# Prevalence and Risks of Chronic Airway Obstruction*

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# Prevalence and Risks of Chronic Airway Obstruction*

## A Population Cohort Study in Taiwan

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***Background:*** **This study investigated the prevalence, incidence, and hospitalization for chronic airway obstruction (CAO) in a population cohort.**
***Methods:*** **Medical reimbursement claims from 1996 to 2002 based on a 1996 insured cohort of 167,372 persons from National Health Insurance, Taiwan, were used. We presented the chronological trends of CAO (International Classification of Diseases, Ninth Revision code 496) and the relationships between the CAO severity and age, sex, urbanization, and hospitalization and comorbidity for the population ≥ 40 years old.**
***Results:*** **The overall average annual prevalence and incidence rates were 2.48/100 and 0.66/100, respectively, for the population, among 4,568 patients with CAO cared during the study period. For the population aged ≥ 70 years, the prevalence rates had a peak of 8.83/100 in 1998 and afterward remained a plateau until 2002. The corresponding incidence decreased from 2.48/100 to 1.62/100, and the hospitalization rate for them had a peak of 2.22/100 in 1999. The multivariate logistic regression analysis showed that the risk of hospitalization for CAO was higher for patients with the comorbidity of renal failure, coronary artery disease, and pneumonia and influenza, but lower with skin and joint disorders.**
***Conclusions:*** **The national insurance program promotes patient care and provides a proper pathway for surveillance and identification of CAO.** ***(CHEST 2007; 131:705–710)***

**Key words:** chronic airway obstructions; comorbidity; population cohort; universal health insurance

**Abbreviations:** BPH = benign prostate hypertrophy; CAD = coronary artery disease; CAO = chronic airway obstruction; CI = confidence interval; CPD = chronic pulmonary disease; ICD-9 = International Classification of Diseases, Ninth Revision; NHI = National Health Insurance; OR = odds ratio; P&I = pneumonia and influenza

Chronic pulmonary diseases (CPDs) are heterogeneous disorders of acute/chronic bronchitis, emphysema, asthma, COPD, and chronic airway obstruction (CAO) not elsewhere classified. These diseases have attracted increasing attention because of the augmentation of prevalence and mortality, and the economic cost worldwide.[1] Community-based investigation has been considered as a reliable approach for the occurrence estimation of and etiologic studies for these diseases, although the results may

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differ from diagnosis criteria.[2,3] Population-based insurance data provide an opportunity to observe the epidemiologic patterns of the diseases and factors associated with the patterns.

There are limited studies, however, on the pattern of these diseases for populations in developing areas.[4] It has been inspirited to investigate the effective prevention strategy, including the reduction of associated risk factors and comorbidities for these diseases.[5–7] Older age and comorbidities such as hypertension and other cardiac conditions, diabetes mellitus, and chronic renal failure have been associated with CPDs.[8–16] Smoking prevention, other risk factors control, screening, and early treatment of the diseases may reduce both the incidence and prevalence of the diseases.[17–19]

This study estimated annual trends of prevalence, incidence, and hospitalization for CAO for the population ≥ 40 years old using cohort data generated from population-based Taiwan National Health Insurance (NHI) claims. Patient demographic characteristics and comorbidity associated with the disease severity were investigated as well.

## Materials and Methods

A representative sample of 200,000 people was randomly selected from all beneficiaries ever enrolled in the Taiwan NHI program between March 1995 and December 2000. Among them, 167,372 were actively enrolled at the first day of 1996 and were considered as the study cohort in the current analysis. We linked, through individual's personal identification number, to both the ambulatory care and inpatient claims (from 1996 to 2002) to identify all episodes of CAO encountered by the study subjects. Attrition of the study cohort was observed due to various reasons such as mortality and emigration. The NHI program had an initial coverage rate of 90.0% population in 1995, and later increased to 96.2% in 2000.[20]

The NHI electronic data files provided scrambled patient identification numbers, gender, birthday, and the classification code of disease, dates of admission, and discharge, and medical institutions providing the services. The NHI has not yet required physicians to use the tenth revision of International Classification of Diseases, and cases of CPD were therefore coded using the International Classification of Diseases, Ninth Revision (ICD-9) clinical modification codes 490–496. The claims of CAO (ICD-9 code 496) not elsewhere classified were what we focused on in this study.

Patients who made only one ambulatory visit for the purpose of screening for CPD instead of receiving care for the disease during the study period (*ie*, 1996 to 2002) were not considered for this study. The incidence cases, however, were patients with the new claims for the care of the disease identified starting in 1997. Prevalence and hospitalization rates from 1996 to 2002 and incidence rates from 1997 to 2002 for population aged ≥ 40 years were estimated and adjusted by annual age-specific population. Average annual prevalence and incidence rates were calculated at intervals of 10 years (Table 1). Chronological trends of CAO were grouped for population aged 40 to 59 years, 60 to 69 years, and ≥ 70 years due to very low prevalence in the younger groups and similar pattern in the oldest groups.

Except for lung function measurement,[21,22] exacerbations and clinic visit frequency were adopted from methods developed by Donaldson et al[23,24] to determine the severity of CPDs. Based on numbers of clinic visit, cases were categorized into four severity levels: level zero for patients with only 1 visit in the 7 years (< 42.2 percentile), level one for 2 to 5 visits (42.2 to 81.1 percentiles), level two for 6 to 24 visits (81.1 to 95.0 percentiles), and level three for ≥ 25 visits (≥ 95 percentile). In addition to estimating trends of prevalence and incidence rates for the study population, we calculated annual visits-to-cases ratios to evaluate the impact of health insurance on CAO. These ratios were determined using annual total clinic visits divided by total cases claimed for CAO and categorized by the disease severity for comparison.

All cases of CAO identified during the entire study period were pooled for further analysis for the association between disease severity and associated comorbidities, controlling for sex, age, and urbanization level (Taipei, Kaohsiung, and Taichung vs the rest areas). We used the polytomous logistic regression (Proc catmod; SAS Institute; Cary, NC) to compute odds ratios (ORs) and confidence intervals (CIs) for factors associated with the disease severity. We further used multiple logistic regression to estimate the relationships between hospitalization and sex, age,

**Table 1—*Distribution of Patients Aged ≥ 40 Years, Average Annual Rates of Primary Diagnosed CAOs, and Male-to-Female Case Ratios by Age and Severity Level in Taiwan, 1996–2002***

| Variables | Cases in 7 Years, No. (%)* | Male/Female Gender, No. | Prevalence Rate, /100 | Incidence Rate, /100 |
|---|---|---|---|---|
| Age, yr | | | | |
| 40–49 | 533 (11.7) | 317/216 | 0.40 | 0.17 |
| 50–59 | 833 (18.2) | 497/336 | 1.53 | 0.49 |
| 60–69 | 1,523 (33.3) | 1,093/429 | 4.48 | 1.19 |
| 70–79 | 1,286 (28.2) | 935/351 | 7.94 | 2.02 |
| ≥ 80 | 393 (8.6) | 249/144 | 8.36 | 2.54 |
| Severity† | | | | |
| 0 | 1,847 (40.4) | 1,148/698 | | |
| 1 | 1,624 (35.6) | 1,088/536 | | |
| 2 | 832 (18.2) | 639/193 | | |
| 3 | 265 (5.80) | 216/49 | | |
| All | 4,568 (100) | 3,091/1,476 | 2.48 | 0.66 |

*CAO cases were grouped based on the age of first clinic visit and primary diagnostic code.

†Based on clinic visit frequency in 7 years, zero for only 1 visit, one for 2 to 5 visits, two for 6 to 24 visits, and three for ≥ 25 visits.

urbanization level, occupation (blue collar, others, vs white collar), disease severity and comorbidities. The potential comorbidities included in this study were hypertensive disease (ICD-9 codes 401.9–405.9), benign prostate hypertrophy (BPH) [ICD-9 code 600], diabetes mellitus (ICD-9 code 250), skin disorders (ICD-9 codes 690–709), cervical and back disorders (ICD-9 codes 721–725), joint disorders (ICD-9 codes 710–719.99), renal failure (ICD-9 codes 585–586), coronary artery disease (CAD) [ICD-9 codes 410–414.9], and pneumonia and influenza (P&I) [ICD-9 codes 480–487]. These were the most frequently diagnosed diseases among the insurance claims. We used the stepwise analysis for model selection, and tested using the likelihood ratio test. Statistical analysis was performed using statistical software (SAS version 8.2; SAS Institute; Cary, NC).

## Results

### *Case Characteristics*

In this study cohort, there were 4,568 patients with at least one claim of primary diagnosis as CAO services during the 7-year study period for the population aged ≥ 40 years (Table 1). The overall average annual prevalence and incidence rates of CAO were 2.48% and 0.66%, respectively, for these age groups. There were more male than female patients, with male-to-female ratios ranged from 1.47 to 2.66 by age. Cases claimed for CAO were in patients predominantly aged 60 to 79 years (61.5%). The pattern of severity revealed that 5.80% of CAO patients had ≥ 25 clinic visits with primary diagnosis of CAO in 7 years.

Among all (n = 745) hospitalized cases of CAO during the study period, 64.4% of inpatients had only CAO, and 32.0% (239 cases) were both CAO and bronchitis/emphysema/asthma (data not shown). These cases included 1,346 hospitalization events with predominantly men (80.3%), rural residents (54.7%), and those aged 60 to 79 years (70.4%).

### *Incidence, Prevalence, and Hospitalization Rates*

Figure 1 shows that the population aged ≥ 60 years dominated chronological changes in incidence, prevalence, and hospitalization of CAO. The prevalence of ambulatory visits for the population aged ≥ 70 years increased from 5.75 per 100 in 1996 to 8.83 per 100 in 1998 and afterward became a plateau until 8.79 per 100 in 2002. In the meanwhile, the incidence among this age group decreased annually to 1.62 per 100 in 2002, with an apparent peak rate of 2.48 per 100 in 1998. The hospitalization rates of CAO were also the highest in those aged ≥ 70 years with a peak in 1999 (2.22 per 100) and declining to 1.83 per 100 in 2002.

### *Risk Factors Related to CAO*

Table 2 shows the risks for the severity of CAO associated with covariates estimated using polytomous logistic regression analysis. The ORs of CAO were higher for males, inpatients, and patients receiving care in 1996, and increased as the severity increased. The OR of hospitalization for patients with the level 3 severity of the disease was 8.01 (95% CI, 5.92 to 10.8) higher than patients with the level zero severity. Compared with population aged 40 to 49 years, the OR for the oldest group with the level 3 severity was 20.6 (95% CI, 2.77 to 152). Elevated severity was also associated with several comorbidities, including BPH, CADS, and the highest with P&I.

The estimated risk of hospitalization for CAO was also evaluated and found to be greater for men and patients identified in 1996 (Table 3). The OR increased as age increased, with the highest OR of 14.2 (95% CI, 6.54 to 30.9) for patients ≥ 80 years old. The comorbidities of CAD, P&I, and renal failure were significant factors to predict the hospitalization of CAO. However, patients with comorbidities of skin and joint disorders were at less risk for hospitalization.

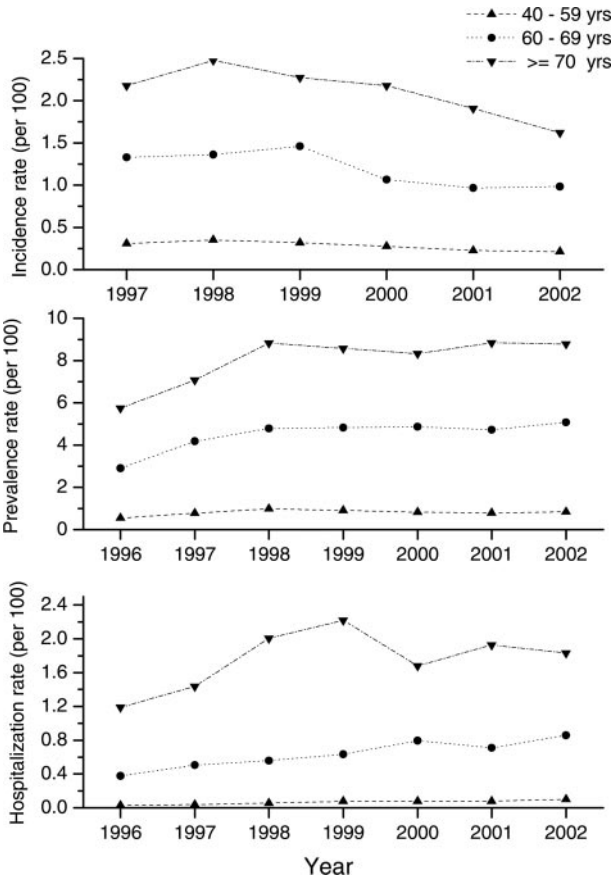


Figure 1. Chronological trends in incidence, prevalence, and hospitalization rates of CAO in Taiwan from 1996 to 2002.

**Table 2—*Disease Severity of CAO in Polytomous Logistic Regression Analysis***

| Variables | Severity Level§, OR (95% CI) | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Male gender | 0.97 (0.68–1.38) | 1.63† (1.16–2.28) | 1.81† (1.29–2.55) |
| Hospitalization | 2.41* (1.84–3.16) | 4.08* (3.12–5.33) | 8.01* (5.92–10.8) |
| Clinic visit in 1996 | 1.96* (1.45–2.65) | 3.55* (2.65–4.75) | 4.50* (3.36–6.04) |
| Urban | 1.14 (0.89–1.46) | 1.19 (0.94–1.51) | 1.21 (0.95–1.55) |
| Age, yr | | | |
| 40–49 | 1.0 | 1.0 | 1.0 |
| 50–59 | 9.14‡ (1.21–69.3) | 12.5‡ (1.68–93.3) | 14.9† (2.01–111) |
| 60–69 | 10.4‡ (1.41–76.7) | 18.4† (2.53–133) | 24.3† (3.34–176) |
| 70–79 | 12.3‡ (1.67–90.7) | 23.6† (3.25–171) | 33.3† (4.55–239) |
| ≥ 80 | 7.86‡ (1.04–59.2) | 13.8‡ (1.87–102) | 20.6† (2.77–152) |
| Comorbidity | | | |
| Hypertensive disease | 0.86 (0.64–1.16) | 1.00 (0.75–1.34) | 0.99 (0.74–1.32) |
| BPH | 1.29 (0.96–1.72) | 1.27 (0.96–1.69) | 1.49† (1.11–1.99) |
| Diabetes mellitus | 0.82 (0.61–1.10) | 0.88 (0.66–1.17) | 0.75 (0.56–1.01) |
| Renal failure | 1.00 (0.74–1.35) | 0.76 (0.57–1.02) | 0.84 (0.62–1.13) |
| CAD | 1.14 (0.87–1.50) | 1.09 (0.84–1.42) | 1.42† (1.09–1.86) |
| P&I | 1.25 (0.92–1.70) | 1.51† (1.12–2.04) | 1.91* (1.42–2.58) |

*$p < 0.0001$.
†$p \geq 0.0001$ to $\leq 0.01$.
‡$p \geq 0.01$ to $< 0.05$
§Based on clinic visit frequency in 7 years, zero for only 1 visit, one for 2 to 5 visits, two for 6 to 24 visits, and three for ≥ 25 visits.

## Discussion

The annual prevalence and incidence of CAO for population in the study cohort increased to the peak in 2 to 3 years after the launch of the universal health insurance, and the incidence declined afterward. But the prevalence of the disease was flattened on approximately similar level after the peak year. A study[25] in the Netherlands for asthma prevalence in children also reported a reversing trend in the period of from 1996 to 2002, similar to our study period. In this study, we believe the trends for CAO events are not resulted from the disease coding because the chronological incidence and prevalence of CAO were opposite to the increasing trend of cardiovascular diseases for the same time period in Taiwan (data not shown).

**Table 3—*Hospitalization of CAO by Selected Covariates in Multiple Logistic Regression, Stepwise Selection***

| Variables | OR | 95% CI | p Value |
|---|---|---|---|
| Male gender | 1.51 | 1.23–1.84 | < 0.0001 |
| Clinic visit in 1996 | 2.06 | 1.71–2.48 | < 0.0001 |
| Disease severity* | | | |
| 0 | 1.00 | | |
| 1 | 1.95 | 1.53–2.48 | < 0.0001 |
| 2 | 3.39 | 2.64–4.34 | < 0.0001 |
| 3 | 8.11 | 6.01–10.6 | < 0.0001 |
| Age, yr | | | |
| 40–49 | 1.00 | | |
| 50–59 | 2.72 | 1.20–6.15 | 0.0164 |
| 60–69 | 6.22 | 2.88–13.4 | < 0.0001 |
| 70–79 | 8.18 | 3.81–17.6 | < 0.0001 |
| ≥ 80 | 14.2 | 6.54–30.9 | < 0.0001 |
| Comorbidity | | | |
| Skin disorder | 0.80 | 0.67–0.97 | 0.00215 |
| Joint disorder | 0.60 | 0.48–0.75 | < 0.0001 |
| Renal failure | 1.36 | 1.12–1.65 | 0.0023 |
| CAD | 1.38 | 1.15–1.66 | 0.0005 |
| P&I | 1.87 | 1.52–2.29 | < 0.0001 |

*Based on clinic visit frequency in 7 years: zero for only 1 visit, one for 2 to 5 visits, two for 6 to 24 visits, three for ≥ 25 visits.

CAO diseases are progressive diseases with mild manifestation at the undiagnosed early stage.[26] Both the incidence and prevalence of the diseases may be thus underestimated prior to the launch of the health insurance. Because of the affordable NHI insurance premium and low copayments for medical services, the general population, particularly those with medical indigence, were encouraged to seek services during the earlier period of the insurance program. Cheng and Chiang[27] found that, compared with the noninsured, the newly insured had more than twice greater outpatient physician visits (0.48 vs 0.21, $p < 0.05$) and hospital admissions (0.11 vs 0.04) in a 2-week period prior to the study interview. In this study cohort, the increased CAO cases reaching the peak level in 1998 are likely in response to the increased physician visits in all levels of medical facilities. The increased detections from 1997 to 1999 are likely the undiagnosed cases existing prior to 1997.

Moreover, the impact from the epidemic of P&I in

the study period is another factor for consideration. The temporal trend of mortality from P&I in Taiwan also demonstrated an increasing trend in 1994 with a peak in 1998 and flattening out afterward.[28] A similar pattern of CAO prevalence appeared in this study. The influenza vaccination campaign has been initiated since October 1998 for the elderly in Taiwan.[29] Several studies[28–30] have evaluated the efficacy of this flu prevention campaign in morbidity of and mortality from CPDs, showing that the mortality from CPDs significantly decreased after the implementation of vaccine program. However, there was no benefit for hospitalization for CPD.[29,30]

Overall, age was found to be an important factor associated with the severity of CPDs in this study. The risk of CAO severity is the highest in the oldest population. Hypertension, CAD, and P&I are the most common comorbidities in patients receiving health-care attention among people with CPDs.[11,12,16] These diseases are prevalent in the elderly and are also associated with age, comorbidities, and other host health conditions. Incalzi et al[11] found that renal failure may predict COPD mortality, but it was observed as a risk only for hospitalized patients of CAO in this study. It is interesting to note that the protective effect of skin and joint disorders in reducing hospitalization for CAO may be due to the activities acceptable for healthier patients. Rana et al[14] also reported COPD as a potential risk factor for developing type 2 diabetes in women. In contrast, diabetes mellitus was a weak protective comorbidity associated with disease severity but with hospitalization of CAO in the present study. The difference could be resulted from the CAO patients being predominant with men in this study. We believed the risk for disease severities associated with covariates were underestimated in this study because the control group was based on severity level zero, which consisted of cases with one medical visit for CAO.

The above observed similarities and differences are obviously important to note. Disease etiology and care across nations and social status display a good amount of variety deserving further study, along with the gender difference in the comorbidity associated with CPDs.

The primary limitation of this study is the nature of disease diagnosis, which precludes the diagnosis variation among physicians. In general, it is difficult to clearly distinguish CAO or asthma from other CPDs, not only about the terminology[31] but also the overlapped symptoms among diseases.[32] Approximately 69% of CAO patients in this cohort have received medical attention for bronchitis/emphysema and/or asthma as well (data not shown), reflecting the coexistence of these diseases,[33,34] introducing the difficulty in taking apart the differences among CPDs.

We were unable to analyze the patterns of asthma separately because of the disease coding in this data set. Claims of bronchitis, emphysema, and asthma were grouped as one code by the Bureau of NHI before 2000. Therefore, we evaluate the patterns of CAO not elsewhere classified with consistent and unique coding during 1996–2002.

In conclusion, the chronological analysis for this population-based cohort has demonstrated the changing patterns of prevalence, incidence, and hospitalization of CAOs for the population in Taiwan after the launch of the nationwide health insurance. The change reflects that this universal health insurance plan provides convenient access to medical care for the insured, particularly for the elderly. CAD and P&I are comorbidities that not only can predict the disease severity of CAO but also can enhance the power of identifying the diseases.

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