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Prevalence and correlates of depression and anxiety in caregivers of children with attention-deficit/hyperactivity disorder during the fifth wave of COVID-19 and school closure in Hong Kong

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Abstract

Background Caregivers of children with attention-deficit/hyperactivity disorder (ADHD) are vulnerable to increased psychological distress during COVID-19. However, specific pandemic- and child-related factors contributing to their poor mental health have not been fully investigated. We aimed to comprehensively examine prevalence and correlates of depression and anxiety among caregivers of ADHD children in Hong-Kong during the peak of fifth pandemic wave with territory-wide school closure.

Method One-hundred-ninety-nine caregivers of ADHD children were assessed with self-rated questionnaires between 29 March–14 April, 2022. Questionnaires encompassed socio-demographics, pre-existing physical/psychiatric morbidity, COVID-19 related factors, children's ADHD and other psychiatric symptoms. Caregivers' psychological distress was quantified by Patient Health Questionnaire-9 (PHQ-9) and Generalized Anxiety Disorder Scale-7 (GAD-7). Caregivers who scored ≥ 10 in PHQ-9 and GAD-7 were classified as having probable depression and probable anxiety, respectively. Univariate and multivariate logistic regression analyses were conducted to identify correlates associated with caregivers' probable depression and anxiety status.

Results Forty-four (22.4%) and 33 (16.9%) caregivers had probable depression and anxiety, respectively. Multivariate regression analyses revealed that caregivers' pre-existing mental disorder, greater COVID-19 stressor burden, and more

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severe emotional symptoms and insomnia of ADHD children were independently associated with both caregivers' depression and anxiety status.

Conclusion A significant proportion of caregivers of ADHD children experienced clinically-significant depressive and anxiety symptoms during the peak of fifth pandemic wave and school closure. Findings suggest that optimizing management of caregivers' pre-existing mental health conditions, addressing emotional and sleep symptoms in ADHD children, and implementing strategies to alleviate pandemic-related stressors may reduce caregivers' psychological distress.

Keywords ADHD, Caregivers, COVID-19, Depression, Anxiety, School closure

Introduction

The COVID-19 pandemic has a negative impact on the mental health of caregivers of children with neurodevelopmental disorders, including attention-deficit/hyperactivity disorder (ADHD) [1–3]. A recent meta-analysis by Gu et al. [1] revealed that 36.6% and 41.1% of caregivers of children with neurodevelopmental disorders reported anxiety and depression, respectively. Caregivers of children with ADHD may face unique stressors compared to caregivers of children with other developmental disabilities, necessitating a focused investigation into the mental health challenges they encountered during this challenging period. Due to pandemic-related social distancing and quarantine measures, the structured routines and support services that were previously vital in managing children's ADHD symptoms have become challenging [4, 5]. Children with ADHD may exhibit increased irritability, disruptive behavior, emotional distress, and insomnia during the pandemic [6–11], alongside a heightened risk of contracting SARS-CoV-2 [12–14]. These factors may have contributed to an increased prevalence of psychological distress among caregivers of ADHD children during the COVID-19 pandemic [15]. These factors suggest a potential rise in psychological distress among caregivers of children with ADHD during the COVID-19 crisis, underscoring the need for further empirical investigation in this area.

The psychological distress of caregivers can be examined using the family adjustment and adaptation responses (FAAR) model [16, 17], which suggests that psychological distress arises when the stressors and demands faced by the family surpass their current coping capacity. The exacerbation of ADHD symptoms, along with associated emotional and sleep problems, can be considered as one of the stressors and demands contributing to this distress during the pandemic [18–20]. Firstly, caregivers experience worries and concerns due to reduced compliance with infection control procedures (such as hand-washing and mask-wearing) in their children with ADHD, as hyperactivity, restlessness and opposition symptoms may disrupt the performance of these tasks [21]. Secondly, caregivers of children with ADHD may struggle with managing their children's discipline in the use of smartphones and the Internet [22], which became essential for remote learning during school closure [23]. Lastly, lockdowns and quarantines may disrupt sleep patterns and worsen sleep quality in children with ADHD, exacerbating their behavioral symptoms and emotional dysregulation [24]. Therefore, it is expected that the severity of ADHD symptoms and related emotional and sleep problems would be associated with caregivers' psychological distress.

The economic and geographical characteristics of a metropolitan area like Hong Kong, such as high living costs, long working hours, and limited living spaces, may have exacerbated psychological distress among caregivers of children with ADHD during the COVID-19 pandemic. Throughout 2021, Hong Kong reported fewer than 4,000 cases of COVID-19 [25]. However, with the emergence of the Omicron variant in the fifth wave of COVID-19 starting in January 2022, the 7-day rolling average of COVID-19-related deaths reached a peak of 3.73 per 100,000 people, the highest in the world [26, 27]. It was estimated that 60% of the population (4.4 million) was infected during the fifth wave [28]. In response to the surge in numbers of infections and deaths, the Hong Kong government announced a territory-wide school closure from March to April 2022, promoted working-from-home arrangements, and enforced stricter social distancing measures, including restrictions on gatherings of four people or more [29]. During this period, Hong Kong implemented the most stringent infection control measures since the pandemic outbreak, with the COVID-19 Stringency reaching the highest of 75 (out of 100) [30] since the outbreak of the pandemic. A local study by Chan and Fung [31], conducted in the initial phase of the pandemic in May 2020, found that 25.5% and 13.7% of caregivers of children with developmental disorders (including ADHD) experienced depression and anxiety, respectively. With the rapid escalation of the fifth wave of the pandemic, accompanied by extensive and stringent infection-control restrictions and school closure, this period offers a unique opportunity to investigate the pandemic- and child-related factors contributing to the increased depression and anxiety among caregivers of children with ADHD.

Therefore, the current study aimed to estimate the prevalence and examine the correlates of depression and anxiety in Chinese ADHD caregivers during the peak of the fifth wave of COVID-19 with school closure in Hong Kong. Previous studies have identified some correlates of psychological distress among caregivers of ADHD children during the pandemic [2, 3, 20, 31], including the severity of children's ADHD symptoms [20, 24, 32, 33], financial stress [3, 31, 33], and caregivers' coping strategies [20]. Extending from these studies, we comprehensively examined a wide array of potential correlates of caregivers' psychological distress, including psychiatric histories of caregivers [20, 33], COVID-19-related stressors [34] and children's psychopathological profiles [20, 31]. Following the FAAR model, we hypothesized that the psychopathological symptoms of the ADHD children would be associated with depression and anxiety of their caregivers, above and beyond caregivers' and children's demographics and COVID-19-related stressors.

Methods

Participants and settings

This cross-sectional study was conducted between 29 March and 14 April 2022, during the peak of fifth COVID-19 wave and school closure in Hong Kong. The Oxford Stringency Index [30] remained at the highest level of 75 (out of 100) throughout the data collection period. Caregivers of children aged 6–17 years with DSM-5 diagnosis of ADHD verified by medical record review, were recruited upon their follow-up appointment in the Child and Adolescent Psychiatric Outpatient Clinic at Queen Mary Hospital (a university-affiliated hospital) serving the Hong Kong West catchment area with approximately 550,000 habitants. A self-administered questionnaire was distributed to caregivers as study assessment. Caregivers of ADHD children who did not turn up the scheduled follow-up appointment were contacted via phone by research staff. An online-version questionnaire (same as the paper-version) was provided and administered on Qualtrics survey platform (https://www.qualtrics.com).

Survey participation was on a voluntary basis and informed consent (written informed consent for paper-version and online informed consent for online-version) was obtained before questionnaire assessment. The survey took around 20 min to complete. The study was performed in accordance with the Declaration of Helsinki, and was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW) (clinical trial number: not applicable).

Measures

Caregivers' basic demographic information, including gender, age, highest educational level attained, marital status, employment status, size of living space, medical morbidities of caregivers (including chronic physical diseases and mental disorders), vaccination status and history of COVID-19 infection were recorded.

Caregivers' psychological distress

Caregivers' severities of depressive and anxiety symptoms over the past two weeks were measured by Patient Health Questionnaire (PHQ-9) [35] and Generalized Anxiety Disorder Questionnaire (GAD-7) [36], respectively, on a 4-point Likert scale (0 [never] to 3 [nearly every day]. Previous studies demonstrated good psychometric properties of the Chinese versions of these two scales [37, 38].

COVID-19-related stressors

COVID-19-related stressors were assessed in eight areas (i.e., finance, work, physical health, mental health, food supply, medicine supply, family relationship, and interpersonal relationship). An 8-item checklist was developed due to the lack of existing measures assessing COVID-19-specific stressors for caregivers during the time of this study. This measure was constructed based on previous research on parental stressors in the early stages of the pandemic [e.g., 31, 39]. The items were designed and adopted according to a consensus among the research team, which included academics, clinical psychologists, and psychiatrists, in order to ensure the face validity of the checklist. Each item was rated on a 5-point Likert scale (0 [not stressful] to 4 [extremely stressful]). We dichotomized responses in each area (0–2 [not to moderately stressful] and 3–4 [severely to extremely stressful]). Internal consistency of the checklist is excellent ($\alpha = 0.90$). The total number of COVID-19-related stressors was then categorized into 0, 1–2, and 3 or more. each on a 5-point Likert scale (0 [not stressful] to 4 [extremely stressful]).

In addition, considering the significant impact of social distancing practices and school closures on caregivers' psychological distress during this period, we assessed caregivers' stress levels related to these infection-control measures using single-item measures. Each measure was rated on a 10-point Likert scale, ranging from 0 (not stressful) to 10 (extremely stressful).

Child-related factors

Information on the children's age, gender, siblings, length of psychiatric service (in years), receipt of ADHD medication, psychiatric comorbidity (including special learning disorders), vaccination status and history of COVID-19 infection was collected. The severity of the children's ADHD symptoms was assessed with the Chinese version

of the Strengths and Weaknesses of ADHD-Symptoms and Normal-Behaviours (SWAN) rating scale [40, 41]. The parents evaluated the children's ADHD symptoms on a bipolar scale (-3 to -1 [below average], 0 [normal], +1 to +3 [above average]) as compared to other children of similar age. The ADHD-inattentive and ADHD-hyperactivity/impulsivity symptom subscale scores were computed. A higher subscale score indicates greater symptom severity.

The children's internalizing and externalising symptoms were assessed using the Chinese version of the Strengths and Difficulties Questionnaire (SDQ) [42, 43]. In this study, we only used four of the five subscales on SDQ to assess conduct problems, emotional symptoms, peer relationship problems and pro-social behaviour (as hyperactivity symptoms were measured by SWAN), on a 3-point Likert scale (0 [not true], 1 [somewhat true], 2 [certainly true]). Previous studies demonstrated satisfactory psychometric properties of the Chinese version of SWAN and SDQ [43, 44]. A higher score indicates greater symptom severity, except for pro-social behaviour subscale on the SDQ, which was inversely scored. Sleep problem (insomnia) in the past two weeks of the ADHD children was rated by caregivers on a 5-point Likert scale, with the score being dichotomized into none-to-mild (0–2) and moderate-to-severe insomnia (3–5) for subsequent analysis.

Statistical analysis

ADHD caregivers were categorized into having probable depression (versus no depression) if they attained PHQ-9 score ≥ 10 [45]. Similarly, caregivers were classified as having probable anxiety (versus no anxiety) if they obtained GAD-7 score ≥ 10 [46]. Then, two sets of univariate binary logistic regression analyses were conducted, with the dependent variables being depression status (probable depression vs. no depression) and anxiety status (probable anxiety vs. no anxiety). Caregivers' demographics, COVID-19-related stressors, and child-related factors were included as independent variables in these analyses. Those variables that were found to be statistically significant in the preceding analyses were included in the multivariable logistic regression models to determine which variables were independently associated with caregivers' probable depression and anxiety status. All statistical analyses were performed using IBM SPSS Statistics 27.0, with a significance level set as $p < 0.05$.

Results

Characteristics of the sample

One hundred ninety-nine ADHD caregivers were recruited and completed the survey. One hundred sixty-six (83.4%) caregivers were female, 154 (77.4%) aged between 18 and 49, 171 (87.7%) were married, and 25 (12.8%) reported having a psychiatric disorder. The majority of ADHD children were male (146, 73.4%) and on ADHD medications (164, 82.4%) (Table 1). Their mean length of psychiatric service for the management of ADHD was 4.8 years (SD = 2.9). Fifty-eight (29.1%) and 36 (18.1%) children reported having special learning disorders and psychiatric comorbidity, respectively. Sixty (30.8%) caregivers and 58 (29.1%) ADHD children had a history of COVID-19 infection.

Prevalence and correlates of probable depression in caregivers

Results of univariate regression analyses for probable depression are summarized in Table 1. Forty-four ADHD caregivers (22.4%) had probable depression. Regarding caregivers' demographics, only a history of psychiatric disorder was significantly related to depression status. For COVID-19 related stressors, children's receipt of at least 2 vaccine doses was associated with a lower likelihood of probable depression, while the presence of COVID-19 related stressors and distress due to school closure was associated with a higher likelihood. For ADHD child-related factors, the inattentive and hyperactivity/impulsivity symptoms scores of SWAN, three SDQ symptom subscale scores (i.e., emotional symptoms, conduct problems and peer relationship problems), and insomnia were associated with depression status.

In the multivariable regression model (Table 2), caregivers' history of mental disorder, a moderate level of COVID-19 related stressors (1–2 stressors), children's emotional symptoms and insomnia were independently associated with caregivers' depression. Association between a higher level of COVID-19 related stressors (3 or more stressors) and caregiver depression approached significance ($p = 0.058$).

Prevalence and correlates of probable anxiety in caregivers

Results of univariate regression analyses for probable anxiety are presented in Table 3. Thirty-three caregivers (16.9%) had probable anxiety. For caregivers' demographics, chronic physical disease and psychiatric disorder were associated with anxiety. For COVID-19 stressors, distress due to social distancing and school closure measures, as well as COVID-19-related stressors, were significantly related to anxiety. Regarding child-related factors, children's psychiatric comorbidity, two symptom subscale scores of SWAN, the emotional symptoms and conduct problems subscale scores of the SDQ, and insomnia were associated with anxiety.

In the multivariable regression model (Table 4), Caregivers' history of mental disorder, COVID-19 related stressors (both moderate and high levels), children's emotional symptoms and insomnia were independently associated with anxiety.

Table 1 Univariate regression analysis on factors associated with probable depression in caregiver of children with ADHD

Variables	Total (*n* = 199)	Without depression [a] (*n* = 152)	With depression (*n* = 44)	OR (95% CI)	*p* value
Demographics of caregivers:					
Female gender	166 (83.4)	125 (82.2)	39 (88.6)	1.69 (0.61–4.67)	0.316
Age, years					
18–49	154 (77.4)	118 (77.6)	34 (77.3)	Reference	N/A
50 or above	45 (22.6)	34 (22.4)	10 (22.7)	1.02 (0.46–2.28)	0.960
Highest education					
Secondary or below	111 (55.8)	84 (55.3)	25 (56.8)	Reference	N/A
Tertiary or above	88 (44.2)	68 (44.7)	19 (43.2)	1.07 (0.54–2.10)	0.855
Marital status					
Married	171 (87.7)	134 (88.7)	37 (84.1)	0.67 (0.26–1.74)	0.411
Unmarried [b]	24 (12.3)	17 (11.3)	7 (15.7)	Reference	N/A
Employment status					
Working	120 (60.3)	91 (59.9)	28 (63.6)	Reference	N/A
Housemaker	69 (34.7)	53 (34.9)	14 (31.8)	0.86 (0.42–1.77)	0.680
Unemployed/retired	10 (5.0)	8 (5.3)	2 (4.5)	0.81 (0.16–4.05)	0.800
Living area					
Less than 500 sq. ft.	117 (58.8)	90 (59.2)	25 (59.5)	Reference	N/A
501 or more sq. ft.	80 (40.2)	62 (40.8)	17 (40.5)	0.99 (0.49–1.98)	0.971
Monthly household income < HK$25,000	75 (37.7)	57 (38.3)	17 (40.5)	1.10 (0.55–2.21)	0.794
Medical morbidities of caregivers					
Chronic physical disease	49 (25.0)	35 (23.2)	12 (28.6)	1.33 (0.62–2.86)	0.472
Mental disorder	25 (12.8)	12 (7.9)	12 (28.6)	4.63 (1.90–11.31)	< 0.001
History of COVID-19 infection (yes)	60 (30.8)	49 (32.5)	10 (23.8)	0.65 (0.30–1.43)	0.285
Vaccination status					
Non-vaccinated or 1 dose	16 (8.0)	11 (7.2)	24 (54.5)	Reference	N/A
2 doses or more	183 (92.0)	141 (92.8)	20 (45.5)	0.61 (0.20–1.86)	0.383
COVID-19-related stressors:					
Number of COVID-19-related stressors [c]					
0	103 (51.8)	92 (60.5)	9 (20.5)	Reference	N/A
1–2	45 (22.6)	29 (19.1)	16 (36.4)	5.64 (2.25–14.11)	< 0.001
3 or more	51 (25.6)	31 (20.4)	19 (43.2)	6.27 (2.57–15.28)	< 0.001
Distress due to social distancing measures	4.7 (3.2)	4.5 (3.2)	5.5 (3.5)	1.10 (0.98–1.23)	0.098
Distress due to school closure					
No or some difficulties	118 (59.3)	96 (63.2)	19 (43.2)	Reference	N/A
Many or a lot of difficulties	81 (40.7)	56 (36.8)	25 (56.8)	2.26 (1.14–4.46)	0.019
Child-related factors:					
Age, years					
6–11	108 (54.3)	84 (55.3)	23 (52.3)	Reference	N/A
12–17	91 (45.7)	68 (44.7)	21 (47.7)	1.13 (0.58–2.21)	0.726
Female gender	53 (26.6)	37 (24.3)	15 (34.1)	1.61 (0.78–3.32)	0.199
With siblings	142 (71.4)	105 (69.1)	34 (77.3)	1.52 (0.70–3.34)	0.294
Duration of psychiatric service, years	4.8 (2.9)	4.8 (3.0)	4.7 (2.5)	0.99 (0.88–1.12)	0.869
Receipt of ADHD medication	164 (82.4)	124 (81.6)	37 (86.0)	1.39 (0.54–3.62)	0.497
History of COVID-19 infection	58 (29.1)	47 (30.5)	9 (21.4)	0.61 (0.27–1.37)	0.609
Special learning disorders	58 (29.1)	42 (27.6)	15 (34.1)	1.36 (0.66–2.78)	0.407
Psychiatric comorbidities [d]	36 (18.1)	27 (17.8)	8 (18.2)	1.03 (0.43–2.46)	0.949
Vaccination status					
Non-vaccinated	39 (19.6)	25 (16.4)	14 (31.8)	Reference	N/A
1 dose or more	160 (80.4)	127 (83.6)	30 (68.2)	0.42 (0.20–0.91)	0.027
ADHD symptom severity (SWAN)					
Inattention	8.9 (7.7)	7.5 (7.4)	13.3 (6.8)	1.12 (1.06–1.19)	< 0.001
Hyperactivity/impulsivity	6.0 (8.8)	4.7 (8.6)	9.9 (8.3)	1.07 (1.03–1.12)	< 0.001

Table 1 (continued)

Variables	Total ($n=199$)	Without depression [a] ($n=152$)	With depression ($n=44$)	OR (95% CI)	p value
Internalizing and externalizing symptoms (SDQ)					
Emotional symptoms	3.1 (2.2)	2.7 (2.0)	4.4 (2.3)	1.45 (1.22–1.73)	< 0.001
Conduct problems	3.1 (1.4)	3.0 (1.4)	3.6 (1.4)	1.39 (1.08–1.78)	0.009
Peer relationship problems	4.6 (1.6)	4.4 (1.5)	5.0 (1.8)	1.27 (1.02–1.58)	0.034
Prosocial behaviour	6.2 (2.3)	6.3 (2.2)	6.0 (2.6)	0.95 (0.82–1.11)	0.536
Insomnia					
None or mild	166 (83.4)	138 (90.8)	27 (61.4)	Reference	N/A
Moderate to very severe	31 (15.6)	14 (9.2)	17 (38.6)	6.21 (2.74–14.08)	< 0.001

Note: CI = confidence interval; OR = odds ratio; SDQ = Strengths and Difficulties Questionnaire; SWAN = Strengths and Weaknesses of ADHD-Symptoms and Normal-Behaviors rating scale

[a] Probable depression was defined by a score ≥ 10 in Patient Health Questionnaire (PHQ)-9

[b] Unmarried included single, separated, divorced, or widowed

[c] COVID-19 stressors were measured in 8 areas: finance, work, physical health, mental health, food supply, medicine supply, family relationship, interpersonal relationship

[d] Comorbidities included psychiatric and developmental disorders such as autism spectrum disorder

Table 2 Multivariable logistic regression models of factors associated with probable depression in caregivers of children with ADHD

Variables	OR (95% CI)	p value
Demographics of caregivers:		
Medical morbidities of caregivers		
Mental disorder	5.34 (1.62–17.62)	0.006
COVID-19-related stressors:		
Child vaccination		
Non-vaccinated	Reference	N/A
1 dose or more	0.53 (0.19–1.48)	0.224
Caregiver stress due to school dismissal		
No or some difficulties	Reference	N/A
Many or a lot of difficulties	2.67 (0.99–7.19)	0.052
Child-related factors:		
Number of COVID-19-related stressors		
0	Reference	N/A
1–2	5.52 (1.67–18.24)	0.005
3 or more	3.31 (0.96–11.38)	0.058
ADHD symptom severity (SWAN)		
Inattention	1.05 (0.97–1.13)	0.223
Hyperactivity/impulsivity	1.04 (0.97–1.11)	0.307
Internalizing and externalizing symptoms (SDQ)		
Emotional symptoms	1.34 (1.06–1.70)	0.016
Conduct problems	0.98 (0.68–1.42)	0.928
Peer relationship problems	1.19 (0.89–1.59)	0.250
Insomnia		
None or mild	Reference	N/A
Moderate to very severe	8.84 (2.87–27.22)	< 0.001
Nagelkerke R^2	0.500	N/A
χ^2	40.2	< 0.001

Note: CI = confidence interval; OR = odds ratio

Discussion

This study aimed to examine the prevalence and correlates of probable depression and anxiety among Chinese ADHD caregivers under the peak of the fifth wave of COVID-19 accompanied by school closure in Hong Kong. Our results on the prevalence of probable depression (22.4%) and anxiety (16.9%) among ADHD caregivers during the pandemic are comparable to those reported in previous local and overseas studies on caregivers of children with developmental disorders in the earlier phases of the pandemic (e.g., Bobo et al. [20]: depression: 26.3%; Chan and Fung [31]: depression: 25.5%, anxiety: 13.7%). Our findings extended the literature by showing that COVID-19-related stressors and children's psychopathological symptoms were strongly associated with caregiver depression and anxiety, and to a lesser extent, caregiver demographic/medical morbidity profile when the most stringent infection-control measures were in force.

We observed that caregivers' pre-existing mental disorder was significantly associated with both depression and anxiety. This is largely consistent with previous research which revealed that history of psychiatric disorder was related to greater levels of psychological distress in the general population during COVID-19 [47, 48]. Their increased psychological distress may partly be attributable to their underlying mental disorder [49], as they may be more prone to symptom exacerbation in COVID-19 due to less effective coping strategies [48], and a reduced access to psychiatric care due to health policy restriction for infection control [50].

In line with previous studies, our findings demonstrated significant association between COVID-19 related stressors and depression and anxiety among ADHD caregivers [3]. While there was an increased incidence of psychiatric disorders in general population

Table 3 Univariate regression analysis on factors associated with probable anxiety in caregiver of children with ADHD

Variables	Total (*n* = 199)	Without anxiety [a] (*n* = 162)	With anxiety (*n* = 33)	OR (95% CI)	*p* value
Demographics of caregivers:					
Female gender	166 (83.4)	134 (82.7)	28 (84.8)	1.17 (0.42–3.29)	0.766
Age, years					
18–49	154 (77.4)	126 (77.8)	24 (72.7)	Reference	N/A
50 or above	45 (22.6)	36 (22.2)	9 (27.3)	1.31 (0.56–3.07)	0.531
Highest education					
Secondary or below	111 (55.8)	87 (53.7)	21 (63.6)	Reference	N/A
Tertiary or above	88 (44.2)	75 (46.3)	12 (36.4)	0.66 (0.31–1.44)	0.297
Marital status					
Married	171 (87.7)	141 (87.6)	30 (90.9)	1.42 (0.40–5.08)	0.591
Unmarried [b]	24 (12.3)	20 (12.4)	3 (9.1)	Reference	N/A
Employment status					
Working	120 (60.3)	96 (59.3)	23 (69.7)	Reference	N/A
Housemaker	69 (34.7)	57 (35.2)	9 (27.3)	0.66 (0.29–1.52)	0.329
Unemployed/retired	10 (5.0)	9 (5.6)	1 (3.0)	0.46 (0.06–3.85)	0.477
Living area					
Less than 500 sq. ft.	117 (58.8)	98 (60.5)	18 (54.5)	Reference	N/A
501 or more sq. ft.	80 (40.2)	64 (39.5)	15 (45.5)	1.28 (0.60–2.71)	0.526
Monthly household income < HK$25,000	75 (37.7)	61 (38.4)	13 (39.4)	1.04 (0.49–2.25)	0.912
Medical morbidities of caregivers					
Chronic physical disease	49 (25.0)	35 (21.7)	13 (39.4)	2.34 (1.06–5.17)	0.035
Mental disorder	25 (12.8)	14 (8.7)	10 (30.3)	4.57 (1.81–11.49)	0.001
History of COVID-19 infection	60 (30.8)	51 (31.7)	9 (27.3)	0.81 (0.35–1.86)	0.618
Vaccination status					
Non-vaccinated or 1 dose	16 (8.0)	14 (8.6)	2 (6.1)	Reference	N/A
2 doses or more	183 (92.0)	148 (91.4)	31 (93.9)	1.47 (0.32–6.78)	0.624
COVID-19-related stressors:					
Number of COVID-19 related stressors [c]					
0	103 (51.8)	96 (59.3)	4 (12.1)	Reference	N/A
1–2	45 (22.6)	33 (20.4)	12 (36.4)	8.73 (2.63–28.94)	< 0.001
3 or more	51 (25.6)	33 (20.4)	17 (51.5)	12.36 (3.88–39.39)	< 0.001
Distress due to social distancing measures	4.7 (3.2)	4.4 (3.2)	6.5 (2.8)	1.24 (1.09–1.42)	0.002
Distress due to school closure					
No or some difficulties	118 (59.3)	103 (63.6)	11 (33.3)	Reference	N/A
Many or a lot of difficulties	81 (40.7)	59 (36.4)	22 (66.7)	3.49 (1.58–7.70)	0.002
Child-related factors:					
Age, years					
6–11	108 (54.3)	88 (54.3)	19 (57.6)	Reference	N/A
12–17	91 (45.7)	74 (45.7)	14 (42.4)	0.88 (0.41–1.87)	0.732
Female gender	53 (26.6)	42 (25.9)	10 (30.3)	1.24 (0.55–2.82)	0.605
With siblings	142 (71.4)	111 (68.5)	28 (84.8)	2.57 (0.94–7.05)	0.066
Duration of psychiatric service, years	4.8 (2.9)	4.9 (3.0)	4.6 (2.3)	0.96 (0.84–1.11)	0.606
Receipt of ADHD medication	164 (82.4)	134 (82.7)	27 (81.8)	0.94 (0.36–2.49)	0.901
History of COVID-19 vaccination					
Special learning disorders	58 (29.1)	47 (29.0)	10 (30.3)	1.06 (0.47–2.41)	0.882
Psychiatric comorbidities [d]	36 (18.1)	24 (14.8)	10 (30.3)	2.50 (1.06–5.91)	0.037
History of COVID-19 infection	58 (29.1)	49 (30.2)	8 (24.2)	0.74 (0.31–1.75)	0.491
Vaccination status					
Non-vaccinated	39 (19.6)	31 (19.1)	8 (24.2)	Reference	N/A
1 dose or more	160 (80.4)	131 (80.9)	25 (75.8)	0.74 (0.31–1.80)	0.505
ADHD symptom severity (SWAN)					
Inattention	8.9 (7.7)	7.9 (7.5)	12.8 (7.2)	1.10 (1.04–1.16)	0.001

Table 3 (continued)

Variables	Total ($n=199$)	Without anxiety [a] ($n=162$)	With anxiety ($n=33$)	OR (95% CI)	*p* value
Hyperactivity/impulsivity	6.0 (8.8)	5.1 (8.4)	9.9 (9.8)	1.07 (1.02–1.12)	0.005
Internalizing and externalizing symptoms (SDQ)					
Emotional symptoms	3.1 (2.2)	2.7 (2.0)	4.7 (2.2)	1.55 (1.28–1.89)	< 0.001
Conduct problems	3.1 (1.4)	3.0 (1.4)	3.7 (1.3)	1.43 (1.09–1.88)	0.010
Peer relationship problems	4.6 (1.6)	4.5 (1.5)	5.0 (1.9)	1.24 (0.98–1.57)	0.080
Prosocial behaviour	6.2 (2.3)	6.3 (2.2)	5.7 (2.7)	0.88 (0.75–1.04)	0.140
Insomnia					
None or mild	166 (83.4)	143 (88.3)	22 (66.7)	Reference	N/A
Moderate to very severe	31 (15.6)	19 (11.7)	11 (33.3)	3.76 (1.58–8.96)	0.003

Note: CI = confidence interval; OR = odds ratio; SDQ = Strengths and Difficulties Questionnaire; SWAN = Strengths and Weaknesses of ADHD-Symptoms and Normal-Behaviors rating scale

[a] Probable anxiety was defined by a score ≥ 10 in General Anxiety Disorder Questionnaire (GAD)-7

[b] Unmarried included single, separated, divorced, or widowed

[c] COVID-19 stressors were measured in 8 areas: finance, work, physical health, mental health, food supply, medicine supply, family relationship, and interpersonal relationship

[d] Comorbidities included psychiatric and developmental disorders such as autism spectrum disorder

Table 4 Multivariable logistic regression models of factors associated with probable anxiety in caregivers of children with ADHD

Variables	OR (95% CI)	*p* value
Demographics of caregivers:		
Medical morbidities of caregivers		
Chronic physical disease	3.31 (0.91–12.01)	0.068
Mental disorder	7.12 (1.68–30.13)	0.008
COVID-19-related stressors:		
Number of COVID-19-related stressors		
0	Reference	N/A
1–2	11.02 (2.01–60.43)	0.006
3 or more	5.80 (1.04–32.37)	0.045
Distress due to social distancing measures	1.15 (0.95–1.38)	0.150
Distress due to school closure		
No or some difficulties	Reference	N/A
Many or a lot of difficulties	2.90 (0.79–10.72)	0.110
Child-related factors:		
Psychiatric comorbidities	1.50 (0.35–6.50)	0.591
ADHD symptom severity		
Inattention	1.03 (0.94–1.14)	0.518
Hyperactivity/impulsivity	1.03 (0.95–1.11)	0.478
Internalizing and externalizing symptoms (SDQ)		
Emotional symptoms	1.70 (1.22–2.36)	0.002
Conduct problems	0.97 (0.62–1.52)	0.906
Insomnia		
None or mild	Reference	N/A
Moderate to very severe	7.07 (1.68–29.81)	0.008
Nagelkerke R^2	0.588	N/A
χ^2	33.2	< 0.001

Note: CI = confidence interval; OR = odds ratio

during COVID-19 [51, 52], caregivers suffered additional COVID-19 stress rooted from financial burden to support the family [20] due to socio-economic ramifications of COVID-19 and its related public health policies [53]. Some caregivers worried about children contracting infection [31, 54] while some had to balance work with childrearing under work-from-home arrangement [55]. These disrupted caregivers' work engagement and social life, increasing cumulative caregiver stress.

As hypothesized, the psychopathological profile of ADHD children was found to be associated with caregivers' depression and anxiety, even after accounting for caregivers' and children's demographics and COVID-19-related stressors. Consistent with the FAAR model [16, 17], our findings underscore that children's psychopathological symptoms, particularly insomnia and emotional symptoms, can place additional strain on families during periods of heightened stress, such as when strict infection-control measures (including territory-wide school closures), are in effect, thereby contributing to caregivers' depression and anxiety.

Our result regarding insomnia aligns with findings from studies conducted before the pandemic [56]. While some recent studies have examined the relationship between caregivers' struggles in managing their children's sleep problems and their own psychological distress, they did not find a significant association [3, 24]. Factors such as home-schooling, poor sleep hygiene [57], and increased screen time [58] during COVID-19 have been shown to contribute to sleep disturbances in ADHD children [6, 59, 60]. The exacerbation of sleep issues, including insomnia, in ADHD children can lead to increased caregiver stress and psychological distress [61].

Consistent with previous research, we found that the severity of emotional symptoms in ADHD children was

positively correlated with caregivers' psychological distress during the pandemic [20, 24]. The lack of structure and daily routine resulting from school closures may heighten irritability and oppositionality in ADHD children [57]. Although our multivariable regression analyses did not reveal significant associations between ADHD core symptoms and caregiver depression and anxiety (albeit being statistically significant in univariate regression analyses), it is possible that other variables included in the final regression model, such as children's emotional and sleep symptoms, could fully mediate the relationship between ADHD core symptoms and caregiver psychological distress [62].

Our findings suggest several important clinical implications. Firstly, as pre-existing psychiatric disorders in caregivers of children with ADHD may increase the risk of psychological distress during the pandemic, it is essential to conduct active screening to identify any undiagnosed psychiatric conditions for proper treatment. Optimizing symptom control of caregivers' psychiatric disorders is also important. Secondly, caregivers of children with ADHD should be educated on personalized coping strategies, such as developing resilience and acceptance-based coping mechanisms, to address COVID-19-related stressors [63]. Thirdly, our findings indicate that targeting ADHD children's insomnia and emotional symptoms could help reduce the risk of depression and anxiety in caregivers during the COVID-19 pandemic and school closures. Therefore, it is recommended to systematically assess sleep disturbances and emotional symptoms alongside managing ADHD core symptoms to enable early detection and prompt interventions. This may involve providing psychoeducation and establishing healthy sleep routines [64] to effectively address ADHD children's insomnia and emotional symptoms.

The study has several limitations. First, the cross-sectional survey design precludes us from drawing conclusions about causality among study variables. Prospective follow-up with reassessment of this study cohort after the peak of fifth COVID-19 wave with school resumption would enable us to track the trajectories of depressive and anxiety symptoms of ADHD caregivers over time, and their longitudinal associations with pandemic fluctuations as well as other relevant variables. Second, this study did not have a control group of parents with neurotypical children for comparison with caregivers of ADHD children in differential psychological distress. Third, we used a self-developed COVID-19-related stressors measure to capture caregivers' stressors during the pandemic. Although the face validity and internal consistency were achieved, the psychometric properties of this measure warrant further investigation. Lastly, the presence and severity of ADHD and other psychiatric symptoms were based solely on caregivers' ratings, without taking into consideration of other sources of information including teachers' reports and clinical interview from children. Although parental/caregivers' rated assessment is a common approach in evaluating ADHD children's symptoms, caregivers' psychological distress may however introduce negative perception towards children's mental state, resulting in potential bias in overestimating their symptom severity and behavioural problems.

Our findings indicate that approximately one-fifths and one-sixths of ADHD caregivers experienced probable depression and anxiety, respectively, amidst the peak of fifth COVID-19 wave with school closure in Hong Kong. Pre-existing mental disorder, greater burden of COVID-19 related stressors, ADHD children's emotional symptoms and insomnia were significantly associated with caregivers' depression and anxiety status. Longitudinal investigation is warranted to examine trajectories of psychological distress and its correlates among caregivers of ADHD children spanning the pandemic and post-pandemic era. Further research should also evaluate the effectiveness of psychosocial interventions to support caregivers and their ADHD children, especially stress coping strategies, as well as children's sleep and emotional symptom management.

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Author contributions
W.C.C., C.S.M.W. and Z.H.S.Y. designed and conceptualized the study. G.H.S.W. and J.H.C.L. prepared questionnaire assessment. S.C.H. and J.H.C.L. conducted statistical analysis, and S.C.H. wrote the first draft of the manuscript. S.C.H., W.C.C., P.W.L.L. and A.K.C.C. interpreted the study data. W.C.C., A.K.C.C., E.T.H.L. and S.C.H. revised and finalized the manuscript. B.M.H.L., P.W.L.L., G.H.K.C. and Z.H.S.Y. provided expert recommendations to the manuscript revision. All authors provided critical feedback and have approved the final manuscript.

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Data availability
No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
The study was performed in accordance with the Declaration of Helsinki, and was approved by Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW) and all participants provided written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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