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FULL-LENGTH REPORT

The relationship of game genres, in-game purchases, and playing duration with probable gaming disorder in two independent, large-scale online surveys of Japanese adults

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ABSTRACT

Background and aims: Game genres, availability on smartphones, in-game purchases, and playing duration, have been thought to influence Gaming Disorder (GD). However, little research has comprehensively examined their relationships with GD. Therefore, we examined the relationship between GD, in-game purchases, gaming duration via consoles and smartphones, and genres of smartphone games. Study 1 was based on self-reports, and Study 2 included objective data to clarify these associations. *Methods:* We conducted two independent online surveys that collected socio-demographic data, game use patterns, and psychopathological assessment data, including GD severity (Study 1: $N = 32{,}690$; Study 2: $N = 3{,}163$). General mental illness scores and objective gaming time were also collected in Study 2. *Results:* In Study 1, in-game purchases, several gaming genres, and subjective gaming duration were positively associated with probable GD. On the other hand, interactions between card games and loot box charges were negatively related to probable GD. In Study 2, objective gaming times of most game genres were not associated with GD. Although the correlation between subjective and objective gaming duration was moderate, their correlations with GD differed. *Discussion and conclusion:* These results suggest the complexity of relationships between GD and in-game purchases, genres, and gaming duration. Results of this study suggest the importance of proper assessment of GD reflecting actual functional impairment in social life. Future studies should improve and update evaluation of assessments for gaming.

KEYWORDS

gaming disorder, loot box, microtransaction, game genre, objective assessment

INTRODUCTION

Gaming Disorder (GD) has received increased attention with its inclusion among official criteria of the International Classification of Diseases, 11th Edition (ICD-11) (World Health Organization, 2019) in 2019 and the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) (American Psychiatric Association, 2013) in 2013, as a pre-diagnosis mental disorder named "internet gaming disorder." It has also been suggested that the prevalence and risk of this disorder were exacerbated because of increased time at home due

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to COVID-19 (Pallavicini, Pepe, & Mantovani, 2022). Digital addiction problems like GD are thought to be the result of a complex interplay of environmental, motivational, and biological domains (Brand, Young, Laier, Wölfling, & Potenza, 2016, 2019; Kakul & Javed, 2023), but there is still no consensus on what elements are important.

Moreover, with the advent of smartphones and other mobile devices, GD has been exacerbated by game accessibility from anywhere (Gilman et al., 2015; Kim, Choi, & Kim, 2020; Mourra et al., 2020). Although some research suggests that smartphone games are less associated with GD than other devices such as game consoles (Higuchi, Nakayama, Matsuzaki, Mihara, & Kitayuguchi, 2021), mobile video games, with their distinctive qualities of portability, immediacy, and accessibility, may increase the risk of addictive behaviors and mental health problems (Wang, Sheng, & Wang, 2019). It has also been suggested that disruptive and habitual smartphone use, such as excessive use of mobile games, may impede the ability to exert prolonged mental effort, making it imperative to understand the mechanisms and identify elements that are closely related to these problems (Aru & Rozgonjuk, 2022).

The nature of gaming systems has changed with widespread use of smartphones. For example, some games implement microtransactions (King & Delfabbro, 2019), such as a system to purchase in-game currency, virtual goods, "textures/skins" that can be purchased with real money, or a "loot box" (King & Delfabbro, 2018), in which "valuable" in-game items that enhance gameplay can be obtained with a probability. Since multiple microtransactions and loot boxes can be acquired through gameplay, the desire to obtain more microtransactions and loot boxes may increase playing time, forming a vicious cycle that worsens excessive gaming (Drummond, Sauer, Ferguson, & Hall, 2020). Since such in-game purchasing systems are reportedly implemented more in smartphone applications (Zendle, Meyer, Cairns, Waters, & Ballou, 2020), examining the relationship between smartphone gameplay and these systems is important. In addition, GD is also affected by the genre and structure of each game (King, Delfabbro, Perales, et al., 2019; Na et al., 2017; Rehbein, King, Staudt, Hayer, & Rumpf, 2021). MMORPGs, First Person Shooters (FPS), and real-time strategy games are associated with higher levels of pathological gameplay (Lemmens & Hendriks, 2016). Another study reported higher GD scores in action/adventure and other games for both men and women (Laconi, Pirès, & Chabrol, 2017).

Although several researchers have investigated the relationship between GD, in-game purchases (loot boxes/microtransactions), and game genres, the interaction of loot boxes and game genres on GD remains unclear (Yokomitsu, Irie, Shinkawa, & Tanaka, 2021). Such in-game purchase systems have been concerned with gambling-like features in hooking players for longer and letting them incur high costs in video games (King, Delfabbro, Gainsbury, et al., 2019; Király, Zhang, Demetrovics, & Browne, 2021). Also, few studies that have examined the relationship between these factors and GD have also taken into account the actual time spent consumed by each genre. Almost all previous studies have relied solely on self-reports (Rehbein et al., 2021), with little examination based on game performance using logs or other objective data. These issues could affect the results, given the relationship between gaming impairment and self-reported game-playing time (Király, Tóth, Urbán, Demetrovics, & Maraz, 2017) and the discrepancies between self-reports and objective data (Jin, Kittaneh, Sidhu, & Lechner, 2022; Parry et al., 2021). Moreover, few studies have used large samples (>3,000) to investigate these relationships. In particular, given the wide variety of mobile game genres and that systems such as loot boxes are more prevalent in mobile games, it is necessary to examine these interactions in relation to GD using large samples. Mobile game companies hold extensive data regarding user experience, e.g., when users purchase in-game content and what game genres are more addictive, with the clear aim of encouraging expenditures and time spent (King, Delfabbro, Gainsbury, et al., 2019). Clarifying these interrelationships could lead to creation of appropriate policies, consumer protection measures, ethical game design guidelines, and psychologically informed and individualized optimal interventions, to protect the well-being and interests of game players (Garrett, Drummond, Lowe-Calverley, & Sauer, 2023).

We examine the relationship between in-game purchase, genres, and objective gaming duration of GD, based on results of two independent, large surveys on smartphone gaming. Study 1 focused on self-report, while Study 2 emphasized objective data. In Study 1, we surveyed and analyzed GD severity, in-game purchases, subjective gaming duration via consoles and smartphones, and genres in smartphone games using a large online sample. However, we did not evaluate objective gaming duration of each genre and general mental health, which could be an important indicator of GD (King, Delfabbro, Perales, et al., 2019) in Study 1. Therefore, in Study 2, in addition to indicators used in Study 1, we conducted a similar analysis by adding a self-report well-being scale and objective gaming time for each genre using smartphone logs.

METHODS

General procedures

This study is part of a larger study on the association between problematic smartphone use and multidimensional psychiatric states (Hamamura et al., 2023; Oka, Kubo, et al., 2021a, b).

STUDY 1

Participants

We conducted an online survey using the platform of Macromill, Inc. (https://monitor.macromill.com/), the largest online survey company in Japan, from October 4th to 6th in 2021. Fifty thousand participants (20–50 years old)

answered our survey. All participants are monitored by the Macromil research service, i.e., they registered themselves as Marcomill users, and we paid a user fee for survey results through the system. The reason why we restricted the age was to assess younger people who use smartphones daily (Chen, Strong, et al., 2020; Leung et al., 2020; Tung et al., 2022; Yam et al., 2019). Of these, we excluded 11,916 participants because they did not have smartphones or play any smartphone games. Additionally, we excluded 5,394 participants for unreliable answers (inconsistencies or contradictions in their answers regarding the duration of smartphone gaming and smartphone usage). Thus, the final analysis included 32,690 participants.

Measures

Demographic data. Demographic data were collected: gender (women and men), age, and job status (self-employed and family-employed employee, unemployed and other).

Playing duration of smartphone and console gaming. We asked participants about daily gaming time via consoles and smartphones on weekdays and holidays separately ("For each of the following devices, what is your daily usage on weekdays or holidays, games on consoles (Nintendo Switch, Xbox, PlayStation, Wii, etc.), or games on smartphones?"). We scored each choice, e.g., 1: less than one hour; 13: more than 12 h (see Table S1 for details). We asked about the daily use of consoles because it is essential to distinguish their effect on GD from that of smartphone gaming. Participants answered the playing time from among options, e.g., if participants usually played games for two-half hours within a day, they answered by "less than 2–3 h" PC games were not included in the question because the study focused on mobile vs. console games, given the differences in barriers to entry and profit margins across devices (Yamaguchi, Iyanaga, Sakaguchi, & Tanaka, 2017).

Internet gaming disorder scale (IGDS). GD was measured according to the Japanese-version of the Internet Gaming Disorder Scale (IGDS), which consists of questions corresponding to each of the nine GD symptoms defined in the Diagnostic and Statistical Manual of Mental Disorders, fifth ed (DSM-5) (Lemmens, Valkenburg, & Gentile, 2015). Items using a binary format assessed the severity of each GD symptom during the preceding 12 months. At least five symptoms are required to return a determination of probable GD. Reliability and validity of the Japanese version of IGDS have been demonstrated with a Cronbach's alpha of 0.81 (Sumi et al., 2018). We defined probable GD as a total IGDS ≥5. We confirmed strong internal reliability in our samples (Cronbach's alpha is 0.81 in Study 1 and 0.81 in Study 2).

Game genre of each game title. We asked participants about the games they play via their smartphones ("Please name up to five games you play on your smartphone, in order of how long you spend playing them"). We picked the game title with the longest playing time for each subject, according to respondent self-reports. Two people labeled the game titles based on the *Google Play Store* category (Balakrishnan & Griffiths, 2019). If games represent two genres, e.g., Pokémon-Go: adventure-action, we extracted the first genre from Google Play (in the case of Pokémon-Go, "adventure"). Then, final labeling was narrowed to 11 genres, with more than 1% of users in the Study 1 population. Final labeling was as follows:

- puzzle, e.g., Woodoku
- role-playing, e.g., Pokémon Masters EX
- simulation, e.g., Animal Crossing: Pocket Camp
- action, e.g., NEW STATE MOBILE
- adventure, e.g., Pokémon-Go
- casual, e.g., Bubble Shooter
- sports, e.g., FIFA mobile
- music, e.g., Deemo
- strategy, e.g., Dino Bash: Dinosaur Battle
- card, e.g., Shadowverse
- casino, e.g., Coin Mania: Farm Dozer, and
- Others (games representing less than 1% of users in our sample or that could not be clearly identified based on Google play).

Loot boxes and other microtransactions. We asked participants about their spending on loot boxes per month ("How much money do you think you spend on Gacha each month?") and other microtransactions in games that they play ("Approximately how much money do you think you spend each month on other items and products in these games with real-world money?"). "Gacha" is the common name for a loot box in Japan and is especially common in smartphone games. Details of questions are described in Table S1. Note that respondent choices were transformed into units of 1,000 yen for this analysis. We asked about loot boxes and other microtransactions separately because their relationships with GD are considered different (Drummond, Hall, & Sauer, 2022).

Statistical analysis

Average GD severity and the prevalence of probable GD were calculated for each gender-age group and genre. Then, we conducted multivariate logistic regression analyses. The dependent variable was probable GD (IGDS ≥5). Independent variables were as follows: smartphone game time per day on weekdays and holidays, charges paid in loot boxes and other microtransactions, and game genre. In order to account for problems due to multicollinearity, indicators for weekday and holiday hours of game use were combined and used as independent variables via consoles or mobile devices, respectively. This analysis was controlled by sex and age, which were considered confounding factors contributing to GD via mobile applications. Two-way interactions were also tested to assess whether the association between GD of each genre varied with loot boxes and the amount of in-game purchase charge. A likelihood ratio test was used to examine whether including a genre and an in-game purchase

interaction term significantly improved the model's fit. To control confounding effects due to the mixed population that played smartphone and console games, we also conducted the same analyses extracting participants who played smartphone gaming time more than one *via* consoles. We used the variance inflation factor (VIF) to assess multicollinearity. A VIF greater than 2.5 indicates multicollinearity (Johnston et al., 2018). Statistical analyses were performed using Python 3.0.1 (Python Release Python 3.0.1, n.d.) and Matlab version R2020b (R2020b - Updates to the MATLAB and Simulink Product Families, n.d.). Statistical tests assumed a significance level α of 5%.

STUDY 2

Participants

Gaming duration data via smartphone logs were collected for 14,035 respondents in July 2022. We also conducted an online survey of the same population and obtained 4,580 participants from October 26 to November 8 in 2022. All participants are monitors of the Macromil research service. The survey was distributed to game log providers who have an application installed to provide game logs. We paid for surveys and collection of gaming logs, separately. We did not restrict the age of this population, collecting data for all people who played smartphone games. Of these, we excluded 1,417 participants following the criteria of Study 1. In the final analysis, we included 3,163 participants. Though the response rate was relatively low in Study 2 and there were significant differences in demographics and gaming performance between responders and non-responders. Effect sizes were small (gender: $\chi^2 = 5.65$, $p = 0.02$, $\phi = 0.02$, age: $t = 6.42$, $p < 0.001$, Cohen's $d = 0.06$, average time spent gaming per a month: $t = 5.78$, $p < 0.001$, Cohen's $d = 0.12$).

Measures

This survey was almost the same as Study 1 except for collection of demographic data and a questionnaire to assess general mental health.

Demographic data. In addition to Study 1, the following demographic data were collected: marital status, the existence of children, and household income.

Kessler Psychological Distress Scale (K6) scale. The Kessler Psychological Distress Scale (K6) is a questionnaire designed to screen for mental disorders, such as depression and anxiety (Kessler et al., 2002). It is intended for a general population and quantifies psychological stress, psychological problems, and well-being. The reliability and validity of the Japanese version of K6 have been demonstrated with a Cronbach's alpha of 0.85 (Sakurai, Nishi, Kondo, Yanagida, & Kawakami, 2011). Cronbach's alpha is 0.91 in our sample, which indicates strong internal reliability.

Objective gaming time via smartphone logs. As mentioned above, objective indicators, such as logs, are important for problematic media use (Jin et al., 2022; Parry et al., 2021). Therefore, Study 2 used logged gaming duration as an objective indicator in addition to subjective evaluation scales. These logs were collected via the application developed by Macromill, Inc. The gaming duration of each game genre was also summed per month. Gaming genres were labeled as in Study 1. Participants had an application installed to provide game logs. Participants provided their data upon agreeing to participate, and data provided were managed with a dedicated ID, which ensured anonymity. Recorded data were stored on a dedicated server at Macromill. As for monthly totals, daily game time and monthly game time were calculated for users who have smartphone logs at the beginning and end of the month. Also, all smartphone applications that had been processed at the front-end were acquired, and only game apps were extracted from these applications. The Google Android API was used for logging app usage when the screen was turned.

Statistical analysis

Average GD severity, prevalence, and gaming duration based on objective logs were calculated for each gender-age group and genre. We also conducted multivariate logistic regression analyses as in Study 1. In this analysis, we added K6 scores and objective gaming duration of each genre via smartphone logs. We did not include total playing time per month from the logs, in order to avoid multicollinearity. Also, in Study 2, marital status and the existence of children were added as control variables, based on previous studies (Mihara & Higuchi, 2017; Oka, Hamamura, et al., 2021a, b). Then, testing of two-way interactions was also added to assess whether the association between GD and gaming duration of each genre varied with loot boxes or the amount of in-game purchases. Also, we checked discrepancies between subjective and objective gaming duration. Statistical software was the same as in Study 1.

Ethics

This study was approved by the Ethics Committee of the Advanced Telecommunications Research Institute International (Japan) (No. 182, 749, and 756-2). All participants gave informed consent before responding to the surveys employed in this study.

RESULTS

STUDY 1

The average age was 33.9 years [standard deviation (SD) = 7.29], and 44.4% were male. Descriptive results in Study 1 are shown in Supplementary results (see Tables S2, S3, and S4). A multiple logistic regression analysis with main effects was used to examine effects of each independent variable on probable GD, controlled by sex and age (Fig. 1A). Correlation coefficients between several variables were high

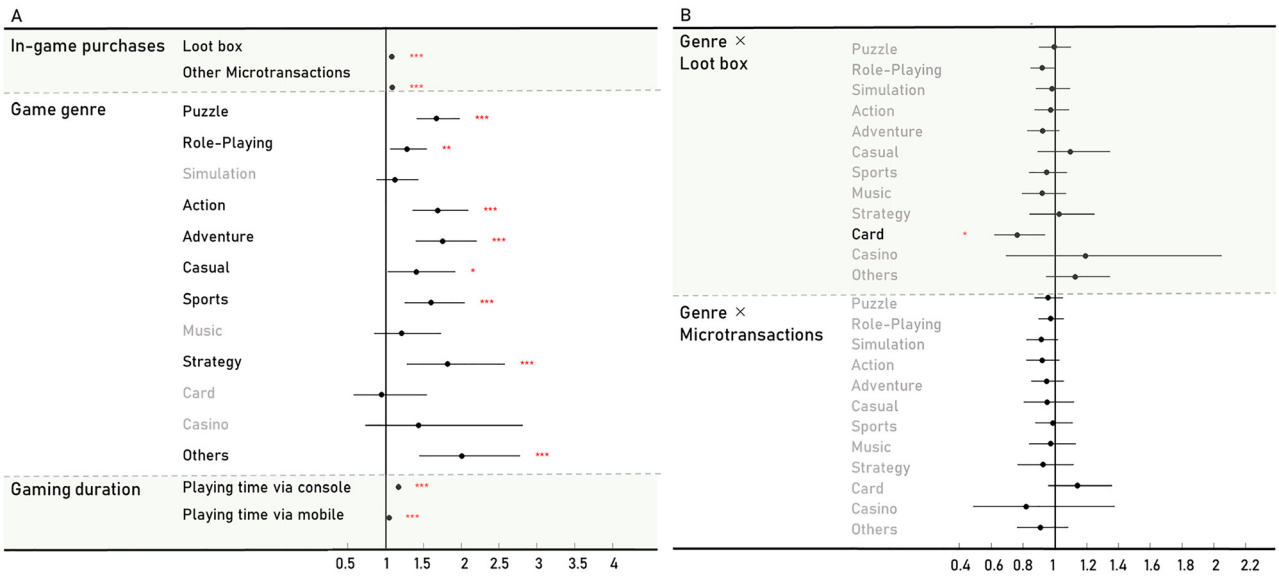

Fig. 1. Results of multiple logistic regression analysis (probable GD, $N = 1865$) A: Main effects B: Interaction terms

Note. Each dot shows a variable's odds ratio (OR), and horizontal lines through symbols line indicate 95% confidence intervals. Regarding the variable of game genre, casual player ($N = 20{,}408$) in smartphones was used as a reference (OR = 1). * indicates significant (*: <0.05, **: <0.01 ***: <0.001). Results were controlled by gender and age, which were considered confounding factors contributing to probable GD. Statistics including these control variables are shown in Table S6 and 7.

(see Table S5); however, since the VIF for independent variables in the model was less than 2.5, we did not remove any variables. Odds ratios (OR) and p values for probable GD of all variables, including control variables, are shown in Table S4. ORs in loot boxes and microtransactions were 1.08 (95%CI [1.05–1.11], $p < 0.001$) and 1.09 (95%CI [1.06–1.12], $p < 0.001$), respectively. Playing time duration via game consoles and smartphones was significantly associated with probable GD (Consoles: OR = 1.17 (95%CI [1.15–1.19]), $p < 0.001$; Smartphones: OR = 1.04 (95%CI [1.03–1.06]), $p < 0.001$). Also, most game genres in which participants spent the most time on mobile phones were significantly related to probable GD (Puzzle: OR = 1.67 (95%CI [1.41–1.98]), $p < 0.001$; Role-playing: OR = 1.28 (95%CI [1.06–1.55]), $p = 0.009$; Action: OR = 1.69 (95%CI [1.36–2.10]), $p < 0.001$; Adventure: OR = 1.75 (95%CI [1.40–2.20]), $p < 0.001$; Casual: OR = 1.41 (95%CI [1.03–1.92]), $p = 0.033$; Sports: OR = 1.60 (95%CI [1.25–2.04]), $p < 0.001$; Strategy: OR = 1.82 (95%CI [1.28–2.58]), $p < 0.001$; Others: OR = 2.01 (95%CI [1.45–2.78]), $p < 0.001$). An interaction term was added to the model to assess potential interaction between game genre and amount of in-game purchase charge (Fig. 1B). The likelihood ratio test provided evidence that the interaction between them significantly improved the model's fit (χ^2 (24) = 39.6, $p = 0.024$). Interaction between game genres and loot box charge indicated that only card games were negatively associated with GD (OR = 0.76 (95%CI [0.62–0.94]), $p = 0.011$) (see Table S6 and S7 for the details of ORs and *p-value*). The logistic regression results from participants who played smartphone games more than consoles were largely consistent with the above regression results (see Table S8 and S9.)

STUDY 2

The average age was 45.9 years [standard deviation (SD) = 11.1], and 55.8% were male. Descriptive results in Study 2 are shown in Supplementary Results (see Table S10 and 11). A multivariate logistic regression analysis with main effects was used to examine effects of each independent variable on probable GD, controlled by sex, age, marital status, and the existence of children (Fig. 2). Correlation coefficients between several variables were high (Table S12); however, since the VIF for independent variables, including added variables, was less than 2.5., we did not remove any variables. ORs and p values for probable GD are shown in Table S13. ORs in loot boxes and other microtransactions were 1.11 (95%CI [1.02–1.22], $p = 0.022$) and 1.14 (95%CI [1.05–1.25], $p = 0.003$). Playing time via both consoles and smartphones was significantly associated with probable GD (Consoles: OR = 1.14 (95%CI [1.08–1.20], $p < 0.001$; Smartphones: OR = 1.13 (95%CI [1.08–1.19]), $p < 0.001$). Probable general mental disorders based on K6 are also a significant risk factor (OR = 1.15, 95%CI [1.11–1.18], $p < 0.001$). However, the gaming duration of most game genres was not significantly related to probable GD, except for the Puzzle category (OR = 0.99 (95%CI [0.97–1.00]), $p = 0.020$). Moreover, the likelihood ratio test indicated that the interaction between in-game purchases and objective gaming duration did not significantly improve the model's fit (χ^2 (24) = 27.6, $p = 0.28$), so a priori interaction effects were not considered in this analysis. Results from participants who played smartphone games more than consoles based on their self-reports were largely consistent with the above regression results (see Table S14.)

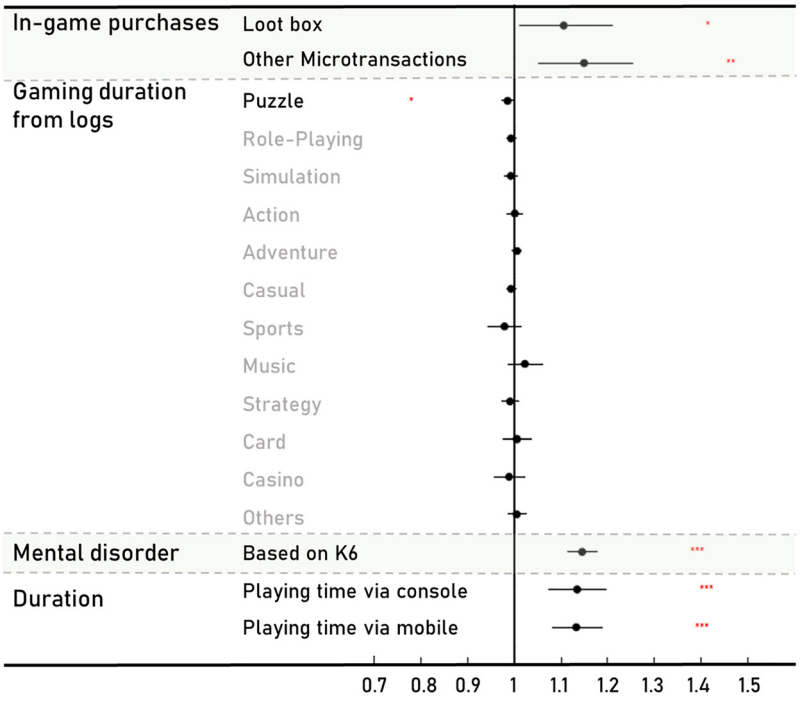

Fig. 2. Results of multiple logistic regression analysis (probable GD, $N = 165$)
Note. Each dot shows a variable's odds ratio (OR), and horizontal lines through symbols line indicate 95% confidence intervals. * indicates significant (*: <0.05, **: <0.01 ***: <0.001). Results were controlled by gender, age, marital status, and the existence of children, which are considered confounding factors for GD. Statistics including these control variables are shown in Table S4.

DISCUSSION

This is the first study to examine the impact of and relationships between game genre, in-game purchases, and game duration to internet gaming disorder (GD) with games accessed via smartphones, combined with logged objective assessments using two large surveys. Consistent with previous studies (Drummond et al., 2020), paying more for loot boxes and other microtransactions had a significant positive correlation with probable GD in both of these studies. Also, subjectively recorded gaming time via consoles and smartphones was associated with probable GD weakly yet positively. Playing several game genres was also associated with probable GD, compared to non-playing (Study 1). Moreover, the interaction between in-game purchases and card games indicated significantly negative associations with probable GD. However, there were no significant effects of objective gaming time of individual game genre on probable GD, except for the Puzzle category (Study 2). Although the current results may indicate a difference between self-reports and objective indices, these results may change if analyses are conducted on samples that have different factors, e.g., demographic differences.

Our results indicate that loot boxes and other microtransactions are associated with probable GD. These results are consistent with previous studies (González-Cabrera et al., 2023; Irie, Shinkawa, Tanaka, & Yokomitsu, 2022), and these transactions may create a vicious cycle that exacerbates excessive gaming via smartphones. We also clarified several genres of smartphone games that are significantly related to probable GD: Puzzle, Role-playing, Simulation, Action, Adventure, Casual, Sports, Strategy, and Others. These results are consistent with previous studies (Laconi et al., 2017; Lemmens & Hendriks, 2016; Rehbein et al., 2021). The analysis of interactions in Study 1 indicated that card games with loot boxes could be protective against GD. In the case of card games, unlike games that use items players can obtain for free as they progress and spend time, using money for loot boxes potentially reduces game time and problems. In summary, these results indicate risks associated with loot boxes in general, but surprisingly, such risks were not present in card games. This relationship should be more carefully examined in future research.

In regard to the relationship between loot boxes, other microtransactions, and gaming disorder, Study 2 yielded a result similar to that in Study 1, which was based on self-reports. Although in-game purchases and the general mental disorder score had positive relationships with probable GD, as in previous studies, objective gaming duration of most genres was not associated with GD. Moreover, the correlation between average objective gaming duration per participant per month and GD severity was low ($rho = 0.10$, $p < 0.001$). Also, adding interaction terms between in-game purchases and the objective gaming duration of each game genre did not improve the model. These results are consistent with those of studies that reported a weak relationship between GD severity and objective gaming time (Jin et al.,

2022). Although previous studies have pointed to measurement problems, such as construct validity (Jin et al., 2022; Parry et al., 2021), such results cannot be considered simply. Subjective and objective game times were moderately correlated in the aforementioned study (Jin et al., 2022) and the present study ($rho = 0.38$, $p < 0.001$), and our results also indicate that correlations between subjective game time and GD severity were moderate ($rho = 0.31$, $p < 0.001$), consistent with previous studies (Chen, Ahorsu, et al., 2020; Leung et al., 2020; Poon et al., 2021). In other words, our results suggest the importance of reconsidering assessment and research methods regarding GD. In fact, the definitions from DSM-5 and ICD-11 do not emphasize gaming time as an essential component, focusing only on functional impairment of patients (American Psychiatric Association, 2013; World Health Organization, 2019). Also, several studies indicated that factors other than gaming time need to be carefully examined, such as co-morbidities (Andreassen et al., 2016), motives for playing (Blasi et al., 2019), and quality of social interactions (Cheng, Cheung, & Wang, 2018). Though some have expressed concerns about the validity of findings relying on self-reported measures (Parry et al., 2021), subjective perception may reflect such dysfunction more than objective measure (Jin et al., 2022; Schreiner, Yalcinbas, & Gremel, 2021; Taschereau-Dumouchel, Michel, & Lau, 2022). The importance of proper assessment reflecting actually functional impairment should be considered, rather than underestimating subjective indicators and overestimating objective ones.

Several limitations to this study should be considered. First, because this was an online survey, bias in responses due to "satisficing" (Couper, Tourangeau, Conrad, & Zhang, 2013) and other confounding factors cannot be excluded. However, as described in the Methods section, data were analyzed after excluding fraudulent or questionable data. Second, causal relationships cannot be determined because the data are cross-sectional. In the future, it will be necessary to conduct longitudinal surveys or designed intervention studies after developing objective indicators, such as those in Study 2. Third, although we followed Google Play standards and other standards for game genres in this study, no consensus has been reached on each genre's exact definition and boundaries (Lemmens & Hendriks, 2016). Definitions for the majority of current game genres are complex, and even within a single genre there are games with numerous different game mechanics and structural elements, which may explain why associations between GD and specific game genres are not so different. The research community needs to reach a consensus regarding genre classification that does not rely solely on existing taxonomy, but considers complexity of game genres and their features. Fourth, while we used log information for gameplay time, we had to rely on self-reports for amounts of in-game purchases, such as loot boxes and other microtransactions. Future research should use objective indicators such as the amount charged based on in-app information. Fifth, there was a period (2 months) between the time that the game logs were taken and the time that the online survey was conducted. Collecting subjective and objective data without a delay will be necessary to examine their effects on internet gaming disorder more accurately. Sixth, although we used gaming data via smartphones to focus on smartphone usage, the influence of in-game purchases and game genre via gaming consoles and computers should also be examined. Computer-based gaming was not assessed in this study, so future studies should include such devices. Seventh, the present studies used the instrument developed according to internet gaming disorder defined by DSM-5. Future studies should consider using GD instruments designed according to ICD-11 (King et al., 2020; Pontes et al., 2019) to replicate and corroborate the present findings. Eighth, the mean age and gender distribution are considerably different in the two studies. Study 1 was conducted with the younger generation (20–50) that would be playing the game, while Study 2 was conducted with the entire population for which game-playing logs were available as described in the Methods. Therefore, it might be inappropriate to compare the results between the studies straightforwardly. Future studies should survey the population including comprehensive attributes with game logs.

CONCLUSIONS

In summary, our results were consistent with those of previous studies on the association of in-game purchases and game genres with internet gaming disorder (GD). They also suggest that risks are associated with loot boxes in general, but not in card games. Although a weak association was obtained for the relationship between objective gaming duration and probable GD, correlation analysis implies that researchers should reconsider definitions and measurements of problematic media use in future studies, in parallel with re-examining classification of game genres. Our findings contribute to development of appropriate policies and consumer protection measures, by developing new measurements to assess gaming problems to protect smartphone game players' interests and well-being.

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Authors' contribution: TO designed both studies, analyzed and interpreted data, and prepared the original draft. TK supervised the data analysis, reviewed and edited the manuscript. MM performed data analysis, reviewed, and edited the manuscript. NK designed both studies, extracted data, reviewed, and edited the manuscript. All authors had full access to all data in the study and accept responsibility for integrity of the data and accuracy of the data analysis.

Conflict of interest: This study was funded by KDDI Corporation; however, KDDI had no role in study design, conclusions drawn, or decision to publish. There are no other disclosures to report.

Data availability: Statistical data supporting this study's findings are available in Supplementary Information. Owing to company cohort data sharing restrictions, individual data cannot be publicly posted. However, data are available from the authors with permission of KDDI Corporation.

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SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1556/2006.2023.00076.

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