

# Trend, characteristics, and pharmacotherapy of adults diagnosed with attention-deficit/hyperactivity disorder: a nationwide survey in Taiwan

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**Objective:** Attention-deficit/hyperactivity disorder (ADHD) in adults may result in functional impairment warranting clinical interventions. However, few studies have investigated the diagnosis and treatment rates of adult ADHD in non-Caucasian ethnic groups. This study used nationwide population-based data to investigate the rate of diagnosis, associated characteristics, and pharmacological treatment for adult ADHD in Taiwan.

**Methods:** Adults (age  $\geq 18$  years) newly diagnosed with ADHD ( $n=5,397$ ) between January 2000 and December 2011 were enrolled from the National Health Insurance database in Taiwan. All patients were monitored until December 31, 2011. Patients who received treatment with immediate-release methylphenidate (IR-MPH), osmotic release oral system-methylphenidate (OROS-MPH), and atomoxetine (ATX) were analyzed.

**Results:** The cumulative prevalence of adult ADHD was 0.028%, and the incidence increased 10.9-fold from 2000 to 2011. The male to female ratio was 1.16, and 74.9% of the patients had the inattentive type. Overall, 55% of the patients received drug therapy for ADHD, and the average treatment duration was 478.3 days. Of the total patients, 50.4%, 13.3%, and 1.7% were prescribed with IR-MPH, OROS-MPH, and ATX, for a mean duration of 453.9, 327.7, and 161.4 days, respectively.

**Conclusion:** This population-based study showed an increasing trend in the diagnosis rate of adult ADHD; however, this rate is still low compared with Western countries. Approximately 45% of the adult patients with ADHD never received medication for their ADHD. Continuous efforts are needed to increase public awareness of adult ADHD.

**Keywords:** ADHD, gender difference, epidemiology, drug adherence, comorbidity, non-Caucasian

## Introduction

Attention-deficit/hyperactivity disorder (ADHD) was thought to be solely a childhood disorder, often causing significant impairment in academic and social functions.<sup>1</sup> However, increasing evidence suggests that ~50% of children with ADHD may continue to suffer from attention problems in adulthood.<sup>2-4</sup> Adult ADHD is often associated with various psychiatric comorbidities including mood disorders, anxiety disorders, and substance use disorders, and it has been reported to cause significant impairment in many aspects of life such as work or legal problems.<sup>5-11</sup> The effectiveness of medication and behavioral treatment for childhood ADHD has been well established,<sup>12,13</sup> and the treatment efficacy of psychostimulants for adult ADHD has also been supported by many studies.<sup>14-16</sup> However, the reported rates of diagnosis and treatment of adult ADHD are low.<sup>5,6,17-22</sup>

One meta-analysis reported that the pooled prevalence of adult ADHD is 2.5% in the general population worldwide.<sup>23</sup> Another review reported the prevalence of adult ADHD ranging from 1.2% to 7.3% in European countries.<sup>5</sup> Some studies have investigated the prevalence of adult ADHD through face-to-face interviews. In these studies, the reported prevalence rates of adult ADHD were 4.4% in the US,<sup>24</sup> 4.7% in Germany,<sup>9</sup> and 3% in New Zealand.<sup>6</sup> Some studies have estimated the prevalence of ADHD using claims data. For example, one study used data from Southern California medical records, and reported that the diagnosis rate of adult ADHD ranged from 0.31% to 0.42%.<sup>17</sup> Two other studies that also used claims data in Spain and in Germany reported the same diagnosis rate of adult ADHD (0.04%) in each country. The differences in the estimated prevalence of adult ADHD between studies may be due to methodological differences and the data sources.<sup>6,25,26</sup>

Although compelling evidence indicates that adult ADHD can result in functional impairment warranting clinical interventions,<sup>15,16,27,28</sup> adults with ADHD rarely receive treatment. Studies in European countries have reported that <3.2% of adults with ADHD receive pharmacotherapy targeting the core symptoms of ADHD,<sup>21</sup> although new data are available especially on pharmacoepidemiology, because when new drugs were licensed in a jurisdiction, their prescription rates increased rapidly.<sup>29</sup> In contrast, a survey conducted in Southern California reported that 48%–58% of adults who were diagnosed with ADHD received pharmacotherapy for ADHD symptoms.<sup>17</sup> This large difference may be because the data used in the US study were more recent, and differences in cultural and medical practice may have further contributed to this wide variation in treatment rate between US and European countries. Despite such low rates of diagnosis and treatment, recent evidence suggests that there is increasing recognition and treatment for adult ADHD.<sup>17,18,22</sup> However, the rates of diagnosis and treatment for adult ADHD are still much lower compared to childhood ADHD,<sup>22,30</sup> both globally and in Taiwan.

Few studies have investigated the diagnosis and treatment rates of adult ADHD in non-Caucasian ethnic groups. Moreover, the associated characteristics and comorbid psychiatric disorders with adult ADHD and the rate and patterns of pharmacological treatment for adult ADHD have rarely been reported. Understanding the characteristics of adult ADHD and patterns of medical treatment is crucial for clinical practice. Therefore, the aim of this study was to use nationwide population-based data to investigate the rate of diagnosis, associated characteristics, and pharmacological treatment for adult ADHD in Taiwan.

## Methods

### Data source

The protocol for this study conformed to the Helsinki Declaration and was approved by the Institutional Review Board (IRB) of Chang Gung Memorial Hospital. Patient records and information were anonymized and de-identified prior to analysis and, therefore, the need for written informed consent was waived by the IRB. The data used in this study were obtained from ambulatory claims stored in the National Health Insurance Research Database of Taiwan (NHIRD-TW). The National Health Insurance (NHI) program of Taiwan was launched in 1995 and is a mandatory universal health insurance program, with the Bureau of NHI as the sole payer of health care services. The Bureau of NHI has contracted 93% of all health care providers in Taiwan, and at least 96% of those insured have benefitted from health care services provided by a contracted hospital or clinic at least once since 1995. These medical care institutions are required to electronically submit monthly medical expense-related claims documents, including the patients' demographic data, the medical institution visited, diagnostic codes, dates of any prescriptions, drugs prescribed, and all claimed medical expenses. The database of this program contains registration files and original claim data for reimbursement. Large computerized databases derived from this system are maintained by the National Health Research Institutes, Taiwan, and are provided as NHIRD-TW to scientists in Taiwan for research purposes. The NHIRD-TW has previously been validated to be an effective resource for population-based research.<sup>31</sup>

### Definition of ADHD, and the incidence and cumulative prevalence rates

This study recruited all adults (age  $\geq 18$  years) who were diagnosed with ADHD from January 2000 to December 2011 and who had records available in the NHIRD-TW. In order to reduce possible misdiagnoses, ADHD was defined as at least two NHI claims records with the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) code 314.X. The index date was established as the date when ADHD was first diagnosed, and medical records of these patients in the NHIRD-TW were monitored until December 31, 2011. If the identified case received another claim record with ADHD diagnosis, it was defined as an incident case. Therefore, one can only be an incident case once in the study population. As such, the study sample consisted of 5,397 adults with ADHD. ADHD subtypes included the inattentive type (ICD-9-CM code 314.00) and the predominantly hyperactive/impulsive or combined type (ICD-9-CM code 314.01, ADHD H/C type).

## Definition of comorbidities and hospital level

The following psychiatric disorders that are commonly comorbid with ADHD were identified in this study: tic disorders (ICD-9-CM code 307.2X), intellectual disability (ICD-9-CM codes 317–319), anxiety disorders (ICD-9-CM code 300.X), and depressive disorders (ICD-9-CM codes 296.2, 296.3, 300.4, or 311). The institutions where the patients were first diagnosed with ADHD were divided into two levels: hospitals and local medical clinics.

## Definition of ADHD medication

ADHD medications were identified according to the Anatomical Therapeutic Chemical Classification System. According to the Food and Drug Administration of Taiwan, only three drugs were licensed to treat ADHD prior to 2011: immediate-release methylphenidate (IR-MPH), osmotic release oral system-methylphenidate (OROS-MPH), and atomoxetine (ATX). IR-MPH entered the market in Taiwan on March 1, 1995; OROS-MPH on September 1, 2004; and ATX on May 1, 2007. All prescriptions for IR-MPH, OROS-MPH, and ATX were recorded in ambulatory care, pharmacy, or hospital care claims.

Patients who received ADHD medications were defined as those with at least one record of pharmacotherapy (IR-MPH, OROS-MPH, or ATX). Incidence of ADHD drug therapy was defined as the first prescription for one of these drugs. Discontinuation of ADHD medication was defined as stopping the drug for 180 days or longer. The duration of treatment was defined as the interval between the index date and the date of discontinuation or December 31, 2011. Treatment lengths were stratified into four groups: <30 days, 31–180 days, 181–365 days, and >365 days. Drug adherence was defined using the medication possession ratio (MPR), which represents the ratio of the total number of defined daily doses the patients received to the total number of days of follow-up.<sup>32,33</sup> If the calculated MPR for a patient was >100%, the MPR was considered 100%.

## Statistical analysis

Statistical Package for the Social Sciences (SPSS) software version 20.0 (SPSS Inc., Chicago, IL, USA) was used for all statistical analyses. Variables were expressed as either the mean (standard deviation) or frequency. A two-tailed *P*-value <0.05 was considered to indicate statistical significance.

Incident cases of adult ADHD were determined annually from the first NHI claims record of newly diagnosed ADHD within the specific year (from 2000 to 2011). To determine the

annual incidence of adult ADHD (per 100,000 people), the annual number of incident cases each year was divided by the total number of adults (age ≥18 years) nationwide during each year. Data on the general population in Taiwan were obtained from the Directorate-General of Budget Accounting and Statistics, Executive Yuan, Taiwan.<sup>34</sup> The cumulative prevalence rates of adult ADHD were also calculated among the total population (per 100,000) by dividing the number of cumulative cases with adult ADHD by the number of adults (age ≥18 years) nationwide each year.

The proportion of patients who received medication treatment in a specific year was also calculated. Then, the cases were stratified into three age groups (18–30 years, 31–45 years, and >45 years). Sex distribution and duration of medication treatment among the different age groups were compared using the chi-square test. Curve estimation linear models were used to evaluate trends with regard to the annual number of cases of ADHD, and incidence and cumulative prevalence rates, and proportions of age groups and those receiving medication treatment. Using curve estimation of linear models, the degree of freedom for regression coefficient was 1 and the total degrees of freedom for each model was 11. In addition, a multivariate logistic regression model was used to estimate the potential factors associated with medical treatment, adjusted for the year of ADHD diagnosis. The adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were also calculated.

## Results

### Trend of adult ADHD diagnosis

Table 1 shows the distribution of adult patients who were newly diagnosed with ADHD during 2000–2011 in Taiwan. The annual number of new cases of adult ADHD increased from 67 in 2000 to 834 in 2011 (12.4-fold increase,  $t=8.06$ ,  $P<0.001$ ), the incidence increased from 0.41 per 100,000 in 2000 to 4.45 per 100,000 in 2011 (10.9-fold increase,  $t=7.35$ ,  $P<0.001$ ), and the cumulative prevalence increased from 0.41 per 100,000 in 2000 to 28.78 per 100,000 in 2011 (70.2-fold increase,  $t=13.29$ ,  $P<0.001$ ). The proportion of the three age groups (18–30 years, 31–45 years, and >45 years) did not significantly change during 2000–2011. In addition, the proportion of patients receiving medication treatment did not significantly change over time ( $P=0.766$ ).

### Characteristics of the adults with ADHD

A total of 5,397 adults with ADHD (mean age:  $31.5\pm 11.2$  years) was enrolled in this study (Table 2). Of these patients, 2,502 (46.4%) were female and 2,895 (53.6%) were male.

**Table 1** Distribution of adult patients who were newly diagnosed with ADHD from 2000 to 2011 in Taiwan

Year	Total population <sup>a</sup>	Patients with ADHD <sup>a</sup>	Incidence rate <sup>b</sup>	Cumulative prevalence <sup>b</sup>	Proportion of 18–30 years (%)	Proportion of 31–45 years (%)	Proportion of >45 years (%)	Proportion of drug treatment (%)
2000	16,497,603	67	0.41	0.41	74.6	19.4	6.0	59.7
2001	16,743,047	74	0.44	0.84	59.5	28.4	12.2	63.5
2002	16,976,243	100	0.59	1.42	72.0	23.0	5.0	72.0
2003	17,174,600	99	0.58	1.98	66.7	30.3	3.0	71.7
2004	17,344,075	300	1.73	3.69	50.0	40.0	10.0	55.0
2005	17,527,455	587	3.35	7.00	37.0	49.6	13.5	33.9
2006	17,874,404	655	3.66	10.53	36.3	50.7	13.0	39.1
2007	17,851,179	712	3.99	14.53	44.8	44.0	11.2	50.8
2008	18,168,727	567	3.12	17.40	58.4	30.9	10.8	72.0
2009	18,374,613	630	3.43	20.63	59.4	30.5	10.2	70.2
2010	18,566,356	772	4.16	24.58	60.9	29.3	9.8	58.5
2011	18,755,562	834	4.45	28.78	58.9	30.7	10.4	56.7
Statistic value	t=44.11 P<0.001	t=8.06 P<0.001	t=7.35 P<0.001	t=13.29 P<0.001	t=-1.04 P=0.324	t=0.83 P=0.425	t=1.41 P=0.188	t=-0.31 P=0.766

Notes: <sup>a</sup>Age  $\geq$  18 years. <sup>b</sup>Per 100,000 people.

Abbreviation: ADHD, attention-deficit/hyperactivity disorder.

Overall, 4,042 (74.9%) had inattentive type ADHD and 1,355 (25.1%) had ADHD H/C type. With regard to psychiatric comorbidities, 76 (1.4%) patients had tic disorders, 396 (7.3%) patients had intellectual disabilities, 3,541 (65.6%) had anxiety disorders, and 2,670 (49.5%) had depressive disorders. Overall, 3,983 (73.8%) patients were first diagnosed with ADHD by doctors in hospitals and 1,414 (26.2%) by local medical clinics. Figure 1 displays the sex distribution among the three age groups. It was found that patients aged between 18 and 30 years were mostly male (65.1%), whereas patients older than 30 years were mostly female (54.7%–60.1%).

## Medication treatment for adult ADHD

Of all patients (Table 2), 2,897 (55.3%) received at least one dose of ADHD medication (IR-MPH, OROS-MPH, or ATX) for a mean duration of 478.3 days and showed a mean MPR of 69.3%. Of these patients, 2,720 (50.4%), 719 (13.3%), and 92 (1.7%) were prescribed with IR-MPH, OROS-MPH, and ATX, for a mean duration 453.9, 327.7, and 161.4 days, with a mean MPR of 69.5%, 73.4%, and 85.3%, respectively.

The distribution of treatment duration among age groups is shown in Figure 2. Overall, in ADHD patients with drug treatment, the proportions of patients who received medication treatment for <30, 31–180, 181–365, and >365 days were 21.8%, 32.5%, 11.7%, and 34%, respectively. A significant difference in the lengths of medication treatment was observed among age groups ( $P=0.032$ ). Patients aged between 18 and 30 years had the highest proportion of receiving treatment <30 days (23.3%), and lowest proportion of receiving treatment >365 days (32%).

Table 3 demonstrates the factors associated with pharmacotherapy for adult ADHD. Older age at the diagnosis

of ADHD (relative to 18–30 years) was associated with a decreased likelihood of being prescribed with medication (31–45 years: aOR =0.40, 95% CI: 0.35–0.46; >45 years: aOR =0.30, 95% CI: 0.26–0.36). In addition, being male (aOR =1.79, 95% CI: 1.59–2.02), having the ADHD H/C type (aOR =1.23, 95% CI: 1.07–1.41), comorbid anxiety disorder (aOR =1.64, 95% CI: 1.42–1.89), or depressive disorder (aOR =1.74, 95% CI: 1.52–1.99) were associated with a higher probability of being prescribed with medication. However, having intellectual disability (aOR =0.54, 95% CI: 0.44–0.68) was associated with a lower probability of being prescribed with medication.

## Discussion

### Diagnosis rate of ADHD

Based on the data from NHIRD, the cumulative prevalence of adult ADHD was only 0.028% in Taiwan throughout the study period, which is much lower than that reported in previous studies using face-to-face interviews (1.2%–7.3% in the general population),<sup>5,6,9,23,24</sup> and also lower than that determined by claims data in European and US studies (0.04%–0.42%).<sup>17,19,20</sup> To date, no study has investigated the prevalence rate of adult ADHD in Taiwan through random sampling or face-to-face interviews using a structured diagnostic tool. Therefore, it remains unclear how many adults actually meet the diagnostic criteria of ADHD in Taiwan. Nevertheless, epidemiological studies have reported that the prevalence of ADHD in school-aged children worldwide is between 5.3% and 7.2%,<sup>35,36</sup> a rate similar to that reported in Taiwan (3.3%–7.5%).<sup>37,38</sup> In the natural course of ADHD, the symptoms decrease in around 50% of patients at puberty or in early adulthood.<sup>39</sup> Moreover, similar with UK,<sup>40</sup> all

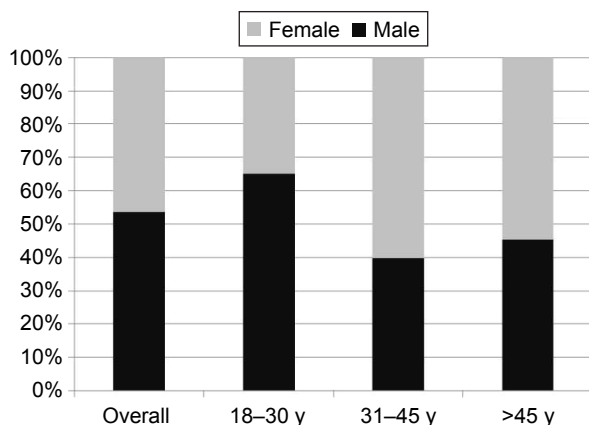


**Table 2** Characteristics of adults newly diagnosed with ADHD (N=5,397) from 2000 to 2011 in Taiwan

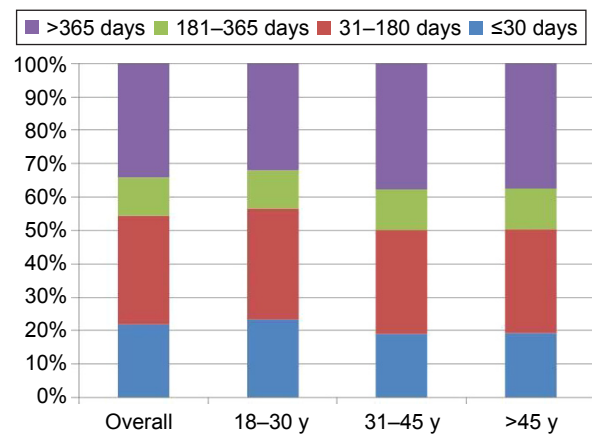
Characteristics	Mean or N	SD or %
<b>Age at diagnosis</b>		
Mean ± SD (years)	31.5	11.2
18–30 years (n, %)	2,822	52.3
31–45 years (n, %)	1,992	36.9
>45 years (n, %)	583	10.8
<b>Sex (n, %)</b>		
Female	2,502	46.4
Male	2,895	53.6
<b>ADHD subtypes (n, %)</b>		
Inattentive type	4,042	74.9
Hyperactive/impulsive or combined type	1,355	25.1
<b>Psychiatric comorbidity (n, %)</b>		
Tic disorders	76	1.4
Intellectual disability	396	7.3
Anxiety disorders	3,541	65.6
Depressive disorders	2,670	49.5
<b>Hospital level of first diagnosis (n, %)</b>		
Medical center or regional hospitals	3,983	73.8
Local medical clinics	1,414	26.2
<b>Pharmacotherapy for ADHD</b>		
Any prescription (n, %)	2,987	55.3
Duration of any drug treatment (days, mean ± SD)	478.3	733.1
MPR of drug treatment (%; mean ± SD)	69.3	32.9
IR-MPH prescription (n, %)	2,720	50.4
Duration of IR-MPH treatment (days, mean ± SD)	453.9	728.9
MPR of IR-MPH treatment (%; mean ± SD)	69.5	33.4
OROS-MPH prescription (n, %)	719	13.3
Duration of OROS-MPH treatment (days, mean ± SD)	327.7	487.9
MPR of OROS-MPH treatment (%; mean ± SD)	73.4	30.9
ATX prescription (n, %)	92	1.7
Duration of ATX treatment (days, mean ± SD)	161.4	221.6
MPR of ATX treatment (%; mean ± SD)	85.3	22.6

**Note:** Data are expressed as n (%) or mean ± SD.

**Abbreviations:** IR-MPH, immediate-release methylphenidate; OROS-MPH, osmotic release oral system-methylphenidate; ATX, atomoxetine; MPR, medication possession ratio; ADHD, attention-deficit/hyperactivity disorder; SD, standard deviation.



**Figure 1** Sex distribution among three age groups in adult ADHD patients in Taiwan. **Abbreviations:** ADHD, attention-deficit/hyperactivity disorder; y, years.



**Figure 2** Different durations of medication treatment among three age groups in adult ADHD patients in Taiwan.

**Abbreviations:** ADHD, attention-deficit/hyperactivity disorder; y, years.

specialists of physicians (ie, general practitioner, pediatrician, or psychiatrist) are allowed to diagnose and treat ADHD in Taiwan. Therefore, the accessibility of medical care could not explain the low diagnosis rate of adult ADHD in Taiwan. In sum, it is suggested that there is still a large number of adults who meet the criteria for ADHD but do not seek medical care.

There are several possible explanations for the low diagnosis rate of adult ADHD in Taiwan. First, because the hyperactive/impulsive symptoms commonly reduce in adulthood, diagnosing ADHD in adults is more difficult than in children or adolescents.<sup>41</sup> Second, cultural influences, medical resources, discretion of the physicians, and the

**Table 3** Logistic regression model for factors associated with pharmacotherapy for adult ADHD

Characteristics	n/N (%)	aOR (95% CI)	P-value
<b>Age at diagnosis</b>			
18–30 years (n, %)	1,919/2,822 (68.0)	1	
31–45 years (n, %)	844/1,992 (42.4)	0.40 (0.35–0.46)	<0.001
>45 years (n, %)	224/583 (38.4)	0.30 (0.26–0.36)	<0.001
<b>Sex</b>			
Female	1,142/2,502 (45.6)	1	
Male	1,845/2,895 (63.7)	1.79 (1.59–2.02)	<0.001
<b>ADHD subtypes</b>			
Inattentive type	2,124/4,042 (52.5)	1	
H/I or combined type	863/1,355 (63.7)	1.23 (1.07–1.41)	0.004
<b>Psychiatric comorbidity</b>			
Tic disorders	49/76 (64.5)	0.94 (0.57–1.57)	0.821
Intellectual disability	182/396 (46.0)	0.54 (0.44–0.68)	<0.001
Anxiety disorders	2,217/3,541 (62.6)	1.64 (1.42–1.89)	<0.001
Depressive disorders	751/1,073 (70.0)	1.74 (1.52–1.99)	<0.001
<b>Hospital level</b>			
Hospitals	2,048/3,983 (51.4)	1	
Local medical clinics	939/1,414 (66.4)	1.55 (1.35–1.78)	<0.001

**Abbreviations:** aOR, adjusted odds ratio; 95% CI, 95% confidence interval; ADHD, attention-deficit/hyperactivity disorder; H/I, hyperactive/impulsive.

patients' willingness to receive treatment may influence the diagnosis rates of adult ADHD.<sup>5</sup> Third, without referral from teachers or parents, self-recognizing attention-related problems is the main source of clinical referral in adults. However, adults often have better coping strategies to deal with ADHD symptoms than children, and are therefore less likely to seek medical help. Although the diagnosis rate of adult ADHD is low in Taiwan, it was found that the incidence rates of adult ADHD increased ~10 times from 2000 (0.41 per 100,000 people) to 2011 (4.45 per 100,000 people). Besides, the annual proportion of the three age groups (18–30, 31–45, and >45 years) did not significantly change during 2000–2011. This may indicate increased awareness of adult ADHD symptoms in clinicians and the general population throughout all age groups.

The results of this study were similar to a previous study which also used NHIRD in Taiwan from 2000–2005 for ADHD diagnosis.<sup>22</sup> However, the present study included patients with at least two claims records of ADHD diagnosis from 2000 to 2011, but Huang et al<sup>22</sup> included patients with only one claim record. This study therefore demonstrated a more reliable ADHD diagnosis rate and data more recently. Besides, Huang et al<sup>22</sup> did not provide information about the types of treatment received by those patients. Nevertheless, similar to the finding of this study, they<sup>22</sup> found very low health-seeking prevalence rate of ADHD in adult groups, higher diagnosis rate in younger age groups, and an increase in the trend of diagnosis in adult ADHD in Taiwan.

## Characteristics of adult ADHD

A more equal male to female ratio (1.16) was found in adults with ADHD than in children with ADHD, and the adults with ADHD predominantly had the inattention subtype ADHD. These findings are compatible with previous studies.<sup>6,9,17,42</sup> In concordance with the present study (Figure 1), a previous study that used NHIRD data in Taiwan also found that the ADHD diagnosis rate was female dominant among those older than 30.<sup>22</sup> In childhood ADHD, it has been well established that boys have a higher prevalence rate than girls with a ratio ranging from 2:1 to 9:1.<sup>43,44</sup> In contrast to girls, boys are more likely to exhibit hyperactivity/impulse symptoms and have a higher probability of clinical referral and diagnosis of ADHD. In addition, the symptoms of ADHD, and particularly hyperactive/impulsive symptoms, naturally decrease at puberty or in early adulthood.<sup>39</sup> Therefore, adults with ADHD, and especially women with ADHD, may be more likely to exhibit attention problems. In addition, adult women are more likely to seek psychiatric help than men,<sup>44,45</sup> and therefore,

women with manifestations of ADHD may be more likely to be diagnosed with ADHD than men. Taken together, these reasons may be associated with the sex distribution and predominance of the inattentive subtype in adult ADHD.

It was also found that adult ADHD was frequently comorbid with other psychiatric disorders including anxiety (65.6%), depressive (49.5%) and tic (1.4%) disorders, and intellectual disabilities (7.3%). Previous studies have also reported that as many as 47%–53% of adults with ADHD have comorbid anxiety disorders.<sup>24</sup> In addition to anxiety disorders, depressive disorders have also been reported to be highly prevalent in adults with ADHD (11.5%–53%).<sup>2,7,9,24</sup> Because the symptoms of ADHD usually begin in childhood, the cumulative effects of these symptoms may lead some young adults with ADHD to eventually develop anxiety or depression.<sup>46,47</sup> Substance abuse has also been a commonly reported comorbid disorder in previous studies.<sup>5,8</sup> However, treatment for substance abuse is not covered by the NHI in Taiwan, and thus substance use disorders could not be analyzed in this study. The comorbid rates of tic disorders (1.4%) and intellectual disabilities (7.3%) were reported in adults with ADHD, and an increasing number of studies have indicated that ADHD can increase the risk of developing numerous neuropsychiatric disorders.<sup>28,48,49</sup> Taken together with the study findings, it is suggested that common psychiatric comorbidities of ADHD should be taken into consideration when managing such patients.

## Pharmacotherapy of adult ADHD

In this study, about 55% of the adults diagnosed with ADHD received medications for ADHD. This result is quite similar to a study in the US which reported that 48%–58% of adults with ADHD received ADHD medications.<sup>17</sup> On the contrary, unlike the data in USA which reported a steady increase in pharmacological treatment over time,<sup>17</sup> the proportion of patients who received medication treatment in this study did not significantly change over time. Medication prescriptions may be associated with patients' acceptance, physicians' willingness, or even some other source. This indicates that the acceptance of medication treatment in public might not necessarily be elevated over time, to accompany an increased diagnosis rate of adult ADHD. Among the ADHD medications, IR-MPH was the most common medication prescribed by clinicians in Taiwan. The Bureau of NHI lists IR-MPH as the first choice of medication for adult ADHD, and OROS-MPH and ATX are only suggested for patients who experience poor drug compliance or are intolerant to the adverse effects of IR-MPH.

In this study, the average duration of treatment was about 478.3 days, and a mean MPR of 69.3%, an indicator of the intensity of pharmacological treatment, was found in the study population. ADHD is thought to be a life-long condition;<sup>5,50,51</sup> however, adults with ADHD may develop adequate coping strategies and then be able to stop using medications.<sup>52</sup> However, the reasons for discontinuing ADHD medication may also be related to other factors such as the severity of symptoms, adverse effects, treatment effectiveness, patients'/clinicians' attitude toward the medication, and social stigma,<sup>8</sup> all of which are difficult to analyze from claims data. Instead, factors associated with the use of ADHD medication were analyzed in the Taiwanese adult population. It was found that older age and having comorbid intellectual disabilities were associated with a lower probability of being prescribed with ADHD medications. Young adults may face tasks that require better attention or self-management skills such as attending university and finding a new job, whereas older adults may have developed strategies to compensate for the symptoms of ADHD, and are therefore less likely to receive pharmacotherapy. Interestingly, the youngest patients (18–30 years) had the shortest duration of treatment in the study population (Figure 2). It warrants further investigation on whether drug adherence was influenced by sociodemographic characteristics other than age (ie, sex or socioeconomic status).

Moreover, lower expectations of general performance in adults with intellectual disabilities may lead to less active treatment. However, having comorbid anxiety or depressive disorders increased the probability of being prescribed with medications. Several studies have suggested that adults with ADHD are at an increased risk of having depressive and anxiety disorders,<sup>6,18,52–54</sup> and clinicians may feel more obliged to treat ADHD in these patients to lower the psychosocial stress resulting from the symptoms of ADHD.

## Limitations

There are several limitations to this study. First, the diagnoses of adult ADHD were identified on the basis of ICD-9-CM codes only, and they were not validated using face-to-face diagnostic instruments. Therefore, the results represent the diagnosis rates of adult ADHD, but not the actual prevalence of adult ADHD in Taiwan. Second, some clinical data such as the severity of ADHD symptoms, family history, past history, physical comorbidities, and treatment effects were not analyzed in this study. Third, because treatment of substance use disorders is not included in the NHIRD, the effect of substance abuse could not be analyzed. Fourth, the indications

of drug prescriptions were difficult to ascertain through data collection, and it was simply assumed that all medicines were used for ADHD. Fifth, information on non-pharmacological treatment was not analyzed for ADHD in this study. Finally, the study did not analyze how many adults had more than one course of ADHD medication treatment.

## Conclusion

This population-based study showed an increasing trend in the diagnosis rate of adult ADHD; however, this rate is still low compared with Western countries. Adult patients with ADHD seeking medical care are characterized by a similar male to female ratio, inattentive type of ADHD, and frequent psychiatric comorbidities. Approximately 55% of the adult patients with ADHD received medication for their ADHD. Overall, the findings in this study suggest that continuous efforts are needed to increase public awareness about adult ADHD.

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## Disclosure

The authors report no conflicts of interest in this work.

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