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# Respiratory diseases and the impact of cough in Taiwan

## Results from the APBORD observational study

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## Abstract

Chronic respiratory diseases such as asthma, allergic rhinitis (AR), chronic obstructive pulmonary disease (COPD), and rhinosinusitis are becoming increasingly prevalent in the Asia-Pacific region. The Asia-Pacific Burden of Respiratory Diseases (APBORD) study was a cross-sectional, observational study which examined the disease and economic burden of AR, asthma, COPD, and rhinosinusitis across Asia-Pacific using 1 standard protocol. Here we report symptoms, healthcare resource use (HCRU), work impairment, and associated cost in Taiwan.

Consecutive participants aged ≥ 18 years presenting to a physician with symptoms meeting the diagnostic criteria for a primary diagnosis of asthma, AR, COPD, or rhinosinusitis were enrolled. Participants and their treating physician completed surveys detailing respiratory symptoms, HCRU, work productivity, and activity impairment. Costs including direct medical costs and indirect costs associated with lost work productivity were calculated.

The study enrolled 1001 patients. AR was the most frequent primary diagnosis (31.2%). A quarter of patients presented with a combination of respiratory diseases, with AR and asthma being the most frequent combination (14.1%). Cough or coughing up phlegm was the primary reason for the medical visit for patients with asthma and COPD, whereas nasal symptoms (watery runny nose, blocked nose, and congestion) were the primary reasons for AR and rhinosinusitis. Specialists were the most frequently used healthcare resource by patients with AR (26.1%), asthma (26.4%), COPD (26.6%), and rhinosinusitis (47.3%). The mean annual cost per patient with a respiratory disease was US$4511 (SD 5395). The cost was almost double for employed patients (US$8047, SD 6175), with the majority attributable to lost productivity.

Respiratory diseases have a significant impact on disease burden in Taiwan. Treatment strategies that prevent lost work productivity could greatly reduce the economic burden of these diseases.

**Abbreviations:** 95%CI = 95% confidence interval, APBORD = The Asia Pacific Burden of Respiratory Diseases study, AQLQ = Asthma Quality of Life Questionnaire, AR = allergic rhinitis, BEACH = Bettering the Evaluation and Care of Health, BNHI = Bureau of National Health Insurance, CAT = COPD Assessment Test, COPD = chronic obstructive pulmonary disease, GPs = general practitioners, HCRU = Healthcare Resource Use, HRQoL = health-related quality of life, ICD-10 = International Statistical Classification of Diseases and Related Health Problems 10th Revision, NHI = national health insurance, SD = standard deviation, SF-12v2 = 12-item Short Form Health Survey version 2, SNOT-20 = Sino-Nasal Outcomes Test-20, US = United States, WPAI-SHP = Work Productivity and Activity Impairment – Specific Health Problem.

**Keywords:** allergic rhinitis, Asia-Pacific, asthma, chronic obstructive pulmonary disorder, cough, health care resource use, rhinosinusitis

## 1. Introduction

Chronic respiratory diseases including asthma, allergic rhinitis (AR), chronic obstructive pulmonary disease (COPD), and rhinosinusitis account for 4 million deaths annually and contribute to 8.3% of the overall burden of chronic diseases.[1]

Respiratory diseases have a major adverse impact on the individual and the community in terms of quality of life, productivity, and economic burden.[1] In recent years, the Asia-Pacific region has undergone a period of rapid growth, urbanization, and economic change, which has been accompanied by an increase in respiratory diseases prevalence.[2–5] This

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increase is thought to be due to a combination of environmental, population, genetic and socioeconomic factors, although the underlying cause remains unclear.[1]

There is limited data on the current socio-economic burden of respiratory disease in Taiwan. A 2002 study of the economic burden of asthma in Taiwan found that patients with asthma had significantly more physician visits, hospital outpatient visits, urgent care visits, and hospital days than those without asthma.[6] A 2008 cost analysis of COPD in Taiwan found that higher disease severity was associated with higher expenditures, particularly in relation to hospital care and intensive care unit stays.[7] Previous research has shown that patients with concomitant respiratory diseases have greater morbidity and health care resource use (HCRU) than patients with a single respiratory disease.[8,9] As such, it is important to identify and manage patients presenting with multiple respiratory diseases.

In order to understand and reduce the socio-economic burden of respiratory diseases in Taiwan, it is essential to identify effective interventions and strategically allocate healthcare funds. Although several studies have addressed prevalence, diagnosis, and treatment of the above respiratory diseases, no study to date has explored the burden of care in Taiwanese adults who present to healthcare professionals (HCP). As such, the aim of this cross-sectional, observational study is to estimate the proportion of adults receiving care for asthma, AR, COPD, and rhinosinusitis in Taiwan and to assess the economic burden of these chronic respiratory diseases.

## 2. Methods

This study formed part of the Asia-Pacific Burden of Respiratory Diseases (APBORD) study, a large cross-sectional, observational study of adult patients receiving care for respiratory diseases in 6 countries of the Asia-Pacific—Taiwan, India, Korea, Malaysia, Thailand, and Singapore.[10,11]

### 2.1. Study design

Subjects were recruited from 4 sites between 31 October 2012 and 13 October 2013. Patients were eligible to participate in the study if their primary reason for attending the healthcare provider was to receive care for a new or existing diagnosis of asthma, AR, COPD, and rhinosinusitis. The healthcare providers at each site included 50% primary and 50% specialist physicians, of which 25% were pulmonologist/chest medicine specialists, 25% ear, nose and throat specialists, 12.5% internal medicine physicians, and 37.5% family practitioners.

During the study visit, physicians completed a Screening and Consent Log and Physician Survey for each enrolled patient and any new diagnosis of asthma, AR, COPD or rhinosinusitis was recorded. Enrolled patients were required to complete a patient survey. All study-related data was collected during a single study visit. The Chang Gung Memorial Hospital Institutional Review Board, National Taiwan University Hospital Institutional Review Board, Changhua Christian Hospital Institutional Review Board, and Kaohsiung Medical University Chung-Ho Memorial Hospital Institutional Review Board gave approval to conduct this study.

### 2.2. Sample size

In the absence of Taiwanese data, the sample size calculation was based upon precision around the proportion of all adults receiving care for a respiratory disease that was related to a primary diagnosis of asthma, which was expected to be the least common of the 4 diseases.[4,12–15] The Bettering the Evaluation and Care of Health (BEACH) program in Australia indicted that asthma was managed at 2.1% of patient visits to general practitioners (GPs).[16] Applying this and other preset assumptions, it was expected that 4% of adults who received care for a respiratory disease would have a new or existing diagnosis of asthma. On the basis of this calculation, a sample size of 5000 enrolled patients (providing ± 0.3% precision around the assumed 4% [CI: 3.7%, 4.3%]) was selected given the lack of epidemiological data in the Asia Pacific region. For the Taiwanese arm of the study, the sample size calculated was 1000 patients with a minimum of 250 enrolled patients required for each site to minimize bias. Based on the assumptions for sample size calculations, it was estimated that in each country, 25% of the total screened patients would enroll in the study.

### 2.3. Patient recruitment

Adult patients were recruited in a consecutive manner by physicians when they presented for a routine consultation. The physician ascertained whether the primary reason for the patient's visit was to receive care for a respiratory disease; possible reasons related to their new or existing primary diagnosis of respiratory disease included physical, diagnostic, therapeutic, and/or nontherapeutic. Patients whose primary reason for the medical visit was not related to receiving care for a respiratory disease were not screened for the study. Eligibility criteria included: ≥ 18 years of age; receiving care for a new or existing diagnosis of asthma, AR, COPD, and/or rhinosinusitis; and ability to provide written informed consent. Patients were excluded if they had participated in an interventional clinical study within the last 12 weeks, or if they had consented to participate in the current study at another site. Patients who did not receive care for asthma, AR, COPD, or rhinosinusitis were not eligible to participate in the study. Eligible patients were provided with study information and invited to participate in the study. Informed consent was obtained from each patient, and a patient could only participate in the study once with no follow-up visits recorded.

### 2.4. Data collection

The diagnosis of respiratory disease was defined by ICD-10 classifications.[17] This excluded some infectious and parasitic diseases that may affect the respiratory system (e.g., tuberculosis) and also excluded neoplasms of the respiratory system. Diagnosis was made by the attending physician using criteria based on international guidelines for asthma, AR, COPD, and rhinosinusitis.[18–21] The physician was required to indicate the clinical criteria for the diagnosis from a list of disease criteria adapted from these clinical practice guidelines for any patients with a new diagnosis of any of the 4 diseases. The patients' clinical management and physicians' usual diagnostic practices were not intended to be influenced by participation in the study; however, some patients may have been diagnosed using a more rigorous and standardized approach than may have occurred prior to commencement of the study. No attempt was made to independently verify or confirm the patient's diagnosis, and no follow-up diagnostic tests were conducted.

No suitable validated survey instruments existed for the 4 diseases of interest, and the Physician and Patient Surveys were

developed specifically to meet the objectives of the study. For each enrolled patient, the treating physician completed the Physician Survey, which was designed to be noninterventional, recording the diagnosis and clinical criteria for the diagnosis. The Physician survey comprised questions relating to the primary diagnosis of asthma, AR, COPD, or rhinosinusitis, reason for the patient's visit, new and existing diagnoses for the 4 diseases, family history of the 4 diseases, referrals to other medical services, medication use, and intended medication use after the study visit.

Patient surveys were self-administered and included questions relating to demographics, disease history and exposure to risk factors, respiratory symptoms, healthcare resource use, work productivity, and quality of life. Additional validated surveys were also incorporated to capture information on work productivity and health-related quality of life (HRQoL). These included the Work Productivity and Activity Impairment-Specific Health Problem (WPAI-SHP) which measures the amount of absenteeism, presenteeism, and daily activity impairment attributable to a specific health problem,[22] the 12-item Short Form Health Survey (SF-12v2) measuring quality of life[23] and disease-specific HRQoL measures (Mini Asthma Quality of Life Questionnaire (mini AQLQ),[24] COPD assessment test (CAT),[25] or Sino-Nasal Outcomes Test-20 (SNOT-20) for rhinosinusitis).[26]

### 2.5. Costing

A broad societal perspective was adopted for the cost analysis and as such costs collected were based on government and patient out of pocket costs. Unit costs for HCRU by practice type (e.g., GP visit, specialist consultation, pharmacist visit, hospitalization for respiratory patient) and primary diagnosis (asthma, AR, COPD, and rhinosinusitis) were collected. Average HCRU costs were calculated using the unit cost of the healthcare resource use item multiplied by reported healthcare resource use in the previous 4 weeks, plus the current visit to the GP or specialist. Unit costs were sourced from the Bureau of National Health Insurance (BNHI) website.

The dosing and duration of medication use was aligned with international therapeutic guidelines.[11] Patient medication use was collected for each medication class (e.g., antibiotic, inhaled anticholinergic, etc.) during the 4 weeks prior to the index consultation. To cost each medication class, 1 medication was identified which represented the most commonly prescribed medication for respiratory disease. The general assumption was that patients would incur the cost of therapy over the full 4-week (28-day) period.

Work productivity was assessed using the WPAI-SHP questionnaire which measured the amount of absenteeism, presenteeism, overall work productivity lost, and daily activity impairment attributable to a specific health problem. The recall period for this questionnaire was 7 days. The value of lost productivity was assumed to be equal to the gross average wage (estimated at NTD 47,223 from ILO Global Wage Database 2012), which were extrapolated to year 2014 values using linear regression. Lost productivity costs were calculated by multiplying the overall productivity lost from the WPAI questionnaire by the average monthly wage. Work productivity costs were only calculated on the proportion of participants who were reportedly employed during the study period.

For all direct and indirect costs, the 4-week costs were multiplied by 13 to estimate the annual cost. Costs are presented in USD using the exchange rate for 15 September 2014: 1 USD = 30.0350 NTD.

### 2.6. Statistical analysis

Statistical analyses were performed using SAS for Windows, version 9.3 (SAS Institute Inc, NC). Patient demographics and clinical characteristics were described using mean (Standard Deviation [SD]) for continuous variables and number (percentage) for categorical variables. The percentage and 95% confidence interval of patients with each disease were calculated using the exact (Clopper–Pearson) method.

## 3. Results

### 3.1. Patient demographics

Based on the assumptions for sample size calculations, it was estimated that 25% of the total screened patients would enroll in the study. In order to enroll 1000 patients, the target for the number of screened patients was 4000 for the study period. A total of 2722 patients were diagnosed with a respiratory disease and subsequently screened. A total of 1607 patients were considered eligible of which 543 (33.8%) presented with AR, 311 (19.4%) with asthma, 269 (16.7%) with COPD, and 484 (30.1%) with rhinosinusitis. The enrolment rate of eligible patients was 59% resulting in the screening of substantially fewer numbers of patients than anticipated. Of the eligible patients, a total of 1001 patients consented and were enrolled in the study, a consent rate of 62.3%.

Patient characteristics are presented in Table 1. The mean (SD) age of enrolled patients was 55.3 (18.17) years and 55% were male and reflected the eligible, nonconsenting patients mean age and gender of 54.6 (17.81) years and 52% male gender. Comparisons were made between eligible consenting and nonconsenting participants for the 4 respiratory diseases to minimize selection bias (Table 1). These were comparable for AR; however, a greater percentage of patients with asthma and COPD were consenting which may result in an over-representation of the diseases, whereas a greater percentage of patients with rhinosinusitis were nonconsenting and may thus be under-represented.

Approximately 47% of patients were in full- or part-time employment. Forty-two percent of patients reported ever smoking, whereas 31.6% (n = 131) were current smokers. Patients with a primary diagnosis of COPD had the greatest proportion of patients who had ever smoked (78.6%), but the lowest proportion of current smokers (18.8%).

### 3.2. Frequency of respiratory disease

Allergic rhinitis was the most frequent primary diagnosis in enrolled patients (31.2%, 95% Confidence Interval [CI]: 28.3, 34.1), followed by asthma (25.1%, 95%CI 22.4, 27.9), rhinosinusitis (22.8%, 95%CI 20.2, 25.5), and COPD (21.0%; 95%CI 18.5, 23.6). Figure 1 shows the proportion of patients with concomitant respiratory diseases. A quarter of patients (n = 249) presented with a combination of the 4 respiratory diseases. The most frequently observed combination was asthma and AR (n = 141, 14.1%), with or without other diseases. Of the patients presenting with a primary diagnosis of AR, 55 (17.6%) were diagnosed with 1 or more concomitant respiratory diseases, including 31 (56.4%) with asthma, 20 (36.4%) with rhinosinusitis, and 5 (9.1%) with COPD.

### 3.3. Respiratory symptoms

Patients were asked to report all respiratory-related symptoms at the current visit and indicate which symptom was the main

**Patient demographics by primary diagnosis and practice type.**

| | Allergic rhinitis | Asthma | COPD | Rhinosinusitis | Total population |
|---|---|---|---|---|---|
| Eligible (n = 1607) vs enrolled (n = 1001) patients by primary disease | | | | | |
| Eligible—consented and enrolled (%) | 312 (31.1%) | 251 (25.1%) | 210 (20.9%) | 228 (22.8%) | 1001 (62.2%) |
| Eligible—did not consent and did not enroll (%) | 231 (38.1%) | 60 (9.9%) | 59 (9.7%) | 256 (42.2%) | 606 (37.7%) |
| Enrolled patients (n = 1001) | | | | | |
| Gender, n (%)* | | | | | |
| N | 312 | 251 | 210 | 228 | 1001 |
| Female | 161 (51.6%) | 150 (59.8%) | 33 (15.7%) | 107 (46.9%) | 451 (45.1%) |
| Male | 151 (48.4%) | 101 (40.2%) | 177 (84.3%) | 121 (53.1%) | 550 (54.9%) |
| Age, y | | | | | |
| N | 312 | 251 | 210 | 228 | 1001 |
| Mean ± SD | 45.9 ± 18.19 | 59.2 ± 15.33 | 71.4 ± 10.92 | 49.1 ± 14.75 | 55.3 ± 18.17 |
| Range | 20-91 | 21-94 | 24-91 | 20-87 | 20-94 |
| Ethnicity, n (%)* | | | | | |
| N | 312 | 251 | 210 | 227 | 1000 |
| Chinese | 311 (99.7%) | 251 (100.0%) | 209 (99.5%) | 226 (99.6%) | 997 (99.6%) |
| Other | 1 (0.3%) | 0 (0.0%) | 1 (0.5%) | 1 (0.4%) | 3 (0.3%) |
| Employment status, n (%)* | | | | | |
| N | 310 | 251 | 210 | 228 | 999 |
| Full-time | 174 (56.1%) | 92 (36.7%) | 21 (10.0%) | 137 (60.1%) | 424 (42.4%) |
| Part-time | 21 (6.8%) | 9 (3.6%) | 7 (3.3%) | 13 (5.7%) | 50 (5.0%) |
| Retired | 68 (21.9%) | 129 (51.4%) | 179 (85.2%) | 57 (25.0%) | 433 (43.3%) |
| Student | 14 (4.5%) | 2 (0.8%) | 1 (0.5%) | 7 (3.1%) | 24 (2.4%) |
| Unemployed | 19 (6.1%) | 3 (1.2%) | 1 (0.5%) | 10 (4.4%) | 33 (3.3%) |
| Other | 14 (4.5%) | 16 (6.4%) | 1 (0.5%) | 4 (1.8%) | 35 (3.5%) |
| Smoking history | | | | | |
| Ever smoked, n (%)* | | | | | |
| N | 312 | 249 | 210 | 229 | 999 |
| Yes | 90 (28.8%) | 73 (29.3%) | 165 (78.6%) | 87 (38.0%) | 415 (41.5%) |
| No | 222 (71.2%) | 176 (70.7%) | 45 (21.4%) | 141 (61.6%) | 584 (58.5%) |
| Current smoking status, n (%)* | | | | | |
| N | 90 | 73 | 165 | 87 | 415 |
| Current smoker | 47 (52.2%) | 21 (28.8%) | 31 (18.8%) | 32 (36.8%) | 131 (31.6%) |
| Former smoker | 43 (47.8%) | 52 (71.2%) | 134 (81.2%) | 55 (63.2%) | 284 (68.4%) |

COPD = chronic obstructive pulmonary disease, SD = standard deviation.
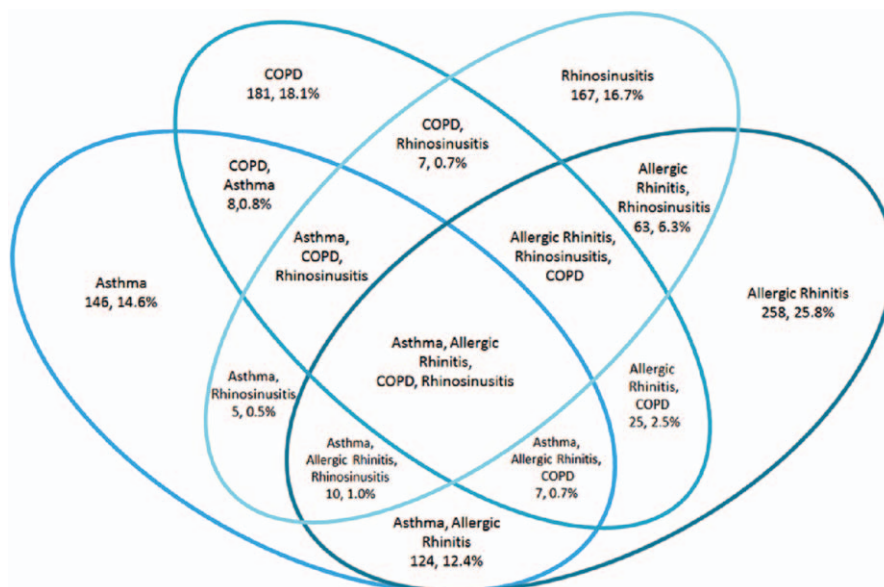* Calculation of percentage excludes participants with missing data.



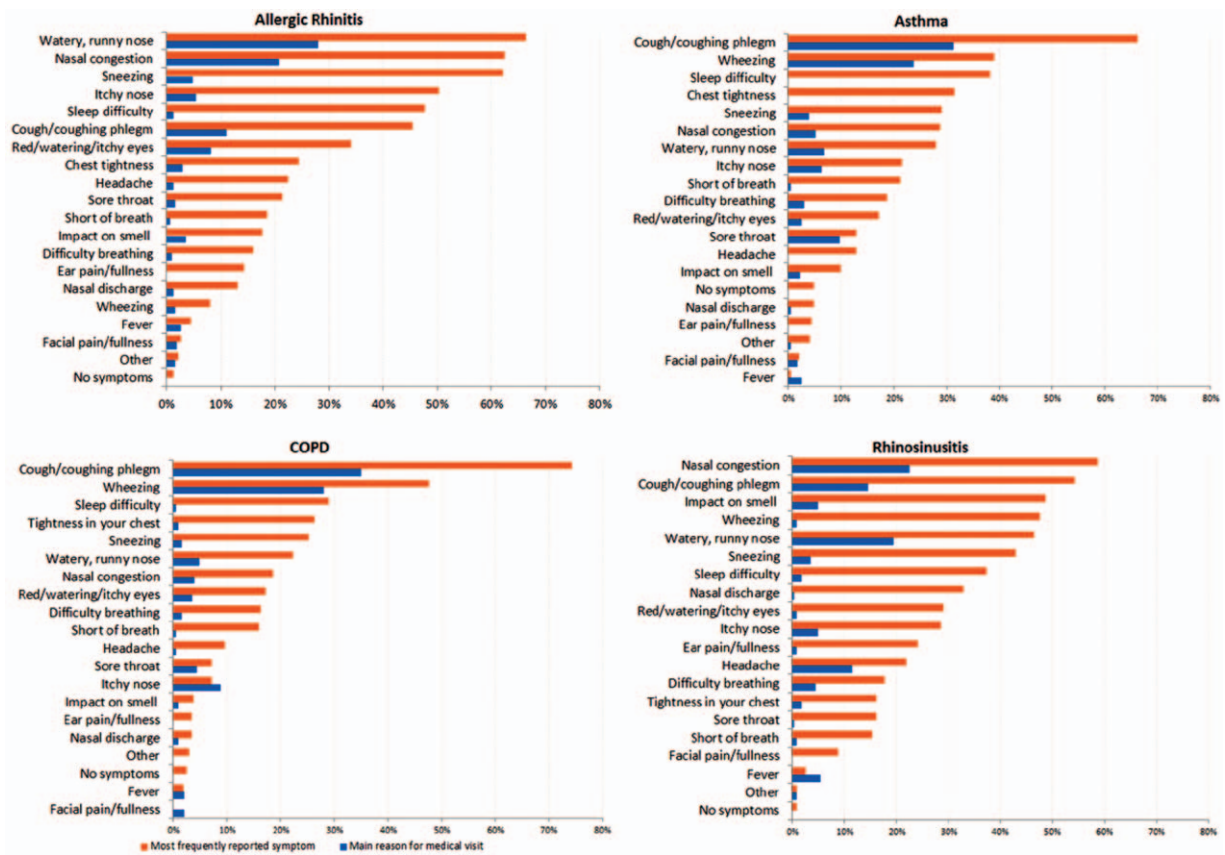Figure 1. Percentage of patients with a combination of diseases (N = 1001).

**Figure 2.** Main reason for the medical visit and symptoms reported by primary diagnosis.

reason for their current visit (Fig. 2). Cough or coughing up phlegm was the most frequently reported symptom for patients with COPD (74.3%) and asthma (66.1%), and the second most reported for rhinosinusitis (54.4%). For those patients with a primary diagnosis of AR, a watery, runny nose (66.4%) or blocked nose/congestion (62.5%) was the most frequently reported symptoms. Cough or coughing up phlegm was also the main reason for the medical visit for patients with a primary diagnosis of asthma (31.4%) and COPD (35.0%), followed by wheezing (23.7% and 28.1%, respectively). However, patients with rhinosinusitis reported blocked nose or congestion as the main reason (22.6%), followed by watery runny nose (19.5%) and then cough (14.6%). Patients with a primary diagnosis of AR reported watery runny nose as the main reason for the medical visit (28.0%), followed by blocked nose or congestion (20.9%).

### 3.4. Healthcare resource utilization

Patients were asked to report their HCRU associated with their main respiratory symptom for the 4 weeks prior to the current medical visit (Fig. 3). Specialists were the most frequently used healthcare resource across all primary diagnoses: AR (26.1%), asthma (26.4%), COPD (26.6%), and rhinosinusitis (47.3%). Patients with a primary diagnosis of asthma reported greater emergency department use (3.8%) than patients with other primary diagnoses. Alternative or traditional medicine practitioners were more frequently utilized by patients with a primary diagnosis of AR (3.3%) and asthma (3.4%) than patients with COPD (1.0%) and rhinosinusitis (1.8%). Pharmacist and hospital utilization were minimal for all patients.

Patients were asked about their history of medication use in the 4 weeks prior to the study visit (Fig. 4). Seventy-two percent of patients reported using medication for their respiratory disease in the previous 4 weeks. Patients with a primary diagnosis of asthma or COPD had higher prior medication use (93.2% and 91.9%, respectively) than patients with AR (54.8%) and rhinosinusitis (53.1%). Asthma patients reported the highest prior use of fixed dose combination inhalers (41.8%), whereas COPD patients reported the highest prior use of mucolytics (44.8%) and methylxanthines (43.3%). Patients with AR reported the highest prior use of oral antihistamines (43.6%), and patients with rhinosinusitis reported steroidal nasal spray as the most frequently used prior medication (27.6%).

Medications prescribed to patients at the medical visit were also recorded (Fig. 4). The main medications prescribed for asthma, AR, and COPD were the same as those used by patients in the prior 4 weeks. Patients with a primary diagnosis of rhinosinusitis were prescribed antibiotics most frequently (39.4%), followed by oral antihistamines (22.8%). Antitussives were prescribed frequently for all patients.

### 3.5. Work productivity and activity impairment

Patients completed a WPAI questionnaire which assessed the impact of their respiratory disease on their activity and work productivity (Fig. 5). The biggest contributing factor to productivity loss was presenteeism (percentage impairment at work) in comparison to absenteeism. This was particularly evident in patients with AR where the impact on productivity loss was 40.0% (SD 27.3) and activity impairment was 38.7% (SD
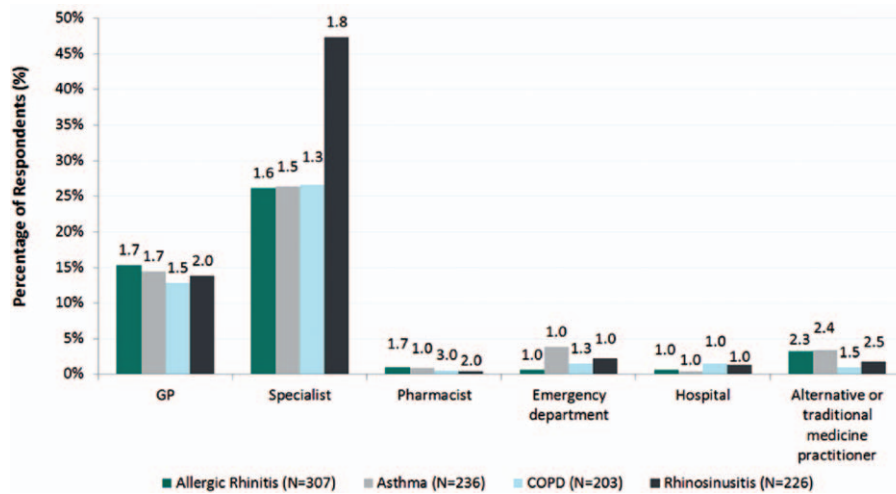
**Figure 3.** Percentage of patients with HCRU in previous 4 weeks by primary diagnosis (N=972). HCRU = healthcare resource use.

28.3). Productivity loss was also high for patients with a primary diagnosis of rhinosinusitis (31.1%, SD 29.5) and slightly lower for asthma (28.0%, SD 28.0) and COPD (28.4%, SD 28.0).

### 3.6. Costs

The annual direct and indirect costs captured in the study by primary diagnosis are presented in Fig. 6. The mean overall cost for patients with a respiratory disorder was US$4511 (SD 5395) per patient annually. For employed patients, the mean annual cost was almost double that of the overall average (US$8047, SD

6175 per patient). The most significant cost for the working population was productivity loss (US$6890, SD 5889 per patient per year). Productivity loss had the greatest impact on patients with a primary diagnosis of AR (US$8177, SD 5577 per patient), although patients with all diagnoses were heavily affected.

The highest direct medical costs were in patients with a primary diagnosis of COPD (82.8% of direct costs). Patients with a primary diagnosis of asthma had the second highest direct medical costs (79.0% of direct costs). Specialist costs were also high, particularly in patients with a primary diagnosis of rhinosinusitis (53.6%).
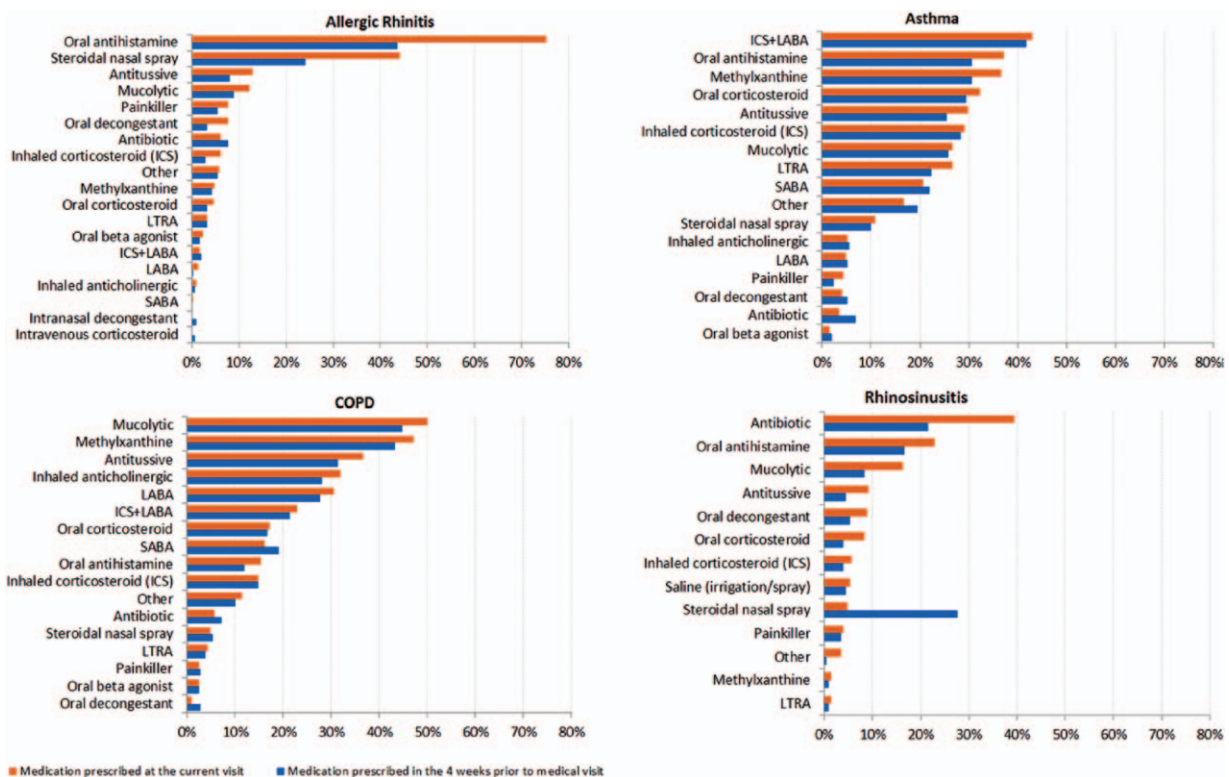


**Figure 4.** History of medication use for respiratory disease and medications prescribed at the medical visit by primary diagnosis.
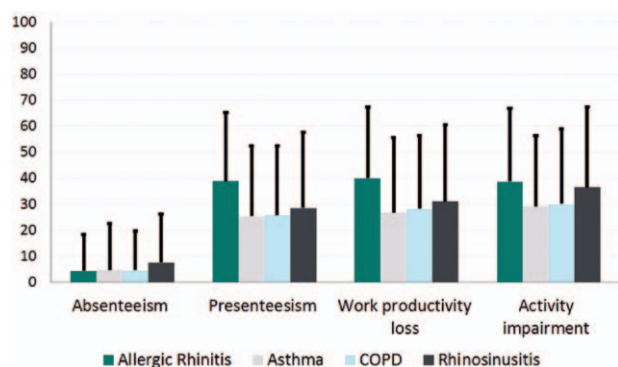
**Figure 5.** Mean % WPAI scores (±SD) by primary diagnosis (N=1001). SD = standard deviation, WPAI = Work Productivity and Activity Impairment.



**Figure 6.** Annual direct and indirect costs for study population by primary diagnosis (N=1001).

## 4. Discussion

The aim of this study was to investigate the disease burden of 4 highly prevalent respiratory diseases in Taiwan using 1 standard protocol. Results show that a quarter of patients were diagnosed with multiple respiratory disorders. The mean annual cost for patients with a respiratory disease was US$4511, with lost productivity the main contributor to overall costs. These findings highlight the large impact these diseases have on both the society and economy.

The most frequent primary diagnosis in the current study was associated with AR ( 31.2%), whereas a quarter of patients reported a primary diagnosis of asthma. These are similar to findings of the Allergies in Asia-Pacific Survey, where 33% of Taiwanese adults reported experiencing nasal allergies through-out the year.[27] The increasing prevalence of AR and asthma in Taiwan has been linked to increasing industrialization, urbanization, and traffic-related air pollutants.[28,29]

Previous research has shown that patients with concomitant respiratory diseases have greater morbidity and HCRU.[8,9] In this current study, approximately a quarter of the patients presented with a combination of respiratory diseases, of which AR and asthma were the most frequent combination (14.1%). Although the higher frequency of AR and asthma is consistent with other studies,[9] the overall frequency of concomitant respiratory diseases in Taiwan is lower than reported for other Asia-Pacific countries.[30,31]

Patients with a primary diagnosis of asthma or COPD reported cough or coughing up phlegm as the main reason for the medical visit. The main reasons for the medical visit in AR and rhinosinusitis patients were nasal symptoms, including watery runny nose and blocked nose or congestion. The allergies in Asia-Pacific Survey reported that 64% of Taiwanese adults were moderately or extremely bothered by nasal congestion, and 30% were unable to tolerate symptoms without relief.[27] Patients with AR and rhinosinusitis also frequently reported cough or coughing up phlegm, which may be indicative of asthma and should be investigated comprehensively.

The mean overall cost per patient with a respiratory disorder was US$4511 (SD 5395) annually. The mean annual cost was almost double this for employed patients, with the majority attributable to lost productivity. Presenteeism (i.e., lost productivity while at work) was the largest contributor to costs compared with absenteeism (i.e., time off work). Patients with a primary diagnosis of AR and rhinosinusitis had considerably higher lost productivity costs than patients with asthma and
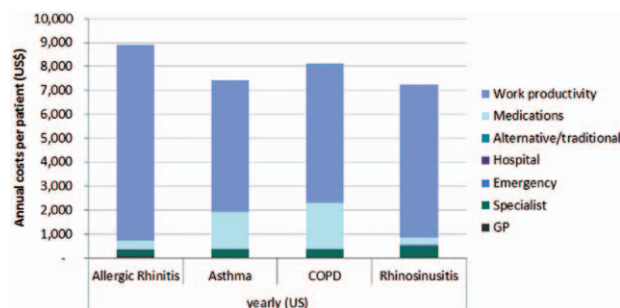
COPD. It is possible that AR symptoms are not as effectively managed by medications in Taiwan, leading to greater activity impairment. A recent study reported that 60% of adults in Taiwan were dissatisfied with steroidal nasal sprays, the lowest satisfaction rate among all Asia-Pacific countries.[27] More effective management of patients with AR and rhinosinusitis may reduce productivity costs associated with presenteeism.

Specialists were the most frequently utilized healthcare resource for all 4 respiratory diseases. In contrast, hospital visits were minimal. The healthcare system in Taiwan, known as National Health Insurance (NHI), is a single-payer compulsory social insurance plan where the government pays for the majority of patient out-of-pocket expenses. No referrals are required to see a specialist, and there is generally no waiting list, leading to easy accessibility.[32] Medication use was high in patients with a primary diagnosis of COPD and asthma, reinforcing the importance of preventative treatment strategies in reducing hospital costs associated with acute exacerbations.[7,33]

Certain study limitations were inevitable and should be considered when interpreting the results of this study. The study recruited adult patients presenting to primary care physicians and specialist medical practices in multiple urban settings of convenience. It was not the intention of the study to measure prevalence estimates that are generalizable to the entire population, country or region and therefore, study participants may not be representative of the broader population with these respiratory diseases. Furthermore, as only adult patients were recruited from urban centers, the results may not be generalizable to either patients under 18 years of age or to rural populations. The validity of the physician and patient surveys were not evaluated as part of this study; however, validated surveys were used to measure work productivity and health-related QoL. Although clinical guidelines were used, the method of diagnosing respiratory disease was not standardized and was based on physician judgment and clinical findings at a single study visit, to reflect current treatment practices in the real world setting. However, this may have led to inconsistencies in diagnosis and frequency rate of the various diseases. Assumptions relating to the cost analysis were required. Publicly available data was used where available to provide cost estimates and where this information was not available certain assumptions were adopted. Information relating to the availability, accessibility, and cost of medication relied on the accuracy of the various study site data provided. As the study included only patients attending primary and specialist care clinics, hospitalized patients may have had different HCRU patterns and utilization that may be more reflective of their chronic and/or severe conditions and incurring

higher costs. And, although hospitalizations are infrequent, the associated cost can be significant. Despite these limitations, this is the first study to comprehensively describe the burden of asthma, AR, COPD, and rhinosinusitis in Taiwan.

## 5. Conclusions

The continued development and urbanization of Taiwan has been accompanied by an increasing prevalence of respiratory disease. The findings of this study contribute to better understanding the socio-economic impact of 4 prevalent respiratory diseases and highlight the relative burden on healthcare resources. Of significance were the high indirect costs associated with lost work productivity, which should be a focus of future disease management.

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