Short communication

Associations of neighborhood socioeconomic conditions with self-rated health, mental distress, and health behaviors: A nationwide cross-sectional study in Japan

Tomoya Hanibuchi[a,b,*], Tomoki Nakaya[c]

[a] School of International Liberal Studies, Chukyo University, 101-2 Yagoto-honmachi, Showa-ku, Nagoya 466-8666, Japan
[b] Department of Geography, Portland State University, Portland, OR, USA
[c] Graduate School of Environmental Studies, Tohoku University, Sendai, Miyagi, Japan

ARTICLE INFO

ABSTRACT

Although associations between neighborhood socioeconomic conditions and health have been well established, their geographical scope is mostly limited to Western societies, while multilevel studies in the non-Western context (e.g., Japan) are limited to specific cities/regions within countries. This consequently limits the external validity of the findings. To fill the gap, this study examined the associations between neighborhood socio-economic conditions and health-related indicators by using nationwide cross-sectional data in Japan. Individual data was collected from a nationwide online survey conducted in 2015 (n = 4593). Self-rated health, mental distress (Kessler Psychological Distress Scale: K6), smoking, and physical activity were analyzed in relation to neighborhood conditions. Analyses of multilevel logistic regression models were done using the Areal Deprivation Index (ADI) with population density as the neighborhood-level independent variable. After adjusting for individual covariates, ADI showed significant positive associations with poor self-rated health (odds ratio for one standard deviation increase and 95% confidence interval: 1.09, 1.00–1.19), mental distress (1.09, 1.02–1.16), current smoking (1.11, 1.03–1.19), and physical inactivity (1.11, 1.04–1.18). Population density was not associated with the four dependent variables. Analyses of the nationwide survey data in Japan showed that neighborhood socioeconomic conditions were independently associated with multiple health statuses and behaviors. These analyses may contribute to generalizing existing findings. Lastly, the results indicate the importance of neighborhood socioeconomic conditions in reducing health disparities in Japan.

1. Introduction

In the past few decades, studies on neighborhood and health have rapidly expanded, with associations between neighborhood socio-economic conditions and health being particularly well studied (Arcaya et al., 2016; Diez Roux and Mair, 2010; Riva et al., 2007). An increasing number of studies using multilevel study design have reported that, even after adjustments for individual socioeconomic status, neighbor-hood socioeconomic conditions are independently associated with varied health statuses and health-related behaviors, including self-rated health, mental health, smoking, and physical activity (Algren et al., 2015; Kim, 2008; Mair et al., 2008; Riva et al., 2007). Moreover, a meta-analysis reported that significantly higher mortality was found among inhabitants living in areas with a low area-level socioeconomic status (Meijer et al., 2012). Neighborhood socioeconomic conditions can impact health and health behaviors by conditioning the physical,

built, and social environment (e.g., air quality, availability of parks, and place reputation/discrimination) of the neighborhoods (Macintyre and Ellaway, 2003).

However, neighborhood and health studies have often been limited in their geographical scope. Globally, research tended to concentrate on Western countries (Nakaya et al., 2014; Riva et al., 2007) or were restricted to specific cities/regions within countries (Cummins and Fagg, 2012; Hanibuchi et al., 2015b). Both factors limited the external validity of the findings because countries/regions with different histories/contexts may have unique neighborhood conditions and associations with health. Similarly, cities/towns could have different contexts in neighborhoods-health relations due to different urban sizes/forms. For example, compared to Western countries, Japanese metropolitan neighborhoods tend to be more socially mixed and have less salient socioeconomic segregation (Fielding, 2004). Therefore, a nationwide study in the non-Western context should be conducted to improve the

generalizability of findings.

Japan is a promising research field in this regard because the country has achieved high life expectancy and economic development similar to that of Western countries but has different histories/contexts of urban/rural development. Several studies in Japan have already reported that socioeconomically disadvantaged areas tend to have worse health outcomes or health-related behaviors at various geographical scales (Fukuda et al., 2005, 2007; Ito et al., 2014; Nakaya and Dorling, 2005; Nakaya and Ito, 2019; Nakaya et al., 2014). However, such studies have been largely limited to specific cities/regions (Ito et al., 2014) or non-metropolitan settings (Nakaya et al., 2014), while nationwide studies have been limited to ecological designs (Fukuda et al., 2007; Nakaya and Dorling, 2005; Nakaya and Ito, 2019) or multilevel analysis with larger spatial units of analysis (i.e., municipalities or prefectures) (Fukuda et al., 2005). To fill the gap, this brief report examines the associations between neighborhood socioeconomic conditions and multiple health-related indicators by using nationwide cross-sectional, multilevel data in Japan.

2. Methods

2.1. Data

Nationwide cross-sectional data was collected through an online survey conducted between September 25 and October 8, 2015. Details about this survey are described elsewhere (Koohsari et al., 2017). Nonetheless, briefly, invitations were sent to Japanese adults aged 20–64 years across the county, who were registered members of the survey company (Nippon Research Center, Ltd.). The quota sampling design was applied to the survey to ensure representative distribution in age, gender, geographical region, and population size of municipality (city, ward, town, and village). A total of 5002 members completed the survey. Respondents who did not provide information on their educational attainments or sufficiently-detailed residential addresses linking them to the Areal Deprivation Index (ADI, described below) were excluded from the study. Therefore, the final sample comprised of 4593 responses nested in 1033 municipalities. Ethical approval was obtained from the Research Ethics Committee of Chukyo University (2015–004).

2.2. Outcome variables

Four outcome variables were used. Poor self-rated health was defined using responses of "fair" or "poor" (vs. "excellent," "very good," or "good") to the question: "What is your current health condition?" The Kessler Psychological Distress Scale (K6) was used and scores of 5 points or more were used to classify those suffering moderate mental distress (Prochaska et al., 2012). In addition, current smoking (sometimes or everyday) and physical inactivity (almost never engaging in exercise or sports regularly) were also used as outcome variables of health-related behaviors.

2.3. Neighborhood exposure variables

We used two variables of neighborhood-level exposure—deprivation and density—both derived from the 2010 Population Census of Japan. Census-based ADI was used as an indicator of neighborhood socioeconomic conditions. Details of this ADI are described elsewhere (Nakaya et al., 2014). Nonetheless, briefly, this composite indicator comprises of weighted sums of several poverty-related census variables, such as the unemployment rate and the proportions of elderly couples in households, elderly single-occupier households, single-mother households, rented houses, sales and service workers, agricultural workers, and blue-collar workers. A larger ADI signifies that there are more deprived conditions in the neighborhood. We also used the population density of neighborhoods as a proxy indicator of urbanization, because it was also considered as influencing health in multiple ways,

such as due to overcrowded housing and individualistic lifestyles (i.e., urban penalty). Furthermore, ADI and the population density were shown to be directly and interactively associated with mortality (Nakaya et al., 2014). Both variables were created at the *chocho-aza* level, which is the smallest administrative unit with an average population of about 500 people and roughly comparable to a US census block group. These were z-score normalized and used as continuous variables in the regression analysis, while tertiles were used in cross tabulation for descriptive purposes.

2.4. Confounders

Possible confounders are gender (men, women), age (20–29, 30–39, 40–49, 50–59, 60–64 years), marital status (married, never married, divorced/separated), education ("high school" including junior high school and high school, "junior college" including junior (technical) college and vocational school, "university" including university and graduate school), annual household income before tax (< 3 million yen, 3–7 million yen, 7 million yen ≤, unreported), and working status (full-time, part-time, not working).

2.5. Statistical analysis

Multilevel logistic regression models were used to estimate odds ratios (ORs) with 95% confidence intervals (CIs) of the ADI and population density for each of the four outcome variables. Since respondents were highly scattered across the country, with only one respondent in most *chocho-aza* (neighborhoods), we used municipalities (n = 1033) as a group variable for adjusting unknown spatial clustering (i.e., municipality-level error term and the *chocho-aza* level independent variables were included in the models). Municipality in Japan is a unit of the local government with an average population of 67,151 people and average area of 198.2 km^2 (as of 2010).

3. Results

Table 1 shows the basic characteristics of the respondents and prevalence of the four outcome variables as shown by the individual and neighborhood independent variables. In total, 15.0% respondents had poor self-rated health, 40.9% were categorized as having moderate mental distress, 20.6% were currently smoking, and 48.9% were physically inactive. Regarding neighborhood variables, all four outcome variables were significantly different according to the levels of ADI: the most deprived neighborhood group showed the highest rates in poor self-rated health, mental distress, current smoking, and physical inactivity.

Table 2 shows the results of the multilevel logistic regression analyses. After adjusting for individual covariates, ADI showed significant associations with poor self-rated health (OR for one standard deviation increase: 1.09, 95% CI: 1.00–1.19), psychological distress (1.09, 1.02–1.16), current smoking (1.11, 1.03–1.19), and physical inactivity (1.11, 1.04–1.18). Population density was neither directly associated with the four dependent variables, nor did it have any interaction effects with the ADI (results not shown in table). Many individual covariates showed significant associations: for example, university degree was negatively associated with the four outcome variables. No multicollinearity was found among the independent variables (all VIFs < 3).

4. Discussion

By using nationwide online survey data in Japan, this study demonstrated that neighborhood socioeconomic conditions were independently associated with health status and behaviors. Similar to many previous studies (Algren et al., 2015; Kim, 2008; Mair et al., 2008; Riva et al., 2007), our results revealed that neighborhood ADI

Table 1

Characteristics of respondents and prevalence of outcome variables according to individual attributes and neighborhood-level variables,[a] Japan, 2015.

	n	%	Poor self-rated health	Mental distress	Current smoking	Physical inactivity
Total	4593	100.0	15.0	40.9	20.6	48.9
Gender					***	***
Men	2308	50.3	15.3	40.8	28.4	42.7
Women	2285	49.7	14.8	41.0	12.6	55.2
Age			***	***	***	***
20–29 years	813	17.7	11.4	52.9	12.2	43.4
30–39 years	1035	22.5	14.0	45.6	21.4	50.0
40–49 years	1197	26.1	16.8	40.4	23.8	54.0
50–59 years	985	21.4	18.0	36.0	24.0	51.3
60–64 years	563	12.3	13.1	24.3	18.1	40.1
Marital status			***	***	***	*
Married	2678	58.3	12.0	34.2	20.5	49.4
Never married	1594	34.7	19.1	52.1	17.8	46.9
Divorced/ Separated	321	7.0	19.9	40.5	34.9	55.8
Education			***	*	***	***
High school	1186	25.8	20.7	44.2	26.4	57.1
Junior college	1141	24.8	15.2	39.8	16.7	56.6
University	2266	49.3	12.0	39.7	19.4	40.8
Income			***	***	***	***
< 3 million Yen	837	18.2	22.3	49.8	18.0	54.1
3–7 million Yen	1913	41.7	13.6	40.0	21.7	49.4
7 million Yen ≤	1159	25.2	10.6	31.9	23.0	41.4
Unreported	684	14.9	17.4	47.5	16.1	54.1
Work status			***	*	***	***
Full-time	2475	53.9	12.7	39.4	25.8	45.9
Part-time	834	18.2	15.8	44.1	15.0	51.4
Not working	1284	28.0	18.9	41.6	14.0	53.1
Population density				*		*
Low	1530	33.3	16.1	43.7	19.8	50.7
Middle	1531	33.3	14.3	38.5	20.4	49.9
High	1532	33.4	14.7	40.5	21.5	46.3
Areal deprivation index			***	***	*	***
Least deprived	1532	33.4	12.3	35.6	18.5	45.6
Intermediate	1530	33.3	15.4	43.3	21.0	48.3
Most deprived	1531	33.3	17.3	43.8	22.1	53.0

***: p < 0.001, **: p < 0.01, *:p < 0.05.
[a] Associations were tested using a chi-squared test or Fisher's exact test.

was associated with multiple health-related outcomes, which suggests that socioeconomic conditions are important in shaping the health levels of neighborhoods in Japan. Namely, those living in deprived areas tended to have poor health status and engage in risky behaviors: one standard deviation increase of ADI were related to about 10% increased odds of having poor self-rated health, mental distress, current smoking, and physical inactivity. The results of multilevel analysis indicated that socioeconomic conditions matter for health both at individual and neighborhood levels. Therefore, researchers and policymakers in Japan should pay more attention to neighborhood socioeconomic conditions and population strategies for addressing them when aiming to improve population health while reducing health disparities.

To our knowledge, this study is the first to examine the associations between neighborhood socioeconomic conditions and multiple health-related variables using a nationwide survey in Japan. As previous neighborhood studies have limited international geographical scope (i.e., concentration in Western countries), this study may contribute enhancing the generalizability of the findings in neighborhood and health studies for it provides evidence from Japan. In addition, as mentioned in the introductory section, previous Japanese studies have often employed ecological designs, investigated limited cities/regions, or used larger spatial units for analysis (Fukuda et al., 2005, 2007; Ito et al., 2014; Nakaya and Dorling, 2005; Nakaya and Ito, 2019; Nakaya

et al., 2014). Therefore, this nationwide study provides basic evidence on the independent associations between neighborhood socioeconomic conditions and health status and behaviors in Japan.

Some inconsistencies in previous neighborhood studies in Japan were found regarding smoking (Hanibuchi et al., 2015a) and physical activity (Hanibuchi et al., 2015b), which reported no significant associations with ADI. The former study used a large sample but was limited to specific municipalities mainly in rural areas. Additionally, because the survey used was conducted in 1990, there were significant differences in social context regarding smoking (e.g., smoking ban policies) and smoking rates itself. The latter study by Hanibuchi et al. (2015b) using nationally representative adult (20–89 years) samples was different from our study settings in terms of sample size and age groups: our study used a larger sample size but was limited to younger adult and middle-aged groups (20–64 years). This indicates that associations between ADI and physical activity might have differed according to age groups.

In contrast to ADI, population density did not show an association with health-related variables or interactions with ADI. Nakaya et al. (2014) found that ADI was more strongly associated with mortality in densely populated areas in Japan. Although the reasons are unclear, different outcome and control variables may have affected the results, and/or our sample size was insufficient to detect such interaction effects. Different study areas (nationwide vs. non-metropolitan settings) and time points (2015 vs. 1990 for baseline) were other possible reasons for the inconsistency. Further studies using multiple neighborhood indices other than ADI and population density are required to fully understand the complex associations among neighborhood conditions, and their influence on health.

This study has some limitations. Our online survey respondents were not representative samples of Japanese population. Although it was efficient in collecting nationwide data, it may have introduced some biases: for example, those living in less-deprived neighborhoods and who were interested in health were more likely to respond to the survey, which could result in underestimating the associations. In fact, our samples tended to have higher socioeconomic status both at individual and neighborhood levels than the national average. Also, this study was based on a cross-sectional design; thus, causal mechanisms were not determined. Further studies using random sampling and longitudinal design are necessary.

5. Conclusion

This nationwide cross-sectional study showed that neighborhood socioeconomic conditions, measured by census-based ADI, were associated with multiple health-related outcomes including poor self-rated health, mental distress, current smoking, and physical inactivity. Importantly, these associations were seen in Japan, a developed country in East Asia, on which previous neighborhood studies have been relatively sparse. Therefore, this study contributes to the enhancement of the generalizability of its findings. Its results underscore the importance of focusing on socioeconomic conditions of neighborhoods when considering research and formulating policies to reduce health disparities.

CRediT authorship contribution statement

Tomoya Hanibuchi: Conceptualization, Methodology, Formal analysis, Writing - original draft, Funding acquisition. **Tomoki Nakaya:** Methodology, Writing - review & editing, Supervision, Project administration.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to

Table 2
Results of multilevel logistic regression analysis for poor self-rated health, mental distress, current smoking, and physical inactivity, Japan, 2015.

	Poor self-rated health			Mental distress			Current smoking			Physical inactivity		
	ORs		95%CIs	ORs		95%CIs	ORs		95%CIs	ORs		95%CIs
Individual level												
Gender (Ref. Men)												
Women	0.79	*	(0.65–0.96)	0.98		(0.85–1.13)	0.34	***	(0.28–0.41)	1.42	***	(1.24–1.64)
Age (Ref. 20–29 years)												
30–39 years	1.82	***	(1.36–2.44)	0.94		(0.77–1.15)	1.79	***	(1.36–2.36)	1.33	**	(1.09–1.62)
40–49 years	2.45	***	(1.83–3.27)	0.81	*	(0.66–0.99)	1.82	***	(1.38–2.40)	1.52	***	(1.24–1.86)
50–59 years	2.89	***	(2.13–3.93)	0.71	**	(0.57–0.88)	1.80	***	(1.34–2.40)	1.38	**	(1.11–1.71)
60–64 years	1.67	**	(1.16–2.39)	0.37	***	(0.29–0.48)	1.31		(0.93–1.83)	0.77	*	(0.60–0.98)
Marital status (Ref. Married)												
Never married	2.17	***	(1.75–2.69)	1.60	***	(1.37–1.87)	0.91		(0.75–1.11)	0.91		(0.78–1.07)
Divorced/Separated	1.55	**	(1.13–2.13)	1.20		(0.93–1.54)	2.48	***	(1.88–3.27)	1.02		(0.80–1.32)
Education (Ref. High school)												
Junior college	0.72	**	(0.58–0.90)	0.82	*	(0.69–0.97)	0.62	***	(0.50–0.76)	0.94		(0.80–1.12)
University	0.57	***	(0.47–0.70)	0.81	**	(0.69–0.94)	0.53	***	(0.44–0.64)	0.61	***	(0.52–0.71)
Income (Ref. < 3 million Yen)												
3–7 million Yen	0.75	*	(0.60–0.95)	0.81	*	(0.67–0.97)	1.26		(0.99–1.59)	0.79	*	(0.66–0.95)
7 million Yen ≤	0.63	**	(0.48–0.84)	0.66	***	(0.53–0.81)	1.39	*	(1.07–1.81)	0.61	***	(0.50–0.75)
Unreported	0.82		(0.63–1.07)	0.93		(0.75–1.15)	1.07		(0.80–1.42)	0.98		(0.79–1.21)
Working status (Ref. Full-time)												
Part-time	1.33	*	(1.04–1.69)	1.16		(0.97–1.38)	0.81		(0.64–1.02)	0.98		(0.82–1.17)
Not working	1.89	***	(1.52–2.34)	1.17		(0.99–1.37)	0.80	*	(0.64–0.99)	1.08		(0.92–1.27)
Neighborhood level												
Population density	0.97		(0.89–1.06)	0.95		(0.89–1.01)	1.05		(0.97–1.14)	0.98		(0.92–1.04)
Areal deprivation index	1.09	*	(1.00–1.19)	1.09	*	(1.02–1.16)	1.11	**	(1.03–1.19)	1.11	**	(1.04–1.18)
Constant	0.10	***	(0.07–0.15)	0.99		(0.75–1.32)	0.33	***	(0.22–0.48)	1.07		(0.80–1.42)
Municipality-level variance (standard error)	0.00 (0.00)			0.00 (0.00)			0.07 (0.06)			0.06 (0.03)		
Number of individuals	4593			4593			4593			4593		
Number of municipalities	1033			1033			1033			1033		

***: p < 0.001, **: p < 0.01, *:p < 0.05.

influence the work reported in this paper.

References

Algren, M.H., Bak, C.K., Berg-Beckhoff, G., Andersen, P.T., 2015. Health-risk behaviour in deprived neighbourhoods compared with non-deprived neighbourhoods: a systematic literature review of quantitative observational studies. PLoS One 10 (10), e0139297.

Arcaya, M.C., Tucker-Seeley, R.D., Kim, R., Schnake-Mahl, A., So, M., Subramanian, S.V., 2016. Research on neighborhood effects on health in the United States: a systematic review of study characteristics. Soc. Sci. Med. 168, 16–29.

Cummins, S., Fagg, J., 2012. Does greener mean thinner? associations between neighbourhood greenspace and weight status among adults in England. Int. J. Obes. (Lond.) 36, 1108–1113.

Diez Roux, A.V., Mair, C., 2010. Neighborhoods and health. Ann. N. Y. Acad. Sci. 1186, 125–145.

Fielding, T., 2004. Class and space: social segregation in Japanese cities. Trans. Inst. Br. Geogr. 29 (1), 64–84.

Fukuda, Y., Nakamura, K., Takano, T., 2005. Accumulation of health risk behaviours is associated with lower socioeconomic status and women's urban residence: a multilevel analysis in Japan. BMC Public Health 5, 53.

Fukuda, Y., Nakamura, K., Takano, T., 2007. Higher mortality in areas of lower socioeconomic position measured by a single index of deprivation in Japan. Public Health 121 (3), 163–173.

Kim, D., 2008. Blues from the neighborhood? neighborhood characteristics and depression. Epidemiol. Rev. 30, 101–117.

Koohsari, M.J., Hanibuchi, T., Nakaya, T., Shibata, A., Ishii, K., Liao, Y., Oka, K., Sugiyama, T., 2017. Associations of neighborhood environmental attributes with walking in Japan: moderating effects of area-level socioeconomic status. J. Urban Health 94 (6), 847–854.

Hanibuchi, T., Nakaya, T., Honjo, K., Ikeda, A., Iso, H., Inoue, M., Sawada, N., Tsugane, S., The Japan Public Health Center-based Prospective Study Group, 2015a. Neighborhood contextual factors for smoking among middle-aged Japanese: a multilevel analysis. Health Place 31, 17–23.

Hanibuchi, T., Nakaya, T., Yonejima, M., Honjo, K., 2015b. Perceived and objective measures of neighborhood walkability and physical activity among adults in Japan: a multilevel analysis of a nationally representative sample. Int. J. Environ. Res. Public Health 12, 13350–13364.

Ito, Y., Nakaya, T., Nakayama, T., Miyashiro, I., Ioka, A., Tsukuma, H., Rachet, B., 2014. Socioeconomic inequalities in cancer survival: a population-based study of adult patients diagnosed in Osaka, Japan, during the period 1993–2004. Acta Oncol. 53 (10), 1423–1433.

Macintyre, S., Ellaway, A., 2003. Neighbourhood and health: an overview. In: Kawachi, I., Berkman, L.F. (Eds.), Neighborhoods and health. Oxford University Press, New York, pp. 20–42.

Mair, C., Diez Roux, A.V., Galea, S., 2008. Are neighbourhood characteristics associated with depressive symptoms? a review of evidence. J. Epidemiol. Commun. Health 62 (11), 940–946.

Meijer, M., Röhl, J., Bloomfield, K., Grittner, U., 2012. Do neighborhoods affect individual mortality? a systematic review and meta-analysis of multilevel studies. Soc. Sci. Med. 74 (8), 1204–1212.

Nakaya, T., Dorling, D., 2005. Geographical inequalities of mortality by income in two developed island countries: a cross-national comparison of Britain and Japan. Soc. Sci. Med. 60 (12), 2865–2875.

Nakaya, T., Honjo, K., Hanibuchi, T., Ikeda, A., Iso, H., Inoue, M., Sawada, N., Tsugane, S., Japan Public Health Center-based Prospective Study Group, 2014. Associations of all-cause mortality with census-based neighbourhood deprivation and population density in Japan: a multilevel survival analysis. PLoS One 9 (6), e97802.

Nakaya, T., Ito, Y. (Eds.), 2019. The Atlas of Health Inequalities in Japan. Springer, Cham.

Prochaska, J.J., Sung, H.Y., Max, W., Shi, Y., Ong, M., 2012. Validity study of the K6 scale as a measure of moderate mental distress based on mental health treatment need and utilization. Int. J. Methods Psychiatr. Res. 21 (2), 88–97.

Riva, M., Gauvin, L., Barnett, T.A., 2007. Toward the next generation of research into small area effects on health: a synthesis of multilevel investigations published since July 1998. J. Epidemiol. Commun. Health 61 (10), 853–861.