansu. The survey respondents included staff from PHC institutions, secondary hospitals, and tertiary hospitals. However, because tertiary hospitals are responsible for the diagnosis and treatment of patients with complex and critical conditions, their functions differ substantially from those of PHC institutions and secondary hospitals. Therefore, tertiary hospitals were excluded from the present analysis. A total of 918 questionnaires were collected. After excluding 8 questionnaires from institutions that could not be identified and 116 questionnaires from tertiary hospitals, 794 questionnaires remained for analysis. Of these, 762 (96.0%) were from PHC institutions and 32 (4.0%) were from secondary hospitals. The 794 respondents represented 357 distinct institutions, comprising 328 PHC institutions and 29 secondary hospitals. Among them, 19.6% (70/357) of institutions were reported by at least two respondents. The geographical distribution of responses was shown in Fig. 1, and the flow diagram of the selection of questionnaires included in the analysis was shown in Fig. 2.

Among respondents from PHC institutions, 82 (10.8%) were institution managers, 446 (58.5%) were physicians, 163 (21.4%) were nurses, and 71 (9.3%) were technical staff. Among respondents from secondary hospitals, two (6.2%) were institution managers, 28 (87.5%) were physicians, two (6.3%) were nurses, and none (0.0%) were technical staff.

Availability of trained personnel

Among respondents from primary healthcare (PHC) institutions, the median reported number of personnel able to perform spirometry at their institution was 2.0 (IQR, 1.0–4.0). Of these respondents, 442 (58.0%) reported having at least one such staff member, whereas 112 (14.7%) reported having none. The median reported number of physicians who had received structured spirometry training was 1.0

(IQR, 0.0–2.0); 301 respondents (39.5%) reported having at least one trained physician at their institution, whereas 218 (28.6%) reported having none. The median reported number of nurses who had received spirometry training was 0.0 (IQR, 0.0–2.0); 251 respondents (32.9%) reported having at least one trained nurse at their institution, whereas 260 (34.1%) reported having no nurses who had received structured spirometry training.

The median reported number of physicians capable of diagnosing COPD was lower among respondents from PHC institutions than among those from secondary hospitals (5.0 [IQR, 3.0–9.0] vs 8.0 [IQR, 5.3–15.0], $P = 0.002$). Across these workforce indicators, the proportions of respondents from PHC institutions selecting “Unknown” ranged from 23.4% to 32.9%. Although these proportions were consistently higher than those among respondents from secondary hospitals, none of the between-group differences was statistically significant (all $P > 0.050$). Reported workforce availability by institution type is presented in Table 1.

Table 1
Reported workforce availability in PHC institutions and secondary hospitals

Personnel indicator	Respondents from PHC institutions (n = 762)	Respondents from Secondary hospitals (n = 32)	Z/χ^2	*P*
Staff able to perform pulmonary function testing				
Number, median (P_{25},P_{75})	2.0 (1.0, 4.0)	2.0 (1.0, 3.0)	-0.404	0.687
Unknown, n (%)	208 (27.3)	4 (12.5)	3.435	0.064
Physicians with structured training in pulmonary function testing				
Number, median (P_{25},P_{75})	1.0 (0.0, 2.0)	1.0 (0.0, 2.0)	1.019	0.308
Unknown, n (%)	243 (31.9)	5 (15.6)	3.782	0.052
Nurses with structured training in pulmonary function testing				
Number, median (P_{25},P_{75})	0.0 (0.0, 2.0)	1.0 (0.3, 2.3)	1.662	0.096
Unknown, n (%)	251 (32.9)	6 (18.8)	2.825	0.093
Physicians capable of diagnosing COPD				
Number, median (P_{25},P_{75})	5.0 (3.0, 9.0)	8.0 (5.3, 15.0)	3.169	0.002
Unknown, n (%)	178 (23.4)	4 (12.5)	0.478	0.489
Physicians trained to provide smoking cessation counseling				
Number, median (P_{25},P_{75})	2.0 (0.0, 6.0)	2.0 (0.0, 7.5)	0.172	0.863
Unknown, n (%)	209 (27.4)	7 (21.9)	0.478	0.489
Nurses trained to provide smoking cessation counseling				
Number, median (P_{25},P_{75})	2.0 (0.0, 6.0)	1.0 (0.0, 4.8)	-0.696	0.486
Unknown, n (%)	226 (29.7)	8 (25.0)	0.321	0.571

Availability of common respiratory diagnostic tests

Among respondents from PHC institutions (n = 762), the three tests most frequently reported as available at their institution were complete blood count (respondents from PHC institutions vs secondary hospitals: 87.7% vs 93.8%, *P* = 0.301), X-ray imaging (74.8% vs 90.6%, *P* = 0.042), and fingertip

pulse oximetry (65.2% vs 84.4%, *P* = 0.025). The proportions reporting availability of computed tomography (42.0% vs 93.8%, *P* < 0.001), fractional exhaled nitric oxide testing (18.8% vs 43.8%, *P* = 0.001), spirometry (59.1% vs 87.5%, *P* = 0.001), bronchodilator reversibility testing (26.9% vs 59.4%, *P* < 0.001), and arterial blood gas analysis (26.9% vs 81.3%, *P* < 0.001) were also lower among respondents from PHC institutions than among those from secondary hospitals.

The proportion of respondents selecting “Unknown” for this question was 3.9% among those from PHC institutions and 0.0% among those from secondary hospitals (*P* = 0.253). The reported availability of respiratory diagnostic tests by institution type is presented in Table 2.

Table 2
Reported availability of common respiratory diagnostic tests in PHC institutions and secondary hospitals

Diagnostic test	**Respondents from PHC institutions (n = 762), n (%)**	**Respondents from Secondary hospitals (n = 32), n (%)**	***χ²***	***P***
Chest radiography	570 (74.8)	29 (90.6)	4.149	0.042
Chest computed tomography (CT)	320 (42.0)	30 (93.8)	33.372	< 0.001
Fractional exhaled nitric oxide (FeNO) testing	143 (18.8)	14 (43.8)	12.084	0.001
Spirometry (e.g., flow-volume loops)	450 (59.1)	28 (87.5)	10.371	0.001
Bronchodilator reversibility testing	205 (26.9)	19 (59.4)	15.989	< 0.001
Pulse oximetry	497 (65.2)	27 (84.4)	5.019	0.025
Arterial blood gas analysis	205 (26.9)	26 (81.3)	43.970	< 0.001
Complete blood count, including eosinophil count	668 (87.7)	30 (93.8)	1.070	0.301
Unknown	30 (3.9)	0 (0.0)	1.308	0.253

Availability and number of pulmonary function testing devices

Regarding spirometry-related equipment, portable or handheld spirometers were the devices most frequently reported as available by respondents from PHC institutions (respondents from PHC institutions vs secondary hospitals: 44.0% vs 53.1%, *P* = 0.888). The proportion reporting the availability of large spirometers was lower among respondents from PHC institutions (17.5% vs 53.1%, *P* < 0.001), whereas the proportion reporting the availability of COPD screening devices was higher (15.2% vs 3.1%, *P* = 0.021). Among respondents from PHC institutions, 385 (51.5%) had at least one type of spirometry

device. “Unknown” responses ranged from 31.9% to 36.5% in PHC institutions and from 12.5% to 21.9% in secondary hospitals (*P* = 0.016, 0.052, and 0.091, respectively).

Regarding funding sources for spirometry equipment, procurement using institutional funds was the most frequently reported source among respondents from PHC institutions (18.8% vs 40.6%, *P* = 0.027). The proportions reporting local government funding (14.8% vs 21.8%, *P* = 0.797), national government funding (5.9% vs 6.3%, *P* = 0.742), and other funding sources (7.2% vs 3.1%, *P* = 0.263) did not differ significantly between respondents from PHC institutions and those from secondary hospitals. “Unknown” responses ranged from 30.2% to 31.8% in PHC institutions and from 6.3% to 15.6% in secondary hospitals (*P* = 0.027, 0.002, 0.007, and 0.077, respectively).

A comparison of reported availability and funding sources of spirometry equipment between PHC institutions and secondary hospitals is presented in Table 3.

Table 3
Comparison of reported availability and funding sources of spirometry equipment between PHC institutions and secondary hospitals

Equipment category/Funding source	Respondents from PHC institutions (n = 762), *n* (%)	Respondents from Secondary hospitals (n = 32), *n* (%)	χ^2	*P*
Large spirometers				
Available	133 (17.5)	17 (53.1)	16.035	< 0.001
Unknown	249 (32.7)	4 (12.5)	5.759	0.016
Portable/handheld spirometers				
Available	335 (44.0)	17 (53.1)	0.020	0.888
Unknown	243 (31.9)	5 (15.6)	3.782	0.052
COPD screening devices				
Available	116 (15.2)	1 (3.1)	5.354	0.021
Unknown	278 (36.5)	7 (21.9)	2.828	0.091
Purchased with institutional funds				
Institutions reporting this source	143 (18.8)	13 (40.6)	4.898	0.027
Unknown	235 (30.8)	4 (12.5)	4.909	0.027
Local government funding				
Institutions reporting this source	113 (14.8)	7 (21.8)	0.066	0.797
Unknown	239 (31.4)	2 (6.3)	9.163	0.002
Central government funding				
Institutions reporting this source	45 (5.9)	2 (6.3)	0.108	0.742
Unknown	242 (31.8)	3 (9.4)	7.212	0.007
Other sources (e.g., corporate donations or research projects)				
Institutions reporting this source	55 (7.2)	1 (3.1)	1.255	0.263
Unknown	230 (30.2)	5 (15.6)	3.124	0.077

Provision of pulmonary function testing

The median reported number of spirometry tests performed at respondents' institutions during the preceding 12 months was lower among respondents from PHC institutions than among those from secondary hospitals (6.0 [IQR, 0.0–111.0] vs 300.0 [IQR, 125.0–585.5], $P < 0.001$). The median reported number of bronchodilator reversibility tests was also lower among respondents from PHC institutions (0.0 [IQR, 0.0–12.0] vs 50.0 [IQR, 0.0–157.5], $P = 0.001$).

The proportions of respondents selecting "Unknown" for the total number of spirometry tests were 39.8% among those from PHC institutions and 25.0% among those from secondary hospitals ($P = 0.094$). For bronchodilator reversibility tests, the corresponding proportions were 38.8% and 25.0% ($P = 0.114$). The reported testing volumes during the preceding 12 months by institution type are presented in Table 4.

Table 4
Reported testing volumes during the preceding 12 months by institution type

Test	Respondents from PHC institutions (n = 762)	Respondents from Secondary hospitals (n = 32)	Z/χ^2	*P*
Spirometry				
Number performed, median (P_{25},P_{75})	6.0(0.0, 111.0)	300.0(125.0, 585.5)	5.125	< 0.001
Unknown, *n*(%)	303(39.8)	8(25.0)	2.809	0.094
Bronchodilator reversibility testing				
Number performed, median (P_{25},P_{75})	0.0 (0.0, 12.0)	50.0 (0.0, 157.5)	3.250	0.001
Unknown, *n*(%)	296 (38.8)	8 (25.0)	2.491	0.114

Availability of medications for COPD treatment

For nebulized medications, the three medications most frequently reported as available by respondents from PHC institutions were budesonide suspension for inhalation (respondents from PHC institutions vs secondary hospitals: 86.7% vs 93.8%, $P = 0.248$), salbutamol sulfate solution for inhalation (61.5% vs 71.9%, $P = 0.238$), and ipratropium bromide solution for inhalation (47.6% vs 56.3%, $P = 0.339$). All other nebulized medications were less frequently reported as available by respondents from PHC institutions than by those from secondary hospitals (all $P < 0.05$).

For inhaled medications, the three medications most frequently reported as available by respondents from both PHC institutions and secondary hospitals were budesonide/formoterol dry-powder inhaler (54.7% vs 81.3%, $P = 0.003$), salbutamol sulfate inhalation aerosol (54.2% vs 65.6%, $P = 0.203$), and tiotropium dry-powder inhaler (37.4% vs 62.5%, $P = 0.004$). Other long-acting or combination inhalers were generally infrequently reported as available by respondents from PHC institutions, with proportions ranging from 5.1% to 37.1%. Specifically, the proportions reporting availability of

budesonide/glycopyrronium/formoterol inhalation aerosol (24.7% vs 53.1%, $P < 0.001$), fluticasone furoate/umeclidinium/vilanterol dry-powder inhaler (10.8% vs 31.3%, $P < 0.001$), salmeterol/fluticasone dry-powder inhaler (37.1% vs 59.4%, $P = 0.011$), and glycopyrronium/formoterol inhalation aerosol (10.4% vs 25.0%, $P = 0.009$) were significantly lower among respondents from PHC institutions than among those from secondary hospitals. The remaining inhaled medications were infrequently reported as available in both groups, with no statistically significant between-group differences (all $P > 0.05$).

Among oral and systemic medications, those most frequently reported as available by respondents from PHC institutions were expectorants (84.4% vs 96.9%, $P = 0.053$), antibiotics (76.6% vs 100.0%, $P = 0.001$), and systemic corticosteroids (66.5% vs 100.0%, $P < 0.001$).

The proportions of respondents who were unable to provide information on the availability of COPD-related medications ranged from 11.8% to 24.4% in PHC institutions and from 0.0% to 6.3% in secondary hospitals.

The reported availability of COPD-related medications in PHC institutions and secondary hospitals is presented in Table 5.

Table 5
Reported availability of COPD-related medications in PHC institutions and secondary hospitals

Medication	**Respondents from PHC institutions (n = 762), *n* (%)**	**Respondents from Secondary hospitals (n = 32), *n* (%)**	**χ^2**	***P***
Nebulized medications				
Budesonide inhalation suspension	661 (86.7)	30 (93.8)	1.335	0.248
Fluticasone propionate inhalation suspension	144 (18.9)	15 (46.9)	15.010	< 0.001
Salbutamol sulfate inhalation solution	469 (61.5)	23 (71.9)	1.389	0.238
Terbutaline sulfate nebulizer solution	332 (43.6)	21 (65.6)	6.050	0.014
Ipratropium bromide inhalation solution	363 (47.6)	18 (56.3)	0.913	0.339
Acetylcysteine inhalation solution	332 (43.6)	23 (71.9)	9.953	0.002
Ambroxol hydrochloride inhalation solution	259 (34.0)	18 (56.3)	6.699	0.010
Unknown	91 (11.9)	2 (6.3)	0.962	0.327
Inhaled medications				
Tiotropium bromide inhalation powder	285 (37.4)	20 (62.5)	8.177	0.004
Indacaterol maleate inhalation powder	60 (7.9)	2 (6.3)	0.113	0.737
Glycopyrronium/formoterol inhalation aerosol	79 (10.4)	8 (25.0)	6.739	0.009
Umeclidinium/vilanterol inhalation powder	81 (10.6)	2 (6.3)	0.629	0.428
Budesonide/formoterol inhalation powder	417 (54.7)	26 (81.3)	8.761	0.003
Salmeterol/fluticasone inhalation powder	283 (37.1)	19 (59.4)	6.443	0.011
Indacaterol/mometasone inhalation powder	55 (7.2)	4 (12.5)	1.246	0.264
Budesonide/glycopyrronium/formoterol inhalation aerosol	188 (24.7)	17 (53.1)	12.981	< 0.001
Beclometasone/formoterol/glycopyrronium inhalation aerosol	39 (5.1)	2 (6.3)	0.080	0.777
Fluticasone furoate/umeclidinium/vilanterol inhalation powder	82 (10.8)	10 (31.3)	12.584	< 0.001
Salbutamol sulfate inhalation aerosol	413 (54.2)	21 (65.6)	1.618	0.203
Ipratropium bromide inhalation aerosol	161 (21.1)	8 (25.0)	0.186	0.667

Medication	Respondents from PHC institutions (n = 762), *n* (%)	Respondents from Secondary hospitals (n = 32), *n* (%)	χ^2	*P*
Unknown	186 (24.4)	2 (6.3)	5.604	0.018
Oral and systemic medications				
Expectorants	643 (84.4)	31 (96.9)	3.735	0.053
Systemic corticosteroids	507 (66.5)	32 (100.0)	15.775	< 0.001
Antibiotics	584 (76.6)	32 (100.0)	12.084	0.001
Unknown	90 (11.8)	0 (0.0)	4.263	0.039

Implementation of COPD screening

COPD screening implementation rate

Among respondents from PHC institutions, 536 (70.3%) reported that their institution conducted COPD screening, compared with 20 (62.5%) respondents from secondary hospitals. The between-group difference was not statistically significant ($\chi^2 = 0.900$, $P = 0.343$).

Use of COPD screening tools and screening volume by tool

This analysis included respondents who reported that their institution conducted COPD screening: 536 from PHC institutions and 20 from secondary hospitals.

Questionnaires were the most frequently reported screening tool in both groups. Their use for screening the general population was reported by 290 respondents (54.1%) from PHC institutions and 13 (65.0%) from secondary hospitals ($P = 0.337$). No statistically significant between-group differences were observed for screening individuals aged 35–65 years ($P = 0.844$), those aged ≥ 65 years ($P = 0.172$), or patients presenting for care ($P = 0.321$). Portable spirometers were the second most frequently reported screening tool. Their use for screening the general population was reported by 170 respondents (31.7%) from PHC institutions and six (30.0%) from secondary hospitals ($P = 0.871$). No statistically significant between-group differences were observed for screening individuals aged 35–65 years ($P = 0.056$), those aged ≥ 65 years ($P > 0.999$), or patients presenting for care ($P = 0.794$). Peak flow meters were the least frequently reported screening tool. Their use for screening the general population was reported by 37 respondents (6.9%) from PHC institutions and one (5.0%) from secondary hospitals ($P > 0.999$). No statistically significant between-group differences were observed for screening individuals aged 35–65 years ($P > 0.999$), those aged ≥ 65 years ($P = 0.387$), or patients presenting for care ($P > 0.999$).

The proportions of respondents selecting “Unknown” across the screening population categories ranged from 38.1% to 50.0% among those from PHC institutions and from 25.0% to 50.0% among those from

secondary hospitals. No statistically significant between-group differences were observed for the general population ($P = 0.236$), individuals aged 35–65 years ($P = 0.661$), those aged ≥ 65 years ($P = 0.143$), or patients presenting for care ($P = 0.948$). The reported use of COPD screening tools across population groups by institution type is presented in Table 6.

During the preceding 12 months, the median reported volume of questionnaire-based screening at respondents' institutions was 100.0 (IQR, 10.0–360.0) among respondents from PHC institutions and 300.0 (IQR, 111.3–956.5) among those from secondary hospitals ($P = 0.072$). The median reported screening volume using spirometry devices was lower among respondents from PHC institutions (50.0 [IQR, 2.0–200.0] vs 350.0 [IQR, 100.0–829.0], $P = 0.003$). Screening volumes using peak flow meters were low in both groups (0.0 [IQR, 0.0–0.0] vs 0.0 [IQR, 0.0–5.0], $P = 0.810$). The median reported number of COPD cases identified through screening was lower among respondents from PHC institutions than among those from secondary hospitals (20.0 [IQR, 3.0–60.0] vs 105.0 [IQR, 32.5–210.0], $P = 0.002$).

The proportions of respondents selecting "Unknown" for these screening indicators ranged from 48.7% to 60.6% among those from PHC institutions and from 30.0% to 50.0% among those from secondary hospitals. No statistically significant between-group differences were observed for screening volumes using questionnaires ($P = 0.068$), spirometry devices ($P = 0.100$), or peak flow meters ($P = 0.172$), or for the number of COPD cases identified through screening ($P < 0.001$). The reported screening workload during the preceding 12 months by institution type is presented in Table 6.

Table 6
Use of COPD screening tools and screening workload in PHC institutions and secondary hospitals

		Respondents from PHC institutions (n = 536)	Respondents from Secondary hospitals (n = 20)	Z/χ^2	*P*
Use of screening tools, *n* (%)					
Questionnaire	General population	290 (54.1)	13 (65.0)	0.923	0.337
	Aged 35–65 years	256 (47.8)	10 (50.0)	0.039	0.844
	Aged ≥ 65 years	265 (49.4)	13 (65.0)	1.869	0.172
	Patients presenting for care	248 (46.3)	7 (35.0)	0.986	0.321
Portable spirometer	General population	170 (31.7)	6 (30.0)	0.026	0.871
	Aged 35–65 years	124 (23.1)	1 (5.0)	3.638	0.056
	Aged ≥ 65 years	127 (23.7)	5 (25.0)	0.018	> 0.999
	Patients presenting for care	126 (23.5)	5 (25.0)	0.024	0.794
Peak flow meter	General population	37 (6.9)	1 (5.0)	0.110	> 0.999
	Aged 35–65 years	45 (8.4)	1 (5.0)	0.293	> 0.999
	Aged ≥ 65 years	41 (7.6)	0 (0)	1.652	0.387
	Patients presenting for care	46 (8.6)	1 (5.0)	0.320	> 0.999
Unknown	General population	204 (38.1)	5 (25.0)	1.402	0.236
	Aged 35–65 years	268 (50.0)	9 (45.0)	0.193	0.661
	Aged ≥ 65 years	250 (46.6)	6 (30.0)	2.149	0.143
	Patients presenting for	264 (49.3)	10 (50.0)	0.004	0.948

	Respondents from PHC institutions (n = 536)	Respondents from Secondary hospitals (n = 20)	Z/χ^2	*P*
Use of screening tools, *n* (%)				
care				
Screening workload during the preceding 12 months				
Number screened using questionnaires, median (P_{25},P_{75})	100.0 (10.0, 360.0)	300.0 (111.3, 956.5)	1.798	0.072
Unknown, *n*(%)	272 (50.7)	6 (30.0)	3.319	0.068
Number screened using spirometry devices, median (P_{25},P_{75})	50.0 (2.0, 200.0)	350.0 (100.0, 829.0)	2.952	0.003
Unknown, *n*(%)	261 (48.7)	6 (30.0)	2.699	0.100
Number screened using peak flow meters, median (P_{25},P_{75})	0.0 (0.0, 0.0))	0.0 (0.0, 5.0)	-0.240	0.810
Unknown, *n*(%)	271 (50.6)	7 (35.0)	1.867	0.172
Number of COPD cases identified through screening, median (P_{25},P_{75})	20.0 (3.0, 60.0)	105.0 (32.5, 210.0)	3.158	0.002
Unknown, *n*(%)	325 (60.6)	10 (50.0)	13.252	< 0.001

COPD management in PHC institutions

As long-term COPD management and follow-up are intended to be delivered in PHC settings, this analysis of COPD management was restricted to the 762 valid responses from PHC institutions. Dedicated COPD clinics have been established in PHC institutions in many regions to improve the quality of COPD management. Among respondents from PHC institutions, 157 (20.6%) reported that their institution had a dedicated COPD clinic, 364 (47.8%) reported that it did not, and 241 (31.6%) selected “Unknown”. During the preceding 12 months, the median reported number of patients newly diagnosed with COPD at respondents’ institutions was 1.0 (IQR, 0.0–30.0), the median reported total number of COPD patient visits was 30.0 (IQR, 0.0–172.5), and the median reported number of patients receiving COPD management was 30.0 (IQR, 0.0–100.0). At the time of the survey, the median reported number of patients with COPD for whom health records had been established was 33.5 (IQR, 0.0–100.0). The proportions of respondents selecting “Unknown” for these management indicators ranged from 31.5% to 49.0%. Reported COPD management activities in PHC institutions are presented in Table 7.

In addition, 514 respondents (67.5%) from PHC institutions and 20 (62.5%) from secondary hospitals reported that their institution provided smoking cessation services, with no statistically significant between-group difference (P = 0.559).

Table 7
COPD management activities in PHC institutions during the preceding 12 months

Item	Dedicated COPD outpatient clinic sessions per week	Newly diagnosed patients with COPD during the preceding 12 months	COPD-related patient visits during the preceding 12 months	Patients with COPD managed during the preceding 12 months	Patients with COPD registered as of the survey date
Respondents from PHC institutions (n = 762), median (P_{25}, P_{75})	0.0 (0.0, 1.0)	1.0 (0.0, 30.0)	30.0 (0.0, 172.5)	30.0 (0.0, 100.0)	33.5 (0.0, 100.0)
Unknown, *n* (%)	241 (31.6)	364 (47.8)	373 (49.0)	367 (48.2)	360 (47.2)

Discussion

This nationwide survey received 918 responses from staff working in medical institutions across 25 provincial-level regions in China, of which 794 were included in the analysis. The survey systematically assessed the current status of COPD management capacity across different levels of medical institutions based on respondents' reports, with a particular focus on PHC institutions. The findings suggest that basic capacity for COPD diagnosis and treatment has been established in PHC institutions, particularly in terms of personnel, equipment, and medication availability. A survey conducted under the national "Happy Breathing" program launched in 2017 found that only 15% of PHC institutions were equipped with spirometers[11]. As greater attention has been drawn towards COPD, equipment availability in PHC institutions appears to have improved. In a 2020 survey involving 144 PHC institutions in China, Chen et al. found that 91 (63.2%) were equipped with spirometers and 81 (56.3%) had personnel capable of performing spirometry[12]. In our survey, 442 respondents (58.0%) from PHC institutions reported that their institution had personnel capable of performing spirometry, and 338 (44.4%) reported having at least one type of spirometry device. Although estimates varied across studies, these findings suggest that spirometry capacity in PHC institutions has improved compared with some earlier reports; however, differences in study samples and units of analysis limit direct comparisons. Reported medication availability in PHC institutions was also higher than some previous estimates. For example, a 2023 survey of 325 primary hospitals found that short-acting muscarinic antagonists (SAMAs) and long-acting muscarinic antagonists (LAMAs) were available in only 57 (17.54%) and 68 (20.92%) hospitals, respectively[13]. In the present survey, 363 respondents (47.6%) from PHC institutions reported that their institution had ipratropium bromide, a SAMA, whereas 285 (37.4%) reported having tiotropium, a LAMA. Other commonly used medications were also widely reported as available: 661 respondents (86.7%) reported that their institution had budesonide inhalation suspension, and 643 (84.4%) reported expectorants. COPD screening was also more frequently reported than in an earlier study. A study conducted in 2020 found that 74 of 144 PHC institutions (51.4%) in China provided COPD screening[12]. In the present study, 536 respondents (70.3%) from PHC institutions reported that their institution provided

COPD screening, using various tools that included questionnaires, portable spirometers, and peak flow meters. These findings suggest that many of the PHC institutions represented in this survey possess the basic conditions required for COPD screening, diagnosis, and treatment.

The establishment of dedicated COPD clinics in PHC institutions also provides support for primary care-based COPD management. To improve the quality of COPD management, several regions have introduced dedicated clinics in PHC institutions. Beijing, for example, began establishing dedicated COPD clinics in PHC institutions in 2021. By the time of the cited report, more than 50 had been established, of which over 80% routinely conducted COPD screening and could generally meet basic COPD diagnostic and treatment needs within their institutions[14]. At the time of the present survey, 157 respondents (20.6%) from PHC institutions reported that their institution had established a dedicated COPD clinic, providing an important platform for COPD management in primary care. Smoking is a major and modifiable risk factor for COPD[15]; however, the implementation of smoking cessation interventions remains challenging. Although this study did not investigate the specific content of these interventions, 514 respondents (67.5%) from PHC institutions reported that their institution provided smoking cessation services.

Overall, respondents' reports suggest that basic personnel and equipment resources, as well as a service framework for COPD diagnosis and treatment, have been established in PHC institutions. We analyzed differences in reported personnel, equipment, and medication availability between secondary hospitals and PHC institutions and found that resource allocation followed a graded pattern that appeared broadly aligned with the respective functions of the two levels of care. This may serve as a foundation for tiered COPD care. Respondents from secondary hospitals more frequently reported availability of CT, arterial blood gas analysis, large spirometers, and long-acting combination inhalers, whereas respondents from PHC institutions more frequently reported availability of COPD screening devices. This pattern appears consistent with their respective roles in COPD management. However, considerable room for improvement remains. Reported availability of long-acting combination inhalers was limited, and spirometry testing volumes, screening coverage, and the number of patients receiving long-term COPD management all remained low. These findings suggest a substantial gap between current service provision and the diagnosis and treatment needs of nearly 100 million patients with COPD in China. Each of these issues is discussed in turn below.

Spirometry personnel and equipment were increasingly available in PHC institutions, but the number of examinations remained low

Spirometry is the gold standard for diagnosing COPD[1]. In this study, 442 respondents (58.0%) from PHC institutions reported that their institution had at least one staff member capable of performing spirometry, suggesting that a substantial proportion worked in institutions with the basic workforce capacity required for COPD case-finding and diagnosis. Regarding equipment funding, 18.8% of respondents from PHC institutions reported purchasing spirometers using institutional funds, and 14.8% reported local government funding. These findings suggest that some PHC institutions have been able to

mobilize internal resources or obtain local financial support to develop basic spirometry capacity. Although large spirometers were less frequently reported as available by respondents from PHC institutions than by those from secondary hospitals (17.5% vs 53.1%, P < 0.001), the reported availability of portable or handheld spirometers did not differ significantly between the two groups (44.0% vs 53.1%, P = 0.888). Furthermore, 59.1% of respondents from PHC institutions reported that their institution provided spirometry. A 2016 survey by Wu et al. involving 771 medical institutions in Guangdong found that only 12 (8.8%) of 137 primary hospitals provided spirometry[16]. In 2018, Chen et al. surveyed 242 community health service centers in Shanghai and found that only 2 (0.83%) were equipped with large spirometers and 67 (27.69%) with portable devices[17]. These findings suggest improvements in some aspects of spirometry capacity compared with earlier reports, although differences in study samples and units of analysis limit direct comparisons. Such improvements may be partly attributable to growing attention to COPD and continued policy support for PHC institutions. Overall, our findings suggest that basic personnel and equipment resources for spirometry are available in many of the PHC institutions represented in this survey.

However, the reported availability of personnel and equipment was accompanied by low testing volumes. In this study, respondents from PHC institutions reported lower volumes of spirometry and bronchodilator reversibility testing than those from secondary hospitals. This pattern suggests that PHC institutions may not yet have fully realized their intended role in COPD management. As COPD is a common chronic respiratory disease, case-finding and follow-up should largely be delivered in primary care. During the preceding 12 months, the median reported numbers of spirometry tests and bronchodilator reversibility tests performed at respondents' PHC institutions were only 6.0 and 0.0, respectively, and were lower than those reported by respondents from secondary hospitals (P < 0.001 and P = 0.001, respectively). The Healthy China Action Plan (2019–2030) calls for annual lung function testing among people aged 40 years or older and those at high risk of chronic respiratory diseases. With respect to this goal, the low reported testing volumes suggest a substantial gap in service provision. Given that personnel and equipment were reported as available in many institutions, these findings raise concerns that some spirometers may remain underused. Notably, a previous study found that, among individuals who were willing to undergo spirometry but did not complete the test, more than one-third cited a lack of trust in PHC institutions[18]. This may partly contribute to the low testing volumes observed in PHC settings. The proportions of respondents from PHC institutions who were unable to provide information ranged from 23.4% to 32.9% for workforce indicators, from 31.9% to 36.5% for equipment availability, and from 38.8% to 39.8% for testing volumes. These findings may reflect limited awareness of spirometry services among respondents and suggest a need for better internal communication and service monitoring. Standardized operational training and competency assessments delivered by spirometry professionals from higher-level hospitals may help strengthen testing capacity in PHC institutions. Incorporating spirometry provision into PHC performance indicators may also improve equipment utilization and staff engagement.

Basic medications were widely available in PHC institutions, but the availability of long-acting combination inhalers remained limited

Pharmacological treatment is a cornerstone of COPD management, especially maintenance inhaled therapy, which generally requires regular, long-term use. In this study, medication availability was assessed across three broad categories: nebulized, inhaled, and oral or systemic medications. Respondents from PHC institutions generally reported good availability of basic respiratory medications. The proportions reporting that their institution had budesonide inhalation suspension, salbutamol sulfate inhalation solution, and ipratropium bromide inhalation solution were 86.7%, 61.5%, and 47.6%, respectively. Inhaled corticosteroid-containing regimens play an important role in reducing COPD exacerbations and achieving long-term disease control in selected patients[19]. In a 2021 nationwide survey of 7,458 PHC institutions across 31 provincial-level administrative regions, Peng et al. reported that budesonide was available in 2,191 institutions (29.38%)[20], compared with 661 of 762 respondents (86.7%) from PHC institutions who reported availability of budesonide inhalation suspension in the present study. These findings suggest that reported availability of budesonide was higher than in the earlier survey. The availability of inhaled corticosteroids and the overall provision of basic respiratory medications in PHC institutions may have improved substantially.

Pharmacological treatment for COPD has advanced in recent years, and the effectiveness of long-acting combination inhalers is well established. However, the reported availability of these medications in PHC institutions remained limited. Examples of dual-combination inhalers with limited reported availability included glycopyrronium/formoterol (10.4%) and salmeterol/fluticasone (37.1%). Limited reported availability was also observed for triple-combination inhalers, including budesonide/glycopyrronium/formoterol (24.7%) and fluticasone furoate/umeclidinium/vilanterol (10.8%). The proportions of respondents reporting availability were lower in the PHC group than in the secondary hospital group for glycopyrronium/formoterol ($P = 0.009$), salmeterol/fluticasone ($P = 0.011$), budesonide/glycopyrronium/formoterol ($P < 0.001$), and fluticasone furoate/umeclidinium/vilanterol ($P < 0.001$). Some combination inhalers had low reported availability in both groups. Umeclidinium/vilanterol was reported as available by 10.6% of respondents from PHC institutions and 6.3% of those from secondary hospitals, whereas the corresponding proportions for beclometasone/formoterol/glycopyrronium were 5.1% and 6.3%, respectively. A 2021 survey by Zhang et al. reached similar conclusions[21]. Overall, 59.52% of physicians and pharmacists considered the availability of COPD combination inhalers in PHC institutions to be insufficient, and 37.01% of patients reported seeking medical treatment at tertiary hospitals because the medications they required were unavailable at community health service centers. These findings suggest that improving medication availability may help strengthen COPD management in PHC institutions.

For patients with COPD who require maintenance pharmacotherapy, regular use of long-acting bronchodilators is central to reducing the risk of exacerbations. Limited availability of long-acting inhalers in PHC institutions may prevent many patients with stable COPD from receiving guideline-concordant treatment locally, resulting in potentially avoidable referrals to higher-level hospitals and

placing further pressure on hospital resources. According to the policy document cited in reference[22], on 9 July 2026, the National Health Commission, National Administration of Traditional Chinese Medicine, and National Disease Control and Prevention Administration jointly released the National Essential Medicines List (2026 Edition), representing the first update to the national list in eight years. Long-acting inhaled therapies, including indacaterol/glycopyrronium and budesonide/glycopyrronium/formoterol, were included in the revised list. Their inclusion is expected to improve the availability of guideline-recommended COPD medications in PHC institutions and represents an important step towards strengthening the prevention and management of chronic respiratory diseases in China. The revised list was scheduled to take effect on 1 September 2026, and its impact on medication availability and COPD management in PHC institutions requires ongoing evaluation.

Institutional uptake of COPD screening was relatively high, but population reach and implementation quality remained limited

Evidence suggests that screening populations at high risk of COPD can facilitate earlier diagnosis and intervention and thereby improve patient outcomes[23]. Underdiagnosis of COPD remains a major challenge in China. In 2016, Peng et al. surveyed 48 PHC institutions or township health centers and 413 health service stations or village clinics in Weifang, Shandong Province[24]. COPD screening was provided by 13 of the 48 centers (27.1%) and 47 of the 413 stations or clinics (11.4%). A survey conducted in 2020 found that 51.4% of PHC institutions provided COPD screening[12]. In the present study, 70.3% of respondents from PHC institutions reported that COPD screening was already available at their institutions. This proportion was higher than earlier estimates. However, population coverage remained limited. Among respondents from PHC institutions reporting that their institution provided COPD screening, median reported screening volumes over the preceding 12 months were 100.0 by questionnaire, 50.0 by spirometry, and 0.0 by peak flow meter; the median reported number of COPD cases identified through screening was only 20.0. Given the large populations served by PHC institutions and the substantial burden of COPD in China, these screening volumes appear disproportionately low. Although screening had been implemented by more than half of the PHC institutions, there is still considerable room for improvement in the quality and efficiency of screening. Moreover, whether COPD screening was provided was based on respondents' self-reports and may not fully reflect actual practice. Further on-site studies remain valuable for assessing routine screening implementation.

A range of COPD screening tools, including questionnaires, portable spirometers, and peak flow meters, are now being used in routine practice, providing institutions with options for case finding. These tools involve different trade-offs in cost, accessibility, and diagnostic accuracy. Questionnaires were the most commonly reported approach, used for general population screening by 54.1% of PHC institutions reported to provide COPD screening, given their low cost, ease of administration, and suitability for resource-limited primary care settings. Portable spirometers provide objective measures of lung function but require greater technical expertise and equipment investment; their use for screening was reported by 31.7% of the same respondent group. Peak flow meters were the least frequently reported tool, at 6.9%. However, the potential value of peak flow meters should not be overlooked, as combining them

with other screening tools may improve screening accuracy[25]. Bibliometric visualization analysis showed that existing research focused more on the development of screening tools than on screening implementation[26]. Previous studies by our group found that the combined use of questionnaires and pulmonary function tests for COPD screening yielded favorable results. For example, parallel use of the Chinese Symptom-Based Questionnaire (C-SBQ) and microspirometry achieved the highest sensitivity among the strategies evaluated, reaching 81.4% (95% CI, 76.8–85.4%), with a specificity of 68.0% (95% CI, 66.0–70.0%)[27]. Moreover, based on a literature visualization analysis, current research has largely focused on the development of screening tools rather than their implementation. These findings support resource-stratified screening strategies. In areas where spirometry devices are unavailable, questionnaires could be prioritized for initial case finding, followed by confirmatory spirometry for individuals who screen positive. Where resources permit, portable spirometry could be prioritized to improve accuracy.

Moreover, the proportion of respondents from PHC institutions who were unaware of the screening data ranged from 48.7% to 60.6%, suggesting that screening at the primary care level still lacks systematic management and that information registration and statistical systems remain inadequate. PHC institutions should improve screening registration and enable automated data collection; at the same time, training should be strengthened to emphasize the importance of screening and enhance healthcare professionals' awareness of the relevant data.

COPD management in PHC institutions has begun to take shape, but service scale and quality require further improvement

Establishing COPD specialty outpatient clinics in PHC institutions may facilitate bidirectional referral, improve residents' access to specialized services, and strengthen institutional capacity to manage chronic respiratory diseases[14]. Our analysis of 762 questionnaires from PHC institutions showed that COPD management services have begun to develop at the primary care level. A total of 157 respondents (20.6%) reported that their institution had established a COPD specialty outpatient clinic. However, the overall scale of service remained limited. During the preceding 12 months, the median number of patients newly diagnosed with COPD was 1.0 per institution, while the median numbers of COPD patient visits and patients under management were both 30.0, and the median number of COPD patients registered at each institution was 33.5. Given that nearly 100 million people in China are living with COPD, these data indicate that the current reach of COPD management remains inadequate. Further efforts should therefore focus on expanding service capacity, standardizing care processes, and improving the quality of long-term COPD management in PHC institutions.

For each survey item, respondents could select "Unknown," enabling us to assess their awareness of COPD management resources and services in their institutions. A substantial proportion of "Unknown" responses may indicate gaps in institutional communication and staff awareness. If healthcare professionals are unaware of available diagnostic tests (e.g., spirometry and bronchodilator reversibility

testing), ongoing COPD screening activities, or prescribable medications, such knowledge gaps may hinder effective COPD management.

Limitations

This study has several limitations. First, the numbers of institutions at different levels were imbalanced, which may have affected the representativeness. Only 32 secondary hospitals were included, accounting for 4.0% of the valid sample, resulting in limited statistical power for comparisons. Secondary hospitals serve as an intermediate link between PHC institutions and tertiary hospitals, and their overall number is substantially smaller than that of PHC institutions distributed across urban and rural areas, with typically only one or two secondary hospitals in each county or district. In addition, the questionnaire was primarily distributed through research networks of PHC institutions, which may have further limited the recruitment of secondary hospitals. Given the important role of secondary hospitals in COPD management, further studies focusing specifically on these institutions are needed to characterize them more accurately. Second, incomplete reporting affected the analysis of several indicators. For some items, 50–60% of respondents selected “Unknown”. A possible reason is that this was a one-time questionnaire survey based on self-reported data, leaving respondents little time to systematically collect the requested information. Consequently, the reported data may not fully reflect actual institutional practice and may be subject to reporting bias. Third, questionnaires were distributed through the “Peking University General Practice Research Network”, the “Chinese General Practice Research Network”, and the Standardized Respiratory Care System and Capacity-Building Project for Primary Healthcare Institutions. Institutions not participating in these networks were less likely to be surveyed, resulting in potential selection bias in the sample of institutions studied. Fourth, this study used a self-administered questionnaire to assess resources and COPD management in PHC institutions in China. After data cleaning, 19.6% of respondents shared an institutional affiliation with at least one other respondent, indicating some overlap in the institutions represented. Nevertheless, the findings provide useful insights into resources and COPD management in the PHC institutions represented in this survey. Fifth, the cross-sectional design captured only the resources and service capacity available during the survey period. It could not assess temporal changes in these indicators or differences before and after the implementation of relevant policies. Longitudinal monitoring is therefore required to evaluate changes in COPD management capacity in primary care and the effects of policy implementation.

Overall, the findings suggest that, supported by national policies, the capacity of PHC institutions in China to prevent and manage COPD has improved compared with that reported in earlier studies. PHC institutions have developed basic capabilities for COPD screening, diagnosis, treatment, and long-term management. The distribution of healthcare resources observed across different levels of medical institutions is broadly consistent with their respective functions and provides a foundation for implementing a hierarchical COPD diagnosis and treatment system. Nevertheless, further improvements are needed in equipment utilization, access to long-acting combination inhalers, and the reach and quality of COPD screening. Future efforts should focus on increasing the use of equipment,

strengthening the implementation of screening, and optimizing medication availability, thereby accelerating the transition from policy coverage to effective service delivery.

Data Availability

The data that support the findings of this study are available from the corresponding authors upon reasonable request.

Declarations

Author Contribution

Author contributions: S.L. performed data analysis and drafted the manuscript; J.X. revised the manuscript; R.C. collected data; X.Z. collected data; Y.C. collected data; Z.P. conceptualized the study, revised the manuscript, and takes overall responsibility for the manuscript; C.C. supervised the study, performed quality control, and revised the manuscript. All authors reviewed the manuscript.

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Data Availability

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Figures

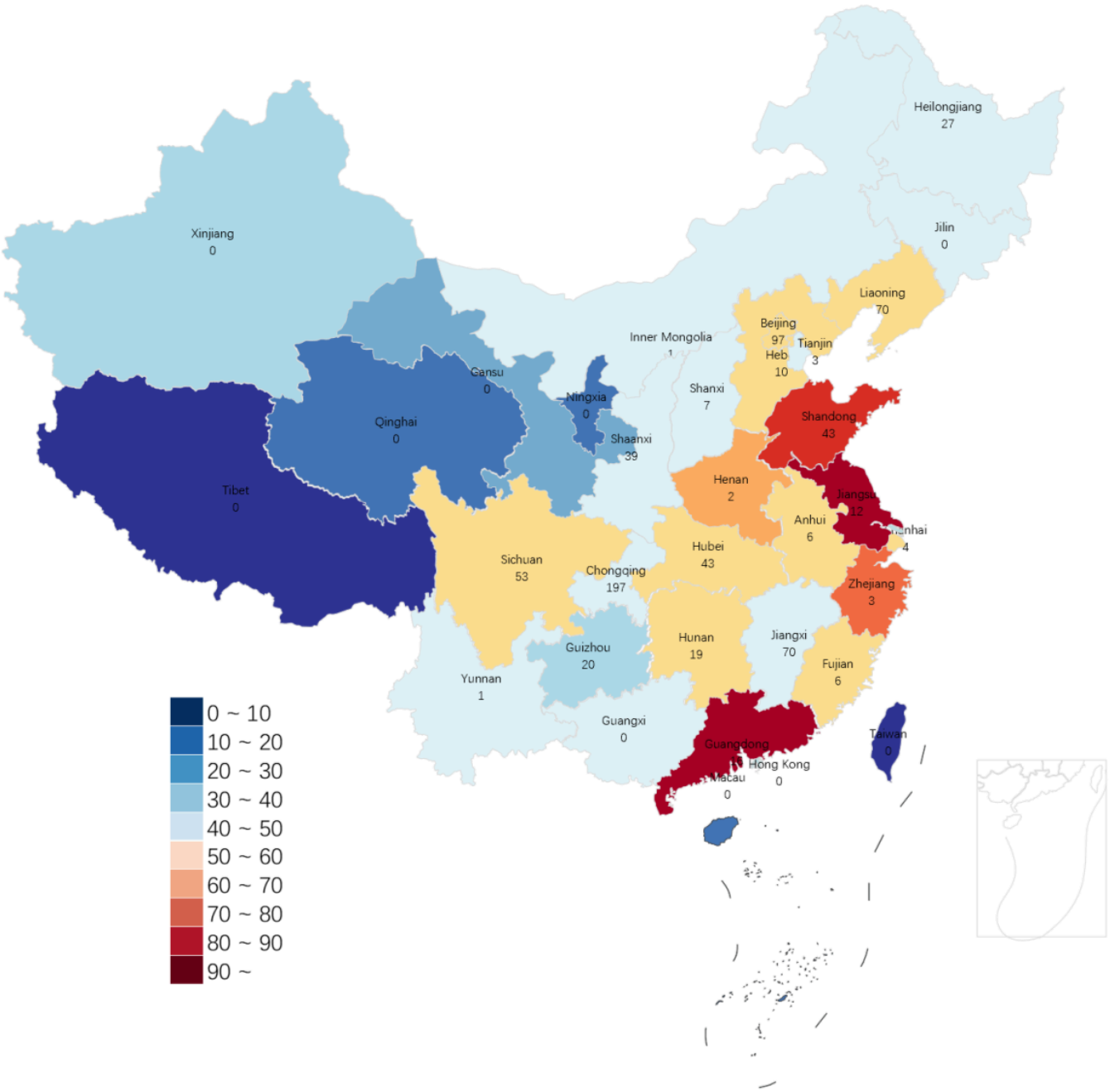


Figure 1

Heat map of the geographical distribution of survey respondents across China

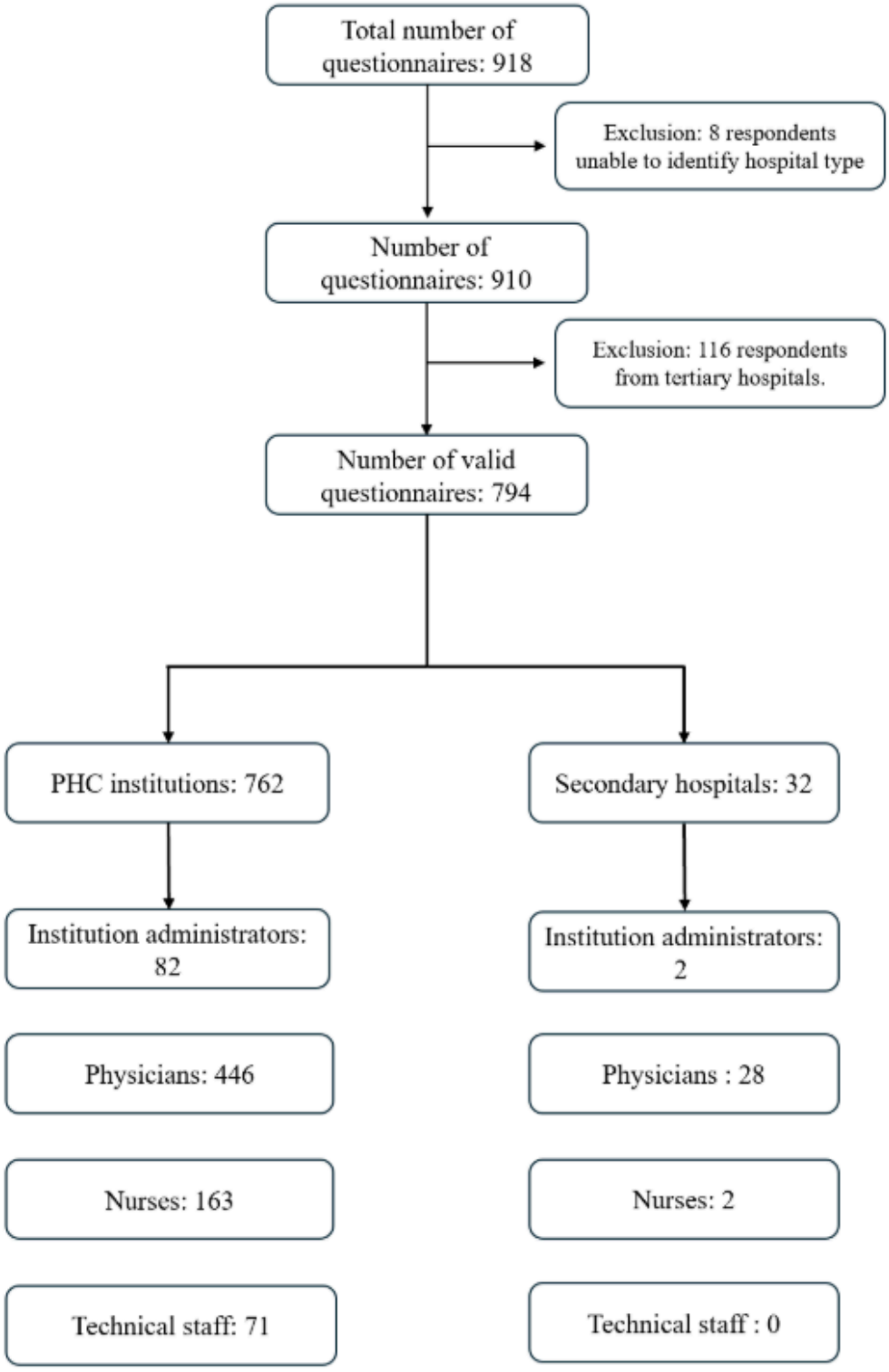


Figure 2

Flow diagram of the selection of questionnaires included in the analysis