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Urbanization and Internet addiction in a nationally representative sample of adult community residents in Japan: A cross-sectional, multilevel study

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ABSTRACT

This study examines the relationship between urbanization and Internet addiction (IA) and association with other psychopathology and social support, in a nationally representative sample in Japan. Data from the World Mental Health Japan Second Survey were used. There were 2450 survey respondents, with an average response rate of 43.4%. Respondents' living areas were divided into three groups on the basis of urbanization (operationalized as city size). IA was measured using the Compulsive Internet Use Scale (CIUS). Three variables — psychological distress, past-12-month mental disorder, and social support — were measured using established instruments. A multilevel model was conducted to clarify the association between urbanization and IA (continuous scores and prevalence), before and after adjusting for possible individual-level and area-level variables and demographic variables. CIUS scores were significantly higher in large cities than in small municipalities before adjusting for psychological distress, social support, and past-12-month mental disorder. After adjustment, these associations attenuated substantially: urbanization was no longer significantly associated with odds of mild/severe IA, while the relationship held for continuous CIUS scores. Thus, residence in large cities is associated with higher odds of IA in Japan; psychological distress, social support, and past-12-month mental disorder partly explain this association.

1. Introduction

Internet addiction (IA) has become a major public health problem all over the world, with increasing prevalence and growing impact on people's social life (Kuss and Lopez-Fernandez, 2016). The concepts, diagnostic criteria, and classifications are various: a wide variety of behavioral problems such as impulse control problems are considered; several subtypes have been proposed, such as cyber sexual addiction, cyber relationship addiction, online game addiction and so on (Mihajlov and Vejmelka 2017). However, broadly saying, IA is defined as excessive, poorly controlled preoccupation with and urges to use the Internet, which can cause various life problems (Kuss and Lopez-Fernandez, 2016). Though it is difficult to simply compare the prevalence of IA across different populations and studies due to use of different scales and cutoff values, in Germany, 4.5% of the general population have been identified as having IA (Zadra et al., 2016), whereas in Japan, 46.1% of people show mild addiction and 8.2% show severe addiction (Ministry of Internet Affairs and Communications, n.d.a). Significant reductions in daily living functions accompanying IA have been reported, such as school refusal and failure, job efficiency decline, unemployment, giving up household chores, domestic violence, divorce, social isolation, economic difficulties, and others (Young, 1998). Furthermore, IA has been shown to be related to suicidal ideation and attempt, which are serious mental

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health problems (Lin et al., 2014).

A few studies have reported on the relationship between urban residence and IA, and at least two have reported that the prevalence of IA is higher in urban areas than in rural areas. In a nationally representative Chinese study, men and women aged 10–24 years were selected using a multistage sampling method, and were divided into residents of urban and rural areas. The prevalence of IA (Internet Addiction Test (IAT) ≥ 50) was higher in urban areas than in rural areas (Cao et al., 2011). In a community-based study in Greek, male and female participants with mean age of 16 were extracted from an urban area (Athens) and rural areas using a proportional stratified random sampling method, and both IAT and Young's Diagnostic Questionnaire for Internet Addiction (YDQ) were administered. Compared to rural areas, people in the urban area had higher mean IAT scores and a higher prevalence of IA (YDQ ≥ 5) (Stavropoulos et al., 2013). However, the evidence thus far is limited to China and Greece, and only to samples of adolescents and young adults; it is not clear if these findings can be generalized to other countries and other generations.

Furthermore, it is not clear why urban areas may have higher prevalence of IA. It has been reported that non-clinical psychological distress (Gong et al., 2016) and common mental disorders such as depression and anxiety (Szabo, 2018) are more prevalent in urban areas, and these conditions are also associated with IA (Hoare et al., 2017; Weinstein et al., 2015). Additionally, IA is reported to be associated with lower social support (Chen et al., 2015), which also may be more prevalent in urban areas (McKenzie, 2008). It would be interesting to know if a higher prevalence of IA among urban areas could be explained by the urban psychopathology such as non-clinical psychological distress, common mental disorders, and/or lack of social support, or if there is a unique impact of urban living on IA. On the other hand, a previous study reported a moderating effect of a classroom characteristic (i.e., the group tendency of extraversion) on the association between anxiety and IA among adolescences (Stavropoulos et al., 2017). There may be a contextual influence of urbanity on IA. For instance, among people living in urban cities, the association between psychological distress and IA could be stronger, compared to people living in non-urban settings, since the urban environment may exaggerate the impact of psychological distress on developing IA. The same could apply to social support: the urban environment may lead people with low social support to developing IA. These results would be useful in understanding the psychopathology and risk factors of IA and also in planning a countermeasure to prevent IA in an urban setting. To our knowledge, however, there are no studies that explore these relationships.

The aims of the present study were three-hold. First, the study investigated the association between the urbanity and IA in a nationally representative sample of Japan; people who lived in urban areas might be more likely to develop IA than those in the rural areas. Second, the study investigated the association between the urbanity and IA, adjusting for area- and individual-level factors (i.e., psychological distress and social support) to know the unique impact of the urbanity: an excess prevalence of IA in the urban areas might be explained by these factors to some extent. Third, the study investigated interactive effects of the urbanity and individual-level psychological distress or social support on the prevalence of IA to know moderating effects of these factors; people in urban areas might show a stronger association between these factors and IA. One of the strength of the study was the population representativeness of the data, that were based on a national sample of community-living adults in Japan, from the World Mental Health Japan Second Survey (WMHJ2; Ishikawa et al., 2018).

2. Methods

2.1. Sample

The sample of the WMHJ2 Survey was selected using a two-stage nationally representative random sampling method applied to community residents in Japan, from 2013 to 2015 (Ishikawa et al., 2018). The survey area was divided into 3 sections: (1) Kanto district (Tokyo Metropolitan area and surrounding areas); (2) Tokai, Hokuriku, Koshin'etsu, Tohoku, Hokkaido (eastern Japan except Kanto); and (3) Kinki, Chugoku, Kyushu, Shikoku, Okinawa (the western part of Japan). About 5000 representative individuals aged 20 to 75 years old were extracted from local residents in 129 municipalities. The respondents numbered 2450, for an average response rate of 43.4%. The response rates varied among areas, with a lower rate for the Kanto area, including Tokyo, Yokohama, and Chiba (36.2%).

Trained interviewers visited the homes of respondents and collected the data using two methods: a face-to-face interview survey and a self-administered questionnaire. For the interview survey, we used the Japanese computerized edition of the World Health Organization Integrated International Diagnostic Interview (WHO-CIDI), version 3.0. The Research Ethics Committees of the Graduate School of Medicine/Faculty of Medicine, The University of Tokyo (nos. 10131-(1), -(2), -(3), and -(4)) approved the aims and procedures of this study before it began.

2.2. Urbanization

The study area (all sections) was divided into three categories, by city size: large cities (Tokyo's 23 wards, government-ordinance-designated cities), middle cities (over 100,000 people), and small municipalities (other regions). The government-ordinance-designated cities are 20 cities designated by Cabinet order as having a population over 500,000, such as Yokohama, Nagoya, Osaka, and Fukuoka. According to the national census of 2015, the average populations and population densities of these three areas were 13.5 million and 15,000 people/km^2 for Tokyo and average 1.38 million and 2,290 people/km^2 for other large cities; 261,823 and 899 people/km^2 for the middle cities; and 53,210 and 234 people/km^2 for the small municipalities.

2.3. Measures

2.3.1. Compulsive Internet Use Scale (CIUS)

CIUS was used to measure Internet addiction as a part of the self-administered questionnaire. This instrument consists of 14 items based on a 5-point Likert scale (0 = never, 1 = seldom, 2 = sometimes, 3 = often, 4 = very often) (Meerkerk et al., 2009). The score range is thus from 0 to 56, where higher scores correspond to higher dependence on the Internet. The cutoff values were 0 to 17 for no dependence, 18 to 22 for mild, and 23 to 56 for severe. ROC curve analysis showed that both mild and severe cutoff points had very high sensitivity (>0.9) and specificity (>0.8). The reliability and validity of the Japanese version of CIUS have been demonstrated (Yong et al., 2017). CIUS was administered only to those respondents who indicated that they used the Internet. Those who replied that they did not use the Internet received 0 points on the CIUS. The internal rate of reliability in the present sample was enough high (Cronbach's α = 0.93).

2.3.2. K6

A six-item scale of psychological distress developed by Kessler et al. (2002), K6 was used for measurement of non-clinical depression and anxiety disorders as a part of the self-administered questionnaire. It consists of 6 items answered on a 5-point Likert scale. Scores thus range from 0 to 24, where higher scores represent higher degrees of non-clinical depression and anxiety disorders. The reliability and validity of the Japanese version of K6 have been shown (Sakurai et al., 2011). The internal rate of reliability for the present sample was enough high (Cronbach's α = 0.88).

2.3.3. Lubben Social Network Scale-6 (LSNS-6)

The LSNS-6 was used to measure social support as a part of the self-

Table 1
Demographic and psychosocial characteristics and prevalence of Internet addiction (IA) of adult participants by urbanity (the city size) from the World Mental Health Japan Second Survey (2013–2015) (N = 2193).

	Large City (N = 605)		Middle City (N = 879)		Small Municipality (N = 709)		χ^2/F	P value
	N (%)	Mean (SD)	N (%)	Mean (SD)	N (%)	Mean (SD)		
Gender							2.02	0.37
Men	281 (46.4)		415 (47.2)		355 (50.1)			
Women	324 (53.6)		464 (52.8)		354 (49.9)			
Age (years)		48.0 (15.2)		50.1 (15.2)		50.8 (14.8)	6.49	<0.01[c]
Educational attainment							27.06	<0.01[c]
Junior high school graduates	44 (7.3)		60 (6.8)		76 (10.7)			
High school graduates	205 (33.9)		361 (41.1)		281 (39.6)			
Some college graduates	168 (27.8)		198 (22.5)		189 (26.7)			
University graduates or higher	188 (31.1)		260 (29.6)		163 (23.0)			
Household Income (per year)							13.43	0.037[c]
≦2.5 million yen	167 (27.6)		249 (28.3)		160 (22.6)			
≦5 million yen	170 (28.1)		253 (28.8)		188 (26.5)			
≦7.5 million yen	123 (20.3)		158 (18.0)		163 (23.0)			
>7.5 million yen	145 (24.0)		219 (24.9)		198 (27.9)			
CIUS scores[a]		8.60 (9.6)		6.82 (8.4)		6.23 (8.3)	12.91	<0.01[c]
Severity of IA (score range)							18.46	<0.01[c]
Non IA (0–17)	490 (81.0)		764 (86.9)		623 (87.9)			
Mild IA (18–22)	53 (8.8)		67 (7.6)		42 (5.9)			
Severe IA (23–56)	62 (10.2)		48 (5.5)		44 (6.2)			
K6		2.55 (3.7)		2.04 (3.1)		2.00 (3.1)	6.38	<0.01[c]
LSNS-6[b]		13.41 (5.7)		14.03 (5.9)		13.81 (5.7)	2.04	0.13
Mental disorder in the past 12 months (yes)	45(7.4)		48(5.5)		29(4.1)		7.00	0.03[c]

[a] CIUS: Compulsive Internet Use Scale.
[b] LSNS-6: Lubben Social Network Scale.
[c] $p < 0.05$.

administered questionnaire (Lubben et al., 2006). It consists of 6 items scored on a 5-point Likert scale: 3 items on family networks and 3 items on non-family networks. The score thus ranges from 0 to 30, where the higher the score, the greater the social support. A score less than 12 is defined as indicating social isolation. The reliability and construct validity (including factor-based validity) of the Japanese version of LSNS-6 have been shown (Kurimoto et al., 2011). The internal rate of reliability for the present sample was enough high (Cronbach's α =0.83).

2.3.4. Mental disorder in the past 12 months

The WHO-CIDI 3.0 (Haro et al., 2006; Kawakami et al., 2005) was used to diagnoses 12 common mental disorders according to the *Diagnostic and Statistical Manual of Mental Disorders*, 4th edition (DSM-IV): agoraphobia, generalized anxiety disorder, panic disorder, social phobia, post-traumatic stress disorder, major depressive disorder, bipolar disorders (I and II), dysthymia, alcohol abuse and dependence, and drug abuse and dependence. Respondents who met diagnostic criteria for any of these mental disorders in the past 12 months were classified as having a past-12-month common mental disorder.

2.3.5. Socio-demographics

For socio-demographics, age, gender, education, and income were examined in the interview. Education was divided into four groups: junior high school graduates, high school graduates, some college, university graduates, or higher. Questions on annual household income covered the respondent's own earned income, spouse's income, income from others, social security income, and other income. Usually a non-negligible proportion of respondents had missing responses on these household income variables (Kawakami et al., 2012). We imputed these missing responses with income estimated by their education, sex, age, employment status and household size. However, for other variances, those without missing values were used. Based on the sum of annual household income, respondents were divided into 4 groups: less than 2.5 million yen, from 2.5 million yen to less than 5 million yen, from 5 million yen to less than 7.5 million yen, and 7.5 million yen or over.

2.4. Analysis

Statistical differences in socio-demographics were first compared across the three groups classified on the basis of urbanization (i.e. city size): large cities, middle, and small municipalities. The chi-squared test was used for gender, education, income, severity categories of Internet addiction, and mental disorder in the past 12 months; one-way analysis of variance was used for age, CIUS scores, K6 scores, and LSNS-6 scores.

A multilevel linear regression analysis was then conducted to investigate the area-level association between urbanization and CIUS scores, adjusting for socio-demographics (Model 1) and additionally for K6, LSNS-6, and mental disorder in the past 12 months (Model 2). K6 and LSNS-6 were considered at both individual and area (city mean score) levels. Intra-class correlation coefficients (ICCs) for these variables were calculated before the analysis. Other covariates were treated at the individual level only. Continuous variables at the individual level (age, K6 scores, and LSNS-6 scores) were area mean centered, while continuous scores at area level (K6 and LSNS-6 mean scores) were grand mean centered. A multilevel logistic regression analysis was also conducted using the CIUS score cutoff values (Non-IA, Mild IA, and Severe IA). We compared Non-IA vs. Mild IA + Severe IA and Non-IA + Mild IA vs. Severe IA. Second, a similar multilevel logistic regression analysis was conducted adjusting for area-level and individual level. Furthermore, a multilevel linear regression analysis was conducted to examine the cross-level interaction between the urbanity and individual-level psychological distress or social support for IA.

Linear and generalized linear mixed modeling in SPSS (Windows version 25) was used for statistical analysis. A p-value less than 0.05 was deemed statistically significant. In these analyses, we did not impute missing responses on the variables used other than household income.

3. Results

3.1. Demographic and psychosocial characteristics and prevalence of IA by urbanization

Among 2450 total survey respondents, 2298 completed the CIUS scale. Some of these respondents had missing values on demographic variables (n = 5), the K6 (n = 70), and/or the LSNS-6 (n = 27); these respondents were excluded, which left an analytic sample of 2193 respondents.

According to Table 1, the prevalence of Mild or Severe IA was 19.0% in large cities (8.8% for mild IA and 10.2% for severe IA), 13.1% in middle cities (7.6% for mild IA and 5.5% for severe IA), and 12.1% in small municipalities (5.9% for mild IA and 6.2% for severe IA). The CIUS score distribution was skewed toward the left. The larger the city, the higher the CIUS scores and K6 scores. LSNS-6 scores were the lowest in large cities. While there were significant differences in both CIUS scores and K6 scores among the three groups classified on the basis of urbanization, there were no significant differences in LSNS-6 scores. ICCs for K6 and LSNS were respectively 0.02 ($p<0.01$) and 0.01 (p = 0.03).

3.2. Urbanization and CIUS scores

3.2.1. Area level

Living in a large city was significantly associated with higher CIUS scores compared to living in a small city ($\gamma=1.94$, SE = 0.56, $p<0.01$) (Model 1) (Table 2). After additionally adjusting for area- and individual-level K6 and LSNS-6 scores (Model 2) (Table 2), living in a large city was still associated with higher CIUS scores ($\gamma=1.55$, SE = 0.54, $p<0.01$) with decreasing the correlation coefficient by about 20%. Area-level K6 scores were significantly and positively correlated with CIUS scores ($\gamma=0.73$, SE = 0.23, $p<0.01$). Area-level LSNS-6 scores were positively, but not significantly, associated with CIUS scores ($\gamma=0.02$, SE = 0.13, p = 0.90).

3.2.2. Individual level

Age ($\gamma=-0.27$, SE = 0.01, $p<0.01$) and Individual-level LSNS-6 scores ($\gamma=-0.07$, SE = 0.03, p = 0.02) were significantly, negatively correlated with CIUS scores. Individual-level K6 scores ($\gamma=0.36$, SE = 0.05, $p<0.01$) and mental disorder in the past 12 months ($\gamma=2.56$, SE = 0.73, $p<0.01$) were significantly and positively associated with the CIUS scores.

3.3. Urbanization and Mild IA + Severe IA and Severe IA only

3.3.1. Area level

Living in a large city was significantly associated with having Mild IA or Severe IA as compared to Non-IA (Exp(γ) = 1.62; 95%CI (1.18–2.23); $p<0.01$) (Model 1) (Table 3). After additionally adjusting for area- and individual-level K6 and LSNS-6, urbanization was sill marginally significantly associated with Mild IA + Severe IA (Exp(γ) = 1.39; 95%CI (1.00–1.93); p = 0.051) (Model 2) (Table 3). Area-level K6 scores were significantly, positively associated with Mild IA + Severe IA (Exp(γ) = 1.27; 95%CI (1.10–1.46); $p<0.01$) (Model 2) (Table 3).

Living in a large city was significantly associated with greater odds of Severe IA compared to Mild or Non-IA (Exp(γ) = 1.55; 95%CI (1.05–2.27); p = 0.027) (Model 1) (Table 3). After adjusting for area- and individual-level K6 and LSNS-6, urbanization was not significantly associated with Severe IA compared to Mild or Non-IA (Exp(γ) = 1.35; 95%CI (0.91–2.01); p = 0.14) (Model 2) (Table 3). Area-level K6 was significantly, positively associated with Severe IA (Exp(γ) = 1.20; 95%CI (1.01–1.43); p = 0.041) (Model 2) (Table 3).

3.3.2. Individual level

Individual-level K6 scores and presence of a mental disorder in the past 12 months were significantly and positively associated with both

Table 2
Urbanity and other predictors of Compulsive Internet Use Scale (CIUS) scores of adult community residents Japan: multivariate linear mixed model regression (N = 2193).

	CIUS scores					
	Model 1[a]			Model 2[a]		
	γ	SE	*P* value	γ	SE	*P* value
Urbanity						
Large City	1.94	0.56	<0.01*	1.55	0.54	<0.01*
Middle City	0.37	0.51	0.48	0.36	0.49	0.47
Small Municipality	Reference			Reference		
Gender						
Men	Reference			Reference		
Women	0.05	0.34	0.88	0.05	0.33	0.89
Age (years)	−0.28	<0.01	<0.01*	− 0.27	0.01	<0.01*
Educational attainment						
Junior high school graduates	Reference			Reference		
High school graduates	- 0.16	0.63	0.80	0.02	0.62	0.99
Some college graduates	1.00	0.67	0.14	1.07	0.66	0.10
University graduates or higher	1.31	0.67	0.05	1.37	0.66	0.04*
House hold Income (per year)						
≦2.5 million yen	Reference			Reference		
≦5 million yen	− 0.38	0.44	0.39	− 0.40	0.43	0.36
≦7.5 million yen	− 0.26	0.48	0.59	− 0.33	0.47	0.48
>7.5 million yen	− 0.11	0.45	0.80	− 0.30	0.44	0.50
K6 (individual level)				0.36	0.05	<0.01*
K6 (area level)				0.73	0.23	<0.01*
LSNS-6 (individual level)				− 0.07	0.03	0.02*
LSNS-6 (area level)				0.02	0.13	0.90
Mental disorder in the past 12 months (yes)				2.56	0.73	<0.01*
Intercept	6.04	0.89	<0.01*	5.96	0.87	<0.01*
Random effect of intercept	2.16	0.76	<0.01*	1.81	0.69	<0.01*
AIC	15,107.36			15,013.26		

[a] Unstandardized regression coefficient (γ) and standard error (SE) are shown. Sociodemographic variables were adjusted for in the Model 1; psychological distress (K6), social support (LSNS-6) and mental disorder in the past 12 months were additionally adjusted for in the Model 2. *p < 0.05.

Table 3
Urbanity and other predictors of mild and severe Internet addiction (IA) based on the Compulsive Internet Use Scale (CIUS) scores of adult community residents in Japan: generalized linear mixed model (mixed effects logistic regression) analysis (N = 2193).

	Non IA vs Mild IA + Severe IA						Non IA + Mild IA vs Severe IA					
	Model 1[a]			Model 2[a]			Model 1[a]			Model 2[a]		
	Exp(γ)	95% CI	*p* value	Exp(γ)	95% CI	*p* value	Exp(γ)	95% CI	*p* value	Exp(γ)	95% CI	*p* value
Urbanity												
Large City	1.62	1.18–2.23	<0.01[c]	1.39	1.00–1.93	0.051	1.55	1.05–2.27	0.027[c]	1.35	0.91–2.01	0.14
Middle City	1.06	0.78–1.45	0.69	1.03	0.76–1.41	0.84	0.92	0.62–1.36	0.68	0.90	0.61–1.34	0.61
Small Municipality	1.00			1.00			1.00			1.00		
Gender												
Men	1.00			1.00			1.00			1.00		
Women	1.32	1.02–1.71	0.037[c]	1.33	1.02–1.74	0.037[c]	1.15	0.83–1.58	0.41	1.15	0.83–1.60	0.41
Age (for one-year increase)	0.94	0.93–0.95	<0.01[c]	0.94	0.93–0.95	<0.01[c]	0.95	0.94–0.96	<0.01[c]	0.95	0.94–0.96	<0.01[c]
Educational attainment												
Junior high school graduates	1.00			1.00			1.00			1.00		
High school graduates	0.82	0.45–1.50	0.53	0.85	0.47–1.56	0.60	0.84	0.42–1.68	0.63	0.86	0.43–1.72	0.68
Some college graduates	1.41	0.78–2.57	0.26	1.43	0.78–2.61	0.24	0.99	0.49–1.99	0.97	0.98	0.49–1.98	0.96
University graduates or higher	1.21	0.67–2.20	0.53	1.20	0.66–2.20	0.56	0.87	0.43–1.76	0.70	0.86	0.42–1.73	0.67
Household income (per year)												
≦2.5 million yen	1.00			1.00			1.00			1.00		
≦5 million yen	0.85	0.61–1.20	0.36	0.84	0.60–1.19	0.33	0.70	0.45–1.08	0.11	0.69	0.44–1.08	0.10
≦7.5 million yen	0.85	0.60–1.22	0.39	0.83	0.58–1.20	0.33	1.04	0.67–1.60	0.86	1.02	0.66–1.58	0.92
>7.5 million yen	0.78	0.55–1.11	0.17	0.74	0.52–1.05	0.09	0.92	0.61–1.41	0.71	0.89	0.58–1.36	0.59
K6 (individual level)[b]				1.08	1.04–1.12	<0.01[c]				1.08	1.03–1.12	<0.01[c]
K6 (area level)[b]				1.27	1.10–1.46	<0.01[c]				1.20	1.01–1.43	0.041[c]
LSNS-6 (individual level)[b]				0.98	0.95–1.00	0.06				0.98	0.95–1.01	0.18
LSNS-6 (area level)[b]				1.02	0.94–1.11	0.68				0.996	0.90–1.11	0.95
Mental disorder in the past 12 months (yes)				1.78	1.14–2.80	0.012[c]				1.50	0.88–2.55	0.13
Intercept	0.08	0.04–0.16	<0.01[c]	0.08	0.04–0.16	<0.01[c]	0.07	0.03–0.15	<0.01[c]	0.06	0.03–0.15	<0.01[c]
AIC	11,160.01			11,266.63			11,679.95			11,690.97		

[a] Exp(γ) and 95% confidence intervals (95%CIs) are shown. Sociodemographic variables were adjusted for in the Model 1; psychological distress (K6), social support (LSNS-6), and mental disorder in the past 12 months were additionally adjusted for in the Model 2.
[b] Exp(γ) for one point increase in the score is shown.
[c] $p < 0.05$.

Mild IA + Severe IA (Exp(γ) = 1.08; 95%CI (1.04–1.12); $p < 0.01$ and Exp(γ) = 1.78; 95%CI (1.14–2.80); $p = 0.012$, respectively) and Severe IA only (Exp(γ) = 1.08; 95%CI (1.03–1.12); $p < 0.01$ and Exp(γ) = 1.50; 95%CI (0.88–2.55); $p = 0.13$, respectively). Older age was significantly, negatively associated with both Mild IA + Severe IA (Exp(γ) = 0.94; 95%CI (0.93–0.95); $p < 0.01$) and Severe IA only (Exp(γ) = 0.95; 95%CI (0.94–0.96); $p < 0.01$). Female sex was significantly, positively associated with Mild IA + Severe IA (Exp(γ) = 1.32; 95%CI (1.02–1.71); $p = 0.037$), but not severe IA only (Exp(γ) = 1.15; 95%CI (0.83–1.58); $p = 0.41$). Individual-level LSNS-6 was negatively, but not significantly, associated with both Mild IA + Severe IA (Exp(γ) = 0.98; 95%CI (0.95–1.00); $p = 0.06$) and Severe IA (Exp(γ) = 0.98; 95%CI (0.95–1.01); $p = 0.18$).

3.4. Interaction of urbanity between psychological distress and IA

The interaction effect of large city on the association between psychological distress and IA was slightly positive but insignificant (γ = 0.01, SE = 0.15, $p = 0.95$) (Table 4). The effect of middle city on the association between psychological distress and IA was also positive (γ = 0.002), which was not significant. The interaction between urbanity and individual-level social support for IA was also tested. However, the model was not converged due to small random slopes of LSNS-6 scores.

Table 4
Interactive effect between urbanity and individual-level psychological distress on IA: multivariate linear mixed model regression (N = 2193).

	CIUS scores		
	γ	SE	*P* value
Urbanity			
Large City	1.90	0.56	<0.01[a]
Middle City	0.35	0.52	0.51
Small Municipality	Reference		
K6 (individual level)	0.44	0.11	<0.01[a]
K6 (individual level) × Large City	0.01	0.15	0.95
K6 (individual level) × Middle City	0.002	0.15	0.99
Random effect of intercept	2.46	0.79	<0.01[a]
Random effect of slope (K6, individual level)	0.09	0.50	0.06

§ Unstandardized regression coefficient (γ) and standard error (SE) are shown. Sociodemographic variables were adjusted.
[a] $p < 0.05$.

4. Discussion

CIUS scores were significantly higher in large cities than in small municipalities. In large cities, the prevalence of both Mild IA + Severe IA and Severe IA only were significantly higher than in small municipalities. After adjusting for area- and individual-levels of psychological distress and social support, as well as mental disorder in the past 12 months, these associations attenuated by 20–37%. However, CIUS scores were still significantly higher for large cities after adjusting for these variables. No significant moderation (interaction) effect between the urbanity and psychological distress on IA was observed.

The present study replicated previous findings of an association between urbanization and IA in China and Greece (Cao et al. 2011; Stavropoulos et al., 2013). Just as the previous studies revealed higher prevalence of IA in urban areas, the present study showed that respondents who lived in large cities had about 1.6 times greater odds of having Mild IA + Severe IA or Severe IA only than their counterparts in small municipalities, while the prevalence odds ratio of IA was almost the same among respondents in middle cities and in small municipalities. The present study thus indicates that living in large cities, but not in middle cities, is uniquely associated with IA in Japan. This pattern was not found in the previous studies, since the Greek study (Stavropoulos et al., 2013) simply compared Athens and a rural area,

while the Chinese study (Cao et al. 2011) did not provide any definitions of urban and rural areas. Whether there is a threshold to the effect of urbanization (e.g., city size) that increases the risk of IA is an interesting research question that should be investigated in future research.

The association between urbanization and IA was largely attenuated after adjusting for psychological distress at both the area level and the individual level, social support at both the area level and the individual level, and mental disorder in the past 12 months at the individual level. The findings demonstrate that these variables could explain a portion of the association between urbanization and IA. In all the regression analyses, both area- and individual-level psychological distress were significantly, positively associated with IA; in most analyses, mental disorder in the past 12 months was significantly, positively associated with IA; and in the analysis of the CIUS scores, individual-level social support was significantly, negatively associated with CIUS scores. These findings are largely consistent with previous literature (Hoare et al., 2017; Weinstein et al., 2015; Chen et al., 2015). Thus, both psychological distress and mental disorders seem to substantially explain the relationship between urbanization and IA, while area-level social support may have a smaller, but non-negligible, impact.

The association between urbanization and CIUS scores remained significant even after effects of these possible variables were applied. The odds of Mild IA + Severe IA and Severe IA were non-significantly but slightly higher in large cities after adjusting for these variables. Other factors that could contribute to higher odds of IA in large cities may include greater Internet accessibility. However, digital divides between areas in Japan are greatly diminished in recent years due to increased availability and use of personal computers and smartphones (Ministry of Internal Affairs and Communications, n.d.b). Proportions of the local population who were Internet users ranged from 72.6% to 88.9% among Japan's prefectures in 2014, with prefectures that have large cities at the high end of this range (81.6% to 88.9%) (Ministry of Internal Affairs and Communications, n.d.a). Internet accessibility may not fully explain the association between urbanization and IA in Japan, however; a mediating role of Internet accessibility should be further investigated in future study, since we were not able to test it, as municipal-level Internet access data were not available. Another possible reason for higher CIUS scores in large cities may be psychopathology, which was not investigated in detail in this study. In addition, even if not reflected in psychological distress or mental disorder, poor urban environment, reflected in factors such as congestion, air pollution, less green space, high crime rate, and poverty (Gong et al., 2016) may cause frustration or anxiety among people living in urban areas, which could lead to maladaptive coping, resulting in increased risk of developing IA (Weinstein and Lejoyeux, 2010).

The urbanity did not significantly moderate the association between psychological distress and IA. The finding does not support an idea that psychological distress lead to IA in the urban setting than in the non-urban setting presumably due to better internet accessibility in the urban setting. This may be attributable to narrowing the digital divide between urban and rural areas in Japan (Ministry of Internal Affairs and Communications, n.d.a). Thus, the generalization of the finding should be done carefully. We also could not test the moderating effect over the association between social support and IA, since the statistical model did not converge. Future research should be done to investigate the contextual influence of the urbanity on IA in diverse settings, including these and additional factors associated with IA.

The strengths of this research are follows. First, this study used a nationally representative sample. Second, the study measured both psychological distress and mental disorders diagnosed by a structured interview. Third, CIUS measures the prevalence of IA more accurately than IAT in the general population (Yong et al., 2017). IAT is heavily skewed towards younger people and shows mean score differences by gender and living location; CIUS does not have these characteristics and can be used for all ages (Yong et al., 2017). Fourth, this research applied a multilevel model to accurately reflect the relationship between urbanization and IA.

Several limitations should also be considered in interpreting the findings, however. First, the response rate of the WMHJ2 survey was not high overall, and it tended to be lower in larger cities. Selection bias in favor of our results may have occurred if people with IA were more willing to participate in the survey; however, this is unlikely, since people with IA are thought to frequently avoid face-to-face contact, which the present survey's method necessitates. Thus, this study may actually underestimate the association if people with IA were less likely than the general population to participate in the study. Second, information bias may be present if respondents in large cities were more aware of problems related to IA and therefore either more willing or hesitating to report such problems in the survey. Third, other area-level covariates may confound the association; for instance, area-level socioeconomic status, which was not measured in this study, may partly explain the association between urbanization and IA, since a thriving economy or concentration of wealth in an area may lead to more Internet service or use in that area. This may be the case even though we adjusted for individual-level education and household income. Fourth, the number of cases with Severe IA as a proportion of our overall sample size was small. This may cause a greater likelihood of type 2 error. Fifth, our classification of “urbanization” followed the official one used by the government of Japan in city planning. However, there may be a more sensitive cutoff point in city size or other urbanization indicators in terms of association with development of IA. This should be investigated in detail. Sixth, we did not consider the urban-rural difference in the utilization of pornographic sites, social networking sites, or online gaming sites, that might explain the association between the urbanity and IA. Seventh, the measurement invariance of CIUS across different cultures has not been established, e.g., by using item response theory (IRT). This might limit the generalization of the findings in Japan to other countries. Eighth, the association between the urbanity and IA may be different across age groups. A future study should investigate age-group differences. Finally, since this study was cross-sectional, it is not clear whether living in an urban area led to the development of IA, or whether people with IA (or with a predisposing trait for IA) were more likely to move to urban areas. Further research should thus be conducted with a prospective study design, a larger sample, measurement of various area-level indicators, and more accurate assessment of IA.

Despite these limitations, the present study indicated that residents of large cities in Japan may be at higher risk of IA than non-urban residents, and that psychological distress at both the area level and the individual level may partly explain this relationship. These findings warrant further investigation.

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