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Sexually Transmitted Infection Among Adolescents and Young Adults With Attention-Deficit/Hyperactivity Disorder: A Nationwide Longitudinal Study

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Objective: Previous studies have suggested that attention-deficit/hyperactivity disorder (ADHD) is related to risky sexual behaviors, which have been regarded as a major risk factor of sexually transmitted infection (STI). However, the association between ADHD and subsequent STIs remains unknown.

Method: Using the Taiwan National Health Insurance Research Database, 17,898 adolescents and young adults who were diagnosed with ADHD by psychiatrists and 71,592 age- and sex-matched comparisons without ADHD were enrolled from 2001 through 2009 and followed to the end of 2011. Participants who developed any STI during the follow-up period were identified. Cox regression analysis was performed to examine the risk of STIs between patients with ADHD and those without ADHD.

Results: Patients with ADHD were prone to developing any STI (hazard ratio [HR] 3.36, 95% CI 2.69∼4.21) after adjusting for demographic data, psychiatric comorbidities, and ADHD medications compared with the comparison group. Substance use disorders (HR 1.94, 95% CI 1.27∼2.98) also were associated with STI risk. Short-term use (HR 0.70, 95% CI 0.53∼0.94) and long-term use (HR 0.59, 95% CI 0.37∼0.93) of ADHD medications were related to a lower risk of subsequent STIs. However, an association between substance use disorders and STIs was observed only in women. By contrast, the effect of ADHD medications on the decrease of STI risk was observed only in men.

Conclusion: Adolescents and young adults with ADHD had an increased risk of developing any STI later in life compared with the non-ADHD comparisons. Patients with ADHD who also had substance use disorders were at the highest risk of subsequent STIs. Treatment with ADHD medications was associated with a lower risk of subsequent STIs.

Key words: ADHD, sexually transmitted infection, substance use disorders, ADHD medications

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Attention-deficit/hyperactivity disorder (ADHD) is the most common neurodevelopmental disorder and begins in childhood. Individuals with ADHD exhibit not only an inability to marshal and sustain attention but also an impairment of modulating activity levels and impulsive actions.[1-3] ADHD is highly prevalent in children, adolescents, and young adults worldwide and affects approximately 5% to 7% of children and adolescents and 2% of young adults, with a male-to-female ratio in the range of 3:1 to 4:1.[2,4,5]

Increasing evidence supports the association between ADHD and various health-risk behaviors, such as risky driving, substance abuse, and risky sexual behaviors, which have been associated with the core symptoms of ADHD, including executive dysfunction, problematic decision making, and impulsivity.[6-10] A prospective 33-year follow-up study of 135 boys with childhood ADHD showed that patients with ADHD had a younger sexual debut ($p < .001$) and more sexual partners ($p = .02$) and were less likely to use condoms in their 20s and 30s ($p = .001$) than their counterparts without ADHD.[8] Sarver *et al.*[7] assessed the association among ADHD symptoms, conduct problems, alcohol and substance abuse, and susceptibility to risky sexual behaviors in 115 adolescents in the juvenile justice system and found that ADHD symptoms predicted risky sexual behaviors in adolescents with prominent conduct problems ($p = .04$), and they reported that the hyperactivity/impulsivity domain, but not the inattention domain, of ADHD correlated significantly with risky sexual behaviors. Flory *et al.*[11] compared young adults (18–26 years old) with and without childhood ADHD based on their self-reported risky sexual behaviors. They found that young adults with childhood ADHD exhibited an earlier initiation of sexual activity and intercourse and had more sexual partners, more frequent casual sex, and less frequent condom use. Østergaard *et al.*[12] further reported that patients with ADHD were significantly more likely to become teenage parents compared with those without ADHD and stated that it would be appropriate to target patients with ADHD with an intervention program that includes sexual education. Risky sexual behaviors, particularly unprotected sex, and substance abuse have been considered major risk factors for sexually transmitted infection (STI).[13]

However, the association between ADHD and STI has rarely been investigated, and findings have been conflicting. Ramos Olazagasti *et al.*[8] assessed the risk of STI in 135 patients with ADHD and 136 controls and found that the prevalence of STI was higher in patients with ADHD than in controls (15% versus 7%, $p = .03$). By contrast, Flory *et al.*[11] reported that youth with and without ADHD were at a similar risk of STI (2% versus 4%, $p = .28$). However, the main limitations of

these studies included small samples, a lack of appropriate adjustment for psychiatric comorbidities (especially substance use disorder), and the use of self-reported STI rather than physician-diagnosed STI, which weakens the diagnostic validity. Furthermore, these studies did not investigate the potential effects of ADHD medications on the risk of subsequent STIs.

In the present study, we used the Taiwan National Health Insurance Research Database (NHIRD), which is a nationally representative database of medical claims data, and a longitudinal follow-up study design to investigate the risk of STIs, namely HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis, in patients with ADHD. We hypothesized that patients with ADHD would be at higher risk of subsequent STIs than non-ADHD controls. Furthermore, we contended that intervention for ADHD could be related to a lower risk of subsequent STIs.

METHOD

Data Source

Taiwan's National Health Insurance, a mandatory universal health insurance program, was implemented in 1995 and offers comprehensive medical care coverage to all Taiwanese residents. The National Health Research Institute (NHRI) is in charge of the entire insurance claims database, namely the NHIRD, which consists of health care data from more than 99% of the entire Taiwan population. The NHRI audits and releases the NHIRD for scientific and study purposes. Individual medical records included in the NHIRD are anonymous to protect patient privacy. Comprehensive information on insured individuals is included in the database, including demographic data, dates of clinical visits, disease diagnoses, and medical interventions. The diagnostic codes used were based on the *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*). The NHIRD has been used extensively in many epidemiologic studies in Taiwan.[14-17]

Inclusion Criteria for Adolescents and Young Adults With ADHD and Control Group

Adolescents (12–17 years old) and young adults (18–29 years old) who were diagnosed with ADHD (*ICD-9-CM* code 314) by board-certificated psychiatrists from January 1, 2001 through December 31, 2009 and who had no history of any STI before enrollment were included as the ADHD cohort. Any STI included HIV (*ICD-9-CM* codes 042 and V08), syphilis (*ICD-9-CM* codes 091∼097), genital warts (*ICD-9-CM* code 078.11), gonorrhea (*ICD-9-CM* code 098), chlamydial infection (*ICD-9-CM* codes 078.8 and 078.88), and trichomoniasis (*ICD-9-CM* code 131). The time of ADHD diagnosis was defined as the time of enrollment. The control cohort, matched by age, sex, and time of enrollment (1:4), was randomly identified after eliminating the study cases, those who had been given a diagnosis of ADHD at any time, and those with any STI before enrollment. Any STI, including HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis, was identified during the follow-up (from enrollment to December 31, 2011 or death). Psychiatric comorbidities, including disruptive behavior disorders, alcohol use disorders, and substance use disorders, were assessed as the confounding factors in this study. In addition, the use of ADHD medications (methylphenidate or atomoxetine) during follow-up was examined and divided into 3 subgroups: nonusers (cumulative defined daily dose [cDDD] during follow-up < 30), short-term users (cDDD $= 30\sim364$), and long-term users (cDDD ≥ 365).[18] Level of urbanization (levels 1–5; level 1, most urbanized region; level 5, least urbanized region) also was assessed for this study.[19]

Statistical Analysis

For between-group comparisons, the F test or Mann-Whitney U test was used for continuous variables and the Pearson χ^2 test was used for nominal variables, where appropriate. Cox regression analyses with the adjustment of demographic data (age, sex, income, level of urbanization), psychiatric comorbidities, and ADHD medications were performed to calculate the hazard ratio (HR) with a 95% CI of any STI in adolescents and young adults with ADHD and the control group. Sensitivity analyses were performed to investigate associations between ADHD and any STI after excluding the first year or first 3 years of observation. The risk of each STI, including HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis, associated with ADHD was analyzed further. The cumulative type 1 error rate from multiple tests was set as 0.05. Sub-analyses stratified by sex and age group (adolescents and young adults) also were assessed for the relation between ADHD and STI risk. We also investigated the association between ADHD medications and STI risk in patients with ADHD. A 2-tailed p value less than .05 was considered statistically significant. All data processing and statistical analyses were performed with SPSS 17 (SPSS, Inc., Chicago, IL) and SAS 9.1 (SAS Institute, Cary, NC).

RESULTS

In total, 17,898 adolescents and young adults with ADHD and 71,592 age- and sex-matched non-ADHD controls were enrolled in this study, with an average age of 14.88 ± 3.33 years and male predominance (80.4% versus 19.6%). During follow-up, adolescents and young adults with ADHD developed any STI at a younger age (20.51 ± 4.48 versus 21.90 ± 4.49, $p < .001$) and had a higher incidence of developing any STI (1.2% versus 0.4%, $p < .001$), including HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis, than the controls (Table 1). Moreover, the ADHD group had a higher prevalence of psychiatric comorbidities, including disruptive behavior disorder (13.5% versus 0.3%, $p < .001$), alcohol use disorders (1.1% versus 0.5%, $p < .001$), and substance use disorders (2.5% versus 0.8%, $p < .001$), compared with non-ADHD controls (Table 1). Furthermore, men (2.7% versus 0.9%) and women (1.5% versus 0.3%) with ADHD had a higher prevalence of substance use disorders than the non-ADHD controls. Those with ADHD resided in a less urbanized region ($p < .001$) and had a lower income ($p < .001$).

Kaplan-Meier survival analysis with log-rank test showed a significant association between ADHD and subsequent risk of any STI ($p < .001$; Figure 1). Cox regression analyses with an adjustment of demographic data, psychiatric comorbidities, and ADHD medications showed that adolescents (HR 3.27, 95% CI 2.51∼4.25) and young adults (HR 3.57, 95% CI 2.30∼5.54) and men (HR 3.81, 95% CI 2.88∼5.04) and women (HR 2.71, 95% CI 1.85∼3.96) with ADHD were prone to developing any STI later in life (Table 2). The relation between ADHD and risk of each STI (HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis) was statistically significant ($p < .001$ for all comparisons; Table 3).

Substance use disorders (HR 1.94, 95% CI 1.27∼2.98), disruptive behavior disorder (HR 1.46, 95% CI 1.01∼2.13), and alcohol use disorders (HR 2.39, 95% CI 1.17∼4.88) were related to the risk of subsequent STI occurrence (Table 2). However, after adjusting for demographic data, comorbidities, and ADHD medications, an association between substance use disorders and STIs was observed only in women (HR 3.87, 95% CI 1.98∼7.55; Table 2). Short-term users (HR 0.70, 95% CI 0.53∼0.94) and long-term users (HR 0.59, 95% CI 0.37∼0.93) of ADHD medications had a significantly lower risk of developing any STI during follow-up among adolescents and young adults with ADHD (Table 4). However, the effect of ADHD medications on the decrease of STI risk was observed only in men (Table 4). Level of urbanization was not related to risk of STIs. Sensitivity analyses after excluding the first year (HR 2.85, 95% CI 2.24∼3.63) or first 3 years (HR 2.45, 95% CI 1.85∼3.25) of observation reported consistent findings (Table 5).

DISCUSSION

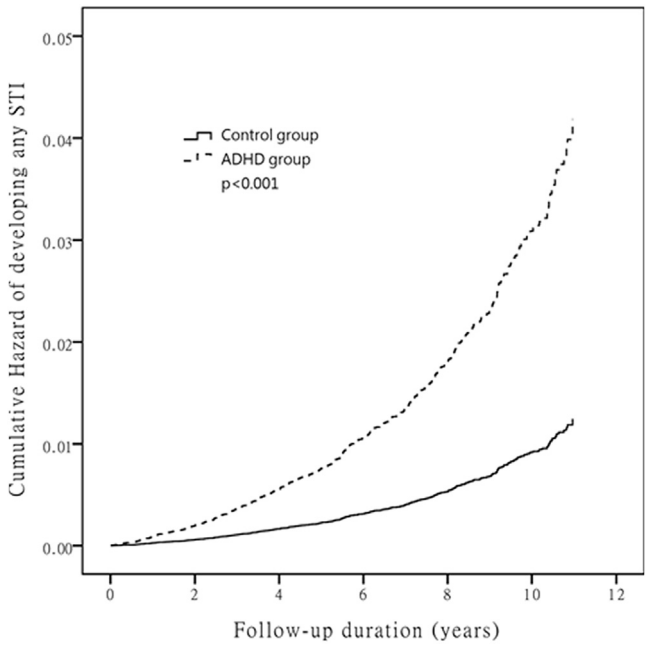
The present findings support the study hypothesis that adolescents and young adults with ADHD are at higher risk of subsequent STIs

TABLE 1 Demographic Data and Incidence of Any Sexually Transmitted Infection (STI) Among Adolescents and Young Adults With Attention-Deficit/Hyperactivity Disorder (ADHD) and Controls

	Participants With ADHD (n = 17,898)	Controls (n = 71,592)	*p* Value
Age at enrollment (y), mean (SD)	14.88 (3.33)	14.89 (3.34)	.547
Sex, n (%)			1.000
Male	14,391 (80.4)	57,564 (80.4)	
Female	3,507 (19.6)	14,028 (19.6)	
ADHD medications, n (%)			<.001
<30 cDDD	7,098 (39.7)	71,555 (99.9)	
30∼364 cDDD	7,940 (44.4)	35 (0.0)	
≥365 cDDD	2,860 (16.0)	2 (0.0)	
Incidence of any STIs, n (%)	219 (1.2)	306 (0.4)	<.001
HIV	18 (0.1)	25 (0.0)	<.001
Syphilis	34 (0.2)	28 (0.0)	<.001
Genital warts	55 (0.3)	81 (0.1)	<.001
Gonorrhea	25 (0.1)	35 (0.0)	<.001
Chlamydial infection	59 (0.3)	86 (0.1)	<.001
Trichomoniasis	47 (0.3)	67 (0.1)	<.001
Age at any STI (y), mean (SD)	20.51 (4.48)	21.90 (4.49)	<.001
Duration between enrollment and any STI (y), mean (SD)	4.12 (2.66)	5.76 (2.75)	<.001
Psychiatric comorbidities, n (%)			
DBDs	2,416 (13.5)	182 (0.3)	<.001
AUDs	199 (1.1)	363 (0.5)	<.001
SUDs	446 (2.5)	538 (0.8)	<.001
Level of urbanization			<.001
1 (most urbanized)	3,748 (20.9)	21,107 (29.5)	
2	5,547 (31.0)	22,129 (30.9)	
3	1,579 (8.8)	12,832 (17.9)	
4	1,257 (7.0)	9,895 (13.8)	
5 (most rural)	5,767 (7.0)	5,629 (7.9)	
Income-related insured amount			<.001
≤15,840 NTD/mo	14,671 (82.0)	55,171 (77.1)	
15,841∼25,000 NTD/mo	2,665 (14.9)	12,464 (17.4)	
≥25,001 NTD/mo	562 (3.1)	3,957 (5.5)	

Note: AUDs = alcohol use disorders; cDDD = cumulative defined daily dose; DBDs = disruptive behavior disorders; NTD = new Taiwan dollar; SD = standard deviation; SUDs = substance use disorders.

FIGURE 1 Survival curve of developing any sexually transmitted infection (STI) among adolescents and young adults with attention-deficit/hyperactivity disorder (ADHD) and controls.



(specifically HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis) than those without ADHD. Short- and long-term use of ADHD medications were related to a lower risk of subsequent STIs.

Studies have demonstrated that patients with ADHD are prone to risky sexual behaviors, which can further increase the risk of STI.[7,8,11] Ramos Olazagasti *et al.*[8] followed 135 boys with childhood ADHD without conduct disorders and matched non-ADHD controls for more than 30 years and observed that patients with childhood ADHD who developed conduct disorders during follow-up were significantly more likely to exhibit risk-taking behaviors, including a younger sexual debut, more sexual partners, and less frequent condom use, than non-ADHD controls. In addition, patients with ADHD were more likely to acquire STIs (except HIV) than non-ADHD controls, indicating that the risk of STI is associated with a larger number of sexual partners.[8] Hosain *et al.*[9] assessed ADHD symptoms and the lifetime risk of STI by administering the Adult ADHD Self-Report Scale to a sample of 462 young women (18–30 years old) and found that those with a lifetime history of STI exhibited more inattentive and hyperactivity/impulsivity symptoms than those without a lifetime history of STI. In the present study, ADHD was observed to be an independent risk factor for subsequent STIs, including HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis. Furthermore, patients with ADHD and psychiatric comorbidities had the highest risk of subsequent STIs.

Increasing evidence suggests that ADHD medications, such as methylphenidate, are beneficial in lowering the risk of several health-risk, impulsive, and criminal behaviors such as risky driving and substance abuse.[20-22] Cox *et al.*[20] reported that patients with ADHD who received methylphenidate treatment self-reported fewer total ADHD and inattentive symptoms, were less likely to exhibit risky driving behaviors, and had fewer collisions than those without methylphenidate treatment. Groenman *et al.*[21] investigated the effects of psychostimulant treatment on the subsequent risk of substance use disorder in a prospective longitudinal ADHD case-control study and found that patients with ADHD who received psychostimulant treatment had a lower risk of substance use disorder than those who did not receive the treatment. Lichtenstein *et al.*[22] reported that compared with patients with ADHD who did not use ADHD medication, those who did exhibited a significant decrease in criminality rates (men, 32%; women, 41%). Furthermore, the findings of the present study suggest that ADHD medication use was related to a lower risk of subsequent STIs. We found that short- and long-term use of ADHD medication lowered the

TABLE 2 Cox Regression Analyses of the Risk of Any Sexually Transmitted Infection (STI) Among Adolescents and Young Adults With Attention-Deficit/Hyperactivity Disorder (ADHD) and Controls[a]

	Adolescents (<18 y)	Young Adults (18–29 y)	Male	Female	Total
	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)
ADHD (presence vs. absence)	3.27 (2.51–4.25)	3.57 (2.30–5.54)	3.81 (2.88–5.04)	2.71 (1.85–3.96)	3.36 (2.69–4.21)
Psychiatric comorbidities (presence vs. absence)					
Disruptive behavior disorders	**1.46 (1.01–2.13)**	0.70 (0.22–2.27)	1.15 (0.74–1.78)	1.76 (0.98–3.19)	1.35 (0.95–1.92)
Alcohol use disorders	**2.39 (1.17–4.88)**	0.58 (0.14–2.39)	1.28 (0.56–2.91)	2.09 (0.76–5.75)	1.53 (0.81–2.90)
Substance use disorders	**2.13 (1.25–3.63)**	1.53 (0.75–3.12)	1.36 (0.78–2.37)	**3.87 (1.98–7.55)**	**1.94 (1.27–2.98)**

Note: *Boldface type indicates statistical significance. DDD = defined daily dose; HR = hazard ratio.*
[a]*Adjusted for demographic data, psychiatric comorbidities, and ADHD medications.*

risk of subsequent STIs by 30% and 41%, respectively. Furthermore, we found that only 16% of adolescents and young adults with ADHD had long-term use of ADHD medications, and even up to 40% did not receive medication treatment in the present study. The high rate of nontreatment could implicate a potentially increased risk of risky sexual behaviors and subsequent STIs in patients with ADHD in Taiwan. Mental health and infection prevention government officers should pay more attention to this issue.

In the present study, we found that sex influenced the risk of STIs in patients with ADHD. Men and women with ADHD had a higher prevalence of substance use disorders than the non-ADHD controls. However, after adjusting for demographic data, comorbidities, and ADHD medications, an association between substance use disorders and STIs was observed only in women. By contrast, the effect of ADHD medications on the decrease of STI risk was observed only in men. A similar pattern was observed for the association between ADHD medications and substance use disorders. Charnigo *et al.*[23] found that the effect of ADHD medications on decreasing the concurrent risk of substance problems was observed only in men with ADHD. Differences in the risk of STIs between male and female patients with ADHD require further investigation.

We propose several explanations for the mechanisms underlying the relation between ADHD and the risk of subsequent STIs and that between ADHD medication use and the lower risk of subsequent STIs. First, ADHD comorbidities, particularly substance use disorders, increase the susceptibility to unprotected sex and intravenous substance use, which increases the risk of subsequent STIs such as HIV.[13] In the present study, ADHD was observed to be an independent risk factor for subsequent STIs (namely HIV, syphilis, genital warts, gonorrhea, chlamydial infection, and trichomoniasis) after adjustment for substance use disorder. In addition, adolescents and young adults with ADHD and substance use disorder exhibited the highest risk of subsequent STIs.

Second, previous studies have suggested that impulsivity, the core symptom of ADHD, is associated with increased susceptibility to risky sexual behaviors and STI.[23,24] Charnigo *et al.*[23] reported that impulsive decision making was consistently associated with various risky sexual behaviors including unprotected sex and sexual acts under the influence of drugs or alcohol (or both). Hayaki *et al.*[24] concluded that the association between impulsivity and risk of STI is mediated by risky sexual behaviors. Previous studies have described the beneficial effects of ADHD medications, such as methylphenidate, in impulsivity control and modulation.[25-27] Moreover, ADHD medications could decrease impulsivity-related risky sexual behaviors, thereby lowering the risk of subsequent STIs. In clinical practice, some clinicians could have concerns about prescribing ADHD medications, especially psychostimulants, to patients with ADHD who also have a substance use disorder. Increasing evidence has indicated that receiving ADHD medication is unlikely to be associated with a greater risk of substance-related problems in adolescence or adulthood and further suggested that medication is associated with lower concurrent risk of substance-related events.[28,29] In the present study, short- and long-term use of ADHD medications was related to a lower risk of subsequent STIs after adjusting for substance use disorder. We recommended that clinicians should focus on the increased risk of STIs for persons with ADHD and substance use disorders and should be exceptionally diligent in seeking compliance with ADHD treatment for this exceptionally high-risk group.

Third, executive dysfunction in ADHD can result in a catastrophic cascade to risky sexual behaviors and STI.[30,31] Golub *et al.*[30] assessed the relation between executive functioning and risky sexual behaviors in substance users and found that poor performance in executive functions across all measures (working memory, attention-shifting, cognitive inhibiting, and reward processing) was associated with an increased susceptibility to risky sexual behaviors. Increasing evidence supports that ADHD medication use could ameliorate ADHD-related executive dysfunction and benefit behavioral inhibition, planning, and response inhibition.[32]

TABLE 3 Risk of Each Sexually Transmitted Infection (STI) Among Adolescents and Young Adults With Attention-Deficit/Hyperactivity Disorder (ADHD) and Controls[a]

	HIV	Syphilis	Genital Warts	Gonorrhea	Chlamydial Infection	Trichomoniasis	Any STI
ADHD	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)	HR (95% CI)
Absence	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
Presence	**4.61 (2.28–9.33)**	**5.21 (2.76–9.83)**	**2.74 (1.72–4.35)**	**3.65 (1.91–6.96)**	**3.57 (2.31–5.51)**	**2.69 (1.64–4.41)**	**3.36 (2.69–4.21)**

Note: *Boldface type indicates statistical significance (p < .001). HR = hazard ratio; ref = reference.*
[a]*Adjusted for demographic data, psychiatric comorbidities, and ADHD medications.*

TABLE 4 Attention-Deficit/Hyperactivity Disorder (ADHD) Medications and the Risk of Any Sexually Transmitted Infection Among Adolescents and Young Adults With ADHD[a]

	Adolescents (<18 y)	Young Adults (18–29 y)	Male	Female	Total
ADHD Medications	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**	**HR (95% CI)**
<30 cDDD	1 (ref)	1 (ref)	1 (ref)	1 (ref)	1 (ref)
30–364 cDDD	0.75 (0.54–1.03)	0.51 (0.26–1.02)	**0.68 (0.48–0.97)**	0.75 (0.45–1.23)	**0.70 (0.53–0.94)**
≥365 cDDD	**0.50 (0.29–0.87)**	1.18 (0.52–2.67)	**0.53 (0.30–0.93)**	0.76 (0.35–1.64)	**0.59 (0.37–0.93)**

Note: Boldface type indicates statistical significance. cDDD = cumulative defined daily dose; HR = hazard ratio; ref = reference.
[a]*Adjusted for demographic data and psychiatric comorbidities.*

Therefore, mitigating ADHD-associated executive dysfunction could decrease the susceptibility to risky sexual behaviors and STIs.

The present study has several limitations. First, the prevalence incidence of STIs could have been underestimated because only those individuals who seek medical help and consultation are identified in the NHIRD. However, STI diagnoses in the NHIRD are assigned by board-certificated physicians, thus improving diagnostic validity. Second, the prevalence of ADHD could be underestimated because only those adolescents and young adults who seek medical consultation are identified in the database. However, ADHD diagnosis in the NHIRD is given by board-certificated psychiatrists, thus improving diagnostic validity. Third, the NHIRD does not provide information on the severity of ADHD symptoms; therefore, we could not investigate the association between ADHD severity and risk of subsequent STIs. Additional clinical studies are required to elucidate this association. Fourth, ADHD is a neurodevelopmental disorder and always begins in childhood. In this study, the time of ADHD diagnosis might be arbitrary, because it might be not when the diagnosis was actually made. A birth cohort study might be necessary to reconfirm these findings. Fifth, to investigate the association between ADHD medication use and the STI risk, we defined short-term and long-term use of ADHD medications based on the number of cDDD, which could be arbitrary. In addition, ADHD medication use could be a proxy measure for treatment compliance or the severity of ADHD. Sixth, the prevalence of ADHD was 3.3% to 7.5% in Taiwanese youths.[33] However, up to 40% of Taiwanese patients with ADHD did not receive medication treatment because Taiwanese parents tend to be concerned about overuse of ADHD medication; the general attitude toward ADHD medication use is conservative in Taiwanese society.[34] A previous study found that only 29.6% of patients with ADHD had used medications for over 180 days in Taiwan.[35] In our study, we found that only 16% of patients with ADHD engaged in long-term use (≥365 cDDD) of medications. Whether the low prevalence of ADHD medication use influences the STI risk in Taiwan requires further investigation. Seventh, the NHIRD does not provide information on factors such as psychosocial stresses, family history, personal lifestyles, environment, and the sociodemographic status of the parents during the upbringing of the cohort members; therefore, we could not investigate their potential influence.

In conclusion, adolescents and young adults with ADHD are more likely to develop subsequent STIs than those without ADHD. In the present study, after adjustment for demographic factors, psychiatric comorbidities (disruptive behavior disorders and alcohol and substance use disorders), and ADHD medication use, we found that ADHD is an independent risk factor for subsequent STIs. Moreover, patients with ADHD and substance use disorder are at highest risk of subsequent STIs. ADHD medication use was related to a lower risk of subsequent STIs. We recommend that clinical psychiatrists focus on the occurrence of risky sexual behaviors and the risk of STIs in patients with ADHD and emphasize that treatment with ADHD medication could be a protective factor for prevention of STIs. Future studies would be necessary to further investigate whether other ADHD treatments, such as family therapy or psychotherapy, are effective in preventing STIs.

TABLE 5 Sensitivity Analysis of the Risk of Any Sexually Transmitted Infection Among Adolescents and Young Adults With Attention-Deficit/Hyperactivity Disorder (ADHD) and Controls[a]

	Total		≥1 y[b]		≥3 y[c]	
ADHD	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
Absence	1 (ref)	—	1 (ref)	—	1 (ref)	—
Presence	3.36	2.69–4.21	2.85	2.24–3.63	2.45	1.85–3.25

Note: Boldface type indicates statistical significance. HR = hazard ratio; ref = reference.
[a]*Adjusted for demographic data, psychiatric comorbidities, and ADHD medications.*
[b]*Excluding the first year of observation.*
[c]*Excluding the first 3 years of observation.*

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REFERENCES

1. Biederman J. Attention-deficit/hyperactivity disorder: a selective overview. Biol Psychiatry. 2005;57:1215-1220.
2. Biederman J, Faraone SV. Attention-deficit hyperactivity disorder. Lancet. 2005;366:237-248.
3. Rappley MD. Clinical practice. Attention deficit-hyperactivity disorder. N Engl J Med. 2005;352:165-173.
4. Vitola ES, Bau CH, Salum GA, *et al*. Exploring DSM-5 ADHD criteria beyond young adulthood: phenomenology, psychometric properties and prevalence in a large three-decade birth cohort. Psychol Med. 2017;47:744-754.
5. Asherson P, Buitelaar J, Faraone SV, Rohde LA. Adult attention-deficit hyperactivity disorder: key conceptual issues. Lancet Psychiatry. 2016;3:568-578.
6. Schoenfelder EN, Kollins SH. Topical review: ADHD and health-risk behaviors: toward prevention and health promotion. J Pediatr Psychol. 2016;41:735-740.
7. Sarver DE, McCart MR, Sheidow AJ, Letourneau EJ. ADHD and risky sexual behavior in adolescents: conduct problems and substance use as mediators of risk. J Child Psychol Psychiatry. 2014;55:1345-1353.
8. Ramos Olazagasti MA, Klein RG, Mannuzza S, *et al*. Does childhood attention-deficit/hyperactivity disorder predict risk-taking and medical illnesses in adulthood? J Am Acad Child Adolesc Psychiatry. 2013;52:153-162.e154.
9. Hosain GM, Berenson AB, Tennen H, Bauer LO, Wu ZH. Attention deficit hyperactivity symptoms and risky sexual behavior in young adult women. J Womens Health (Larchmt). 2012;21:463-468.
10. Dekkers TJ, Popma A, Agelink van Rentergem JA, Bexkens A, Huizenga HM. Risky decision making in attention-deficit/hyperactivity disorder: a meta-regression analysis. Clin Psychol Rev. 2016;45:1-16.
11. Flory K, Molina BS, Pelham WE Jr, Gnagy E, Smith B. Childhood ADHD predicts risky sexual behavior in young adulthood. J Clin Child Adolescent Psychol. 2006;35:571-577.
12. Østergaard SD, Dalsgaard S, Faraone SV, Munk-Olsen T, Laursen TM. Teenage parenthood and birth rates for individuals with and without attention-deficit/hyperactivity disorder: a nationwide cohort study. J Am Acad Child Adolesc Psychiatry. 2017;56:578-584.e573.
13. Sonnenberg P, Clifton S, Beddows S, *et al*. Prevalence, risk factors, and uptake of interventions for sexually transmitted infections in Britain: findings from the National Surveys of Sexual Attitudes and Lifestyles (Natsal). Lancet. 2013;382:1795-1806.
14. Chen MH, Lan WH, Hsu JW, *et al*. Risk of developing type 2 diabetes in adolescents and young adults with autism spectrum disorder: a nationwide longitudinal study. Diabetes Care. 2016;39:788-793.
15. Chen MH, Pan TL, Li CT, *et al*. Risk of stroke among patients with post-traumatic stress disorder: nationwide longitudinal study. Br J Psychiatry. 2015;206:302-307.
16. Li CT, Chen LF, Tu PC, *et al*. Impaired prefronto-thalamic functional connectivity as a key feature of treatment-resistant depression: a combined MEG, PET and rTMS study. PLoS One. 2013;8:e70089.
17. Shen CC, Tsai SJ, Perng CL, Kuo BI, Yang AC. Risk of Parkinson disease after depression: a nationwide population-based study. Neurology. 2013;81:1538-1544.
18. Wang LJ, Shyu YC, Yuan SS, *et al*. Attention-deficit hyperactivity disorder, its pharmacotherapy, and the risk of developing bipolar disorder: a nationwide population-based study in Taiwan. J Psychiatr Res. 2016;72:6-14.
19. Liu CY, Hung YT, Chuang YL, Chen YJ, Weng WS, Liu JS. Incorporating development stratification of Taiwan townships into sampling design of large scale health interview survey. J Health Manage (Chin). 2006;4:1-22.
20. Cox DJ, Davis M, Mikami AY, Singh H, Merkel RL, Burket R. Long-acting methylphenidate reduces collision rates of young adult drivers with attention-deficit/hyperactivity disorder. J Clin Psychopharmacol. 2012;32:225-230.
21. Groenman AP, Oosterlaan J, Rommelse NN, *et al*. Stimulant treatment for attention-deficit hyperactivity disorder and risk of developing substance use disorder. Br J Psychiatry. 2013;203:112-119.
22. Lichtenstein P, Halldner L, Zetterqvist J, *et al*. Medication for attention deficit-hyperactivity disorder and criminality. N Engl J Med. 2012;367:2006-2014.
23. Charnigo R, Noar SM, Garnett C, Crosby R, Palmgreen P, Zimmerman RS. Sensation seeking and impulsivity: combined associations with risky sexual behavior in a large sample of young adults. J Sex Res. 2013;50:480-488.
24. Hayaki J, Anderson BJ, Stein MD. Sexual risk-taking mediates the association between impulsivity and acquisition of sexually transmitted infections among hazardously drinking incarcerated women. Am J Addict. 2012;21(suppl 1):S63-S71.
25. Dalley JW, Roiser JP. Dopamine, serotonin and impulsivity. Neuroscience. 2012;215:42-58.
26. DeVito EE, Blackwell AD, Kent L, *et al*. The effects of methylphenidate on decision making in attention-deficit/hyperactivity disorder. Biol Psychiatry. 2008;64:636-639.
27. Shiels K, Hawk LW Jr, Reynolds B, *et al*. Effects of methylphenidate on discounting of delayed rewards in attention deficit/hyperactivity disorder. Exp Clin Psychopharmacol. 2009;17:291-301.
28. Humphreys KL, Eng T, Lee SS. Stimulant medication and substance use outcomes: a meta-analysis. JAMA Psychiatry. 2013;70:740-749.
29. Quinn PD, Chang Z, Hur K, *et al*. ADHD medication and substance-related problems. The American journal of psychiatry. 2017;174:877-885.
30. Golub SA, Starks TJ, Kowalczyk WJ, Thompson LI, Parsons JT. Profiles of executive functioning: associations with substance dependence and risky sexual behavior. Psychol Addict Behav. 2012;26:895-905.
31. Pachankis JE, Rendina HJ, Ventuneac A, Grov C, Parsons JT. The role of maladaptive cognitions in hypersexuality among highly sexually active gay and bisexual men. Arch Sex Behav. 2014;43:669-683.
32. Coghill DR, Seth S, Pedroso S, Usala T, Currie J, Gagliano A. Effects of methylphenidate on cognitive functions in children and adolescents with attention-deficit/hyperactivity disorder: evidence from a systematic review and a meta-analysis. Biol Psychiatry. 2014;76:603-615.
33. Gau SS, Chong MY, Chen TH, Cheng AT. A 3-year panel study of mental disorders among adolescents in Taiwan. Am J Psychiatry. 2005;162:1344-1350.
34. Wang LJ, Lee SY, Yuan SS et al. Prevalence rates of youths diagnosed with and medicated for ADHD in a nationwide survey in Taiwan from 2000 to 2011 [published online ahead of print July 20, 2016]. Epidemiol Psychiatr Sci. https://doi.org/10.1017/S2045796016000500.
35. Chen VC, Yang YH, Liao YT, *et al*. The association between methylphenidate treatment and the risk for fracture among young ADHD patients: a nationwide population-based study in Taiwan. PLoS One. 2017;12:e0173762.