Article

Association between Adverse Childhood Experiences and Time Spent Playing Video Games in Adolescents: Results from A-CHILD Study

Satomi Doi 1,2, Aya Isumi 1,2 and Takeo Fujiwara 1,*

1 Department of Global Health Promotion, Tokyo Medical and Dental University (TMDU), Bunkyo 113-8519, Japan; doi.hlth@tmd.ac.jp (S.D.); isumi.hlth@tmd.ac.jp (A.I.)
2 Japan Society for the Promotion of Science, 5-3-1 Kojimachi, Tokyo 102-0083, Japan
* Correspondence: fujiwara.hlth@tmd.ac.jp; Tel.: +81-3-5803-5187

Abstract: Background: Excessive time spent playing video games is associated with adverse health outcomes in adolescents. Although poor child–parent relationship and social relations with peers are considered as possible predictors, little is known as to whether adverse childhood experiences (ACEs) are associated with time spent playing video games. The aim is to examine the association between ACEs and time spent playing video games in adolescents. Methods: We used pooled data from the Adachi Child Health Impact of Living Difficulty (A-CHILD) study in 2016 and 2018, which is a population-based cross-sectional study in Adachi City, Tokyo, Japan (N = 6799, 4th, 6th, and 8th-grade students). Adolescents answered questionnaires examining the time spent playing video games, per day, on weekdays (“less than 1 h”, “less than 3 h”, and “more than 3 h”) and ACEs (eight types). Results: The results of the ordinal logistic regression analysis showed a positive association between ACE total score and time spent playing video games after adjusting for covariates (1 ACE: OR = 1.28, 95% CI = 1.10–1.48; 2 ACEs: OR = 1.25, 95% CI = 1.06–1.48; 3 + ACEs: OR = 1.44, 95% CI = 1.14–1.82, p for trend < 0.001). Regarding each type of ACE, the experiences of single parenthood, parental history of psychiatric disorders, and peer isolation were independently positively associated with time spent playing video games. Conclusions: Health policy to address ACEs might be important to shorten the time spent playing video games.

Keywords: adolescent; adverse childhood experience; gaming; peer isolation

1. Introduction

Excessive time spent playing video games in children and adolescents has been a public health issue globally. The American Psychiatric Association has defined “Internet gaming disorder (IGD)” which refers to “persistent and recurrent use of the Internet to engage in games, often with other players, leading to clinically significant impairment or distress” in the Diagnostic and Statistical Manual, Fifth Edition (DSM-5) [1]. The World Health Organization (WHO) also included Gaming Disorder (GD) into the 11th Revision of the International Classification of Diseases (ICD-11) [2]. A long duration of video game play is a risk factor for IGD [3,4]. Furthermore, excessive time spent playing video games is associated with adverse physical and psychological health outcomes in adolescents such as overweight and obesity [5,6], poor sleep quality [6,7], depression and anxiety [8,9], increased aggression [10], and reduced prosocial behaviors [10]. To prevent these negative physical and psychological health outcomes including IGD, identifying predictors for excessive time spent playing video games is needed.

Previous studies have shown several predictors for excessive time spent playing video games in adolescents including problematic video gaming and IGD. The systematic review, which identified predictors for problematic video gaming in adolescents, showed that a poor quality of parent–child relationship (i.e., attachment) might predict problematic
video gaming [11]. Another review paper investigating predictors for IGD in children and adolescents also showed poor parent–child relationships, family dysfunction such as parental divorce and single parenthood, and childhood maltreatment might predict IGD [11,12]. In addition to these family factors, poor social relations with peers such as peer isolation or peer victimization is associated with problematic video gaming [13–15]. However, as these factors can be comorbid, the cumulative effect of these childhood adverse experiences (ACEs) needs to be assessed, along with the independent association to longer time periods spent playing video games.

ACE is defined as childhood experiences before the age of 18 years including parental loss, household dysfunction such as parental divorce, and child maltreatment such as physical abuse and neglect [16]. A recent study has added peer isolation and low household income to the original ACE scale [17]. In the literature related to addictive behaviors such as substance use, alcohol use, tobacco use, and gambling, studies have shown that an increased number of ACEs is associated with addictive behaviors in adolescents [18–20]. A previous study of gamers reported a positive association between ACEs and problematic video gaming [21]. However, little is known about the association between ACE and time spent playing video games among population-based adolescence, the sensitive period for addictive behavior [22]. This study aims to examine the association in adolescents between ACE and amount of time spent playing video games.

2. Materials and Methods

2.1. Participants

We used pooled data of the Adachi Child Health Impact of Living Difficulty (A-CHILD) study in 2016 and 2018, which is a population-based cross-sectional study in Adachi City, Tokyo, Japan. The details of the A-CHILD study protocol are available from the protocol paper of the A-CHILD [23]. In 2016, anonymized self-reported questionnaires with unique IDs were distributed to 1994 adolescents (in fourth, sixth, and eighth grades) in nine elementary schools and seven junior high schools. Schools were selected based on geographical and socioeconomic representation. In 2018, the questionnaires were distributed to 6625 adolescents in all 69 elementary school fourth grades, nine representative elementary schools sixth grades, and seven representative junior high school second grades. Both adolescents and caregivers completed the questionnaires. For questionnaires to be deemed valid, they needed: (1) informed consent; (2) at least one question to have a response; and (3) the respondent was to have completed another survey, the Study Attitude survey, which was conducted by Adachi City Board of Education. A total of 1652 valid questionnaires was received (response rate = 82.0%) in 2016 and 5382 (response rate = 81.5%) in 2018. Among the valid responses, the participants who missed exposure and outcome variables in this study (i.e., ACEs and time spent playing video games) were excluded. The analytical sample included 6799 adolescents (fourth grade: \( N = 4654 \); sixth grade: \( N = 1016 \); eighth grade: \( N = 1129 \)) (Figure 1).

2.2. Measurements

ACEs consist of the following eight types, which were based on a previous study [17]: single parent, physical and psychological abuse, neglect, parental psychiatric history, witness to domestic violence between parents, low household income, and peer isolation. Instead of using the ACE scale, we assessed ACEs using the questions related to each type of ACE from both the caregiver and adolescent questionnaires. In this study, seven types, except peer isolation (i.e., single parent, physical and psychological abuse, neglect, parental psychiatric history, witness to domestic violence between parents, and low household income), were assessed on the caregiver’s questionnaire in order to avoid the adolescent’s psychological invasiveness. For each type of ACE, we created a binary variable: a score of “0” denoted that adolescents have never experienced (i.e., “no” response), and a score of “1” denoted that adolescents have ever experienced (i.e., “yes” response).
2.2. Measurements

ACEs consist of the following eight types, which were based on a previous study [17]: single parent, physical and psychological abuse, neglect, parental psychiatric history, witness to domestic violence between parents, low household income, and peer isolation. Instead of using the ACE scale, we assessed ACEs using the questions related to each type of ACE from both the caregiver and adolescent questionnaires. In this study, seven types, except peer isolation (i.e., single parent, physical and psychological abuse, neglect, parental psychiatric history, witness to domestic violence between parents, and low household income), were assessed on the caregiver’s questionnaire in order to avoid the adolescent’s psychological invasiveness. For each type of ACE, we created a binary variable: a score of “0” denoted that adolescents have never experienced (i.e., “no” response), and a score of “1” denoted that adolescents have ever experienced (i.e., “yes” response).

Figure 1. Participants flow chart.

Single parenthood was assessed on the caregiver’s questionnaire with a question about living with family members. When family members living together did not include a mother or father, single parenthood was coded as “1”. Parental history of psychiatric disorder was assessed by two questions (i.e., maternal history of psychiatric disorders and paternal history of psychiatric disorders) on the caregiver’s questionnaire. When the caregiver reported either maternal or paternal history of psychiatric disorders, parental history of psychiatric disorder was coded as “1”. Physical and psychological abuse, witness to domestic violence, and neglect were assessed via the caregiver questionnaires using seven items on a scale of 1 = “often”, 2 = “sometimes”, 3 = “rarely”, and 4 = “not at all.” Physical abuse was assessed from two questions: “hit the child’s body (buttocks, hand, head, or face)”, in which the responses were dichotomized with “often” equated to a “yes” response, and “beat the child,” in which the responses were dichotomized with “rarely”, “sometimes”, or “often”, which equated to a “yes” response. When either item was classified as “yes,” physical abuse was coded as “1”. Psychological abuse was assessed by two questions: “yell at the child,” in which the responses were dichotomized with “often” equated to a “yes” response, and “insult the child repeatedly”, in which the responses were dichotomized with “sometimes” or “often”, which equated to a “yes” response. When either item was classified as “yes,” psychological abuse was coded as “1”. Witness to domestic violence was assessed by the question “have a big fight in front of the
child,” in which the responses were dichotomized with “sometimes” or “often”, which were both equated to a “yes” response. Neglect was assessed by two questions: “shut the child outside” and “do not feed the child,” in which the responses were dichotomized with “rarely”, “sometimes”, or “often”, which equated to a “yes” response. When either item was classified as “yes”, neglect was coded as “1”. This coding was developed in a previous study [24]. Low household income was assessed in the caregiver questionnaire, in which the response “3 million yen or less” was coded as “1”. Peer isolation was assessed in the adolescent questionnaire with the question “how many friends can you talk to about your worries/troubles?” The responses were “0”, which was coded as “1.”

The amount of time spent playing video games on weekdays was measured by the adolescent questionnaires. Adolescents assessed the item on a scale of 1 = “not at all”, 2 = “30 min”, 3 = “1 h”, 4 = “1 h and a half”, 5 = “2 h”, 6 = “2 h and a half”, 7 = “3 h”, and 8 = “more than 3 h”. In this study, “not at all”, “30 min”, and “1 h” were categorized as “1” (less than 1 h), “1 h and a half”, “2 h”, “2 hours and a half”, and “3 h” were categorized as “2” (less than 3 h), and “more than 3 h” was categorized as “3” (more than 3 h).

Covariates were the child’s sex, number of siblings, grade in school, and maternal age, which were measured via the questionnaire. These variables were selected as covariates because the child’s sex and maternal age were used as confounders in previous studies that examined the association between ACEs and addictive mobile phone use [25] and the association between family function and problematic Internet use [26]. Furthermore, the number of siblings is associated with ACEs [27] and gaming [28,29].

2.3. Ethics

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the institutional review board of the Tokyo Medical and Dental University (M2016-284).

2.4. Statistical Analysis

In the analyses, the cumulative ACE total score was calculated using all eight types and collapsed as 0, 1, 2, and 3+ due to the small sample size for 4+ cases (N = 149, 2.2%). Each type of ACE was used in the separate analysis. Ordinal logistic regression analysis was performed to examine the association of the cumulative number of ACEs and each type of ACE with time spent playing games (i.e., “1 h or less”, “3 h or less”, and “more than 3 h”). After estimating the crude model, we examined the association between the cumulative number of ACEs and time spent playing games, adjusting for the child’s sex, grade in school, number of siblings, maternal age, and child’s school (Model 1). As for each type of ACE, Model 2 adjusted for child’s sex, grade, number of siblings, maternal age, and child’s schools. Model 3 included types of ACEs that were significant in Model 2. All analyses included the missing data as dummy variables and were weighted for the number of responses in each grade. We conducted all analyses using STATA version 15.0 SE. These analyses were not pre-registered.

3. Results
3.1. The Distribution of Characteristics

Table 1 shows the distribution of characteristics by grade among the participants. About half of the adolescents, in all grades, had one or more siblings. Approximately 90% of mothers involved in the research were 35 years old or older. A total of 60.2% of adolescents had no ACEs, 19.4% had one ACE, 13.9% had two ACEs, and 6.5% had three or more ACEs. In terms of time spent playing video games, per day, on weekdays, 62.9% of adolescents played video games 1 h or less per day, 27.0% played video games 3 h or less per day, and 10.1% played video games more than 3 h per day. As the adolescent participant’s age increased, those who played video games more than 3 h per day also increased (4th grade = 8.2%, 6th = 10.1%, 8th = 17.6%, p < 0.001).
Table 1. Characteristics of the sample (n = 6799).

| Characteristic                      | Total         | Grade 4th (n = 4654; 68.5%) | Grade 6th (n = 1016; 14.9%) | Grade 8th (n = 1129; 16.6%) |
|-------------------------------------|---------------|------------------------------|-----------------------------|-----------------------------|
|                                     | n or Mean     | % or SD                      | n or Mean                   | % or SD                     | n or Mean                   | % or SD                     |
| Child’s sex                         |               |                              |                             |                             |                             |                             |
| Male                                | 3375          | 49.6                         | 2342                        | 50.3                        | 491                        | 48.3                        | 542                        | 48.0                        |
| Female                              | 3422          | 50.3                         | 2311                        | 49.7                        | 525                        | 51.7                        | 586                        | 51.9                        |
| Missing                             | 2             | 0.1                          | 1                           | 0                           | 0                          | 0                           | 1                          | 0.1                          |
| Number of siblings                  |               |                              |                             |                             |                             |                             |                             |                             |
| No sibling                          | 3334          | 49.0                         | 2283                        | 49.1                        | 483                        | 47.5                        | 568                        | 50.3                        |
| 1                                   | 1725          | 25.4                         | 1146                        | 24.6                        | 274                        | 27.0                        | 305                        | 27.0                        |
| 2                                   | 351           | 5.2                          | 257                         | 5.5                         | 39                         | 3.8                         | 55                         | 4.9                         |
| 3+                                  | 92            | 1.4                          | 61                          | 1.3                         | 15                         | 1.5                         | 16                         | 1.4                         |
| Missing                             | 1297          | 19.1                         | 907                         | 19.5                        | 205                        | 20.2                        | 185                        | 16.4                        |
| Maternal age                        |               |                              |                             |                             |                             |                             |                             |                             |
| <30                                 | 48            | 0.7                          | 44                          | 0.9                         | 4                          | 0.4                         | 0                          | 0.0                          |
| 30–34                               | 563           | 8.3                          | 455                         | 9.8                         | 64                         | 6.3                         | 44                         | 3.9                          |
| 35–39                               | 1508          | 22.2                         | 1162                        | 25.0                        | 208                        | 20.5                        | 138                        | 12.2                        |
| 40–44                               | 2460          | 36.2                         | 1687                        | 36.2                        | 361                        | 35.5                        | 412                        | 36.5                        |
| 45+                                 | 1967          | 28.9                         | 1145                        | 24.6                        | 341                        | 33.6                        | 481                        | 42.6                        |
| Missing                             | 253           | 3.7                          | 161                         | 3.5                         | 38                         | 3.7                         | 54                         | 4.8                          |
| Cumulative ACE total score          |               |                              |                             |                             |                             |                             |                             |                             |
| 0                                   | 4093          | 60.2                         | 2719                        | 58.4                        | 659                        | 64.9                        | 715                        | 63.3                        |
| 1                                   | 1318          | 19.4                         | 894                         | 19.2                        | 190                        | 18.7                        | 234                        | 20.7                        |
| 2                                   | 946           | 13.9                         | 688                         | 14.8                        | 120                        | 11.8                        | 138                        | 12.2                        |
| 3+                                  | 442           | 6.5                          | 353                         | 7.6                         | 47                         | 4.6                         | 42                         | 3.7                          |
| Time spent playing video game per day (weekdays) |               |                              |                             |                             |                             |                             |                             |                             |
| Not at all                          | 1553          | 22.8                         | 1126                        | 24.2                        | 212                        | 20.9                        | 215                        | 19.0                        |
| 30 min                              | 1494          | 22.0                         | 1124                        | 24.2                        | 198                        | 19.5                        | 172                        | 15.2                        |
| 1 h                                  | 1228          | 18.1                         | 889                         | 19.1                        | 169                        | 16.6                        | 170                        | 15.1                        |
| 1 h and a half                      | 714           | 10.5                         | 466                         | 10.0                        | 132                        | 13.0                        | 116                        | 10.3                        |
| 2 h                                  | 569           | 8.4                          | 338                         | 7.3                         | 104                        | 10.2                        | 127                        | 11.2                        |
| 2 h and a half                      | 346           | 5.1                          | 212                         | 4.6                         | 66                         | 6.5                         | 68                         | 6.0                         |
| 3 h                                  | 209           | 3.1                          | 115                         | 2.5                         | 32                         | 3.1                         | 62                         | 5.5                         |
| More than 3 h                       | 686           | 10.1                         | 384                         | 8.3                         | 103                        | 10.1                        | 199                        | 17.6                        |

Table 2 shows the distribution of each type of ACE by grade in school. Among all of the participants, approximately 15% of adolescents had experiences of single parenthood, 13% had the experience of peer isolation, and 11% had experiences of low household income. We also show the relationship between each type of ACE in Table 3 in which high comorbidity was found. For example, 61.5% of adolescents who had single parents also experienced low household income; and 41.6% of adolescents who experienced psychological abuse from parents also experienced physical abuse from their parents.

Table 2. Distribution of categories of adverse childhood experiences (ACEs).

| ACE Category                                | Total         | 4th           | 6th           | 8th           |
|---------------------------------------------|---------------|---------------|---------------|---------------|
| 1. Single parenthood                        | 985           | 14.5%         | 599           | 12.9%         | 157           | 15.5%         | 229           | 20.3%         |
| 2. Parental history of psychiatric disorders| 505           | 7.4%          | 354           | 7.6%          | 59            | 5.8%          | 92            | 8.1%          |
| 3. Physical abuse from parents (hit, slap)  | 616           | 9.1%          | 461           | 9.9%          | 76            | 7.5%          | 79            | 7.0%          |
| 4. Psychological abuse from parents (verb)  | 294           | 4.3%          | 213           | 4.6%          | 41            | 4.0%          | 40            | 3.5%          |
| 5. Witness of domestic violence between parents | 291           | 4.3%          | 201           | 4.3%          | 47            | 4.6%          | 43            | 3.8%          |
| 6. Neglect from parents (out, unfed)        | 543           | 8.0%          | 423           | 9.1%          | 54            | 5.3%          | 66            | 5.8%          |
| 7. Peer isolation                          | 875           | 12.9%         | 679           | 14.6%         | 99            | 9.7%          | 97            | 8.6%          |
| 8. Lower household income (<3,000,000)      | 750           | 11.0%         | 486           | 10.4%         | 119           | 11.7%         | 145           | 12.8%         |
Table 3. Relationships between categories of adverse childhood experiences (ACEs).

| N and Percent (%) Exposed to Another ACEs | 1. Single Parenthood | 2. Parental History of Psychiatric Disorders | 3. Physical Abuse from Parents (Hit, Slap) | 4. Psychological Abuse from Parents (Verb) | 5. Witness of Domestic Violence between Parents | 6. Neglect from Parents (Out, Unfed) | 7. Peer Isolation | 8. Lower Household Income (<3,000,000) |
|------------------------------------------|----------------------|---------------------------------------------|-------------------------------------------|---------------------------------------------|---------------------------------------------|------------------------|------------------|-----------------------------------|
| n %                                       | n %                  | n %                                        | n %                                       | n %                                        | n %                                        | n %                    | n %              | n %                  |
| 1. Single parenthood                      | 112 11.4             | 119 12.4                                   | 46 4.8                                    | 30 3.1                                     | 102 10.6                                   | 140 14.7               | 487 61.5         |                     |
| 2. Parental history of psychiatric disorders | 112 22.2             | 67 13.4                                    | 48 9.6                                    | 39 7.8                                     | 60 12.0                                    | 70 14.1                | 99 22.1         |                     |
| 3. Physical abuse from parents (hit, slap) | 119 19.3             | 67 10.9                                    | 122 19.9                                  | 71 11.6                                    | 174 28.3                                   | 93 15.6                | 105 20.0         |                     |
| 4. Psychological abuse from parents (verb) | 46 15.7              | 48 16.3                                    | 122 41.6                                  | 67 22.9                                    | 82 27.9                                    | 58 20.2                | 43 16.5         |                     |
| 5. Witness of domestic violence between parents | 30 10.3              | 71 24.4                                    | 67 23.0                                   | 60 20.6                                    | 46 16.1                                    | 43 17.1                |                 |                     |
| 6. Neglect from parents (out, unfed)     | 102 18.8             | 60 11.1                                    | 174 32.2                                  | 82 15.2                                    | 60 8.1                                     | 90 17.0                | 88 18.7         |                     |
| 7. Peer isolation                        | 24 26.4              | 70 8.0                                     | 93 10.8                                   | 58 6.7                                     | 46 5.3                                     | 90 10.5                | 119 15.5        |                     |
| 8. Lower household income (<3,000,000)   | 487 64.9             | 99 13.2                                    | 105 14.4                                  | 43 5.9                                     | 43 5.9                                     | 88 12.0                | 119 16.3        |                     |
3.2. The Association between ACEs and Time Spent Playing Video Games

The results of the ordinal logistic regression analysis are shown in Table 4. The cumulative number of ACEs was found to have a positive association with time spent playing video games, after adjusting for covariates ($p$ for trend < 0.001). After adjusting for covariates, the odds ratio (OR) of ACEs was significant (1 ACE: OR = 1.28, 95% CI = 1.10–1.48; 2 ACEs: OR = 1.25, 95% CI = 1.06–1.48; 3+ ACEs: OR = 1.44, 95% CI = 1.14–1.82, $p$ for trend < 0.001). Regarding each type of ACE, the ORs of single parenthood (OR = 1.60, 95% CI = 1.35–1.90), parental history of psychiatric disorders (OR = 1.68, 95% CI = 1.35–2.10), peer isolation (OR = 1.31, 95% CI = 1.10–1.54), and lower household income (OR = 1.51, 95% CI = 1.24–1.83) were significant after adjusting for covariates. In Model 3, which added not only covariates, but also types of ACE that were associated with time spent playing video games (i.e., single parenthood, parental history of psychiatric disorders, peer isolation, and lower household income), it was found that single parenthood (OR = 1.55, 95% CI = 1.21–1.97), parental history of psychiatric disorders (OR = 1.62, 95% CI = 1.28–2.04), and peer isolation (OR = 1.32, 95% CI = 1.10–1.58) were independently associated with time spent playing video games.

| Table 4. The associations between ACEs and time spent playing video games. |
|-------------------------------------------------|-----------------|-----------------|-----------------|-----------------|
| ACE total score | Crude | Model 1 | Model 2 | Model 3 |
| 0 | Ref | Ref | Ref | Ref |
| 1 | 1.29 (1.12–1.48) | 1.28 (1.10–1.48) | 1.26 (1.10–1.48) | 1.25 (1.10–1.48) |
| 2 | 1.49 (1.28–1.75) | 1.25 (1.06–1.48) | 1.44 (1.14–1.82) | 1.44 (1.14–1.82) |
| 3+ | 1.67 (1.34–2.06) | 1.44 (1.14–1.82) | 1.44 (1.14–1.82) | 1.44 (1.14–1.82) |
| $p$ for trend | < 0.001 | < 0.001 | < 0.001 | < 0.001 |
| Single parenthood | No | Ref | Ref | Ref |
| Yes | 1.58 (1.35–1.84) | 1.60 (1.35–1.90) | 1.55 (1.21–1.97) | 1.55 (1.21–1.97) |
| Parental history of psychiatric disorders | No | Ref | Ref | Ref |
| Yes | 1.64 (1.34–2.02) | 1.68 (1.35–2.10) | 1.62 (1.28–2.04) | 1.62 (1.28–2.04) |
| Physical abuse from parents (hit, slap) | No | Ref | Ref | Ref |
| Yes | 1.05 (0.86–1.27) | 0.93 (0.76–1.14) | 0.93 (0.76–1.14) | 0.93 (0.76–1.14) |
| Psychological abuse from parents (verb) | No | Ref | Ref | Ref |
| Yes | 1.04 (0.79–1.37) | 1.05 (0.78–1.41) | 1.05 (0.78–1.41) | 1.05 (0.78–1.41) |
| Witness of domestic violence between parents | No | Ref | Ref | Ref |
| Yes | 1.08 (0.83–1.39) | 1.14 (0.87–1.50) | 1.14 (0.87–1.50) | 1.14 (0.87–1.50) |
| Neglect from parents (out, unfed) | No | Ref | Ref | Ref |
| Yes | 1.05 (0.85–1.28) | 0.95 (0.77–1.17) | 0.95 (0.77–1.17) | 0.95 (0.77–1.17) |
| Peer isolation | No | Ref | Ref | Ref |
| Yes | 1.60 (1.37–1.86) | 1.31 (1.10–1.54) | 1.32 (1.10–1.58) | 1.32 (1.10–1.58) |
| Lower household income (<3,000,000) | No | Ref | Ref | Ref |
| Yes | 1.49 (1.25–1.77) | 1.51 (1.24–1.83) | 1.51 (1.24–1.83) | 1.15 (0.90–1.47) |

Note. All analyses were weighted for grade. Model 1 adjusted child’s sex, grade, number of sibling, maternal age, and child’s schools. Model 2, which examined the association of each type of ACE with playing time of game independently, adjusted child’s sex, grade, number of sibling, maternal age, and child’s schools. Model 3 added type of ACE which were significant in Model 2. ACE = adverse childhood experience, OR = odds ratio, 95% CI = 95% confidence interval.

4. Discussion

The current study found a positive relationship between the cumulative number of ACEs, which included the experiences of peer isolation and lower household income, and more time spent playing video games among Japanese adolescents. Specifically, adolescents living in single-parent families, adolescents who had parents with a history of psychiatric disorders, and adolescents with the experiences of peer isolation were more likely to spend...
time playing videogames per day on weekdays than those without such experiences. These three types of ACE were independently associated with longer amounts of time spent playing video games. Even though there is no consistent and standardized definition of excessive time spent playing video games, a previous study showed that adolescents who categorized as clinical group of IGD spent 27.8 h (SD = 13.3), those at risk of IGD spent 20.8 h (SD = 16.3), and those without problems spent 4.8 h (SD = 8.1) playing video games per week [30]. The categorical variable of time spent playing video games used in this study (i.e., “1 h or less”, “3 h or less”, and “more than 3 h”) is broadly similar to the average of time spent playing video games among IGD classification groups.

Our findings, which had a positive relationship between ACEs and time spent playing video games, were consistent with the results of a previous study focusing on problematic video gaming among gamers [21]. ACEs might already impact the amount of time adolescents spend playing video games, which would be consistent with findings from previous studies examining the adverse impact of ACEs and other addictive behaviors in adolescence [18–20]. Furthermore, the results for each type of ACE, single parenthood, paternal history of psychiatric disorders, and peer isolation were associated with longer time spent playing video games, which is consistent with previous longitudinal and cross-sectional studies [31–33]. However, child maltreatment (physical abuse, psychological abuse, witness to domestic violence between parents, and neglect in this study) showed no significant association with time spent playing video games. Although a few studies have examined the association between child maltreatment and problematic gaming among children and adolescents [31,34,35], two studies focusing on physical abuse showed no association [31,34]. In this study, we might assess slight-to-moderate child maltreatment rather than severe child maltreatment. Moreover, we could not assess sexual abuse. Thus, the caregivers who reported child maltreatment as a form of strict discipline might also be strict in dictating the amount of time the child is allowed to play video games. Further studies need to examine the association between severe child maltreatment and time spent playing video games.

The positive association between the cumulative number of ACEs and time spent playing video games in adolescents may be explained by the following psychological and biological mechanisms. In terms of psychological mechanism, attachment style or child–parent relationship may mediate the association between ACEs and longer time spent playing video games. The previous systematic reviews regarding adolescent problematic gaming indicate that a poor parent–child relationship is a critical risk factor for problematic gaming including IGD [11,36,37]. A poor parent–child relationship may lead to less time to communicate with family members, which may increase the amount of time spent playing video games [38]. Additionally, a poor parent–child relationship may affect parental supervision and care for the child. Thus, adolescents who live in single-parent families or have parents with a history of psychiatric disorders might be less likely to be supervised and cared for by their parents [31]. Moreover, Zhu et al. [39] found that poor parent–child relationships had an indirect effect on IGD via poor school connectedness. Additionally, another study indicated that children with lower levels of social integration into school classes were more likely to be at a higher risk of video game addiction [31], as peer isolation was associated with longer time spent playing video games in this study. Children with poor peer relationships might be more likely to engage in virtual worlds instead of real life.

In terms of biological mechanism, structural and functional brain alterations [40] might mediate the association between ACE and time spent playing video games. For example, Herzog and Schmahl [40] indicated that ACEs led to structural and functional alterations of the anterior cingulate cortex (ACC) and hippocampus, which are related to the ability of error monitoring [41] and self-regulation [42]. Adolescents with ACEs showed lower levels of self-regulation skills, which were assessed using a flanker task [43]. Numerous studies have found dysfunction of self-regulation skills to be associated with IGD among adolescents [44,45]. Furthermore, as a bio-psychological mechanism, ACEs may induce biological changes such as stress-related inflammation including C-reactive
protein (CRP), interleukin 6 (IL-6), and soluble urokinase plasminogen activator receptor (suPAR) [46], structural and functional brain alterations including ACC, hippocampus, and amygdala [40], which may lead to mental health problems. As the interaction with poor mental health status and longer time spent playing games has been found [36], we cannot assure a causal relationship. Instead, we can merely recognize that adolescents with mental health problems such as depression due to ACEs may be more likely to spend time playing games.

The current study has the following limitations. First, we cannot suggest a causal relationship between ACEs and time spent playing games due to the cross-sectional study, that is, reverse causation is likely. As for peer isolation, adolescents who spend longer amounts of time playing games might struggle with having friends with whom they can consult. Further longitudinal studies that examine the causal relationships are needed. Second, sexual abuse was not included in ACEs. In Japan, the prevalence of sexual abuse is low (0.5%) [47] and sexual abuse is considered to be a sensitive issue [48]. Thus, asking about sexual abuse may cause a lower response rate [49]. Third, almost all types of ACEs were assessed on the caregiver’s questionnaire because we avoided the adolescent’s psychological invasiveness, which might cause information bias. There might be discrepancies between the caregiver’s and child’s reports related on ACEs such as abuse and neglect. Fourth, there might be sampling bias related to responses to the questionnaire due to a lower response rate from adolescents with ACEs and their caregivers. Fifth, the study did not assess the time spent playing games on weekends due to the logistics of implementing the study. Although previous studies have confirmed the correlation between weekday and weekend time spent playing games, further study should include the time spent playing games on the weekend.

To prevent longer times spent playing video games in adolescents and eventually to prevent IGD and GD in children and adolescents, the development of self-regulation skills might need to be addressed in schools [50], targeting those who experienced ACEs, especially children and adolescents with single parents, parental history of psychiatric disorders, and peer isolation. Additionally, providing opportunities to increase time spent on other leisure-time activities, aside from gaming for adolescents with ACEs, may be helpful [51–53]. For parents who are single or have a history of psychiatric disorders, education on how to supervise their child’s use of games might be needed [54].

5. Conclusions

We found that the cumulative number of ACEs was associated with longer time spent playing video games in adolescents. Regarding the types of ACEs, single parenthood, parental history of psychiatric disorders, and peer isolation were independently associated with longer times spent playing video games. To develop a population approach program designed to prevent longer times spent playing video games in adolescents, it may be needed to assess not only family background and relationships with their peers.

Author Contributions: T.F. designed the study, supervised the analysis, and undertook the critical revision of the manuscript. S.D. conducted literature searches, provided summaries of previous research studies, conducted the statistical analysis, and wrote the first draft of the manuscript. A.I. developed the study method. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by a Health Labor Sciences Research Grant, Comprehensive Research on Lifestyle Disease from the Japanese Ministry of Health, Labor and Welfare (H27-Jyunkankito-ippan-002); Research of Policy Planning and Evaluation from the Japanese Ministry of Health, Labor and Welfare (H29-Seisaku-Shitei-004); Innovative Research Program on Suicide Countermeasures (IRPSC); Grants-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (JSPS KAKENHI Grant Number 16H03276, 16K21669, 17J05974, 17K13245, 19K19310, 19K14029, 19K19309, 19K20109, 19K14172, 19J01614, 19H04879, 20K13945, and 21H04848); St. Luke’s Life Science Institute Grants; and the Japan Health Foundation Grants.
Institutional Review Board Statement: This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the institutional review board at the Tokyo Medical and Dental University.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to ethical restrictions.

Acknowledgments: We are grateful to the staff members and central office of Adachi City Hall for conducting the survey. We would like to thank everyone who participated in the survey.

Conflicts of Interest: The authors declare no conflict of interest.

References
1. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-5®); American Psychiatric Association Publising: Washington, DC, USA, 2013.
2. World Health Organization. International Classification of Diseases for Mortality and Morbidity Statistics (11th Revision). Available online: https://icd.who.int/browse11/l-m/en (accessed on 31 August 2021).
3. Ferreira, F.D.M.; Bambini, B.B.; Tonsig, G.K.; Fonseca, L.; Picon, F.A.; Pan, P.M.; Salum, G.A.; Jackowski, A.; Miguel, E.C.; Rohde, L.A.; et al. Predictors of Gaming Disorder in Children and Adolescents: A School-Based Study. Braz. J. Psychiatry 2020, 43, 289–292. [CrossRef] [PubMed]
4. Gentile, D.A.; Choo, H.; Liu, A.; Sim, T.; Li, D.; Fung, D.; Khoo, A. Pathological Video Game Use among Youths: A Two-Year Longitudinal Study. Pediatrics 2011, 127, e319–e329. [CrossRef] [PubMed]
5. Marker, C.; Gnambs, T.; Appel, M. Exploring the Myth of the Chubby Gamer: A Meta-Analysis on Sedentary Video Gaming and Body Mass. Soc. Sci. Med. 2019, 112325. [CrossRef] [PubMed]
6. Bélanger, R.E.; Akre, C.; Berchtold, A.; Michaud, P.A. A U-Shaped Association between Intensity of Internet Use and Adolescent Health. Pediatrics 2011, 127, e330–e335. [CrossRef] [PubMed]
7. Weaver, E.; Gradisar, M.; Dohnt, H.; Lovato, N.; Douglas, P. The Effect of Presleep Video-Game Playing on Adolescent Sleep. J. Clin. Sleep Med. 2010, 6, 184–189. [CrossRef] [PubMed]
8. Coyne, S.M.; Stockdale, L.A.; Warburton, W.; Gentile, D.A.; Yang, C.; Merrill, B.M. Pathological Video Game Symptoms from Adolescence to Emerging Adulthood: A 6-Year Longitudinal Study of Trajectories, Predictors, and Outcomes. Dev. Psychol. 2020, 56, 1385. [CrossRef] [PubMed]
9. Männikkö, N.; Ruotsalainen, H.; Miettunen, J.; Pontes, H.M.; Kääräinen, M. Problematic Gaming Behaviour and Health-Related Outcomes: A Systematic Review and Meta-Analysis. J. Health Psychol. 2020, 25, 67–81. [CrossRef] [PubMed]
10. Ferguson, C.J. Do Angry Birds Make for Angry Children? A Meta-Analysis of Video Game Influences on Children’s and Adolescents’ Aggression, Mental Health, Prosocial Behavior, and Academic Performance. Perspect. Psychol. Sci. 2015, 10, 646–666. [CrossRef]
11. Schneider, L.A.; King, D.L.; Delfabbro, P.H. Family Factors in Adolescent Problematic Internet Gaming: A Systematic Review. J. Behav. Addict. 2017, 6, 321–333. [CrossRef]
12. Bender, P.K.; Kim, E.L.; Gentile, D.A. Gaming Disorder in Children and Adolescents: Risk Factors and Preventive Approaches. Curr. Addict. Rep. 2020, 7, 553–560. [CrossRef]
13. Yang, X.; Jiang, X.; Mo, P.K.H.; Cai, Y.; Ma, L.; Lau, J.T.F. Prevalence and Interpersonal Correlates of Internet Gaming Disorders among Chinese Adolescents. Int. J. Environ. Res. Public Health 2020, 17, 579. [CrossRef] [PubMed]
14. Rasmussen, M.; Meilstrup, C.R.; Bendtsen, P.; Pedersen, T.P.; Nielsen, L.; Madsen, K.R.; Holstein, B.E. Perceived Problems with Computer Gaming and Internet Use Associated with Poorer Social Relations in Adolescence. Int. J. Public Health 2015, 60, 179–188. [CrossRef]
15. Lee, C.; Kim, O. Predictors of Online Game Addiction among Korean Adolescents. Addict. Res. Theory 2017, 25, 58–66. [CrossRef]
16. Felitti, V.J.; Anda, R.F.; Nordenberg, D.; Williamson, D.F.; Spitz, A.M.; Edwards, V.; Koss, M.P.; Marks, J.S. Relationship of Childhood Abuse and Household Dysfunction to Many of the Leading Causes of Death in Adults. The Adverse Childhood Experiences (ACE) Study. Am. J. Prev. Med. 1998, 14, 245–258. [CrossRef]
17. Finkelhor, D.; Shattuck, A.; Turner, H.; Hamby, S. A Revised Inventory of Adverse Childhood Experiences. Child Abus. Negl. 2015, 48, 13–21. [CrossRef] [PubMed]
18. Marchica, L.A.; Keough, M.T.; Montreuil, T.C.; Derevensky, J.L. Emotion Regulation Interacts with Gambling Motives to Predict Problem Gambling among Emerging Adults. Addict. Behav. 2020, 106, 106378. [CrossRef]
19. Afifi, T.O.; Taillieu, T.; Salmon, S.; Davila, I.G.; Stewart-Tufescu, A.; Fortier, J.; Struck, S.; Asmundson, G.J.G.; Sareen, J.; MacMillan, H.L. Adverse Childhood Experiences (ACES), Peer Victimization, and Substance Use among Adolescents. Child Abus. Negl. 2020, 106, 104504. [CrossRef]
20. Sharma, A.; Sacco, P. Adverse Childhood Experiences and Gambling: Results from a National Survey. J. Soc. Work. Pract. Addict. 2015, 15, 25–43. [CrossRef]
21. Grajewski, P.; Dragan, M. Adverse Childhood Experiences, Dissociation, and Anxious Attachment Style as Risk Factors of Gaming Disorder. *Addict. Behav.* Rep. 2020, 11, 100269. [CrossRef]

22. Crews, F.; He, J.; Hodge, C. Adolescent Cortical Development: A Critical Period of Vulnerability for Addiction. *Pharmacol. Biochem. Behav.* 2007, 86, 189–199. [CrossRef]

23. Ochi, M.; Isumi, A.; Kato, T.; Doi, S.; Fujiwara, T. Adachi. Child Health Impact of Living Difficulty (a-Child) Study: Research Protocol and Profiles of Participants. *J. Epidemiol.* 2021, 31, 77–89. [CrossRef]

24. Isumi, A.; TFujiwara, a.; Nawa, N.; Ochi, M.; Kato, T. Mediating Effects of Parental Psychological Distress and Individual-Level Social Capital on the Association between Child Poverty and Maltreatment in Japan. *Child Abus. Negl.* 2018, 83, 142–150. [CrossRef] [PubMed]

25. Li, W.; Zhang, X.; Chu, M.; Li, G. The Impact of Adverse Childhood Experiences on Mobile Phone Addiction in Chinese College Students: A Serial Multiple Mediator Model. *Front. Psychol.* 2020, 11, 834. [CrossRef]

26. Cacioppo, M.; Barni, D.; Correale, C.; Mangialavori, S.; Danioni, F.; Gori, A. Do Attachment Styles and Family Functioning Predict Adolescents’ Problematic Internet Use? A Relative Weight Analysis. *J. Child Fam. Stud.* 2019, 28, 1263–1271. [CrossRef]

27. Doidge, J.C.; Higgins, D.J.; Delfabbro, P.; Segal, L. Risk Factors for Child Maltreatment in an Australian Population-Based Birth Cohort. *Child Abus. Negl.* 2017, 64, 47–60. [CrossRef] [PubMed]

28. Yang, S.-J.; Stewart, R.; Lee, J.; Kim, J.; Kim, S.; Shin, I.; Yoon, J. Prevalence and Correlates of Problematic Internet Experiences and Computer-Using Time: A Two-Year Longitudinal Study in Korean School Children. *Psychiatry Investig.* 2014, 11, 24. [CrossRef]

29. Yu, Q.; Zhang, L.; Wu, S.; Guo, Y.; Jin, S.; Sun, Y. The Influence of Juvenile Preference for Online Social Interaction on Problematic Internet Use: The Moderating Effect of Sibling Condition and the Moderated Moderating Effect of Age Cohort. *Comput. Hum. Behav.* 2017, 68, 345–351. [CrossRef]

30. Herzog, J.I.; Schmahl, C. Adverse Childhood Experiences and the Consequences on Neurobiological, Psychosocial, and Somatic Stress Exposure. *Front. Psychiatry* 2020, 11, 38. [CrossRef] [PubMed]

31. Hall, J.R.; Bernat, E.M.; Patrick, C.J. Externalizing Psychopathology and the Error-Related Negativity. *Psychol. Sci.* 2019, 30, 71–83. [CrossRef] [PubMed]

32. Yu, C.; Li, W.; Liang, Q.; Liu, X.; Zhang, W.; Lu, H.; Dou, K.; Xie, X.; Gan, X. School Climate, Loneliness, and Problematic Online Game Use among Chinese Adolescents: The Moderating Effect of Intentional Self-Regulation. *Front. Public Health* 2019, 7, 90. [CrossRef]

33. Moilanen, K.L.; Shaw, D.S.; Criss, M.M.; Dishion, T.J. “Growth and Predictors of Parental Knowledge of Youth Behavior During Early Adolescence: Results of a German Nationwide Survey.” *Cyberpsychol. Behav. Soc. Netw.* 2010, 13, 269–277. [CrossRef]

34. Moilanen, K.L.; Shaw, D.S.; Criss, M.M.; Dishion, T.J. “Growth and Predictors of Parental Knowledge of Youth Behavior During Early Adolescence: Results of a German Nationwide Survey.” *Cyberpsychol. Behav. Soc. Netw.* 2010, 13, 269–277. [CrossRef]

35. Liu, T.; Parental Mental Health and Internet Addiction in Adolescents. *Addict. Behav.* 2015, 42, 20–23. [CrossRef]

36. Rehbein, F.; Baier, D. Family-, Media-, and School-Related Risk Factors of Video Game Addiction. *J. Media Psychol.* 2013, 25. [CrossRef]

37. Lackner, C.L.; Santesso, D.L.; Rigter, H. Parental and Family Factors Associated with Problematic Gaming and Psychiatric Symptoms among Adolescents in Two Samples. *Addict. Behav.* 2016, 61, 8–15. [CrossRef]

38. Sugaya, N.; Shirasaka, T.; Takahashi, K.; Kanda, H. Bio-Psychosocial Factors of Children and Adolescents with Internet Gaming Disorder: A Systematic Review. *Biopsychosoc. Med.* 2019, 13, 3. [CrossRef]

39. Nielsen, P.; Favez, N.; Rigter, H. Parental and Family Factors Associated with Problematic Gaming and Problematic Internet Use in Adolescents: A Systematic Literature Review. *Curr. Addict. Rep.* 2020, 7, 365–386. [CrossRef]

40. Moilanen, K.L.; Shaw, D.S.; Criss, M.M.; Dishion, T.J. “Growth and Predictors of Parental Knowledge of Youth Behavior During Early Adolescence.” *J. Early Adolesc.* 2009, 29, 800–825. [CrossRef] [PubMed]

41. Zhu, J.; Zhang, W.; Yu, C.; Bao, Z. Early Adolescent Internet Game Addiction in Context: How Parents, School, and Peers Impact Youth. *Comput. Hum. Behav.* 2015, 50, 159–168. [CrossRef]

42. Hu, J.; Schmahl, C. Adverse Childhood Experiences and the Consequences on Neurobiological, Psychosocial, and Somatic Conditions across the Lifespan. *Front. Psychiatry* 2018, 9, 420. [CrossRef]

43. Hall, J.R.; Bernat, E.M.; Patrick, C.J. Externalizing Psychopathology and the Error-Related Negativity. *Psychol. Sci.* 2007, 18, 326–333. [CrossRef] [PubMed]

44. Van Bodegom, M.; Homberg, J.R.; Henckens, M.J.A.G. Modulation of the Hypothalamic-Pituitary-Adrenal Axis by Early Life Stress Exposure. *Front. Cell. Neurosci.* 2017, 11, 87. [CrossRef]

45. Lackner, C.L.; Santesso, D.L.; Dywan, J.; O’Leary, D.D.; Wade, T.J.; Segalowitz, S.J. Adverse Childhood Experiences Are Associated with Self-Regulation and the Magnitude of the Error-Related Negativity Difference. *Biol. Psychol.* 2018, 132, 244–251. [CrossRef]

46. Wichstrom, L.; Stenseng, F.; Belsky, J.; von Soest, T.; Weinstock, J.; van Soest, T.; Hygen, B.W. Symptoms of Internet Gaming Disorder in Youth: Predictors and Comorbidity. *J. Abnorm. Child Psychol.* 2019, 47, 71–83. [CrossRef]

47. Liu, A.K.; Neo, E.C.; Gentile, D.A.; Choo, H.; Sim, T.; Li, D.; Khoo, A. Impulsivity, Self-Regulation, and Pathological Video Gaming among Youth: Testing a Mediation Model. *Asian Pac. J. Public Health* 2015, 27, NP2188–NP2196. [CrossRef]
48. Yoshihama, M.; Horrocks, J. Risk of Intimate Partner Violence: Role of Childhood Sexual Abuse and Sexual Initiation in Women in Japan. *Child. Youth Serv. Rev.* 2010, 32, 28–37. [CrossRef]

49. Ishii, T.; Asukai, N.; Konishi, T.; Inamoto, E.; Kageyama, H. Mental Health Effects of Child Sexual Victimization in Japan. *Jpn. J. Ment. Health* 2002, 15, 23–28.

50. Pandey, A.; Hale, D.; Das, S.; Goddings, A.; Blakemore, S.; Viner, R.M. Effectiveness of Universal Self-Regulation–Based Interventions in Children and Adolescents: A Systematic Review and Meta-Analysis. *JAMA Pediatrics* 2018, 172, 566–575. [CrossRef]

51. Rose, T.; Barker, M.; Jacob, C.M.; Morrison, L.; Lawrence, W.; Strömer, S.; Vogel, C.; Woods-Townsend, K.; Farrell, D.; Inskip, H. A Systematic Review of Digital Interventions for Improving the Diet and Physical Activity Behaviors of Adolescents. *J. Adolesc. Health* 2017, 61, 669–677. [CrossRef]

52. Pluta, B.; Bronikowska, M.; Tomczak, M.; Laudarna-Krzemińska, I.; Bronikowski, M. Family Leisure-Time Physical Activities–Results of the “Juniors for Seniors” 15-Week Intervention Programme. *Biomed. Hum. Kinet.* 2017, 9, 165–174. [CrossRef]

53. Cronholm, F.; Rosengren, B.E.; Karlsson, C.; Karlsson, M.K. A Physical Activity Intervention Program in School Is Also Accompanied by Higher Leisure-Time Physical Activity: A Prospective Controlled 3-Year Study in 194 Prepubertal Children. *J. Phys. Act. Health* 2017, 14, 301–307. [CrossRef] [PubMed]

54. Krossbakken, E.; Torsheim, T.; Mentzoni, R.A.; King, D.L.; Bjorvatn, B.; Lorvik, I.M.; Pallesen, S. The Effectiveness of a Parental Guide for Prevention of Problematic Video Gaming in Children: A Public Health Randomized Controlled Intervention Study. *J. Behav. Addict.* 2018, 7, 52–61. [CrossRef] [PubMed]