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Association of child-specific and household material deprivation with depression among elementary and middle school students in Japan

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Abstract

Purpose This study aimed to investigate the association between child-specific and household material deprivation with depression among elementary and middle school students in Japan.

Methods We used cross-sectional data from 10,505 and 10,008 students for fifth-grade elementary school students (G5) and second-grade middle school students (G8), respectively, and their caregivers. The data were collected from August to September 2016 in 4 municipalities of Tokyo and from July to November 2017 in 23 municipalities of Hiroshima prefecture. Caregivers completed questionnaires including household income and material deprivation, and children completed child-specific material deprivation and depression status using the Japanese version of the Birleson depression self-rating scale for children (DSRS-C). To explore the associations, logistic regression was used after conducting multiple imputation for the missing data.

Results 14.2% of G5 students and 23.6% of G8 students had DSRS-C scores of more than or equal to 16, denoting the risk of depression. We found that household equivalent income was not associated with childhood depression in both G5 and G8 students when adjusted for material deprivations. While at least one item of household material deprivation was significantly associated with depression in G8 students (OR = 1.19, CI = 1.00, 1.41), but not in G5 children. Child-specific material deprivation of more than 5 items was significantly associated with depression in both age groups (G5: OR = 1.53, CI = 1.25, 1.88; G8: OR = 1.45, CI = 1.22, 1.73).

Conclusion Future research on child mental health needs to consider children's perspectives, especially material deprivation in young children.

Keywords Children · Depression · Deprivation · Japan

Introduction

Childhood depression in elementary and middle school students can usually be neglected even though the depressed status can continue into adulthood [1, 2]. Children in Japan have the near-worst mental health of all OCED countries, with a relatively high suicide rate (7.5 per 100,000 adolescents aged 15–19) [3]. According to data from the Ministry of Health, Labor and Welfare, the prevalence of mood disorders (including manic depression) was 1.6% among people under 20 in 2017 [4]. Early-onset depression has a poorer prognosis than adult-onset depression, and there is a risk of premature death due to mental and physical complications in adulthood [1, 5–7].

The low socioeconomic status of the family can be a major determinant of childhood mental disorders [8, 9]. When measuring poverty for well-being among children, household income is usually a poor predictor because it measures the previous year's income, fails to cover non-monetary provisions from friends and social welfare, and does not consider the amount of consumption [10]. Later, material deprivation was also recognized as an indicator of poverty, and it was found to have an independent impact on

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childhood mental health, regardless of household income [9–12]. Material deprivation not only affects a child's mental health directly but can also affect it through parenting behaviors [9]. Lack of household items can also cause mental distress in parents, which can affect the mental health of children [13]. Hence, material deprivation in the literature mainly focused on the deprivation of daily necessities among household items such as cars, microwaves, and refrigerators from caregivers' and parents' responses [14, 15].

In recent years, the child-centered approach has been proposed. That is, it is needed to explore children's perceptions and awareness of their own lives to accurately assess their standard of living [16]. A previous study suggested that a child's perception of what is deprived can be a better predictor of the child's mental health [17] because children often do not know about or are not interested in their parents' income. Children may also have different opinions about their parents' status, especially in countries like Japan where it is taboo to ask for details about their socioeconomic status to their parents [18]. In Japan, research has been conducted to distinguish between child-specific needs and family needs [14], but no research has been conducted to identify the association between child-specific deprivation and childhood depression, as assessed by the children themselves.

This study aimed to find the association between child-specific and household material deprivation and depression among elementary and middle school students in Tokyo and Hiroshima prefectures, Japan. Tokyo prefecture, the capital of Japan, is mainly urban, while Hiroshima prefecture which locates in the Chugoku region, the western part of Japan, contains several large cities but also has a vast rural area.

Methods

Study participants

We used data from the "Child Living Condition Survey" which focused on the child poverty and lifestyle of elementary, middle, and high school children and adolescents in different prefectures across Japan. In this study, we included fifth-grade elementary school students (hereafter G5 including 10–11 years old) and second-grade middle school students (hereafter G8 which were eighth grade including 13–14 years old) from 4 municipalities in Tokyo and 23 municipalities in Hiroshima prefecture according to the data availability. The Tokyo survey was commissioned by the Tokyo Prefectural Government and was conducted by Tokyo Metropolitan University. The survey was approved by the Tokyo Metropolitan University research ethics committee (approval number H28-73, approval date 22 July 2016). The Hiroshima survey was reviewed and approved by the Ministry of Internal Affairs

and Communications (MIC), as the survey was conducted directly by the Hiroshima Prefectural Government. Data were collected from August to September 2016 in Tokyo and from July to November 2017 in Hiroshima. Parents (or caregivers) and children completed separate questionnaires, after which the reported data were merged according to the household identification number given. Different municipalities used different methods of sampling and data collection. In 4 municipalities in Tokyo, all G5 and G8 children and their parents were recruited from the basic resident register, and questionnaires were distributed and collected by mail. In Hiroshima city in Hiroshima prefecture, households were randomly selected (4000/10,830 for G5 and 4000/9490 for G8 children) from the basic resident register, and questionnaires were distributed and collected by mail. In Fukuyama city in Hiroshima prefecture, schools were randomly selected, and questionnaires were distributed and collected by the selected schools (1502/4277 for G5 and 1554/3850 for G8 children). All G5 and G8 students were recruited in another 6 cities and questionnaires were distributed and collected by each school (3723 G5 and 3,711 G8 children). For the rest of the cities and towns in Hiroshima prefecture, the prefectural government grouped schools depending on whether they were governmental or private schools and sent the questionnaires to each group of schools (4193/5917 G5 and 3788/5695 G8 students). The sampling flowchart is described in Supplementary Fig. 1 and Fig. 2. Together with the questionnaires, the consent forms were attached for both children and caregivers where participants could check their willingness to participate. We only included responses consented to by both children and caregivers. After excluding samples with the missing outcome variables (childhood depression), main exposure variable (household and child-specific deprivation), gender, and city, the analysis included 10,505 G5 children and 10,008 G8 children.

Measures

Childhood depression

As an outcome variable, the self-reported depression status of children was measured using the Birleson Depression Self-Rating Scale for Children (DSRS-C) which is validated in Japanese [19]. The DSRS-C measures the orientations and disturbances felt by children and adolescents aged between 8 and 14 years old in the past week and consists of 18 items with scores of 0, 1, and 2. The higher is the score, the stronger the depressive tendency, with a maximum score of 36 [20]. The cutoff value was set at 16 points or more, indicating a clinical risk of depression [21].

Income and deprivation

Equivalent income, household material deprivation, and child-specific material deprivation were assessed. Income and material deprivation of the household was answered by the parents, and child-specific material deprivation was answered by the children themselves. The parents were asked about their annual household income with a questionnaire of 12 categories to choose from 0 to 9 million yen. Equivalent income was calculated by dividing the household's annual income by the squared root of the household size. The results were divided into the following categories: less than 1500 thousand yen, 1500 to 2499 thousand yen, 2500 to 3499 thousand yen, and more than 3500 thousand yen based on the income distribution of the entire population [22].

The household material referred to 10 basic household material items such as a washing machine, rice cooker, vacuum cleaner, heating equipment, cooling equipment, microwave oven, telephone, bath, beds, and bedding for household members, and savings of at least 50,000 yen ($\approx$ US\$474) for unexpected expenses. Parents could select "Yes (I have it)" or "No (I don't have it)" for each item. This questionnaire set was applied to refer to parental non-monetary deprivation in previous literature [14, 23].

Child-specific material referred to a list developed specifically for Japanese children [18]. This list included 14 items: age-appropriate books at home, a child's room, an Internet connection at home, a place to do homework at home, the child's desk, sports equipment, a game console, toys that most friends have, a bicycle, pocket money to buy small snacks, the clothes like other children, at least two pairs of shoes that fit, a mobile cell phone, and portable music players. The response options included "I have it," "I don't have it but want it," "I don't have it and don't want it," and "not answered". We considered "I have it" as having a specific item, "I don't have it, but I want it" and "I don't have it and I don't want it" as not having it. Such a classification follows traditional relative deprivation research [24]. Household deprivation was classified into two categories: no deprivation and deprivation of one or more items, and child-specific material into three categories: less than 3 items deprived, 3–5 items deprived, and more than 5 items deprived according to previous literature on material deprivation of children in Japan [14].

Covariates

Other covariates included the child's gender, relationship with friends (using the friendship part of the Japanese version of Kid-Kindl quality of life in children questionnaire [25] as a continuous variable), maternal education (high school or below and others, junior college and technical college, university and above), caregiver's age (under 35, 35–49, 40–44, 45+ years old), caregiver's mental health (measured by the validated Japanese version of K6 psychological screening tool [26]), and prefecture (Tokyo, Hiroshima). We assumed that these covariates can be associated with both material deprivation and childhood depression according to the previous literature [15, 27, 28]. We also included the number of times per week that the children performed more than 30 min of physical activity (no activity, 1–4 times, > 5 times) if physical activity might explain the association [27, 29]. The variables answered by the children were supposed reliable as we used validated materials for Japanese children of the same age groups and for recall questions, we set the recall time for a week which is optimal for children above 8 years old [30].

Statistical analysis

As 2,994 (28.5%) G5 students and 2817 (28.1%) G8 students had missing data for one or more of the covariates, we applied multiple imputation. 20 multiple imputed data sets were created by chained equation procedures and combined the estimated parameters using Rubin's combination methods [31, 32]. Population proportions were estimated by applying sampling weights, which were the respective student population of a municipality divided by the number of samples in each municipality.

Chi-squared test was used to find the descriptive association between each variable and the missing data. We checked the Pearson correlation between equivalent income, household, and child-specific material deprivations. Logistic regression was used to assess the association between depression and low income and deprivation. We used equivalent income of at least 3500 thousand yen, no deprivation in the household, and less than 3 items of child-specific deprivation as reference categories. Model 1 examined the crude associations between depression status and each variable. Model 2 adjusted for potentially confounding demographic variables (gender, relationship with friends, maternal education, caregiver's age, caregiver's mental health, and prefecture) and each of the main exposures (income, household, or child-specific deprivation). Model 3 was adjusted for all three main exposures while Model 4 was additionally adjusted for the possible mediator of the association between poverty and depression, physical activity, as a previous study reported poverty induces poor physical activity [33], and physical activity is one of the risk factors of depression [29].

The population-attributable fraction (PAF) was also calculated to predict the reduction in the number of children at high risk of depression when the material deprivation for households and children was eliminated or reduced, as a previous study applied the method to detect the reduction in mental deficits among children against a combined

measurement [34]. It was calculated with the following formula:

$$PAF = (I_p - I_u)/I_p$$

where I_p (the incidence in the population) refers to the proportion of children with a DSRS-C score more than or equal to 16 in the entire population of Tokyo (4 districts) and Hiroshima, I_u (the incidence if the population were unexposed to the risk factor) refers to the proportion of children with a DSRS-C score ≥ 16 that would be reduced if the risk factors (more than 3 items and 5 items deprivation of child-specific materials or, deprivation of any household material) were eliminated. The proportions were estimated using the punaf function of Stata and adjusted for all variables included in our model 3. As the punaf function cannot be applied under multiple imputation, we calculated PAF only for the complete cases without missing covariates. Supplementary analyses were done with the complete cases to find out if there were any changes in the findings and caregiver responses were limited only to those of fathers and mothers to emphasize the confounding effect of parents. Stata version 16.0 was used for all analyses (STATA Corp., College Station, TX, USA).

Results

Table 1 describes the participants' characteristics of both complete cases, the types of caregivers who participated, those who had missing data in any of the covariates (equivalent income, physical activity, relationship with friends, caregiver's age, maternal education, and caregiver's mental health) in G5 and G8 students. The numbers of complete cases were 7511 and 7191 for G5 and G8, respectively, and we performed multiple imputations to maintain the sample size of 10,505 for G5 and 10,008 for G8. 14.2% of G5 students and 23.6% of G8 students had DSRS-C scores of more than or equal to 16. For both grades, students with a complete set of variables tended to have lower DSRS-C scores, a household equivalent income of more than 2500 thousand yen per year, less child-specific material deprivation, higher maternal education, caregiver's age of between 35 and 44 years, and prefecture Tokyo.

Table 2 presents Pearson's correlation between socioeconomic variables (household equivalent income, household material deprivation, and child-specific material deprivation) as categorical variables included in the regression models. The correlations for both G5 and G8 were significant but small ($r < 0.4$, $p < 0.05$), and these indicate some overlap between income and material deprivations. However, as described in the previous literature

[35], the overlap is not perfect and as the correlations were small, these would not arise collinearity during the multivariate logistic regression.

Table 3 describes the results of logistic regression between childhood depression and socioeconomic variables after applying multiple imputation for G5. All socioeconomic variables were associated with childhood depression in bivariate regressions (Model 1). Equivalent income and household material deprivation were not significantly associated with depression after adjusting for covariates (Model 2). Regarding child-specific materials, children who were deprived of 3–5 items had no association with depression but those who were deprived of more than 5 items were 1.53 times (OR = 1.53, CI = 1.25, 1.88) more likely to have depression compared to children with less than 3 items deprived. The association had small reductions but remained significant after adjusting for physical activity (Model 4).

Table 4 describes the results of logistic regression for G8. All socioeconomic variables had a significant bivariate association with depression (Model 1) though the equivalent income had no significant association with depression after adjusting for covariates (Model 2). Household material deprivation and child-specific material deprivation were consistently associated with depression both before and after involving all socioeconomic variables. Children who were deprived of at least one item of household material were 1.19 times more likely to have depression when compared to children with no household material deprivation (OR = 1.19, CI = 1.00, 1.41). Children who were deprived of 3 to 5 items of child-specific materials were 1.18 times (OR = 1.18, CI = 1.03, 1.34), and those who were deprived of more than 5 items were 1.45 times (OR = 1.45, CI = 1.22, 1.73) more likely to have depression when compared to children with less than 3 items deprived. These associations also remained significant after adjusting for physical activity (Model 4).

Table 5 represents population-attributable fractions (PAF) for G5 and G8. If all G5 students in Hiroshima prefecture and four municipalities in Tokyo had at least 5 items of child-specific materials, PAF was 7% (CI = 0.03, 0.11) and the prevalence of childhood depression would be reduced from 14.2% to 13.3%. If all G8 students had at least 5 child-specific items, PAF was 3% (CI = 0.01, 0.04) and the prevalence would be reduced from 23.6% to 23.0%. If the deprivation was reduced to less than 3 items, the prevalence would be reduced from 23.6% to 21.7%. PAF for eliminating household material deprivation was 3% (CI = 0.01, 0.05), and the prevalence of depression would be reduced from 23.6% to 23.0%. Supplementary analyses were done with the complete cases (Supplementary Tables 1 and 2) and the caregiver responses were limited to those of parents (Supplementary Tables 3 and 4) and both results were almost similar.

Table 1 Participants' characteristics and comparison between participants with or without missing data

Variables	Elementary school				Middle school			
	Total (n = 10,505)	Complete cases (n = 7511)	Participants who had missing data (n = 2994)	p value	Total (n = 10,008)	Complete cases (n = 7191)	Participants who had missing data (n = 2817)	p value
	N (%)/mean (SD)	N (%)/mean (SD)	N (%)/mean (SD)		N (%)/mean (SD)	N (%)/mean (SD)	N (%)/mean (SD)	
DSRS score								
< 16	9011 (85.8%)	6507 (86.5%)	2504 (83.6%)	< 0.001	7645 (76.4%)	5532 (76.9%)	2113 (75%)	0.042
≥ 16	1494 (14.2%)	1004 (13.4%)	490 (16.4%)		2363 (23.6%)	1659 (23.1%)	704 (25%)	
Equivalent income (thousand yen)								
< 1500	1387 (16.9%)	1231 (16.4%)	156 (21.9%)	< 0.001	1362 (17.5%)	1219 (17%)	143 (24%)	< 0.001
1500–2499	1996 (24.3%)	1812 (24.1%)	184 (25.8%)		1619 (20.8%)	1478 (20.6%)	141 (23.7%)	
2500–3499	2101 (25.6%)	1940 (25.8%)	161 (22.6%)		1907 (24.5%)	1754 (24.4%)	153 (25.7%)	
≥ 3500	2739 (33.3%)	2528 (33.7%)	211 (29.6%)		2898 (37.2%)	2740 (38.1%)	158 (26.6%)	
Household material deprivation								
No deprivation	8892 (84.7%)	6310 (84.0%)	2582 (86.2%)	0.004	8512 (85.1%)	6062 (84.3%)	2450 (87%)	0.001
At least one item deprived	1613 (15.4%)	1201 (16.0%)	412 (13.8%)		1496 (15%)	1129 (15.7%)	367 (13%)	
Child-specific material deprivation								
Less than 3 items deprived	3285 (31.3%)	2429 (32.3%)	856 (28.6%)	< 0.001	5041 (50.4%)	3705 (51.5%)	1336 (47.4%)	< 0.001
3–5 items deprived	4799 (45.7%)	3436 (45.8%)	1363 (45.5%)		3585 (35.8%)	2559 (35.6%)	1026 (36.4%)	
More than 5 items deprived	2421 (23.1%)	1646 (21.9%)	775 (25.9%)		1382 (13.8%)	927 (12.9%)	455 (16.2%)	
Gender								
Boy	5168 (49.2%)	3694 (49.2%)	1474 (49.2%)	0.963	4806 (48%)	3475 (48.3%)	1331 (47.3%)	0.33
Girl	5337 (50.8%)	3817 (50.8%)	1520 (50.7%)		5202 (52%)	3716 (51.7%)	1486 (52.8%)	
Physical activity								
No activity	1199 (11.6%)	868 (11.6%)	331 (11.6%)	0.27	1696 (17.1%)	1258 (17.5%)	438 (16.2%)	0.049
1 to 4 times	6089 (58.8%)	4450 (59.3%)	1639 (57.6%)		2227 (22.5%)	1646 (22.9%)	581 (21.5%)	
> 5 times	3068 (29.6%)	2193 (29.2%)	875 (30.8%)		5972 (60.4%)	4287 (59.6%)	1685 (62.3%)	
Relationship with friends	12.7 (2.0)	12.8 (2.0)	12.6 (2.1)		12.4 (2.0)	12.4 (2.0)	12.3 (2.0)	
Caregiver								
Father	1078 (10.3%)			0.002	1042 (10.4%)			0.24
Mother	9102 (86.6%)				8480 (84.7%)			
Grandparents, siblings, others	72 (0.7%)				109 (1.1%)			
Not answered	253 (2.4%)				377 (3.8%)			
Caregiver's mental health								
High risk	622 (5.9%)	456 (6.1%)	166 (6.2%)	0.853	586 (5.9%)	6774 (94.2%)	2170 (92.8%)	0.013
Low risk	9579 (91.2%)	7055 (93.9%)	2524 (93.8%)		8944 (89.4%)	417 (5.8%)	169 (7.2%)	

Discussion

To our knowledge, this is the first study that identifies the association between material deprivation and depression using children's responses in Japan. The prevalence of childhood depression was 14.2% among elementary students in fifth grade (G5) and 23.6% among middle school eighth-grade (G8) students. According to our study,

Table 1 (continued)

Variables	Elementary school				Middle school			
	Total (n = 10,505)	Complete cases (n = 7511)	Participants who had missing data (n = 2994)	p value	Total (n = 10,008)	Complete cases (n = 7191)	Participants who had missing data (n = 2817)	p value
	N (%)/mean (SD)	N (%)/mean (SD)	N (%)/mean (SD)		N (%)/mean (SD)	N (%)/mean (SD)	N (%)/mean (SD)	
Maternal education								
High school, below, and others	2588 (26.4%)	1881 (25.0%)	707 (30.6%)	< 0.001	2687 (29.2%)	1992 (27.7%)	695 (34.4%)	< 0.001
Junior COL-LEGE, technical college	4705 (47.9%)	3574 (47.6%)	1131 (49.0%)		4589 (49.8%)	3576 (49.7%)	1013 (50.1%)	
University and above	2528 (25.7%)	2056 (27.4%)	472 (20.4%)		1938 (21%)	1623 (22.6%)	315 (15.6%)	
Caregiver's age (year old)								
< 35	847 (8.2%)	596 (7.9%)	251 (9.1%)	< 0.001	238 (2.4%)	172 (2.4%)	66 (2.6%)	0.001
35–39	2545 (24.8%)	1863 (24.8%)	682 (24.7%)		1291 (13.2%)	971 (13.5%)	320 (12.4%)	
40–44	4126 (40.2%)	3127 (41.6%)	999 (36.2%)		3791 (38.8%)	2852 (39.7%)	939 (36.3%)	
≥ 45	2755 (26.8%)	1925 (25.6%)	830 (30.1%)		4460 (45.6%)	3196 (44.4%)	1264 (48.8%)	
Prefecture								
Tokyo	2616 (24.9%)	1995 (26.6%)	621 (20.7%)	< 0.001	2665 (26.6%)	2081 (28.9%)	584 (20.7%)	< 0.001
Hiroshima	7889 (75.1%)	5516 (73.4%)	2373 (79.3%)		7343 (73.4%)	5110 (71.1%)	2233 (79.3%)	

Table 2 Correlation between equivalent income and material deprivation

Variable		Correlations (elementary school)			Correlations (middle school)		
		1	2	3	1	2	3
1	Equivalent income	–			–		
2	Household material deprivation	− 0.33*	–		− 0.32*	–	
3	Child-specific material deprivation	− 0.16*	0.12*	–	− 0.16*	0.14*	–

*p value < 0.05

childhood depression was associated with income, household material deprivation, and child-specific material deprivation in bivariate models. However, after including all factors in a single model, only child-specific material deprivation was associated with depression for both G5 and G8 children.

The prevalence of depression in the study population was quite high, especially among middle school students. For Japanese students, several factors, such as competitive academic life and family circumstances were assumed to contribute to the high depression rate [36, 37]. Although these statistics were pre-COVID-19 pandemic, there was evidence of an increase in childhood mental disorders due to the global epidemic of COVID-19 [38]. Thus, this study warns that childhood depression is an urgent issue that needs to be addressed in Japan.

It has been reported that children's perspectives on poverty may be strongly associated with children's mental health [18], and we supported this finding that children's perspectives on deprivation were an independent predictor of children's mental health, regardless of income or household materials. Even children as young as elementary school age could sense a comparison between friends in terms of the socioeconomic status of their household, which could lead to stressful social interactions if there were deprivation of child-specific materials [39]. One other possible explanation may be bullying. A study conducted in China showed that children reported material deprivation was strongly associated with the victimization of crimes including bullying by peers and siblings and that this association was entirely mediated by the perceived social support of the children [40]. Materially disadvantaged children often have less

Table 3 Logistic regression of childhood depression with income and deprivation by multiple imputed data sets (elementary students, $n = 10{,}505$)

	Prevalence of DSRS≥16	Model 1	Model 2			Model 3	Model 4
		Odd ratios (CI)	Odd ratios (CI)	Odd ratios (CI)	Odd ratios (CI)	Odd ratios (CI)	Odd ratios (CI)
Equivalent income (thousand yen)							
< 1500	222 (16.0%)	1.47 (1.18, 1.84)	1.16 (0.89, 1.50)			1.06 (0.80, 1.40)	1.06 (0.80, 1.40)
1500–2499	290 (14.5%)	1.28 (1.04, 1.57)	1.11 (0.88, 1.40)			1.04 (0.82, 1.33)	1.03 (0.81, 1.32)
2500–3499	289 (13.8%)	1.24 (1.01, 1.51)	1.15 (0.93, 1.44)			1.13 (0.91, 1.41)	1.13 (0.90, 1.41)
≥ 3500	325 (11.9%)	Ref	Ref			Ref	Ref
Household material deprivation							
No deprivation	1198 (13.5%)	Ref		Ref		Ref	Ref
At least one item deprived	296 (18.4%)	1.49 (1.25, 1.78)		1.16 (0.94, 1.43)		1.11 (0.89, 1.38)	1.1 (0.88, 1.37)
Child-specific material deprivation							
Less than 3 items deprived	339 (10.3%)	Ref			Ref	Ref	Ref
3–5 items deprived	613 (12.8%)	1.30 (1.09, 1.55)			1.10 (0.91, 1.33)	1.09 (0.90, 1.32)	1.08 (0.89, 1.31)
More than 5 items deprived	542 (22.4%)	2.38 (1.98, 2.86)			1.55 (1.27, 1.91)	1.53 (1.25, 1.88)	1.48 (1.20,1.82)
Relationship with friends		0.62 (0.59, 0.64)	0.62 (0.59, 0.64)	0.62 (0.59, 0.64)	0.62 (0.60, 0.65)	0.62 (0.60, 0.65)	0.63 (0.61, 0.66)
Caregiver's mental health							
High risk	157 (25.2%)	2.36 (1.87, 2.99)	1.97 (1.49, 2.62)	1.94 (1.46, 2.57)	1.97 (1.49, 2.61)	1.91 (1.43, 2.55)	1.85 (1.39, 2.48)
Low risk	1280 (13.4%)	Ref	Ref	Ref	Ref	Ref	Ref
Prefecture							
Tokyo	351 (13.4%)	Ref	Ref	Ref	Ref	Ref	Ref
Hiroshima	1143 (14.5%)	1.06 (0.92, 1.22)				1.17 (0.99, 1.37)	1.18 (1.00, 1.39)
Physical activity							
No activity	289 (24.1%)	3.16 (2.53, 3.96)					1.73 (1.33, 2.25)
1 to 4 times	871 (14.3%)	1.5 (1.26, 1.79)					1.24 (1.02, 1.50)
> 5 times	299 (9.8%)	Ref					Ref

Model 1: bivariate regression, Model 2: adjusted for gender, relationship with friends, maternal education, caregiver's age, caregiver's mental health, and prefecture., Model 3: mutually adjusted model, Model 4: model 3 + physical activity

Table 4 Logistic regression of childhood depression with income and deprivation by multiple imputed data sets (middle school students, $n = 10{,}008$)

	Prevalence of DSRS ≥ 16	Model 1 Odd ratios (CI)	Model 2 Odd ratios (CI)	Odd ratios (CI)	Odd ratios (CI)	Model 3 Odd ratios (CI)	Model 4 Odd ratios (CI)
Equivalent income (thousand yen)							
< 1500	371 (27.2%)	1.29 (1.1, 1.52)	1.06 (0.88, 1.28)			0.97 (0.79, 1.18)	0.96 (0.78, 1.17)
1500–2499	400 (24.7%)	1.25 (1.07, 1.46)	1.1 (0.91, 1.32)			1.04 (0.86, 1.25)	1.04 (0.86, 1.26)
2500–3499	450 (23.6%)	1.14 (0.97, 1.32)	1.06 (0.89, 1.25)			1.03 (0.87, 1.23)	1.04 (0.88, 1.24)
≥ 3500	591 (20.4%)	Ref	Ref			Ref	Ref
Household material deprivation							
No deprivation	1918 (22.5%)	Ref		Ref		Ref	Ref
At least one item deprived	445 (29.8%)	1.52 (1.32, 1.75)		1.23 (1.05, 1.45)		1.19 (1.00, 1.41)	1.20 (1.01, 1.42)
Child-specific material deprivation							
Less than 3 items deprived	934 (18.5%)	Ref			Ref	Ref	Ref
3–5 items deprived	917 (25.6%)	1.6 (1.42, 1.8)			1.18 (1.04, 1.35)	1.18 (1.03, 1.34)	1.14 (1.00, 1.30)
More than 5 items deprived	512 (37.1%)	2.66 (2.29, 3.08)			1.48 (1.24, 1.76)	1.45 (1.22, 1.73)	1.34 (1.12, 1.61)
Relationship with friends		0.61 (0.59, 0.62)	0.60 (0.58, 0.62)	0.60 (0.59, 0.62)	0.61 (0.59, 0.63)	0.61 (0.59, 0.63)	0.62 (0.60, 0.64)
Caregiver's mental health							
High risk	218 (37.2%)	2.11 (1.73, 2.57)	1.74 (1.38, 2.19)	1.66 (1.31, 2.1)	1.71 (1.36, 2.15)	1.65 (1.3, 2.09)	1.62 (1.28, 2.05)
Low risk	1996 (22.3%)	Ref	Ref	Ref	Ref	Ref	Ref
Prefecture							
Tokyo	575 (21.6%)	Ref	Ref	Ref	Ref	Ref	Ref
Hiroshima	1788 (24.4%)	1.13 (1.01, 1.26)	1.24 (1.09, 1.4)	1.24 (1.09, 1.41)	1.22 (1.07, 1.38)	1.21 (1.06, 1.38)	1.28 (1.12, 1.46)
Physical activity							
No activity	649 (38.3%)	2.5 (2.19, 2.85)					1.71 (1.46, 2.00)
1 to 4 times	549 (24.7%)	1.4 (1.22, 1.59)					1.16 (1.00, 1.34)
> 5 times	1140 (19.1%)	Ref					Ref

Model 1: bivariate regression, Model 2: adjusted for gender, relationship with friends, maternal education, caregiver's age, caregiver's mental health, and prefecture, model 3: mutually adjusted model, model 4: model 3 + physical activity

social support from friends and family, which can result in bullying and poor social interactions, leading to psychological conflicts [41].

Unlike previous literature, household material deprivation was associated with depression in G8 students (ages 13–14) but not in G5 students (ages 10–11). It was possible that younger students were less conscious of their parents' possessions and did not feel emotional stress about the deprivation of household goods if their needs were met [42]. Older students might be more aware of and sensitive to household conditions [17]. Like previous studies on Japanese

households and children's material deprivation [14], household income was not associated with childhood depression after adjusting for maternal psychological status and other demographic factors. While household income was not often discussed in Japanese households, children might be more aware of easily noticeable materials. Therefore, unlike studies in Western countries where income might be openly discussed among family members [17, 43], the impact of household income on the mental health of school-aged children might be small, even among older children. Results on PAF indicated that material deprivation had a substantial risk

Table 5 Population attributable fractions for depression

Variable	(Elementary school, complete cases, $N=7616$)			(Middle school, complete cases, $N=7122$)		
	PAF	Prevalence of DSRS ≥ 16	Population of children with DSRS ≥ 16	PAF	Prevalence of DSRS ≥ 16	Population of children with DSRS ≥ 16
All families were not less than 3 items of child-specific material deprivation	NA	NA	NA	0.08 (0.04,0.13)	21.7%	6408
All families were not less than 5 items of child-specific material deprivation	0.07 (0.03,0.11)	13.3%	4126	0.03 (0.01,0.04)	23.0%	6792
All families were not under household material deprivation	NA	NA	NA	0.03 (0.01,0.05)	23.0%	6792

The estimated population of elementary students in 4 municipalities of Tokyo and 23 municipalities of Hiroshima was 31,025. The population of middle school students in 4 municipalities of Tokyo and 23 municipalities of Hiroshima was 29,531

of being attributed to childhood depression. Current Japanese policies and child welfare programs focus primarily on financial support for families and educational advancement for children [44]. To reduce the burden of childhood depression, it may be necessary to consider child-specific material support in future programs.

Limitations

Regardless of the above findings, this study had several limitations. As this study was a cross-sectional study, we could not prove a causal relationship between childhood material deprivation and depression in children. In addition, we could not include child lifestyle factors such as sleep habits as covariates although these can be the main determinants of a child's mental health [45]. The study included only four municipalities in Hiroshima and Tokyo out of 47 prefectures, which might not be representative of all elementary and middle school students in Japan. Even though this study included only two prefectures, this study was able to include both urban (Tokyo) and suburban/rural areas (Hiroshima) of Japan, and the differences between them were not observed. In addition, the list of child-specific materials, such as music players, might not represent the essential needs of present-day children. This resulted in a quite low percentage of children who were not deprived at all. To overcome limitations, future research should consider including nationwide samples, using child-specific materials which will match children's needs in the current situation, and designing a longitudinal survey of child mental health.

Implications

Despite these limitations, our results suggested that child-specific material deprivation in terms of children's responses was significantly associated with childhood depression, especially among young adolescents, compared to household income and household material deprivation. Therefore, it is important to address child-specific material deprivation to eliminate and mitigate childhood depression, and future children's mental health research should emphasize children's perspectives on material deprivation.

Conclusion

Child-specific material deprivation was associated with depression in both elementary and middle school students, while household material deprivation was associated with depression only in middle school students. In future children's mental health studies, child-specific material deprivation should be included as one of the indicators of socioeconomic status.

Declarations

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