ADHD symptoms in relation to depressive and sleep-related symptoms among university students during the COVID-19 outbreak in Japan

Toshinobu Takeda (toshinobu_takeda@yahoo.co.jp)
Ryukoku University: Ryukoku Daigaku https://orcid.org/0000-0002-6905-5013
Yui Tsuji
Sapporo Gakuin University: Sapporo Gakuin Daigaku
Reiko Akatsu
Ryukoku Daigaku - Fukakusa Campus: Ryukoku Daigaku
Tatsuya Nomura
Ryukoku Daigaku - Fukakusa Campus: Ryukoku Daigaku

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ADHD symptoms in relation to depressive and sleep-related symptoms among university students during the COVID-19 outbreak in Japan

Running title: ADHD among undergraduates during the pandemic

Toshinobu Takeda, MD, PhD [1]; Yui Tsuji, MA[2,3]; Reiko Akatsu, PhD [1]; Tatsuya Nomura, PhD [4]

1. Department of Clinical Psychology, Ryukoku University, Kyoto, Japan

2. Sapporo Gakuin University, Hokkaido, Japan

3. Graduate School of Psychological Science, Health Sciences University of Hokkaido, Hokkaido, Japan

4. Department of Media Informatics, Ryukoku University

Corresponding Author:

Toshinobu Takeda, MD, PhD

Ryukoku University

t-tak@umin.ac.jp

Postal Code: 600-8268

Address: 125-1 Daiku-cho Shimogyo-ku, Kyoto, Japan

TEL: +81-75-343-3311

FAX: +81-75-343-4302

Abstract

Background: The COVID-19 pandemic and its associated societal response are anticipated to have wide-ranging effects on youth development and mental health. The three most common mental health problems among university students are depression, anxiety, and attention-deficit hyperactivity disorder (ADHD). Many factors that can threaten the mental health during the outbreak affect these three conditions as well as the sleep conditions of the undergraduate students. Thus, determining how these abrupt changes in students' circumstances will impact their mental health is very important from a public health perspective.

Objective: We investigated both usual conditions and changes during the outbreak in sleep, depression, and ADHD symptoms among undergraduate students.

Methods: A total of 252 students, primarily juniors answered the online survey.

Results: As a result, 12% of the students exceeded the cutoff score of the ADHD questionnaire before the pandemic and approximately 6-21 % of the students especially with ADHD traits rated their ADHD behaviors as worse during the outbreak. Additionally, changes in circadian rhythm, depression, and ADHD symptoms are intertwined and often create a vicious cycle.

Conclusion: This study suggested that students with ADHD-trait is more susceptible to further deterioration in their daily lives during the pandemic. In case it is difficult to intervene with ADHD symptoms, approaching circadian rhythm or depression will be of clinical use.

Keywords: ADHD; depression; sleep; students; COVID-19

Background

The novel coronavirus disease 2019 (COVID-19) pandemic has quickly spread across the globe from Wuhan, China since late 2019 [1]. Prior to the declaration of the COVID-19 outbreak as a pandemic by the World Health Organization (WHO) on March 11, the Japanese government "requested" local governments to shut down elementary and junior and senior high schools throughout the country on February 27, 2020. Other educational facilities such as colleges and universities soon followed suit.

On April 7, the government declared a state of emergency in Japan and "requested" that the entire nation stay at home except when leaving to perform essential tasks. The government completely rescinded the state of emergency on May 26. Colleges and universities in Japan largely switched from in-person teaching to remote learning thereafter, and students were not allowed to enter campuses without legitimate reasons from the beginning of the first semester, which started in April.

The COVID-19 pandemic and its associated societal response are anticipated to have wide-ranging effects on youth development and mental health [2]. There are numerous factors supporting this prediction. Fear of illness causes people to become anxious and experience depressive symptoms. Social distancing interventions force people to restrict direct human contact, and most activities such as extracurricular activities, socialization with peers, exercise, and physical activities are also restricted, which may result in a state of isolation. Staying home for a long period of time is likely to lead to a sedentary lifestyle and reduced exposure to sunlight, which is imperative for a consistent sleep routine [3]. A sedentary lifestyle also increases the time spent gaming on the internet [4], which directly affects sleep onset and exposes students to blue light for a prolonged time. Students may struggle with establishing a new structure and routine to adapt to a new way

of life. This is a particularly tough task for students who live alone. Conversely, students living with their families who need to stay home almost 24/7 might face a difficult time if they are not in good terms with their parents [5].

Depression, anxiety, and attention deficit hyperactivity disorder (ADHD) are the three most common mental health problems among university students [6]. All the above-mentioned factors that can threaten mental health among undergraduates affect these three conditions and the sleep conditions of the students. Sleep, depression, and ADHD symptoms are intertwined with one another and often create a vicious cycle. Thus, determining how these abrupt changes in students' circumstances will impact their mental health is very important from a public health perspective. So far, there is scarce research in effect of the COVID-19 pandemic on ADHD. This study investigates changes in symptoms of ADHD symptoms in relation to depressive and sleep-related symptoms among undergraduate students during the pandemic.

Methods

A total of 252 students, primarily sophomores and juniors belonging to the faculty of literature, economics, law, or technology, responded to this survey in early August 2020. The mean students' age was 19.89 (SD = 1.99), and there were 93 males and 156 females (N/A 3). This study was approved by the ethical committee of Ryukoku University. Informed consent was obtained from all students.

The following information was collected for this study: (1) ADHD symptoms in their normal state, as measured by the Adult ADHD Self-Report Scale – Japanese Version (ASRS-J) [7, 8]; (2) depressive symptoms in their normal state, as evaluated by the new mood inventory [9]; (3) degree of change in circadian rhythm and sleep duration during

the pandemic, as evaluated on seven-point Likert scales (1 = no change, 7 = major change; and 0 = 3-hour sleep deprivation, 3 = no change, 6 = 3-hour increase in sleep, respectively); and (4) general quality of life (QoL) during the pandemic, as evaluated on a 10-point Likert scale (0 = worst, 10 = best).

For (1) and (2), following a precedent example, the participants were asked to rate their relevant symptoms during the outbreak compared with their normal state on a scale of 1 to 4 (1 = improved, 2 = not different, 3 = a little worse, and 4 = much worse) [10]. The mean changes in total ADHD symptoms, inattention, and hyperactivity-impulsivity were calculated by the sum of changes in 18, 9, and 9 ADHD symptoms per 18, 9, and 9, respectively (ranging from 1 to 4). The degree of change for the mean change in the total ADHD symptoms, inattention, and hyperactivity-impulsivity was judged by the criterion such as 1-1.75, improved; 1.75-2.5, not different; 2.5-3.25, a little worse; and 3.25-4, much worse. A mean change in depression symptoms was likewise calculated and categorized.

To investigate whether there were significant changes in depression, ADHD, sleep, and QoL during the COVID-19 outbreak, the students' responses were analyzed by a one-sample *t*-test. Pearson's correlation coefficients between depression, ADHD, circadian rhythm, sleep duration, and QoL were calculated by correlation analysis. Furthermore, students were divided into two groups, the ADHD-trait and the non-ADHD groups according to the cut-off score of the ASRS-J. Then, chi-square test was administered to probe if any significant difference exists in the rate of the degree of change in ADHD symptoms between the ADHD and non-ADHD groups. In case any significant difference exists through the administration of the chi-square test, a residual analysis was performed to detect which cells contribute to the significance. The residual analysis calculated the

adjusted

Results

The mean scores of each questionnaire assessing the changes in depression; ADHD total, inattention, and hyperactivity-impulsivity of ADHD; circadian rhythm; sleep duration; and QoL during the pandemic were 2.35 (0.64), 2.12 (0.25), 2.15 (0.32), 2.09 (0.25), 2.70 (1.23), 3.97 (1.67), and 4.82 (2.58), (the scores indicating "no change" were 2, 2, 2, 2, 3, 3 and 5, respectively) and the *t*-scores (*p* value) for one-sample *t*-test were 8.64 ($p < .001$), 6.78 ($p < .001$), 6.66 ($p < .001$), 5.17 ($p < .001$), 3.83 ($p < .001$), 9.25 ($p < .001$) and 1.12 ($p = 0.26$), respectively. The change in each ADHD symptom and the results of one-sample *t*-test for it are shown in Table 2. The correlations between the scores for depression, ADHD total, sleep, and QoL are indicated in Table 3.

The changes in depression, total ADHD, inattention, and hyperactivity-impulsivity according to the aforementioned classification criteria were shown in Figure 1.

Thirty students (11.90 %) exceeded the ASRS-J cutoff score. There was significant difference in the change of (total) ADHD symptoms between the ADHD (2.30 ± 0.27) and the non-ADHD groups (2.10 ± 0.24) during the outbreak ($t = 4.23$, $p < 0.001$). As for the degree of ADHD symptom change, the ADHD and the non-ADHD groups showed changes of 0% and 3% (improved), 79% and 91 % (not different), and 21% and 6 % (a little worse) during the pandemic. Chi-square analysis for this cross-tabulation reached a significant level ($p = 0.012$), and further residual analyses revealed the "no difference" and "a little worse" ASRS-J response in the control group were 2.0 and -2.9, respectively. On the other hand, they were -2.0 and 2.9 in the ADHD group. These findings mean that the ADHD group has a significantly higher ratio of "a little worse" response and lower

ratio of “no difference” response than the control group does.

[Insert Table 1, 2 & 3 and Figure 1 & 2 around here]

Discussion

This is the first study to investigate the changes in ADHD symptoms, in relation to depression and sleep-related symptoms among university students during the outbreak in Japan. As expected, some of the university students experienced greater mental health difficulties in the emergency state than in normal circumstances, although there were a wide variety of diverse reactions in response to the outbreak. Additionally, depression, ADHD, sleep, and QoL were shown to negatively affect one another.

It is natural for people to become anxious or depressed during emergent situations such as an epidemic [11]; however, this is a particular problem in students who are already in a vulnerable mental state, and such students may reach clinical levels of anxiety or depression. A large online survey of 44,447 college students revealed that the prevalence of depression symptoms during COVID-19 was 12.2% [12]. The current study cannot estimate the prevalence of depression during the pandemic; however, one-third of the students who reported negative changes in mental health would be candidates for interventions.

Time spent in undergraduate studies is characterized by the specific period between adolescence and adulthood when students are expected to be independent and engage in self-management, such as controlling their own activities (academic, social, economic, interpersonal), which demands executive function. Furthermore, academic activities in colleges or universities are less structured than during childhood [13]. During the emergent pandemic, such activities became even less structured. Thus, even students with typical development may experience difficulties in accomplishing things until they

establish a new routine. Studies on children with ADHD in both China and France revealed that approximately one-third to one-half of children displayed worse ADHD symptoms [10, 14]. Our study indicated that approximately 6 to 21 % of students rated their ADHD behaviors (i.e., inattention or hyperactivity-impulsivity) as worse during the outbreak. This percentage is an unexpected number considering the abrupt change in their circumstances; however, this turmoil would continue to lead to deteriorations in the academic and daily life of around 10% of students. The possibility that a certain proportion of students with ADHD traits experienced even tougher times in adapting to new routines and getting things done during this fluctuating situation is an alarming but expected finding. This study confirmed that students with ADHD traits were more susceptible to further deterioration in their daily lives during the COVID-19 pandemic. These students are strong candidates for any mental health interventions.

In terms of individual ADHD symptoms, eight out of nine inattentive symptoms changed significantly during the pandemic. By contrast. only four out of nine hyperactive-impulsive symptoms did. The only inattentive symptom that did not reach statistical significance was “lose things.” This result likely resulted from decreased opportunities to go out during the self-lockdown period. Among the other eight inattentive symptoms, three symptoms, namely,” “difficulty keeping attention,” “avoids efforts,” and “easily distracted,” almost reached medium effect size (i.e., $d = 0.5$). These symptoms possibly resulted from numerous distractions at home (e.g., the presence of family members, video games) during the self-lockdown which encouraged people to stay at home. Among the four hyperactive-impulsive symptoms, two symptoms, namely “fidgeting” and “feels restless,” almost reached a medium effect size. These symptoms might result from the restraint situation during the pandemic. In addition, these two symptoms potentially

negatively affected inattention symptoms. Acute and/or chronic physical activity might mitigate ADHD symptoms and is also good for general health [15].

The prevalence of poor sleep quality among students was originally very high, particularly in Japan. In our study, students reported a longer duration of sleep and moderate or major changes in their circadian rhythm during the outbreak. These findings are consistent with those in a study of nursing students [16], which may reflect longer free time by saving time to commute to universities. Longer sleep may have a positive effect on students' mental health, considering the consistent lack of sleep in the normal state. However, the disruption in the circadian rhythm will negatively affect students' mental health and academic performance in the long run.

Many papers exist on the relationship between ADHD and sleep problems (see Hvolby for review) [17]. Individuals with ADHD have a higher risk of suffering from sleep disruption by hyperfocusing on entertainment such as video gaming [18]. Higuchi et al. (2020) indicated that the social restrictions during the COVID-19 pandemic negatively affected internet use and gaming behavior among treatment seekers in Japan [4]. Furthermore, ADHD is often comorbid with internalizing disorders including depression and anxiety [6]. Thus, these three conditions may negatively affect one another, which was confirmed in this study. In our study, ADHD, depression, and circadian rhythm have significant and mild to moderate correlation one another.

Among the discussed conditions, sleep problems are the most convenient and easiest for which to perform interventions. Healthy sleep practices include the following: a regular sleep/wake schedule; adequate opportunity for sleep; calming and structured bedtime routines; avoidance of caffeine, large amounts of liquids, naps, exercise, and alerting activities (e.g., use of electronic devices) soon before bedtime; sleeping only in

bed and using the bed only for sleeping; and attention to environmental factors such as bedroom furniture, lighting, and temperature [19]. Thus, implementing healthy sleep practices is the recommended first-line option for addressing problems during the outbreak, which may also enhance immune health.

A relatively strong relationship exists between depression and ADHD. Treating depression is another option for the intervention of ADHD symptoms, given that only practitioners specialized in developmental disorders can manage the mental crisis of students with ADHD. However, starting ADHD medication during the outbreak is risky in this emergent situation [20].

There are some limitations of this study. Firstly, due to potential selection biases and the small number of participants, the results of our study may not be generalizable to all university students. Additionally, this study employed a retrospective design for the emergent situation. All the data were collected through online questionnaires, and the reliability and validity of the online version of the questionnaires has not yet been evaluated. Furthermore, the questionnaires to probe changes in ADHD and depressive symptoms are not validated as well. Finally, correlation does not necessarily imply causation. Effects can be in either direction, bi-direction, or due to a third variable.

This study focused on the negative aspects of mental health among university students; however, the fact that approximately up to 10 % of students endorsed positive answers in depression or ADHD domain, and students sleep longer on average than usual during the outbreak possibly because this emergent period gives students a respite from social jetlag, albeit only temporarily, is notable [21].

Conclusion

This is the first study to investigate the changes in ADHD symptoms in relation to

depression, sleep duration, circadian rhythm, and QoL among university students during the COVID-19 outbreak in Japan. As expected, some of the university students experienced greater mental health difficulties in the emergency state than in normal circumstances, although there were a wide variety of diverse reactions in response to the outbreak. Additionally, depression, ADHD, sleep, and QoL were shown to negatively affect one another. Our study also indicated that approximately 6 to 21 % of students rated their ADHD behaviors (i.e., inattention or hyperactivity-impulsivity) as worse during the outbreak. A possibility that a certain portion of students who originally have ADHD traits were experiencing even tougher times in adapting to new routines and getting things done during this fluctuating situation is an alarming but expected finding. They can be strong candidates for any mental health intervention. In case it is difficult to intervene with ADHD symptoms, approaching circadian rhythm or depression will be of clinical use.

Abbreviations

ADHD: attention-deficit hyperactivity disorder; ASRS-J: the Adult ADHD Self-Report Scale – Japanese Version; QoL: quality of life.

Authors' contributions

The corresponding author, TT, was responsible for data collection and drafting the first manuscript. YT analyzed and interpreted the data in collaboration with TT. All co-authors (RA and TN) made substantial contributions to critical revision of the first draft for key intellectual content and have given their final approval for the version to be published. All authors read and approved the final manuscript.

Author details

[1] Department of Clinical Psychology, Ryukoku University, Kyoto, Japan. [2] Sapporo Gakuin University, Hokkaido, Japan. [3] Graduate School of Psychological Science, Health Sciences University of Hokkaido, Hokkaido, Japan. [4] Department of Media Informatics, Ryukoku University.

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Competing interests

The authors declare that they have no competing interests.

Availability of data and materials

The datasets used and/or analyzed during the study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Ethics approval and consent to participate

This study was approved by the ethical committee of Ryukoku University. Informed consent was obtained from all students.

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Table 1. Reported change in comparison to normal state

	change	*SD*	*t*-score
depression	2.35	0.64	8.64 **
ADHD total	2.12	0.25	6.78**
inattention	2.15	0.32	6.66**
hyperacrivity-impulsivity	2.09	0.25	5.17**
circadian rhythm	2.70	1.23	3.83**
sleep duration	3.97	1.67	9.25**
QoL	4.82	2.58	1.12

Note: change was calcurated by sum of symptom scores per 8 and 18 for depression and ADHD, respectively. One sample *t*-test was administered to investigate if there is significant chage between the two points, i.e., before and during the pandemic . The scores indicating “no change” for seven variables were 2, 2, 2, 2, 3, 3 and 5, respectively. ** $p < .001$

Table 2. Reported change for each ADHD symptom in comparison to normal state

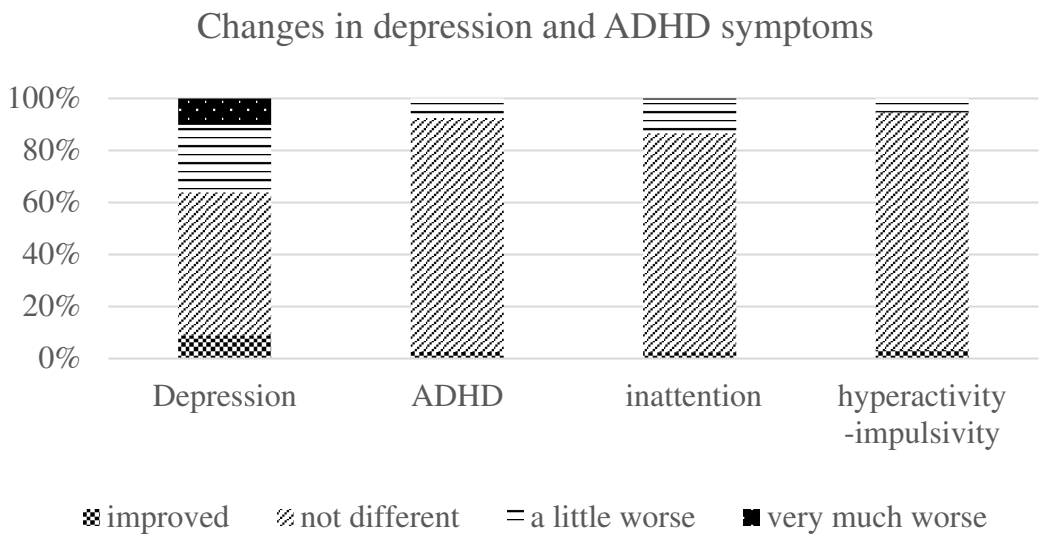
	change	*SD*	*t*-score	Cohen's *d*
1. Careless mistakes	2.09	0.48	3.47*	0.23
2. Fidgeting	2.27	0.59	7.17**	0.46
3. Difficulty keeping attention	2.31	0.64	7.64**	0.48
4. Leaves seat	2.10	0.40	3.92**	0.25
5. Does not listen	2.07	0.47	2.31*	0.15
6. Feels restless	2.24	0.55	6.89**	0.43
7. Does not follow through	2.13	0.48	4.20**	0.27
8. Diificulkty relaxing	2.06	0.64	1.38	0.09
9. Difficulty organizing	2.10	0.58	2.62*	0.17
10. On the go	2.13	0.57	3.57**	0.23
11. Avoids effort	2.37	0.76	7.72**	0.49
12. Talks excessively	2.01	0.42	0.30	0.02
13. Loses things	2.02	0.45	0.70	0.04
14. Rules conversation one-sidedly	1.99	0.37	0.52	0.03
15. Easily distracted	2.25	0.57	6.80**	0.43
16. Diificulty waiting turn	2.00	0.22	0.00	0.00
17. Forgetful	2.06	0.47	2.04*	0.13
18. Interrupts others	2.01	0.26	0.73	0.04

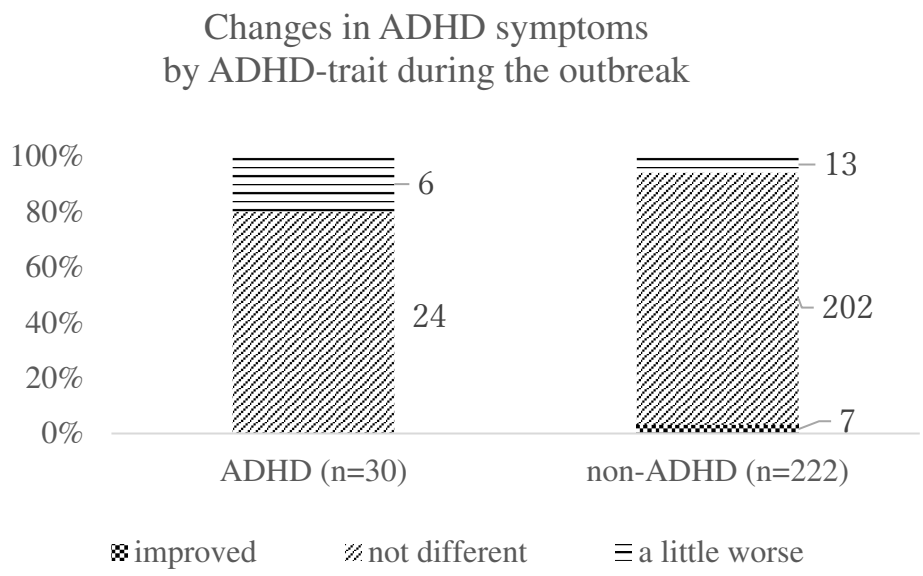
Note: One sample *t*-test was administered to investigate if there is significant chage between the two points, i.e., before and during the pandemic . The score indicating “no change” for each 18 variable was 2.
* $p < .05$, ** $p < .001$

Table 3. Correlations between changes from normal state in relevant variables

	ADHD	circadian rhythm	sleep duration	QoL
depression	0.43 **	0.17 **	-0.04 *n.s.*	-0.44 **
ADHD	—	0.28 **	-0.08 *n.s.*	-0.32 **
circadian rhythm	—	—	-0.04 *n.s.*	-0.21 **
sleep duration	—	—	—	0.11 *n.s.*

Note: Peason's correlation coefficients. * $p < 0.05$, ** $p < 0.01$


Changes in depression and ADHD symptoms
100%
80%
60%
40%
20%
0%
Depression
ADHD
inattention
hyperactivity -impulsivity
improved
not different
a little worse
very much worse


Changes in ADHD symptoms
by ADHD-trait during the outbreak
100%
80%
60%
40%
20%
0%
6
24
13
202
7
ADHD (n=30)
non-ADHD (n=222)
improved
not different
a little worse

Figures

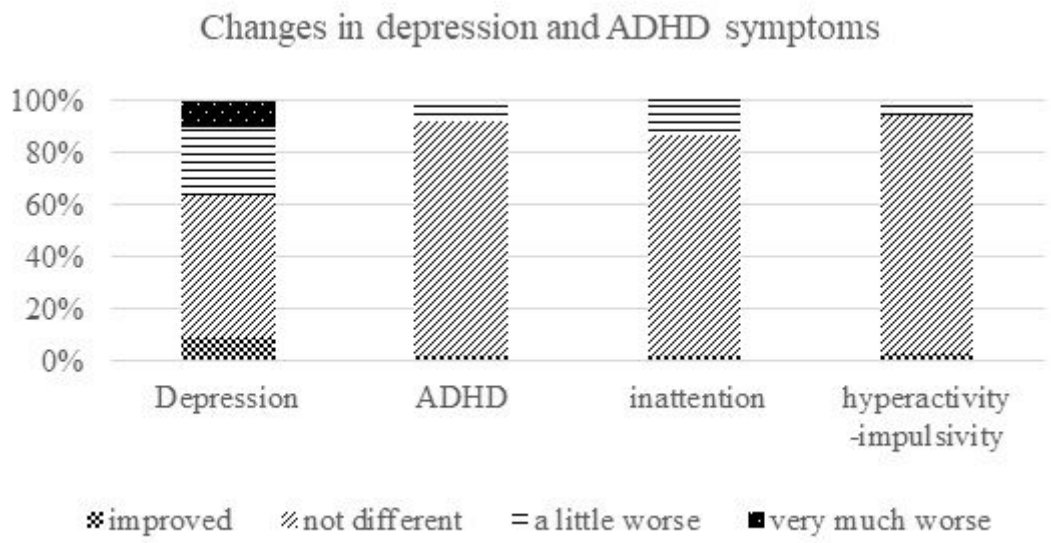


Figure 1

Changes in depression and ADHD symptoms

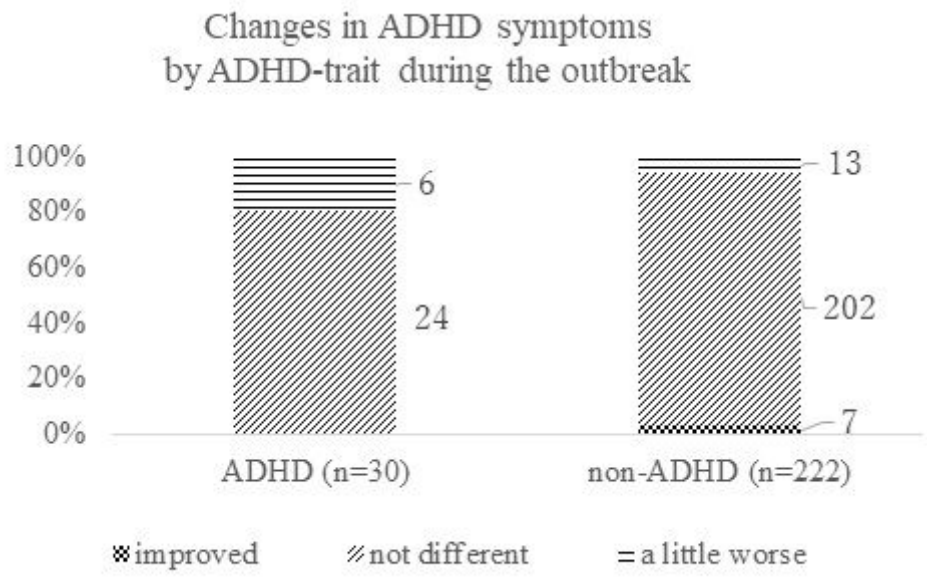


Figure 2

Changes in ADHD symptoms by ADHD-trait during the outbreak