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Prescription pattern of Chinese herbal products for adult-onset asthma in Taiwan: a population-based study

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ABSTRACT

Background: Throughout the world, asthma can be a life-threatening disease. Traditional Chinese medicine (TCM) is commonly used among Taiwanese adults to control many diseases.

Objective: To analyze the use of Chinese herbal products (CHPs) among adults with asthma in Taiwan.

Methods: The use, frequency of service, and the type of CHP prescribed for asthma among adults with asthma were evaluated. The study group consisted of a randomly sampled cohort of 1,000,000 beneficiaries from the National Health Insurance Research Database. Logistic regression was used to estimate the odds ratios (ORs) for use of CHP.

Results: Overall, 20,627 asthma patients (85.7%) used TCM. Ding-chuan-tang (panting-stabilizing decoction) was the most frequently prescribed CHP, followed by xiao-qing-long-tang (minor green-blue dragon decoction) and ma-xing-gan-shi-tang (ephedra, apricot kernel, licorice, and gypsum decoction).

Conclusion: The use of CHPs among adults with asthma appears high. Ding-chuan-tang containing ma-huang is the most commonly prescribed and consumed among adults with asthma.

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Introduction

The incidence and prevalence of asthma among adults, which is sometimes a life-threatening disease, appear to be increasing, and the disease now affects more than 8 million adults in the United States.^{1–4} Although relief medication that quickly controls the bronchospasm and symptom controllers that prevent or diminish the inflammatory process and the consequent increase in airway hyperactivity are available for those with asthma,⁵ there are a number of adverse effects of the steroids and β_2 -adrenergic agonists in these medications, which may result in patients seeking alternatives.^{6–9}

Traditional Chinese medicine (TCM) has been increasing in popularity and offers an important alternative or complementary medication in many countries. In contrast to the long history of use of TCMs for asthma, newer pharmacotherapeutic agents have been in use for a shorter period. Previous studies of TCMs have found that some Chinese herbs^{10–17} may have antiasthmatic activity. TCM, which includes acupuncture, traumatology manipulative therapies, and Chinese herbal products (CHPs), has been an

important part of health care in Taiwan for hundreds of years and is fully reimbursed under the current National Health Insurance (NHI) system. Accordingly, the claims database part of the Taiwan National Health Insurance Research Database (NHIRD) provides a platform for understanding the use of TCM therapies by licensed TCM physicians. The aims of our study are to analyze a random sample from this comprehensive database and to determine CHP utilization patterns among Taiwanese adults newly diagnosed as having asthma. The results of this study should provide valuable information that will enable physicians to respond to patient use of TCMs in an informed way, which will, in turn, further strengthen the patient-physician relationship when treating asthma and asthma-related complications.

Methods

Data Resources

This study was conducted after approval by the review board of the Taipei City Hospital. It was designed as a population-based study analyzing a sample of 1 million individuals selected at random from the 22 million beneficiaries of the NHI scheme of Taiwan between January 1, 1997, and December 31, 2008. The data set was obtained from the NHIRD, which includes all the NHI reimbursement data with the identification numbers of all individuals encrypted and transformed; this database is maintained by the National Health Research Institutes of Taiwan.^{18,19} The NHIRD contains the patient's sex, the patient's date of birth, all

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records of the patient's clinical visits and hospitalizations, and all drugs prescribed to the patient with dosages, including CHP, together with 3 major diagnoses coded using the *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* format.²⁰

Study Participants

The selection of study participants from the random sample of 1 million individuals was performed as follows (Fig 1). First, we included all patients who had at least 3 outpatient visits with a diagnosis of asthma within 1 year ($n = 50,955$) or having 1 or more hospital admission with an asthma diagnosis ($n = 6,228$). A total of 53,251 study participants were obtained. Second, we excluded those with missing information on sex and age ($n = 673$). Third, cases ($n = 4,329$) that had been diagnosed before the end of 1997 and patients younger than 20 years ($n = 24,187$) were also excluded to make sure that all the individuals included in the study were newly diagnosed as having asthma and to limit the study sample to adults. Finally, 24,062 study participants formed the study cohort.

Traditional Chinese Medicine

CHPs composed of 1 or more herbs (the formula) are more widely adopted than other forms of TCM by patients in Taiwan.^{21–25} To study the use of prescribed CHPs in the present study, we downloaded the detailed herbal content of all reimbursed CHPs from the website of the Department of Chinese Medicine and Pharmacy, Ministry of Health and Welfare, Taiwan, including the name of each CHP, the proportion of each constituent, the date and period of approval of use as a drug, the code, and the name of manufacturer.²⁶

Study Variables

To determine the key independent variables for use of CHP among adults with asthma, we selected a series of demographic factors based on previous studies.^{1,3,4,22–25} Patients were classified, based on age, into 1 of 6 groups, as follows: 20 through 29 years, 30 through 39 years, 40 through 49 years, 50 through 59 years, 60 through 69 years, and 70 years or older. The geographic areas of Taiwan where patients resided were classified as 1 of the following 7 regions: Taipei City, Kaohsiung City, Northern region, Central region, Eastern region, Southern region and outlying islands. Patients' monthly income in New Taiwan dollars (NT\$) was categorized into 1 of the following 4 levels: \$0, \$1 through \$19,999, \$20,000 through \$39,999, and \$40,000 or more.

We also searched the NHIRD for diagnosis and treatment records related to asthma as independent variables. The clinical features associated with asthma may be classified as atopic (*ICD-9-CM* code, 493.0), nonatopic (*ICD-9-CM* code, 493.1), chronic obstructive (*ICD-9-CM* code, 493.2: asthma with chronic obstructive pulmonary disease, chronic asthmatic bronchitis), other forms of asthma (*ICD-9-CM* code, 493.8), and asthma unspecified (493.9). In addition, we categorized the types of medicines used for treating asthma according to clinical guidelines (Global Initiative for Asthma) into 2 groups: controllers (glucocorticosteroids, sodium cromoglycate, anti-leukotrienes, anti-IgE monoclonal antibody, and long-acting β_2 -agonists) and relievers (short-acting β_2 -agonists, anticholinergics, and epinephrine). Because the use of nonsteroidal anti-inflammatory drugs (NSAIDs) has been associated with an increased risk of causing bronchospasm in susceptible patients with asthma, we also analyzed the use of NSAID use among adults with asthma.

Statistical Analysis

Data analysis consisted of descriptive statistics, including the prescription rates of the CHP users stratified by patient demographic characteristics, indications for the prescription of the CHP, and the most frequently prescribed herbal formula for treating asthma. Primary indications were classified according to their *ICD-9-CM* code. The diagnoses were coded according to the *ICD-9-CM* and grouped into a series of distinct broad disease categories. The potential antiasthmatic effects of Chinese herbs contained in 10 most commonly prescribed CHPs were grouped according to previous *in vivo* and *in vitro* studies, and these are summarized in Table 3.^{10–17} Multiple logistic regression was conducted to evaluate the factors that correlated with CHP use. A significance level of $\alpha = .05$ was selected. The statistical software package SAS, version 9.13 (SAS Institute Inc, Cary, North Carolina), was used for data management and analysis.

Results

The database of outpatient claims from 1997 to 2008 contained information on 24,062 adults with asthma. Among them, 20,627 asthma patients (85.7%) used TCM services at least once. Most TCM users (86.0%) also received conventional asthma treatment. Details on the demographic distribution of TCM users and nonusers are provided in Table 1. The mean age of the non-TCM users was higher than that of the TCM users.

The adjusted odds ratios (aORs) and 95% confidence intervals (CIs) obtained by multiple logistic regression are given in Table 1. Compared with the other age groups and insured regions, those aged 20 to 29 years and who were residing in Northern and Central Taiwan were more likely to be TCM users. There was also a significant difference between TCM users and nonusers, with there being more of the former in the income group of NT\$20,000 to NT\$39,999. After adjusting for other factors, patients with chronic obstructive asthma (aOR, 1.26; 95% CI, 1.11–1.43) were more likely to

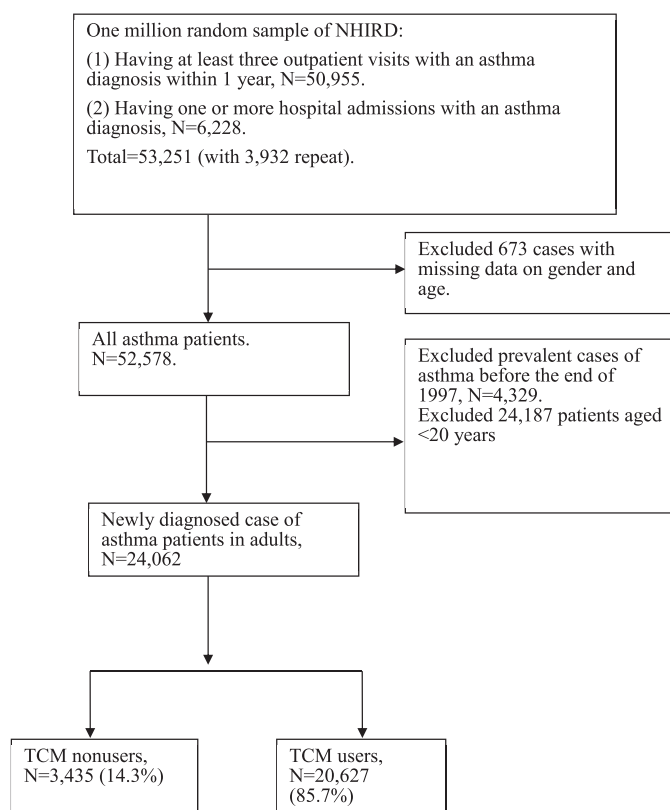


Figure 1. Flowchart of recruitment of subjects from the 1-million random sample of the National Health Insurance Research Database (NHIRD) from 1997 to 2008 in Taiwan.

Table 1

Demographic characteristics and the results of multiple logistic regression for Taiwanese adults with asthma from 1998 to 2008

Characteristic	No. (%) of patients ^a			aOR ^b (95% CI ^c)
	All patients	TCM users	TCM nonusers	
No. (%) of patients	24,062 (100)	20,627 (86.0)	3,435 (14.0)	
Sex				
Male	11,093 (46.1)	8,944 (43.4)	2,149 (62.6)	0.48 (0.45–0.52)
Female	12,969 (53.9)	11,683 (56.6)	1,286 (37.4)	1.00
Age at diagnosis, y				
Mean age (SD)		48.8 (15.5)	53.8 (16.4)	
20–29	3,172 (13.2)	2,831 (13.7)	341 (9.9)	1.00
30–39	4,058 (16.9)	3,594 (17.4)	464 (13.5)	0.94 (0.81–1.10)
40–49	4,619 (19.2)	4,070 (19.7)	549 (16.0)	0.88 (0.76–1.02)
50–59	4,698 (19.5)	4,109 (19.9)	589 (17.1)	0.85 (0.74–0.98)
60–69	4,946 (20.6)	4,098 (19.9)	848 (24.7)	0.64 (0.56–0.73)
≥70	2,569 (10.7)	1,925 (9.3)	644 (18.7)	0.41 (0.36–0.48)
Insured salaries, NT\$ per month ^b				
0	4,620 (19.2)	3,933 (19.1)	687 (20.0)	1.02 (0.91–1.13)
1–19,999	8,825 (36.7)	7,477 (36.2)	1,348 (39.2)	1.00
20,000–39,999	8,266 (34.4)	7,198 (34.9)	1,068 (31.1)	1.15 (1.03–1.28)
≥40,000	2,351 (9.8)	2,019 (9.8)	332 (9.7)	1.09 (0.94–1.27)
Insured region				
Taipei City	4,543 (18.9)	3,826 (18.5)	717 (20.9)	1.00
Kaohsiung City	1,314 (5.5)	1,123 (5.4)	191 (5.6)	1.19 (0.99–1.41)
Northern Taiwan	7,586 (31.5)	6,489 (31.5)	1,097 (31.9)	1.17 (1.06–1.30)
Central Taiwan	4,397 (18.3)	3,957 (19.2)	440 (12.8)	1.83 (1.60–2.08)
Southern Taiwan	5,311 (22.1)	4,477 (21.7)	834 (24.3)	1.08 (0.97–1.21)
Eastern Taiwan	773 (3.2)	645 (3.1)	128 (3.7)	1.04 (0.84–1.29)
Outlying islands	138 (0.6)	110 (0.5)	28 (0.8)	0.73 (0.47–1.12)
Classification of asthma				
Nonatopic asthma	3,980 (16.5)	3,514 (17.0)	466 (13.6)	1.00
Atopic asthma	3,172 (13.2)	2,747 (13.3)	425 (12.4)	0.86 (0.75–0.99)
Chronic obstructive asthma	5,339 (22.2)	4,467 (21.7)	872 (25.4)	1.26 (1.11–1.43)
Other forms of asthma	11,571 (48.1)	9,899 (48.0)	1,672 (48.7)	1.09 (0.97–1.22)
Patterns of antiasthmatic agents				
Controllers ^c				
Glucocorticosteroids	23,627 (98.2)	20,315 (98.5)	3,312 (96.4)	
Sodium cromoglycate	1,033 (4.3)	948 (4.6)	85 (2.5)	
Antileukotrienes	2,913 (12.1)	2,609 (12.6)	304 (8.9)	
Anti-IgE monoclonal antibody	2 (0)	2 (0)	0	
Long-acting β_2 -agonists	13,815 (57.4)	11,907 (57.7)	1,908 (55.5)	
Coprescribed NSAIDs	14,509 (60.3)	12,547 (52.1)	1,962 (8.2)	
Relievers ^d				
Short-acting β_2 -agonists	18,597 (77.3)	16,050 (77.8)	2,547 (74.1)	
Anticholinergics	7,050 (29.3)	5,934 (28.8)	1,116 (32.5)	
Epinephrine	152 (0.6)	134 (0.6)	18 (0.5)	
Coprescribed NSAIDs	6,987 (29.0)	5,893 (24.5)	1,094 (4.6)	
No. of medications used to treat asthma				
None or monotherapy	108 (0.5)	72 (0.3)	36 (1.0)	1
2-Drug combination	1,252 (5.2)	1,036 (5.0)	216 (6.3)	2.40 (1.57–3.67)
3-Drug combination	3,001 (12.5)	2,530 (12.3)	471 (13.7)	2.69 (1.78–4.06)
4-Drug combination	4,947 (20.6)	4,233 (20.5)	714 (20.8)	2.96 (1.97–4.46)
5-Drug combination	5,397 (22.4)	4,688 (22.7)	709 (20.6)	3.31 (2.20–4.97)
≥6-Drug combination	9,357 (38.9)	8,068 (39.1)	1,289 (37.5)	3.13 (2.09–4.69)

Abbreviations: aOR, adjusted odds ratio; CI, confidence interval; NSAIDs, nonsteroidal anti-inflammatory drugs; TCM, traditional Chinese medicine.

^aData are presented as number (percentage) of patients unless otherwise indicated.^bNT\$ refers to new Taiwan dollars (US\$1 = NT\$30).^cControllers include glucocorticosteroids, sodium cromoglycate, antileukotrienes, anti-IgE monoclonal antibody, and long-acting β_2 -agonists.^dRelievers include short-acting β_2 -agonists, anticholinergics, and epinephrine.

seek TCM treatment than those with nonatopic asthma (aOR, 1.00); on the other hand, patients with atopic asthma were less likely to seek TCM treatment (aOR, 0.86; 95% CI, 0.75–0.99). Compared with monotherapy for the treatment of asthma (aOR, 1.00), adults with asthma who need to take more than one type of medication to control asthma (2 medications: OR, 2.40; 95% CI, 1.57–3.67; 3 medications: OR, 2.69; 95% CI, 1.78–4.06; 4 medications: OR, 2.96; 95% CI, 1.97–4.46; 5 medications: OR, 3.31; 95% CI, 2.20–4.97; ≥6 medications: OR, 3.13; 95% CI, 2.09–4.69) were more likely to be TCM users. In addition, NSAIDs were the type of prescribed conventional drug most frequently combined with antiasthma medications.

Among the adults with asthma who visited TCM physicians, 516,727 (76.7%) of visits involved the prescription of Chinese herbal

remedies, whereas the rest involved the prescription of acupuncture and traumatology manipulative therapy. Analysis of the major disease categories for all TCM visits are summarized in Table 2, which reveals that “diseases of the respiratory system” (160,633 [23.8%]) was the most common disease category documented among those seeking the care of a practitioner of TCM.

Details of the most frequently prescribed CHPs used to treat asthma among 5,418 adults with asthma are outlined in Table 3, which shows that ding-chuan-tang (panting-stabilizing decoction) was the most frequently prescribed CHP, followed by xiao-qing-long-tang (minor green-blue dragon decoction) and ma-xing-gan-shi-tang (ephedra, apricot kernel, licorice, and gypsum decoction). The mean prescription duration of the top 10 most commonly prescribed CHPs for treating asthma varied from 18.0 to

Table 2

Frequency distribution of traditional Chinese medicine visits by major disease categories (According to ICD-9-CM Codes) for asthma from 1998 to 2008 in Taiwan

Major disease category	ICD-9-CM codes	No. (%) of visits		
		Chinese herbal remedies	Acupuncture and manipulative therapies	Total of TCM
Infectious and parasitic diseases	001-139	898 (0.1)	35 (0.0)	933 (0.1)
Neoplasms	140-239	3,076 (0.5)	157 (0.0)	3,233 (0.5)
Endocrine, nutritional, metabolic diseases, and immunity disorders	240-289	9,486 (1.4)	236 (0)	9,722 (1.4)
Mental disorders	290-319	4,609 (0.7)	245 (0)	4,854 (0.7)
Diseases of the nervous system and sense organs	320-389	17,289 (2.6)	3,037 (0.5)	20,326 (3.0)
Diseases of the circulatory system	390-459	17,915 (2.7)	1,756 (0.3)	19,671 (2.9)
Diseases of the respiratory system	460-519	158,729 (23.6)	1,904 (0.3)	160,633 (23.8)
Asthma	493-494	36,427 (5.4)	592 (0.1)	37,019 (5.5)
Diseases of the digestive system	520-579	68,214 (10.1)	846 (0.1)	69,060 (10.3)
Diseases of the genitourinary system	580-679	31,792 (4.7)	323 (0.1)	32,115 (4.8)
Diseases of the skin and subcutaneous tissue	680-709	12,332 (1.8)	223 (0)	12,555 (1.9)
Diseases of the musculoskeletal system and connective tissue	710-779	47,581 (7.1)	63,624 (9.4)	111,205 (16.5)
Symptoms, signs, and ill-defined conditions	780-799	126,343 (18.8)	2,083 (0.3)	128,426 (19.1)
Injury and poisoning	800-999	3,923 (0.6)	69,475 (10.3)	73,398 (10.9)
Supplementary classification ^a and others ^b	V01-V82, E800-E999	14,540 (2.2)	13,083 (1.9)	27,623 (4.1)
Total		516,727 (76.7)	157,027 (23.3)	673,754 (100)

Abbreviation: ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.

^aSupplemental classification codes permit the reporting of circumstances and conditions that affect the disease or injury.^bOthers include missing or error data.

36.4 days. Among the top 3 most commonly prescribed CHPs for treating asthma, the mean daily dose of ma-huang varied from 1.0 to 1.5 g per adult with asthma. The potential effects of these Chinese herbs, when used to treat asthma, are summarized in Table 3 and include enhancing or suppressing an immune response and enhancing adrenal functioning.

Discussion

The incidence of adult asthma in Taiwan during the 11 years of the study was 2.4%, which appears to be slightly lower than the estimates given by previous surveys that used data obtained via self-reported questionnaires.^{27–29} The present study includes all patients who were newly diagnosed as having asthma by qualified conventional physicians between 1998 and 2008 from a random sample of 1 million individuals among the insured general population; therefore, we can rule out the possibility of either selection or recall bias. Worthy of note, the use of TCM among adults with asthma in Taiwan during the study period was 85.7%, which appears to be high compared with previous findings.^{30,31} TCM is a unique traditional therapy approach for various ailments and has been used in Taiwan for more than hundreds of years. This long period of acceptance and

use may contribute significantly to the high prevalence of TCM use. In addition, both conventional medicine and TCM treatment are covered by the NHI system in Taiwan. This system allowed all beneficiaries to choose either conventional medicine or TCM freely when relieving their discomfort and/or treating a disease; choice is therefore made freely because of the high insured rate of 99% for the NHI program among the Taiwanese population. Therefore, unsurprisingly, the use of TCM among the adult asthma population is comparatively higher in Taiwan than in other countries.

The present results indicate that more than 86% of Taiwanese adults with asthma have ever received 4 types of asthma medications to relieve asthma; in this context, glucocorticosteroids and short-acting β_2 -agonists are the most frequently prescribed controller and reliever, respectively. Previous studies have reported that treating patients with a glucocorticosteroid may prevent a large proportion of subsequent hospital admissions for asthma.³² In addition, a glucocorticosteroid increases the expression of β_2 -receptors by increasing gene transcription and thus protects against the loss of β_2 -receptors in response to the exposure to β_2 -agonists. There is a strong scientific rationale for combining these 2 drug classes to obtain more effective control of asthma in most patients without significant adverse effects.³³ The concurrent use of asthma

Table 3

Top 10 herbal formulas prescribed by traditional Chinese medicine physicians for treating 5,418 patients with asthma from 1998 to 2008 in Taiwan

Herbal formula	English name	Frequency of prescriptions, ^a No. (%)	Mean daily dose, g	Mean duration per prescriptions, d	Mean ma-huang daily dose, g
Ding-chuan-tang ^{b,c,d}	Panting-stabilizing decoction	8,402 (23.1)	8.2	36.4	1.2
Xiao-qing-long-tang ^{b,c,d}	Minor green-blue dragon decoction	5,495 (15.1)	5.9	34.1	1.0
Ma-xing-shi-gan-tang ^{b,c,d}	Ephedra, apricot kernel, gypsum, and licorice decoction	4,818 (13.2)	5.8	26.9	1.5
Su-zi-jiang-qi-tang ^{c,d}	Perilla fruit qi-downbearing decoction	2,350 (6.5)	5.9	27.7	
Zhi-sou-san ^{c,d}	Cough-Stopping powder	1,815 (5.0)	4.2	20.5	
Mai-men-dong-tang ^{c,d}	Ophiopogon decoction	1,582 (4.3)	10.0	19.1	
Bai-he-gu-jin-tang ^{c,d}	Lily bulb metal-securing decoction	1,473 (4.0)	8.5	21.7	
Xing-su-san (pediatric ^{c,d})	Apricot kernel and perilla powder (pediatric)	1,426 (3.9)	6.5	22.4	
Xin-yi-qing-fei-tang ^{c,d}	Magnolia flower lung-clearing decoction	1,315 (3.6)	5.2	25.3	
Er-chen-tang ^{c,d}	Two matured ingredients decoction	982 (2.7)	5.6	18.0	
Total		29,658 (100)	6.8	29.3	

^aFrequency of prescriptions refers to the total cumulative number of individual Chinese herbal product taken during the study period.^bBronchodilation effect: herbal formulae contain ma-huang.¹⁰^cAnti-inflammatory effect on suppressing T_H2 cell: herbal formulas contain xing-ren,¹¹ gan-cao,¹² or huang-qin.¹³^dAnti-inflammatory effect on decreasing cytokine secretion: herbal formulae contain gan-cao,¹² bei-mu,¹⁴ huang-qin,¹⁵ jie-geng,¹⁶ or mai-men-dong.¹⁷

treatment and NSAIDs is common in Taiwan. Previous studies have reported that asthmatic patients treated with NSAIDs may be at a higher risk of inducing bronchospasm. Both physicians and asthmatic patients should be aware of the association between NSAID use and the potential risk of precipitating an asthma attack in Taiwan. We also observed that adults with asthma who were prescribed multiple asthma medications were more likely to use a CHP compared with patients who were prescribed only one type of asthma medication. It is possible that fear of resistance to glucocorticosteroid use, fear of increasing dependence on glucocorticosteroid use, or the possibility of developing adverse effects related to NSAIDs may motivate patients to seek TCM therapy.

The present findings indicate that, among adults with asthma, females and those aged 20 to 39 years were more likely to be TCM users than males and other age groups (Table 1). "Diseases of the respiratory system" were the most common reasons for using CHPs ($n = 158,729$ [23.6%]), followed by "symptoms, signs, and ill-defined conditions" ($n = 126,343$ [18.8%]) and "diseases of the digestive system" ($n = 68,214$ [10.1%]) (Table 2). Although ancient Chinese books have documented that acupuncture might be an effective means of treating asthma, the present study indicated that acupuncture in Taiwan is used by this study population mainly for "symptoms, signs, and ill-defined conditions." In addition, less than 2% of adults with asthma had sought TCM advice when an asthma attack occurs. This finding seems to imply that either CHPs or acupuncture and manipulative therapies, when used to treat Taiwanese adults with asthma, are generally used as adjunct therapy to conventional antiasthma treatment rather than as replacements for conventional antiasthma treatment. Furthermore, adults with asthma tended to use CHP therapies to relieve chronic obstructive asthma, as well as being a means of targeting nervous or shaky feelings, sleep disturbance, gastrointestinal disorders, and muscle aches, all of which might be the uncomfortable adverse effects of conventional antiasthma drugs.^{34,35}

Previous clinical trials have demonstrated that ding-chuan-tang (panting-stabilizing decoction), which is the most frequently prescribed formula for treating adult-onset asthma in our study, may be an efficacious add-on therapy that is able to reduce asthma-related symptoms significantly in children with persistent asthma.³⁶ Among the top 10 most frequently prescribed formulas for treating asthma, xiao-qing-long-tang (minor green-blue dragon decoction) and ma-xing-gan-shi-tang (ephedra, apricot kernel, licorice, and gypsum decoction), which all have a long history of use, are said to facilitate lung qi to flow more easily, thereby allowing the lungs to breathe properly and deeply, helping patients stop coughing, and reducing respiratory difficulty; these formulas are often prescribed by TCM physicians to treat lung cold type asthma. Other commonly prescribed formula are often used to relieve coughing with sputum (su-zi-jiang-qi-tang, zhi-sou-san, mai-men-dong-tang, xing-su-san [pediatric]), wheezing and coughing with a sore throat (bai-he-gu-jin-tang), nasal congestion (xin-yi-qing-fei-tang), and gastrointestinal discomfort (er-chen-tang). It is apparent from this study that TCM physicians in Taiwan prescribe herbal therapies mainly to reduce asthma-related symptomatic discomfort.^{37–41} The top 10 most common asthma treatment prescriptions that contain various doses of xing-ren, gan-cao, huang-qin, bei-mu, jie-geng, or mai-men-dong, which have been reported to have anti-inflammatory effects on either suppressing T_H2 cell or decreasing cytokine secretion, might benefit asthma patients.^{10–17} However, there is as yet insufficient evidence to allow a conclusion to be reached regarding the cost-effectiveness of the aforementioned formulas in relation to relieving the asthma-associated symptom. Further studies are warranted to assess the formula found to be generally used by TCM practitioners in this study and to determine whether they should be used as an add-on treatment for adults with asthma receiving conventional treatment.

Previous studies have revealed that ma-huang (*Ephedrae herba*) has the properties of relieving airway hyperresponsiveness and episodic periods of bronchospasm.⁴² These modes of action are a reasonable explanation for the use of the 3 most frequent prescription formulas, all of which contain ma-huang in the present study. The present findings extend beyond previous work in showing that consumption of less than 1.5 g of ma-huang per adult per day for no more than 1 month may be appropriate and rational use in adults with asthma. However, in 2004, the Food and Drug Administration banned the US sale of dietary supplements that contained ephedrine because of safety concerns. Obviously, there is as yet insufficient evidence to allow a conclusion to be reached regarding the rational use of the aforementioned formulas among the asthma population. Further studies are warranted to assess the formulas that contain ma-huang found to be generally used by TCM practitioners in this study and to determine whether certain combinations pose a potential toxicologic problem in terms of higher risk of stroke, myocardial infarction, and high blood pressure than others.

The present study has 3 limitations. First, this study did not include Chinese herbal remedies or decoctions that were purchased directly from TCM herbal pharmacies, and we have not included health foods that contain herbs. Thus, the frequency of CHP use might have been underestimated. However, because the NHI system covers TCM prescriptions, which generally cost less than the herbs sold in Taiwan's markets, the likelihood that individuals purchased a lot of other herbs outside the NHI database is not high. Second, we are unable to draw any conclusion about the association of the severity of the asthma-related symptoms with respect to CHP use owing to the lack of actual clinical data. Third, this was a retrospective study and thus does not include a randomized placebo group. Thus, great caution is necessary when interpreting the results of the most commonly prescribed Chinese formulas identified in the present study because of the possibility of a placebo effect.

In conclusion, it is apparent that our findings may have implications for physicians who treat adults with asthma in Taiwan. Our results suggest that, under the coexistence of the conventional medical treatments and TCM, many asthmatic patients consume herbal therapies that contain ma-huang. Recognizing the use of CHP, exploring potential interactions and adverse effects, and integrating both technologies may be beneficial to the overall health and quality of life among adults with asthma. Although some evidence supports the use of CHP to treat asthma, there remains a need for well-conducted, double-blind, randomized, placebo-controlled studies to further evaluate cost-effectiveness when ding-chuan-tang and other formulas are prescribed to treat adults with asthma.

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