Public Health (2005) **119**, 875–884

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PUBLIC HEALTH

JOURNAL OF THE ROYAL INSTITUTE OF PUBLIC HEALTH

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Reduced likelihood of cancer screening among women in urban areas and with low socio-economic status: A multilevel analysis in Japan

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Received 7 October 2004; received in revised form 15 February 2005; accepted 29 March 2005
Available online 27 July 2005

KEYWORDS
Socio-economic factors;
Income;
Mass screening;
Urban health;
Cancer;
Residential characteristics

Summary *Objectives*: To elucidate socio-economic predictors of participation in cancer screening in Japanese women, paying attention to regional variations.

Methods: In a nationally representative sample of women aged 40–64 years ($n=$ 15,224) in Japan, the relationships of self-reported attendance at screening for stomach, colon, uterine and breast cancers with individual characteristics (marital status, occupation and household income) and regional variables (living in a metropolitan area or not, and per capita income) were examined using multilevel analysis.

Results: The participation rate ranged from 21.6% for colon cancer to 32.5% for uterine cancer. Being married, employed and having a higher household income were significantly associated with a higher likelihood of cancer screening for all types of cancer: the adjusted odds ratio in the lowest income quintile ranged from 0.45 for uterine cancer to 0.53 for colon cancer compared with the highest income quintile. There was significant regional variance, and living in a metropolitan area and per capita income were associated with a reduced likelihood of cancer screening.

Conclusions: Women with lower socio-economic status and living in urban areas are less likely to participate in cancer screening in Japan. Cancer screening should be encouraged in urban areas, taking account of the socio-economic inequalities.
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Introduction

Socio-economic inequalities have been demonstrated in mortality, morbidity and health-related behaviours, such as smoking, alcohol consumption, nutritional intake, exercise and participation in health examinations, including cancer screening.[1–3] Lower socio-economic status (SES) represented by income and educational level has been shown to be associated with a reduced likelihood of participation in cancer screening, in combination with marital status, health insurance coverage, residential area, ethnicity and other parameters in western countries.[4–10] The socio-economic inequalities in

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doi:10.1016/j.puhe.2005.03.013

cancer screening are responsible for the higher mortality rate % among people of lower SES, due to the associated decrease in the chance of early detection of cancer.[11-13]

In Japan, cancer screening has become widespread in several settings. Cancer screening programmes in communities have been encouraged by the Health Law for the Elderly since 1983.[14,15] Screening for stomach, lung, uterine, breast and colon cancers is offered to community residents, generally aged over 40 years, by local municipal governments, with or without a low copayment.[14,16] Hospitals and clinics provide preventive health programmes, typically the so-called 'Ningen (= Human) Dock', which is a comprehensive preventive health programme for cardiovascular disease, cancer and other diseases; a total of over five million people attended these programmes in 2001.[17] Health insurance organizations encourage the insured to participate in the programmes with some financial support.[16,18] A multiphasic health check-up, including cancer screening in addition to the mandatory periodic health check-ups, is provided in the workplace, especially in large companies.[19,20]

Thus, there are various opportunities to participate in cancer screening with little financial barrier, and socio-economic inequalities in cancer screening might be overcome in Japan. Only a few studies have examined socio-economic factors affecting attendance at cancer screening in small limited areas,[21-23] and little is known about the individual socio-economic predictors of attendance at cancer screening, paying particular attention to regional characteristics in the Japanese population.

This study, using a nationally representative sample, was performed to examine the relationships between participation in cancer screening and individual socio-economic characteristics, including marital status, residential area, household income and employment status, as well as regional characteristics in Japanese women.

Methods

Data source

The 2001 Comprehensive Survey of the Living Conditions of People on Health and Welfare conducted by the Ministry of Health, Labour and Welfare[24] was used for analysis in the present study. All household members within 5240 area units, sampled at random from all prefectures, were interviewed. The survey included household and individual information about demographics, health, illness profiles, lifestyle and others. The total number of households sampled for basic information was 247,195, of which 30,386 were interviewed about income and savings. We obtained microdata files of this survey with the official permission of the Ministry of Public Management, Home Affairs, Posts and Telecommunications, and used the data for 16,007 women aged 40–64 years whose basic and income data were surveyed.

Cancer screening

Attendance at screening programmes for stomach, colon, uterine and breast cancer in the past year was surveyed by interview at the same time as collection of other information, and the study subjects reported on their own attendance at screening. The questionnaire for each type of cancer screening included all types of programmes and examinations, providers and settings, e.g. 'Have you attended cancer screening for stomach cancer, such as community mass screening, regular health check-up or Ningen Dock, in the past 12 months?'. The most common screening programmes in Japan are roentgenographic screening using X-ray diagnosis with barium contrast medium (barium photofluorography) for stomach cancer, faecal occult blood test (immunological test) for colon cancer, Pap smear for uterine (cervical) cancer, and inspection and palpation by a trained doctor for breast cancer. These are provided as community mass screening.[14]

Individual and regional variables

We used age, marital status, employment status and household income as individual variables. Marital status was divided into married, never married, widowed and divorced. Annual household income before tax, including benefits and inheritances, was used as income information. To take into account differences in household size and composition in the comparison of income level, the amounts given were per 'equivalent adult'. The annual household income was divided by its equivalent size using the modified Organization for Economic Co-operation and Development equivalence scale. This scale gave a weight of 1.0 to the first adult, 0.5 to the second adult and each subsequent person aged 14 years and over, and 0.3 to each child under 14 years of age in the household.[25]

Occupational classification was based on the Vital Statistics in Japan:[26] professional and technical workers (profession); clerical and related

workers (clerical work); sales workers (sales work); service workers (service work); agriculture, forestry and fishery workers (agriculture); workers in transport and communications (transport); craftsmen, mining, production process, and construction workers and labourers (labour); housework; and other, including unemployed and students.

Residential area was categorized into metropolitan areas and others. Metropolitan areas were defined for 23 special wards of Tokyo and 12 ordinance-designated cities (Sapporo, Sendai, Chiba, Yokohama, Kawasaki, Nagoya, Kyoto, Osaka, Kobe, Hiroshima, Kitakyushu and Fukuoka). Japan consists of 47 prefectures, and each metropolitan area is part of one prefecture, e.g. Hokkaido Prefecture contains Sapporo City, which is a metropolitan area and the seat of prefectural government, and other areas including many cities, municipalities and villages. Per capita income in 1999 by prefecture was calculated by dividing the aggregated annual taxable income by the total prefectural population,[27] and used as a regional socio-economic variable.

Statistical analysis

Among 16,007 women, the occupation of 524 was not identified and 291 did not respond to the screening questions (32 missed both items). The data from the remaining 15,224 women, in whom all variables were available, were analysed.

Multilevel analysis was performed for 15,224 individuals (level 1) nested within 47 prefectures (level 2). To estimate the average relationship between participation in cancer screening and individual variables across all regions (individual fixed parameter), the variation between prefectures that cannot be accounted for by individual factors (regional random variance), and the effects of regional variables on participation in cancer screening (regional fixed parameter), the multilevel binomial non-linear logit link model using the Iterative Generalized Least Squares was fitted.[28] First, to calculate crude odds ratios (ORs) with 95% confidence intervals (CIs), variables were introduced into the model separately (separate model). Second, to estimate the proportion of variance related to the region remaining after considering individual factors, individual-related variables (age, marital status, occupation and income) but not region-related variables (living in metropolitan area and per capita income) were introduced into the model simultaneously (individual model). The proportion of variance related to the region (intraclass correlation: ICC) was approximated as: regional variance/(regional variance$+\pi^2/3$).[29,30] Finally, to calculate the adjusted OR with 95%CI and ICC after considering individual and regional variables, all variables were introduced into the model simultaneously (full model). MLwiN version 1.10 was used for statistical analyses.[31]

Results

Table 1 shows the basic characteristics of the study subjects and prefectures. The majority were married and lived in a non-metropolitan area (84.2 and 86.4%, respectively). The majority of subjects reported their occupation as 'housework' (32.8%), followed by 'other' (13.3%), 'labour'

Table 1 Basic characteristics of study subjects and regions.

Variable	Mean (range), *n* (%) or median	
Individual variable ($n=15,224$)		
Age (mean (range): years)	52.1	(40–64)
Marital status (*n* (%))		
Married	12,818	(84.2)
Never married	681	(4.5)
Widowed	868	(5.7)
Divorced	857	(5.6)
Occupation[a] (*n* (%))		
Housework	4990	(32.8)
Profession	1303	(8.6)
Clerical work	1572	(10.3)
Sales work	1289	(8.5)
Service work	1678	(11.0)
Agriculture	595	(3.9)
Labour	1779	(11.7)
Others	2018	(13.3)
Income (median: thousand yen)		
5th (highest) quintile	6244.5	
4th quintile	4042.8	
3rd quintile	2990.0	
2nd quintile	2120.0	
1st (lowest) quintile	1185.7	
Residential area (n (%))		
Metropolitan areas	2068	(13.6)
Non-metropolitan areas	13,156	(86.4)
Regional variable ($n=47$)		
Per capita income (mean (range): million yen)	1.36	(0.87–1.85)

[a] Profession, professional and technical workers; clerical work, clerical and related workers; agriculture, agriculture, forestry and fishery workers; labour, craftsmen, mining, production process, and construction workers and labourers.

Table 2 Participation rate of cancer screening according to socio-economic variables among Japanese women.

Variable	Stomach cancer	Colon cancer	Uterine cancer	Breast cancer
Total	28.2	21.6	32.5	26.0
Marital status				
Married	28.9	22.4	34.0	27.3
Never married	21.7	15.0	19.4	16.3
Widowed	30.0	23.4	26.8	23.6
Divorced	21.0	13.0	26.0	16.8
Occupation[a]				
Housework	25.6	21.2	29.4	23.3
Profession	38.1	23.3	39.8	31.8
Clerical work	32.8	24.4	39.8	32.4
Sales Work	24.3	16.2	30.6	23.8
Service work	25.1	19.7	28.5	22.9
Agriculture	36.8	28.7	38.3	31.4
Labour	28.2	23.0	31.6	25.6
Others	27.4	20.7	33.5	26.9
Income				
5th (highest) quintile	37.3	27.1	42.4	34.7
4th quintile	31.1	23.1	35.7	29.3
3rd quintile	26.5	21.6	32.4	25.0
2nd quintile	24.7	19.3	27.2	21.8
1st (lowest) quintile	21.5	16.7	24.8	19.4
Residential area				
Metropolitan areas	19.9	15.9	25.8	20.4
Non-metropolitan areas	29.5	22.5	33.6	26.9

[a] Profession, professional and technical workers; clerical work, clerical and related workers; agriculture, agriculture, forestry and fishery workers; labour, craftsmen, mining, production process, and construction workers and labourers.

(11.3%), 'service work' (11.0%) and 'clerical work' (10.3%).

Participation rates in cancer screening by socio-economic characteristics are shown in Table 2. Uterine cancer showed the highest rate (32.5%), followed by stomach cancer (28.2%), breast cancer (26.0%) and colon cancer (21.6%). Married subjects showed the highest participation rate for uterine and breast cancer screening, and widows showed the highest participation rate for stomach and colon cancer screening. Among the occupational categories, 'profession', 'clerical work' and 'agriculture' showed the higher rates of participation in screening for all types of cancer. There was a marked gradient in the rate of participation according to household income for all types of cancer. The rates of those living in a metropolitan area were lower than rates for those living in a non-metropolitan area.

Table 3 shows crude and adjusted ORs with 95% CIs for participation in screening. Age showed a significant positive association with screening for stomach, colon and breast cancer, but a negative association for uterine cancer. Single or divorced marital status showed significant negative associations for all four types of cancer. Compared with 'housework', no occupational categories showed a significantly decreased OR except for 'sales work' for colon cancer. Among the occupational categories, 'profession', 'clerical work', 'agriculture', 'labour' and 'others' generally showed a higher OR. Compared with the crude OR, the adjusted OR for occupation showed a tendency for an increase for stomach and colon cancer and a decrease for uterine and breast cancer, except in the case of 'agriculture' in which the adjusted OR was higher than the crude OR for all types of cancer.

For all types of cancer, a clear gradient of OR according to household income was found. Compared with the highest income quintile, the adjusted OR of the lowest income quintile was 0.46 (95% CI 0.41, 0.52) for stomach cancer, 0.53 (95% CI 0.46, 0.60) for colon cancer, 0.45 (95% CI 0.40, 0.51) for uterine cancer and 0.48 (95% CI 0.42, 0.54) for breast cancer.

Living in a metropolitan area and per capita income were significantly negatively associated with screening for all types of cancer. The adjusted OR of living in a metropolitan area compared with living in a non-metropolitan area ranged from 0.69 (95% CI 0.53, 0.90) for stomach cancer to 0.85 (95% CI 0.75, 0.97) for uterine cancer. An increment of one million yen in per capita income, which was similar to the difference between the lowest (0.87 million yen) and highest (1.85 million yen) per capita income among prefectures, showed an adjusted OR ranging from 0.47 (95% CI 0.32, 0.70) for uterine cancer to 0.61 (95% CI 0.42, 0.90) for colon cancer.

There was significant regional variance, and ICC in the individual model without region-related variables ranged from 0.195 for colon cancer to 0.276 for breast cancer. The full model showed a decrease in ICC compared with the individual model of 23.6% $[=(0.271-0.207)/0.271]$ for stomach cancer, 13.3% for colon cancer, 28.3% for uterine cancer and 19.5% for breast cancer.

Discussion

This analysis of a nationally representative sample demonstrated substantial differences in

Table 3 Crude and adjusted odds ratio (OR) of cancer screening participation: results of multilevel analysis in Japanese women.

a)		Stomach cancer				Colon cancer			
		Crude[a]		Adjusted[a]		Crude[a]		Adjusted[a]	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual	Age (increase of 10 years)	1.36	1.29, 1.43***	1.54	1.45, 1.63***	1.41	1.33, 1.49***	1.52	1.43, 1.62***
	Marital status								
	Married	1.00		1.00		1.00		1.00	
	Never married	0.69	0.58, 0.82***	0.75	0.62, 0.90**	0.60	0.49, 0.73***	0.71	0.57, 0.88**
	Widowed	1.03	0.89, 1.19	0.95	0.81, 1.11	1.05	0.89, 1.22	0.95	0.80, 1.12
	Divorced	0.66	0.56, 0.77***	0.78	0.66, 0.93**	0.52	0.42, 0.63***	0.62	0.51, 0.76***
	Occupation[b]								
	Housework	1.00		1.00		1.00		1.00	
	Profession	1.71	1.50, 1.95**	1.95	1.70, 2.24**	1.08	0.94, 1.25	1.26	1.08, 1.47**
	Clerical work	1.39	1.23, 1.57***	1.62	1.42, 1.85***	1.16	1.02, 1.33*	1.39	1.21, 1.60***
	Sales work	0.90	0.78, 1.03	1.03	0.89, 1.19	0.70	0.59, 0.82***	0.81	0.68, 0.95*
	Service work	0.95	0.84, 1.08	1.15	1.01, 1.31*	0.88	0.76, 1.01	1.07	0.93, 1.24
	Agriculture	1.51	1.26, 1.81***	1.63	1.36, 1.97***	1.39	1.15, 1.68***	1.48	1.21, 1.79***
	Labour	1.06	0.94, 1.20	1.24	1.10, 1.41***	1.03	0.91, 1.18	1.22	1.06, 1.39**
	Others	1.07	0.95, 1.20	1.19	1.06, 1.35**	0.94	0.82, 1.06	1.06	0.93, 1.21
	Income								
	5th (highest) quintile	1.00		1.00		1.00		1.00	
	4th quintile	0.75	0.67, 0.83***	0.79	0.71, 0.88***	0.81	0.72, 0.90**	0.83	0.74, 0.93**
	3rd quintile	0.57	0.51, 0.63***	0.61	0.55, 0.68***	0.70	0.62, 0.78***	0.72	0.64, 0.81***
	2nd quintile	0.51	0.46, 0.57***	0.54	0.48, 0.61***	0.61	0.54, 0.69***	0.62	0.55, 0.70***
	1 st (lowest) quintile	0.44	0.39, 0.49***	0.46	0.41, 0.52***	0.51	0.45, 0.57***	0.53	0.46, 0.60***
	Living in a metropolitan area	0.69	0.60, 0.79***	0.69	0.53, 0.90***	0.74	0.65, 0.85***	0.75	0.64, 0.87***
Region	Per capita income (increase of one million yen)	0.58	0.37, 0.91*	0.51	0.33, 0.79**	0.68	0.46, 1.00	0.61	0.42, 0.90*
Regional random variance[c]		0.124 ***[d]		0.087***		0.081***[d]		0.068***	
−2 log likelihood		17739.6[d]		17,632.2		15,152.3[d]		15,068.0	
Intraclass correlation		0.271[d]		0.207		0.195[d]		0.169	

***$P<0.001$, **$P<0.01$, *$P<0.05$.

[a] Crude: variables were introduced separately (separate model); Adjusted: all variables were introduced simultaneously (full model).

[b] Profession, professional and technical workers; clerical work, clerical and related workers; agriculture, agriculture, forestry and fishery workers; labour, craftsmen, mining, production process, and construction workers and labourers.

[c] Variance at the regional level in a logit model.

[d] Age, marital status, occupation and income were introduced simultaneously (individual model).

(*continued on next page*)

Table 3 (*continued*)

b)		Uterine cancer				Breast cancer			
		Crude[a]		Adjusted[a]		Crude[a]		Adjusted[a]	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Individual	Age (increase of 10 years)	0.85	0.81, 0.90***	0.90	0.85, 0.94***	1.00	0.95, 1.06	1.07	1.01, 1.14*
	Marital status								
	Married	1.00		1.00		1.00		1.00	
	Never married	0.43	0.36, 0.52***	0.46	0.38, 0.56**	0.50	0.41, 0.60***	0.53	0.43, 0.65***
	Widowed	0.69	0.60, 0.80**	0.85	0.73, 1.00	0.84	0.72, 0.98*	0.91	0.77, 1.07
	Divorced	0.68	0.58, 0.79***	0.82	0.70, 0.97*	0.53	0.45, 0.64***	0.64	0.53, 0.77
	Occupation[b]								
	Housework	1.00		1.00		1.00		1.00	
	Profession	1.54	1.36, 1.75***	1.31	1.14, 1.50***	1.48	1.30, 1.70***	1.40	1.21, 1.61***
	Clerical work	1.57	1.39, 1.76***	1.40	1.23, 1.58***	1.56	1.38, 1.77***	1.53	1.34, 1.74***
	Sales work	1.03	0.90, 1.18	1.02	0.89, 1.17	1.01	0.87, 1.16	1.06	0.91, 1.22
	Service work	0.93	0.83, 1.05	0.98	0.86, 1.11	0.96	0.70, 1.32	1.08	0.94, 1.23
	Agriculture	1.37	1.15, 1.64***	1.48	1.24, 1.78***	1.39	1.15, 1.68***	1.49	1.27, 1.76***
	Labour	1.05	0.94, 1.19	1.06	0.94, 1.20	1.08	0.95, 1.22	1.15	1.01, 1.30*
	Others	1.19	1.06, 1.33**	1.13	1.01, 1.27*	1.20	1.06, 1.35**	1.21	1.07, 1.36**
	Income								
	5th (highest) quintile	1.00		1.00		1.00		1.00	
	4th quintile	0.72	0.65, 0.80***	0.74	0.67, 0.82***	0.78	0.70, 0.87***	0.78	0.70, 0.87***
	3rd quintile	0.61	0.55, 0.68***	0.63	0.57, 0.70***	0.62	0.56, 0.69***	0.62	0.55, 0.69***
	2nd quintile	0.48	0.43, 0.53***	0.50	0.45, 0.56***	0.53	0.47, 0.59***	0.52	0.46, 0.59***
	1st (lowest) quintile	0.41	0.36, 0.45***	0.45	0.40, 0.51***	0.48	0.43, 0.55***	0.48	0.42, 0.54***
	Living in a metropolitan area	0.81	0.71, 0.91***	0.85	0.75, 0.97*	0.78	0.68, 0.89***	0.81	0.70, 0.93
Region	Per capita income (increase of one million yen)	0.55	0.37, 0.81***	0.47	0.32, 0.70***	0.60	0.38, 0.94*	0.52	0.33, 0.82**
Regional random variance[c]		0.103 ***[d]		0.068***		0.127 ***[d]		0.095***	
−2 log likelihood		19277.7[d]		19,200.2		17,254.5[d]		17,178.5	
Intraclass correlation		0.236[d]		0.169		0.276[d]		0.222	

***$P<0.001$, **$P<0.01$, *$P<0.05$.

[a] Crude: variables were introduced separately (separate model); Adjusted: all variables were introduced simultaneously (full model).

[b] Profession, professional and technical workers; clerical work, clerical and related workers; agriculture, agriculture, forestry and fishery workers; labour, craftsmen, mining, production process, and construction workers and labourers.

[c] Variance at the regional level in a logit model.

[d] Age, marital status, occupation and income were introduced simultaneously (individual model).

participation in cancer screening according to individual socio-economic characteristics related to household income, marital status and occupation. A higher income, being married and being employed promoted screening. In addition, there was significant regional variance in participation in cancer screening, and living in metropolitan areas and areas with higher per capita income were negatively associated with cancer screening.

As cancer screening is provided in various settings with little copayment and with financial support in Japan,[14–16,18] the economic barrier seems to be relatively small. In this study, however, socio-economic characteristics, especially household income, were significant predictors of participation in cancer screening. The negative associations between the likelihood of cancer screening and both living in a metropolitan area and higher per capita income suggested the successful spread of cancer screening programmes overcoming the socio-economic inequalities among regions. Consequently, even people living in rural and socio-economically disadvantaged areas have access to cancer screening. Nevertheless, the inequalities in cancer screening according to individual SES have not been overcome sufficiently.

Employers have a responsibility for the occupational health of their employees according to the Occupational Health and Safety Law,[32] and a multiphasic health check-up, including cancer screening, is provided.[19] The finding that there were few occupations showing a significantly lower likelihood of cancer screening compared with 'housework' confirmed the dependency of cancer screening on the workplace among women of working age. The increase in OR for stomach and colon cancer after adjustment for other variables for employed occupational categories such as 'profession', 'clerical work' and 'labour' suggested that screening for these cancers was particularly dependent on the workplace.

Another notable finding related to occupation was a higher participation rate among primary industrial workers. Preventive health, including cancer screening, in rural communities has been encouraged and implemented by institutions based on agricultural co-operatives.[33] As a previous study in Japan demonstrated that activities of community organizations were positively associated with participation in uterine cancer screening,[34] close social ties among primary industrial workers are likely to be associated with a higher likelihood of cancer screening.

The difference in OR between the separate and full models for marital status, household income, living in a metropolitan area and per capita income was modest, and thus the confounding and collinearity between these variables in cancer screening seems to be limited. Concerning per capita income, the full model showed an increase in the impact compared with the crude model, e.g. crude OR = 0.58 and adjusted OR = 0.51 for stomach cancer. This increased impact was possibly caused by contradictory directions between individual and regional socio-economic variables, whereby higher individual SES had a positive impact but higher regional income had a negative impact on cancer screening, and the individual (compositional) effects seemed to conceal the regional (contextual) effects.

We found significant regional variation for all types of cancer screening, and ICC ranged from 0.195 for colon cancer to 0.276 for breast cancer after considering individual variables. ICC represents the proportion of the total variance in cancer screening related to the region,[29,30] and the findings indicated that the region-related variance was smallest for colon cancer and largest for breast cancer. The percent decrease in ICC in the full model compared with the individual model shows the amount of explanation by the added variables in region-related variance.[30] Consequently, part of the variance from 13.3% for colon cancer to 28.3% for uterine cancer in region-related variance could be explained by the variables of living in a metropolitan area and per capita income.

In contrast to the present study, studies in other countries have indicated that living in a socio-economically advantaged area was a positive factor in cancer screening.[10,35,36] There are a few plausible explanations for this inconsistency. First, previous studies applied an ecological study design or did not consider different levels (individual and region).[10,35,36] Therefore, they could not adequately identify contextual effects distinguishing compositional effects, unlike this study which applied a multilevel method. Next, indicators related to urbanization, such as population size and population density, are strongly correlated with higher income and education-related regional indicators in Japan,[37,38] and thus the findings of the relationship between cancer screening and per capita income could be interpreted as showing less likelihood of cancer screening in urban areas. This interpretation provides a plausible explanation for the contrary relationship between cancer screening and income between individual and regional levels. Although the urban variable (living in a metropolitan area) was used, non-metropolitan areas included medium-sized and small cities, and a large variation remained between urban and rural

areas. If the data can identify lower regional levels than prefecture, such as the municipal level, and more precise indices representing regional socio-economic conditions such as deprivation indices in other countries[39] were available in Japan, the influence of regional socio-economic conditions on cancer screening could be explored in more detail.

The possible limitations of this study should be mentioned. First, since the information on cancer screening was based on self-reporting, this study might not be free from biases related to self-reporting, especially misclassification bias.[40,41] Previous studies have demonstrated that self-reporting of cancer screening overestimated the participation rate, and the difference between self-reporting and actual participation depended on individual characteristics including SES.[42–44] Second, the programmes and examinations for screening of each type of cancer were not distinguished in this study. In addition to the common programmes as mentioned above, many programmes and examinations at different intervals are available, such as endoscopy for stomach and colon cancer, endometrial cytology for uterine endometrial cancer and mammography for breast cancer.[15–20,45–47] The lack of distinction of screening programmes would yield some bias in the relationship between individual and regional characteristics and cancer screening, and the relationship might depend on the programme.

A study group organized by the Ministry of Health, Labour and Welfare evaluated the effectiveness of ongoing cancer screening in Japan, and concluded that there was a lack of sufficient evidence of effectiveness of breast cancer screening (inspection and palpation by trained doctors) and uterine endometrial cancer screening (endometrial cytology), while stomach, colon and uterine cervical cancer screening were shown to be effective.[48,49] As the present study did not show notable differences in the relationship between SES and cancer screening among the different types of cancer, there does not seem to be a significant bias due to the effectiveness of cancer screening.

As a last but important limitation, this study did not directly propose an explanation for the lower likelihood of cancer screening among lower SES women. Previous studies have demonstrated that educational level and attitudes and knowledge about cancer screening were associated with cancer screening.[35,50,51] In this context, educational attainment, which was not surveyed in this study, might play an important role in combination with household income and other variables. Further studies exploring intermediate factors between SES and cancer screening are required to encourage lower SES women to attend cancer screening and to diminish socio-economic inequalities.

Cancer is the leading cause of death in the Japanese population, accounting for approximately 40% of deaths in the population aged 40–64 years.[16] One of the notable features of the geographical variation in health in Japan is deteriorating relative health levels of urban populations, especially among women.[52] This deterioration in health levels is contributed to by higher mortality from cancer in urban areas.[53] In addition to increased incidence of cancer due to the higher likelihood of health risk behaviours in women living in urban areas, such as Tokyo and Osaka,[54] the lower prevalence of cancer screening might be partially responsible for the higher mortality from cancer in urban areas.

In conclusion, this study indicated substantial differences in participation in cancer screening according to individual socio-economic characteristics, such as household income, marital status and occupation, i.e. individuals with lower SES showed a reduced likelihood of cancer screening. Marked regional variance was found, and living in a metropolitan area and per capita income were significantly associated with a lower likelihood of participation in cancer screening. Cancer screening for women with socio-economic disadvantages and living in urban areas should be encouraged.

Acknowledgements

This research was supported by Grant-in-Aid for Scientific Researches (C) (2) by the Japan Society for the Promotion of Science (Grants No. 14570326 and 16590497).

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