The impact of mask-wearing influenced by restricted interest and repetitive behavior on the mental distress of individuals with autism spectrum disorder during the COVID-19 pandemic: a multisite survey

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Research Article

Keywords: Asperger's, autism spectrum disorder, COVID-19 pandemic, CoRonavIruS Health Impact Survey (CRISIS), mask-wearing, restricted interest and repetitive behavior (RRB)

Posted Date: April 26th, 2022

DOI: https://doi.org/10.21203/rs.3.rs-1552588/v1

Abstract

Background

The coronavirus disease of 2019 pandemic has caused considerable changes in daily life. For children with autism spectrum disorder, adapting to the “new normal,” including mask-wearing, may be difficult because of their restricted interest and repetitive behaviors symptoms. We aimed to examine the relationships between restricted interest and repetitive behaviors symptoms and the impact of mask-wearing on their social communications during the pandemic.

Methods

We recruited 102 children with autism spectrum disorder and collected data on sleep and exercise and the restricted interest and repetitive behaviors symptom frequency before and during the pandemic using an international questionnaire. Then, we conducted factor analyses to compute the restricted interest and repetitive behaviors severity composite scores, which are divided into lower-, such as sensory seeking, and higher-order, such as restricted interest. We also asked about the mask-wearing culture using a bespoke questionnaire. Using Spearman’s rank correlation analyses, we examined the relationships between the before pandemic restricted interest and repetitive behaviors symptoms and the impact of mask-wearing on their social communications during the pandemic.

Results

The current participants spent significantly less time outdoors during the pandemic than before (rho = 0.75, p = 0.005). We also revealed children who exhibited lower-order restricted interest and repetitive behaviors before the pandemic had more challenges with mask-wearing. Mask-wearing was associated with an uncomfortable sensation (rho=-0.34, p = 0.0004) and difficulty in referring to others’ emotions while wearing masks (rho=-0.30, p = 0.0002). We also found an association between higher-order restricted interest and repetitive behaviors and an uncomfortable sensation (rho=-0.42, p = 0.00001).

Conclusions

These symptoms could be an important predictor for children with autism to adapt to the new normal.

Introduction

Since its emergence, the COVID-19 pandemic has disrupted every aspect of daily life. To minimize the spread of the COVID-19 virus, governments worldwide declared a state of emergency and mandated or recommended (depending on each country’s legal system) people to maintain social distance, wear masks, and stay home [1, 2]. The rapid transformation of society into the new normal has caused a tremendous degree of stress for many people and has resulted in significant psychosocial impacts, including increased rates of depression and suicide in the general population [3, 4].

Autism spectrum disorder (ASD) is a developmental disorder, of which the prevalence is approximately 2.3% of the general population [5]. Its core symptoms are deficits in social communication, and restricted interest and repetitive behavior (RRB), including sensory symptoms and cognitive rigidity. Sensory symptoms can be both hyper- and hyposensitivity of the five senses and are present in a certain proportion of individuals with ASD [6]. Cognitive rigidity refers to the inability to adapt to changes or new environments. No established effective pharmacological intervention for these core ASD symptoms is available. Thus, one of the recommended approaches to mitigate RRBs in ASD at this time is to provide a stable environment, such as establishing routines, that is suitable for individuals with ASD [7]. However, under isolation, sticking with the routines is not always possible. Thus, the rapid transformation toward the new normal would have been particularly difficult for individuals with ASD [8].

Mask-wearing may impair social cognition [9]. Because impairment of social cognition is one of the core ASD symptoms, mask wearing would worsen the deficit. Besides, because the sensory symptoms include tactile hyper-sensitivity, wearing masks would be particularly uncomfortable for individuals with ASD. Despite such a close link between mask-wearing and the core ASD symptoms, no study has focused on the impact of mask-wearing on individuals with ASD during the pandemic.

In this context, we examined the relationships between RRB symptoms and mask-wearing as well as mask-wearing and social cognition using an internationally developed questionnaire designed for ASD. Because this is an observational study using questionnaires, observational bias is problematic. Thus, we focused on children and adolescents, instead of adults, with ASD. This is because we expect their caregivers to objectively observe kids with ASD. In addition, we assumed that children and adolescents with ASD have difficulty in sticking with routines under the pandemic because their classes were closed and school events were canceled.

Methods

Participants

We recruited participants from the outpatient clinics of Showa University and the National Center for Child Health and Development, Tokyo, Japan. These institutes are located in the western part of Tokyo. We contacted all clients with a clinical diagnosis of ASD based on the DSM-5 diagnostic criteria who visited one of these institutes from November 2020 to March 2021. As a result, we collected data from 102 children with ASD. During the data collection period, the pandemic was overwhelming, and Tokyo was under a state of emergency. Participants received a maximum of ¥1,000 gratuity for completing questionnaires.

Among the 102 participants, 75 participants (73.5%) were male (Table 1). The mean ages of the participants and caregivers were 11.6 (standard deviation [SD] = 5.3) and 45.7 (SD = 6.2) years, respectively. Most of the caregivers were mothers (n = 92, 90.2%) or fathers (n = 7, 6.9%) of children with ASD, while three did not indicate their relationship with the participants. The psychiatric and neurological comorbidities included attention-deficit/hyperactivity disorder (n = 28), learning disorder (n = 5), epilepsy (n = 8), and intellectual disabilities (n = 22). On the basis of the low per capita patients who contracted COVID-19 in Japan, only two participants had a family member diagnosed with COVID-19 whereas 99 participants did not have any member diagnosed with COVID-19 (one participant did not answer). One person had contact with a person with symptoms potentially related to COVID-19, whereas the rest had no contact with anyone who had symptoms or diagnosis of COVID-19.

Questionnaires

We used the **C**o**R**onav**I**ru**S** Health **I**mpact **S**urvey (**CRISIS**) – **A**dapted for **A**utism and **R**elated Neurodevelopmental conditions **(AFAR)** [10]. This questionnaire, which is openly available online (http://www.crisissurvey.org/crisis-afar/), assesses daily life behaviors, others clinically relevant to autism including RRB, as well as service changes occurring during the pandemic, and COVID-19 worries. The survey has three versions depending on the participant's age and reporters, such as a caregiver-report form for children and adolescents (3–21 years old), a self-report form for youth and adults (14 years and older), and a caregiver-report form for adults with ASD. In the present study, we used the caregiver-report form for children and adolescents. The caregiver-report form for children and adolescents consists of 93 questions. Some were Likert fashion, whereas others were discrete variables or descriptive (please see details on the original version in English). Some authors (YS, TY, FJ, and HT) translated the English version into Japanese. The Japanese version was then back-translated by different authors (YYA and TH) (All language version of the questionnaire is openly available online (http://www.crisissurvey.org/crisis-afar/). For the purpose of this study, we selected on three specific domains including Changes in Life, Mass media and social networking service (SNS) usage, and RRB symptoms, as detailed below.

Besides the CRISIS-AFAR, we added original questionnaires that focus on the mask-wearing culture in Japan (CRISIS-AFAR-J). It includes six questions of the CRISIS-AFAR-J as follows:

1. Did your child find it difficult to wear masks and go out?
2. Did your child feel an uncomfortable sensation while wearing a mask?
3. Do you think your child finds it difficult to communicate because others are wearing masks?
4. Do you think your child finds it difficult to refer to other people's emotions because they are wearing masks?
5. Do you think that your child's wearing a mask makes it harder for people to hear him or her?
6. Do you think your child finds it difficult to convey his or her emotions to others while wearing masks?

The answers for these questions were formulated in a Likert-type format: (1) yes, (2) sort of yes, (3) I cannot say either, (4) sort of no, and (5) no.

Changes in life

We focused on questionnaires that measure sleep and physical exercise as well as media and SNS usage in the CRISIS-AFAR. The questions are listed in the Supplement. In the pairs of the questions, the first asked regarding the participants' behavior during the 3 months prior to the pandemic, and the second asked regarding the participants' behavior during the past 2 weeks (i.e., during the pandemic).

RRB symptoms

We focused on questionnaires that measure RRB symptoms before and during the pandemic in the CRISIS-AFAR. The questionnaires are listed in the Supplement. In the pairs of questions, the first asked regarding the participants' behavior during the 3 months prior to the pandemic, and the second asked regarding the participants' behavior during the past 2 weeks (i.e., during the pandemic).

Statistical analyses

We computed the composite scores using answers of questions on RRB in our data. The combinations of the answers were derived from the original CRISIS-AFAR Parent/Caregiver survey [10]. Briefly, in the original CRISIS-AFAR Parent/Caregiver survey, exploratory and confirmatory factor analyses (i.e., EFA and CFA) were performed on separate split-half datasets matched for demographic information, including sample, sex, child age, full-scale intelligence quotient, and primary DSM-5 diagnosis. In the EFA, the questions with resulting factor loading ≥ 0.3 were retained. Then, the CFA was subsequently performed only on the retained questions. Using the questions identified by these procedures, we calculated the composite scores in RRB. The lower-order RRB symptoms include sensory seeking, repetitive motor mannerisms/movements, and rituals and routines. The higher-order RRB symptoms refer to request to family members to maintain specific routines, rituals, and habits as well as engaging in an activity related to a highly restricted and strong interest.

Changes in life

Sleep and exercise

To see the change before and during the pandemic, we conducted Wilcoxon signed-rank tests in each pair of questionnaires to compare the scores of each question before and after the pandemic. Statistical significance was set at $P < 0.005$ (=0.05/11) after correcting for multiple comparisons using the Bonferroni method.

Mass media and SNS usage

To see the change before and during the pandemic, we conducted Wilcoxon signed-rank tests in each pair of questionnaires. Statistical significance was set at $P < 0.017$ (=0.05/3) after correcting for multiple comparisons using the Bonferroni method.

Association between hypersensitivity and mask-wearing

To examine the relationships between RRB and mask-wearing, we focused on the results of factor analyses: the lower- and higher-order RRB symptoms (see Results section). We conducted Spearmans' rank correlation analyses between both the lower- and higher-order RRB symptoms and mask-wearing impact of CRISIS-AFAR-J. Statistical significance was set at $P < 0.0042$ (=0.05/6/2, Bonferroni corrected for multiple comparisons).

Results

Changes in life

Sleep and exercise

No changes were observed in sleep behavior, such as the time to go to bed on either weekday (No. 43 vs. No 67, rho = 0.78, p = 0.76) or weekends (No. 44 vs. No 68, rho = 0.83, p = 0.41), sleep durations on either weekday (No. 45 vs. No 69, rho = 0.82, p = 0.81) or weekends (No. 46 vs. No 70, rho = 0.74, p = 0.02), frequency of difficulty falling asleep (No. 47 vs. No 71, rho = 0.77, p = 0.03), or nocturnal awakening (No. 48 vs. No 72, rho = 0.77, p = 0.33) before and after the pandemic. On the other hand, although not significant, the participants exercised less frequently during the pandemic than before (No. 49 vs. No 73, rho = 0.80, p = 0.05). They also spent significantly less time outdoors during the pandemic than before (No. 50 vs. No 74, rho = 0.75, p = 0.005) (Table 2).

Mass media and SNS usage

No significant change was found in the time spent on TV or digital media (No. 58 vs. No 82, rho = 0.58, p = 1), social media (No. 59 vs. No 83, rho = 0.87, p = 0.81), or video games (No. 60 vs. No 84, rho = 0.77, p = 0.08) before and after the pandemic (Table 2).

RRB symptom frequency change

The frequency of the RRB symptoms did not change after the pandemic, especially repetitive motor mannerisms/movements (No. 51 vs. No 75, rho = 0.84, p = 0.85); sensory-seeking behaviors (No. 52 vs. No 76, rho = 0.74, p = 0.62); other rituals or routines (No. 53 vs. No 77, rho = 0.89, p = 0.63); changes in daily routines (No. 54 vs. No 78, rho = 0.69, p = 0.47); requiring family members and others he/she interacts with to maintain specific routines, rituals, and habits (No. 55 vs. No 79, rho = 0.75, p = 0.52); or activities related to a highly restricted, strong interest (No. 56 vs. No 80, rho = 0.76, p = 0.37) (Table 3).

Association between hypersensitivity and mask-wearing

Our analysis revealed that children who exhibited lower-order RRB more frequently had more challenges with mask-wearing because it was associated with an uncomfortable sensation (CRISIS-AFAR-J Question No. 2) (rho = -0.343, p = 0.0004) and difficulty in referring to others' emotions while wearing masks (CRISIS-AFAR-J Question No. 4) (rho = -0.295, p = 0.0002) (It should be noted that a negative correlation coefficient denotes a positive association because of the questionnaire). We also found an association between higher-order RRB and an uncomfortable sensation during mask-wearing (CRISIS-AFAR-J Question No. 2) (rho = -0.415, p = 0.000013).

Discussion

The present study examined the association between pre-pandemic RRB symptoms and the ramification of mask-wearing in individuals with ASD. The CRISIS-AFAR focused on RRB and anxiety as well as changes in daily life induced by the pandemic. We analyzed the data on children and adolescents obtained from the caregiver-report form. It was indicated that the higher frequency of both lower- and higher-order RRB before the pandemic were associated with more difficulty wearing masks. Of note, people with ASD presenting more frequent lower-order RRB showed the greater increment of social communication difficulties during mask-wearing. In contrast to our prediction, except for less time outdoors and exercise, the children with ASD did not show any changes in life, such as sleep cycle and mass media and SNS usage during the pandemic. The present findings suggest that the children with ASD were able to keep their indoor activities without major disruptions even during the pandemic.

The present findings are in part consistent with those of a previous study. Specifically, Pazhoohi et al. demonstrated that in typically developing individuals, people with higher autistic traits measured by the Autism Spectrum Quotient were less accurate and less confident in identifying emotional face expressions during mask-wearing [11]. Indeed, given that individuals with ASD spend more time looking at the mouth than the eyes, it is reasonable to suggest that mask-wearing would make it more difficult to refer to others' emotions [12]. In the present study, the questionnaire does not cover baseline social communication skills. Thus, we cannot specify that the association with the ramifications of mask-wearing is specific to RRBs or can be applied to baseline communication skills. On the other hand, using the CRISIS-AFAR-J, we specifically asked regarding the change in social communication skills induced by mask-wearing. Thus, it is not likely that the present findings reflected the association between RRB and social communication impairment symptoms, which is confirmed by a number of previous studies (e.g., [13]). This assumption is supported by the lack of association between RRB change and the ramifications of mask-wearing. However, it is still possible that people with more severe ASD show more difficulty adapting to the new normal and mask-wearing. Future studies are needed to comprehensively identify the risk factors for the ramification of mask-wearing.

In contrast to our hypothesis that the COVID-19 pandemic disrupted a stable and ideal environment, the present findings showed that the children with ASD did not experience any changes in the sleep cycle and mass media and SNS usage. However, these findings have potential explanations. The first is the characteristics of the participants. Because we recruited participants from outpatient clinics, some participants refused to go to school even before the pandemic. Additionally, caregivers are well instructed to provide a structured lifestyle at home without depending on schools. These factors could protect the study participants from the disruption of daily life.

On the basis of the low per capita COVID-19 patients in Japan at the time of study, almost all of the participants did not have contact with anyone diagnosed with COVID-19, indicating that they did not see anyone suffering from the infection. However, even without facing the catastrophic scene, mass media could still induce psychological stress among the people [14–16]. Similarly, exposure to tragic information and sceneries through mass media could negatively affect the psychological state, which might occur in different contexts (i.e., pandemic) and in different populations (i.e., individuals with ASD). Despite the evident relationships between prenatal exposure to the disaster and child ASD likelihood [17–19], only a few studies have examined the impact of the disaster on ASD before the COVID-19 pandemic [20]. Thus, the present research and previous studies covering the COVID-19 pandemic provided novel evidence on what is

specific to ASD and what is shared with other psychiatric conditions in the impact of unprecedented incidents on their psychological state. The present findings have emphasized the impact of mask-wearing on individuals with ASD, especially children, and adolescents.

Limitation

The present findings need to be treated with caution. Although the CRISIS-AFAR is a well-designed questionnaire that covers RRB and daily life behaviors, it does not measure ASD severity or establish the diagnosis. Moreover, it does not cover social communication deficits, which means that we cannot specify that the present findings are specific to RRB or ASD severity itself. The current questionnaire asked regarding the symptoms 3 months prior to the pandemic, which means that the results may suffer from recall bias. The impact of mask-wearing was associated with not only the frequency of RRB symptoms before the pandemic but also that during the pandemic. However, it should be noted that 2 weeks and 3 months prior to the pandemic are at risk of recall bias, although the degree differs. Finally, although the experts established the questionnaires, they were not validated in English or Japanese. Furthermore, because the questionnaires asked the caregivers to select the answers from the options, the sensitivity of the questionnaires to detect the change was limited.

Conclusions

Mask-wearing may negatively affect the social communication skills of children with ASD, especially considering the high frequency of RRB symptoms.

Declarations

Ethics approval and consent to participate

This study was approved by the ethical committees of Showa University (B-2020-021) and the National Center for Child Health and Development based on The Code of Ethics of the World Medical Association. All methods were performed in accordance with the Declarations of Helsinki. After a complete description of the study, written informed consent was obtained from all participants. In case of minor participants, written informed consent was obtained from a parent and/or legal guardian.

Consent for publication

Not applicable.

Availability of data and materials

The datasets analyzed during the current study are available from the corresponding author on reasonable request. The datasets generated and/or analysed during the current study are not publicly available because they will be further analysed but are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests

Funding

This work was partially supported by the JSPS KAKENHI (grant numbers 21K07493 for YT and 21K15719 for YYA). This work was also supported by the Japan Agency for Medical Research and Development (AMED) (grant numbers 21he2202007h0001 for YT, JP21dm0307008 and JP19dm0307026 for TI).

Authors' contributions

YYA organized the project and created Japanese questionnaires. HT, SY, YT, and JF translated the questionnaires. TH and YYA back-translated the questionnaires. HT, MI, MK, RT, SN, and YYA collected data. HT and YYA drafted the initial manuscript. TI and YYA analyzed the data. TI, SY, YT, JF, NS, YN, SN, and TH provided critical input to the initial version. All the authors approved the final version.

Acknowledgements

We thank Prof. Ryuta Kawashima for his kind guidance. We also appreciate Dr. Adriana Di Martino for her constructive input.

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Tables

Table 1. Frequencies and percentages of key demographic variables and COVID-related experiences

Age	mean (SD)
participants	11.6 (5.3)
caregivers	45.7 (6.2)
Sex	**n (%)**
Male	75 (73.5)
Female	27 (26.5)
NA	0 (0.0)
Relationship to the child	
Mother	92 (90.2)
Father	7 (6.9)
NA	3 (2.9)
Psychiatric and neurological comorbidities	
Attention-deficit/hyperactivity disorder	28 (27.5)
Learning disorder	5 (4.9)
Epilepsy or seizures	8 (7.8)
Obsessive compulsive disorder	1 (1.0)
Emotional or mental health problems such as depression or anxiety	16 (15.7)
Problems with alcohol or drugs	1 (1.0)
Intellectual disability	22 (21.6)
Other problems requiring special education services	4 (3.9)
Other neurodevelopmental conditions	2 (2.0)
Developmental delay	28 (27.5)
Family member diagnosed	
No	99 (97.1)
Yes	2 (2.0)
NA	1 (1.0)
2-week exposure	
None	101 (99.0)
Exposure to person with symptoms	1 (1.0)
NA	0 (0.0)

Abbreviations: ASD; autism spectrum disorder, COVID; coronavirus disease of 2019, NA; Not Answer

Table 2. Changes in life

		Before the pandemic				During the pandemic				Spearman's rank correlation analyses	Wilcoxon signed-rank tests
question	choices	overall (%)	mean	SD	n	overall (%)	mean	SD	n	rho	p
Sleep and exercise											
On average, what time did your child go to bed on WEEKDAYS? (No. 43 and 67)	1. Before 8 pm 2. 8 pm-10 pm 3. 10 pm-12 am 4. After midnight 5. NA	2 (2.0) 43 (42.2) 44 (43.1) 12 (11.8) 1 (1.0)	2.6	0.7	101	4 (3.9) 44 (43.1) 32 (31.4) 21 (20.6) 1 (1.0)	2.7	0.8	101	0.78	0.76
On average, what time did your child go to bed on WEEKENDS? (No. 44 and 68)	1. Before 8 pm 2. 8 pm-10 pm 3. 10 pm-12 am 4. After midnight 5. NA	1 (1.0) 38 (37.3) 44 (43.1) 18 (17.6) 1 (1.0)	2.8	0.7	101	5 (4.9) 38 (37.3) 34 (33.3) 24 (23.5) 1 (1.0)	2.7	0.9	101	0.83	0.41
On average, how many hours per night did your child sleep on WEEKDAYS? (No. 45 and 69)	1. <6 hours 2. 6-8 hours 3. 8-10 hours 4. >10 hours 5. NA	4 (3.9) 27 (26.5) 59 (57.8) 10 (9.8) 2 (2.0)	2.8	0.7	100	4 (3.9) 25 (24.5) 62 (60.8) 10 (9.8) 1 (1.0)	2.8	0.7	101	0.82	0.81
On average, how many hours per night did your child sleep on WEEKENDS? (No. 46 and 70)	1. <6 hours 2. 6-8 hours 3. 8-10 hours 4. >10 hours 5. NA	2 (2.0) 17 (16.7) 66 (64.7) 16 (15.7) 1 (1.0)	3.0	0.6	101	1 (1.0) 14 (13.7) 66 (64.7) 20 (19.6) 1 (1.0)	3.1	0.6	101	0.74	0.02
On average, did your child have difficulties falling asleep (e.g., within 20 minutes) after going to bed? (No. 47 and 71)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly 6. NA	20 (19.6) 30 (29.4) 27 (26.5) 12 (11.8) 13 (12.8) 0 (0.0)	2.7	1.3	102	29 (28.4) 23 (22.6) 27 (26.5) 12 (11.8) 9 8.8) 2 (2.0)	2.5	1.3	100	0.77	0.03
On average, did your child wake up and remain awake during the night after falling asleep? (No. 48 and 72)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly 6. NA	48 (47.1) 35 (34.3) 12 (11.8) 4 (3.9) 3 (2.9)	1.8	1.0	102	54 (52.9) 30 (29.4) 8 (7.8) 7 (6.9) 3 (2.9)	1.8	1.1	102	0.77	0.33
How many days per week did your child	1. None 2. 1-2 days	21 (20.6)	2.6	1.2	101	24 (23.5)	2.5	1.2	101	0.80	0.05

exercise (e.g., increased heart rate, increased rate of breathing) for at least 30 minutes? (No. 49 and 73)	3. 3-4 days 4. 5-6 days 5. Daily 6. NA	30 (29.4) 23 (22.5) 19 (18.6) 8 (7.8) 1 (1.0)				35 (34.3) 21 (20.6) 14 (13.7) 7 (6.9) 1 (1.0)					
How many days per week did your child spend time outdoors? (No. 50 and 74)	1. None 2. 1-2 days 3. 3-4 days 4. 5-6 days 5. Daily 6. NA	98 (96.1) 9 (8.8) 17 (16.7) 34 (33.3) 18 (17.6) 2 (2.0)	3.3	1.2	100	12 (11.8) 31 (30.4) 17 (16.7) 28 (27.5) 13 (12.7) 1 (1.0)	3.0	1.3	101	0.75	0.005
Mass media and SNS usage											
How much time per day did your child spend watching TV or digital media (e.g., Netflix, YouTube, web surfing)? (No. 58 and 82)	1. No TV or digital media 2. Under 1 hour 3. 1-3 hours 4. 4-6 hours 5. More than 6 hours 6. NA	1 (1.0) 6 (5.9) 62 (60.8) 23 (22.5) 8 (7.8) 2 (2.0)	3.3	0.8	100	1 (1.0) 8 (7.8) 59 (57.8) 22 (21.6) 11 (10.8) 1 (1.0)	3.3	0.8	101	0.58	1
How much time per day did your child spend using social media (e.g., Facetime, Facebook, Instagram, Snapchat, Twitter, TikTok)? (No. 59 and 83)	1. No social media 2. Under 1 hour 3. 1-3 hours 4. 4-6 hours 5. More than 6 hours 6. NA	69 (67.6) 15 (14.7) 10 (9.8) 3 (2.9) 4 (3.9) 1 (1.0)	1.5	1.0	101	66 (64.7) 15 (14.7) 9 (8.8) 4 (3.9) 5 (4.9) 3 (2.9)	1.6	1.0	99	0.87	0.81
How much time per day did your child spend playing video games? (No. 60 and 84)	1. No video games 2. Under 1 hour 3. 1-3 hours 4. 4-6 hours 5. More than 6 hours	49 (48.0) 23 (22.5) 25 (24.5) 3 (2.9) 2 (2.0)	1.9	1.0	102	46 (45.1) 21 (20.6) 25 (24.5) 8 ()7.8 2 (2.0)	2.0	1.1	102	0.77	0.08

Abbreviation: NA; Not Answer, SNS; social networking service

Table 3. RRB symptom frequency

		Before the pandemic				During the pandemic				Spearman's rank correlation analyses	Wilcoxon signed-rank tests
question	choices	overall (%)	mean	SD	n	overall (%)	mean	SD	n	rho	p
How frequently did your child engage in repetitive motor mannerisms/movements (e.g., repetitive movements of the whole body, or just with their hands and fingers)? (No. 51 and 75)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly	54 (52.9) 17 (15.7) 20 (19.6) 8 (7.8) 3 (2.9)	1.9	1.1	102	59 (57.8) 12 (11.8) 17 (16.7) 10 (9.8) 4 (3.9)	1.9	1.2	102	0.84	0.85
How frequently did your child engage in sensory seeking behaviors (e.g., visually inspecting things, touching or feeling things for a long time)? (No. 52 and 76)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly	53 (52.0) 22 (21.6) 12 (11.8) 12 (11.8) 3 (2.9)	1.9	1.2	102	53 (52.0) 24 (23.5) 14 (13.7) 8 (7.8) 3 (2.9)	1.9	1.1	102	0.74	0.62
How frequently did your child engage in other rituals or routines? (No. 53 and 77)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly	47 (46.1) 24 (23.5) 19 (18.6) 6 (5.9) 6 (5.9)	2.0	1.2	102	47 (46.1) 28 (27.5) 11 (10.8) 8 (7.8) 8 (7.8)	2.0	1.3	102	0.89	0.63
How frequently did your child adjust easily to changes in daily routines (e.g., changes in time, location, order, or occurrence of regularly scheduled or typical daily activities such as appointments, mealtimes, or the addition of unexpected events/activities)? (No. 54 and 78)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly 6. NA	6 (5.9) 18 (17.7) 33 (32.4) 31 (30.4) 13 (12.8) 1 (1.0)	3.3	1.1	101	9 (8.8) 13 (12.8) 31 (30.4) 31 (30.4) 17 (16.7) 1 (1.0)	3.3	1.2	101	0.69	0.47
How frequently did your child require family members and others he/she interacts with to maintain specific routines, rituals, habits, including doing things consistently, and requiring warning or change in family behavior (e.g., takes longer to complete tasks, changes schedule to accommodate child)? (No. 55 and 79)	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly	37 (36.3) 17 (16.7) 28 (27.5) 13 (12.8) 7 (6.9)	2.4	1.3	102	37 (36.3) 24 (23.5) 21 (20.6) 13 (12.8) 7 (6.9)	2.3	1.3	102	0.75	0.52
How frequently did your child engage in an activity related to a highly restricted, strong interest (e.g., play with the toy/topic, talk about the toy/topic, watch	1. Not at all 2. Rarely 3. Occasionally 4. Often 5. Regularly	21 (20.6) 16 (15.7) 30 (29.4) 23	2.9	1.3	102	20 (19.6) 14 (13.7) 26 (25.5) 32	3.0	1.3	102	0.76	0.37

content related to that toy/topic)? (No. 56 and 80)	(22.6) 12 (11.8)	(31.4) 10 (9.8)

Abbreviation: RRB; restricted interest and repetitive behavior

Supplementary Files

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- TamonetalSupplementaryInformation.docx