**Protective Factors for Children with Autism Spectrum Disorder During COVID-19-related Strict Lockdowns: A Shanghai Autism Early Developmental Cohort Study**

**Supplementary Materials**

**Methods**

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**Survey on Omicron pandemic**

For the caregivers, we developed questions about the origin of Omicron infection (Yourself/Immediate family/Extended family/Neighbor/Friend or colleague/None), lockdown (Yes/No), lockdown duration (days), participation in anti-epidemic work (Yes/No) and the origin of stress (severity of the pandemic/access restriction/worries about the safety of yourself and family/concerns about the safety of frontline workers/ worries about shortage of daily necessities/ fears of unemployment), also we designed rating scale ranging from 0 to10 about the feelings (fearful, panic, angry, helpless, worried, irritable, doubtful and unable to accept reality, respectively) during the lockdown restriction. For the ASD children, we applied caregiver-report questionnaire about origin of Omicron infection (himself or herself/Immediate family/Extended family/Neighbor/Friend or classmate/None), rating scale about the feelings, impact on school attendance (Yes/No), impact on behavioral intervention (Yes/No), impact on medication use (Yes/No)

Figure S1. The selection process for participants ****

# Figure S2. The relationship between the duration of lockdown and the CGI-I score in the entire lockdown group

The higher the CGI improvement score, the less the clinical improvement

****

# Table S1. Association between lockdown and SDQ and CSHQ in ASD children.

| **Item** | **No lockdown** | | **Shorter duration,**  **strict lockdown** | | **Difference-in-difference** | | | | **Longer duration,**  **strict lockdown** | | | **Difference-in-difference** | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Baseline** | **Follow-up** | **Baseline** | **Follow-up** | **β (95% CI)\*** | **P** | **FDR** | **Baseline** | | **Follow-up** | **β (95% CI)\*** | | **P** | **FDR** |
| **SDQ** |  |  |  |  |  |  |  |  | |  |  | |  |  |
| Total score | 16.6 (4.0) | 16.0 (4.0) | 16.4  (4.5) | 15.5 (4.0) | -0.20  (-1.82 to 1.43) | 0.81 | / | 17.1 (4.4) | | 16.5 (4.8) | 0.09  (-1.53 to 1.71) | | 0.91 | / |
| Emotional symptoms | 2.1  (2.0) | 1.9 (1.7) | 2.1  (1.5) | 1.8 (1.3) | -0.06  (-0.77 to 0.64) | 0.86 | / | 2.2 (1.7) | | 2.0 (1.6) | 0.02  (-0.68 to 0.72) | | 0.96 | / |
| Conduct problems | 1.9  (1.1) | 1.8 (1.4) | 1.9  (1.2) | 1.7 (1.4) | -0.14  (-0.63 to 0.35) | 0.58 | / | 2.2 (1.2) | | 2.4 (1.1) | 0.27  (-0.22 to 0.76) | | 0.27 | / |
| Hyperactivity/inattention | 7.1  (1.9) | 6.8 (1.9) | 6.7  (2.1) | 6.6 (2.3) | 0.22  (-0.48 to 0.93) | 0.53 | / | 7.2 (2.1) | | 6.7 (2.5) | -0.22  (-0.92 to 0.49) | | 0.54 | / |
| Peer relationship problems | 5.5  (1.5) | 5.4 (1.4) | 5.8  (1.7) | 5.5 (1.4) | -0.22  (-0.81 to 0.37) | 0.46 | / | 5.5(1.7) | | 5.4 (1.4) | -0.02  (-0.61 to 0.57) | | 0.94 | / |
| Prosocial behaviour | 3.0  (2.4) | 3.0 (2.2) | 2.8  (2.2) | 3.1 (2.2) | 0.30  (-0.39 to 1.00) | 0.38 | / | 3.6 (2.5) | | 3.6 (2.7) | -0.01  (-0.70 to 0.68) | | 0.97 | / |
| **CSHQ** |  |  |  |  |  |  |  |  | |  |  | |  |  |
| Total score | 68.8 (9.8) | 53.6 (7.4) | 68.4 (10.4) | 55.0 (7.1) | 1.79  (-1.87 to 5.45) | 0.33 | 0.68 | 68.2  (8.4) | | 54.0  (7.3) | 0.97  (-2.66 to 4.61) | | 0.59 | 0.71 |
| Bedtime Resistance | 12.8  (2.6) | 11.9 (2.2) | 12.0  (2.7) | 11.2 (2.9) | 0.10  (-0.83 to 1.02) | 0.83 | 0.83 | 11.5  (2.4) | | 11.0 (2.4) | 0.40  (-0.52 to 1.32) | | 0.38 | 0.69 |
| Sleep Anxiety | 10.3 (1.9) | 7.2 (1.8) | 10.5  (2.4) | 7.2 (1.9) | -0.33  (-1.19 to 0.52) | 0.44 | 0.71 | 10.4  (2.1) | | 7.5  (1.9) | 0.15  (-0.70 to 1.01) | | 0.72 | 0.81 |
| Sleep Duration | 4.7  (1.7) | 4.8 (1.7) | 5.0  (1.7) | 4.9 (1.7) | -0.19  (-0.82 to 0.45) | 0.55 | 0.71 | 5.1  (1.9) | | 4.9  (1.6) | -0.19  (-0.82 to 0.45) | | 0.56 | 0.71 |
| Sleep Disordered Breathing | 5.5  (1.3) | 3.2 (0.5) | 5.4  (1.7) | 3.7 (1.1) | 0.50  (-0.09 to 1.08) | 0.09 | 0.40 | 5.5  (1.6) | | 3.6  (1.1) | 0.36  (-0.22 to 0.94) | | 0.22 | 0.68 |
| Parasomnias | 13.1 (3.2) | 8.2  (1.6) | 13.5  (3.1) | 9.2 (2.3) | 0.59  (-0.65 to 1.84) | 0.34 | 0.68 | 13.3  (3.2) | | 8.8  (2.1) | 0.40  (-0.83 to 1.64) | | 0.51 | 0.71 |
| Daytime Sleepiness | 15.4 (2.8) | 12.7  (2.4) | 14.7  (3.3) | 13.3 (2.8) | 1.27  (0.21 to 2.33) | 0.02 | 0.30 | 14.8  (2.9) | | 12.6  (2.1) | 0.53  (-0.52 to 1.58) | | 0.31 | 0.68 |
| Night Wakings | 5.6  (1.5) | 3.6 (1.1) | 5.6  (1.7) | 3.8 (1.3) | 0.09  (-0.56 to 0.75) | 0.77 | 0.82 | 6.0  (1.9) | | 3.7  (1.1) | -0.37  (-1.02 to 0.28) | | 0.26 | 0.68 |
| Sleep Onset Delay | 1.3  (0.9) | 1.8 (0.8) | 1.6  (0.9) | 1.8 (0.9) | -0.28  (-0.58 to 0.02) | 0.07 | 0.40 | 1.7  (0.9) | | 1.8  (0.8) | -0.32  (-0.62 to 0.02) | | 0.03 | 0.30 |

SDQ, The Strengths and Difficulties Questionnaire; CSHQ, Children's Sleep Habits Questionnaire.

\* Adjusted for sex, age, parental education, and parental income.

# Table S2. Sequential adjustment in the association between longer duration, strict lockdown and CGI-I of ASD children.

|  |  |  |
| --- | --- | --- |
|  | **Adjusted model** |  |
|  | **β (95% CI)** | **P** |
| **No lockdown** | 0 (ref) |  |
| **Longer duration, strict lockdown** | 0.54 (0.23 to 0.84) \* | 0.001 |
| **+Difficulty in attending school** | 0.56 (0.23 to 0.89) | 0.001 |
| **+ Difficulty in continuing behavioral intervention** | 0.53 (0.21 to 0.86) | 0.001 |
| **+ Difficulty in access ASD-related medicine** | 0.49 (0.16 to 0.81) | 0.004 |
| **+infection in neighborhood** | 0.59 (0.22 to 0.97) | 0.002 |

ASD, autism spectrum disorders; CGI-I, Clinical Global Impression-Improvement

\* Adjusted for sex, age, parental education, and parental income.

# Table S3. Potential effect moderators in the association between longer duration lockdown and CGI-I of ASD children.

|  |  |  |  |
| --- | --- | --- | --- |
| **Potential effect moderators** | **Longer duration, strict lockdown**  **× moderator** | |  |
|  | **β (95% CI)\*** | **P** | **FDR** |
| **Parental BFI** |  |  |  |
| Neuroticism | 0.05 (0.01 to 0.10) | 0.025 | 0.062 |
| Extroversion | -0.04 (-0.08 to 0.00) | 0.044 | 0.073 |
| Conscientiousness | 0.01 (-0.06 to 0.08) | 0.827 | 0.914 |
| Agreeableness | -0.11 (-0.17 to -0.04) | 0.002 | 0.009 |
| Openness | -0.01 (-0.06 to 0.05) | 0.914 | 0.914 |
| **CD-RISC-10** | -0.03 (-0.07 to 0.02) | 0.22 | / |
| **FACSII-CV** |  |  |  |
| Family adaptation | 0.01 (-0.02 to 0.04) | 0.73 | / |
| Family cohesion | 0.00 (-0.03 to 0.04) | 0.80 | / |
| **Parental ERQ** |  |  |  |
| Cognitive reappraisal | -0.03 (-0.09 to 0.03) | 0.27 | / |
| Expressive suppression | 0.04 (-0.01 to 0.10) | 0.14 | / |

ASD, autism spectrum disorders; CGI-I, Clinical Global Impression-Improvement; BFI, Big Five Inventory; CD-RISC-10, 10-item Connor-Davidson Resilience Scale; FACSII-CV, Family Adaptability and Cohesion Evaluation Scale, second edition- Chinese version; ERQ, Emotion Regulation Questionnaire.

\* Adjusted for sex, age, parental education, and parental income.

# Table S4. Association of agreeableness with family-related characters and parental stress

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Personality trait** |  |  | **Agreeableness** |  |
|  | **Mean** | **SD** | **β (95% CI)\*** | **P** |
| **Full cohort** |  |  |  |  |
| CD-RISC | 26.4 | 6.5 | 0.33 (0.11 to 0.54) | 0.003 |
| FACSII-CV |  |  |  |  |
| Family adaptivity | 45.4 | 8.1 | 0.44 (0.17 to 0.71) | 0.002 |
| Family cohesion | 64.3 | 10.5 | 0.62 (0.27 to 0.97) | 0.001 |
| ERQ |  |  |  |  |
| Cognitive reappraisal | 29.3 | 5.1 | 0.22 (0.04 to 0.39) | 0.014 |
| Expressive suppression | 15.8 | 4.6 | -0.25 (-0.40 to -0.10) | 0.001 |
| **Children having lockdown for ≥35 days** |  |  |  |  |
| Stress sources related with COVID-19 | 3.40 | 1.62 | -0.17 (-0.27 to -0.07) | 0.001 |
| BAI | 28.70 | 4.43 | -0.11 (-0.42 to 0.20) | 0.472 |
| BDI | 5.60 | 5.10 | -0.24 (-0.60 to 0.12) | 0.195 |

CD-RISC-10, 10-item Connor-Davidson Resilience Scale; FACSII-CV, Family Adaptability and Cohesion Evaluation Scale, second edition- Chinese version; BAI, Beck Anxiety Inventory; BDI, Beck Depression Inventory; ERQ, Emotion Regulation Questionnaire.

\* Adjusted for parental income and education levels.

† While resilience and family adaptivity/cohesion were thought stable regardless of lockdown, COVID-related stress, anxiety, and depression were likely to be changed by lockdown. Thus, the latter three indicators were studied specifically in children with longer duration lockdown.

# Table S5. The interaction of longer duration lockdown and parental agreeableness on CGI-I score in ASD children, sequentially adjusted for potential confounders.

|  |  |  |
| --- | --- | --- |
| **Moderator** | **Longer duration lockdown × moderator** |  |
|  | **β (95% CI)\*** | **P** |
| **Agreeableness** |  |  |
| +CD-RISC | -0.10 (-0.17 to -0.04) | 0.003 |
| +Family adaptation | -0.10 (-0.17 to -0.04) | 0.002 |
| +Family cohesion | -0.10 (-0.17 to -0.03) | 0.003 |
| +Stress sources related with COVID-19 | -0.13 (-0.20 to -0.05) | 0.001 |
| +Cognitive reappraisal | -0.11 (-0.17 to -0.04) | 0.002 |
| +Expressive suppression | -0.10 (-0.17 to -0.04) | 0.003 |

ASD, autism spectrum disorders; CGI-I, Clinical Global Impression-Improvement.

\* Adjusted for sex, age, parental education, and parental income.