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Original Article

Educational inequalities in smoking among Japanese adults aged 25–94 years: Nationally representative sex- and age-specific statistics

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ABSTRACT

Background: Few studies have investigated differences in age- and gender-specific educational gradients in tobacco smoking among the whole range of adult age groups. We examined educational inequality in smoking among Japanese adults aged 25–94 years.

Methods: Using a large nationally representative sample (167,925 men and 186,588 women) in 2010, prevalence of current smoking and heavy smoking among daily smokers and their inequalities attributable to educational attainment were analyzed according to sex and age groups.

Results: Among men aged 25–34 years, junior high school graduates had the highest current smoking prevalence at 68.4% (95% confidence interval [CI], 66.0%–70.6%), and graduate school graduates had the lowest at 19.4% (95% CI, 17.2%–21.9%). High school graduates had the second highest current smoking prevalence (e.g., 55.9%; 95% CI, 54.9%–56.8% in men aged 25–34 years). Among men aged 75–94 years, the difference in current smoking across educational categories was small. A similar but steeper educational gradient in current smoking was observed among women. Among women aged 25–34 years, junior high school graduates had the highest current smoking prevalence at 49.3% (95% CI, 46.3%–52.3%), and graduate school graduates had the lowest at 4.8% (95% CI, 2.9%–7.4%). Compared with older age groups, such as 65–94 years, younger age groups, such as 25–54 years, had higher estimates of inequality indicators for educational inequality in both current and heavy smoking in both sexes.

Conclusions: Educational inequalities in current and heavy smoking were apparent and large in the young population compared with older generations. The current study provides basic data on educational inequalities in smoking among Japanese adults.

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Introduction

Tobacco smoking is the most attributable and preventable risk factor for adult mortality and morbidity in Japan.^{1,2} Tobacco smoking has been confirmed as an independent risk factor for many disorders, such as cancer and cardiovascular diseases, with dose-response verifications.^{3,4} Heavy smokers are more likely to suffer from tobacco-related harm than light smokers.³ Smoking cessation and tackling regional and socioeconomic inequalities in smoking are key public health targets throughout the world. The

World Health Organization (WHO)'s Commission on Social Determinants of Health recommended, in its final report, monitoring and evaluating socioeconomic inequalities in health and health behavior, including smoking.⁵ Japan's new health promotion strategy, Health Japan 21 (Second term),⁶ follows the WHO recommendations and includes monitoring socioeconomic inequalities in tobacco smoking and other public health targets.

When monitoring socioeconomic inequality in smoking, using educational attainment as a socioeconomic indicator is important. Educational attainment is a representative socioeconomic factor⁷ that barely changes in adulthood after around 25 years of age, whereas other socioeconomic variables, such as income and occupation, could change considerably during a life-course. Moreover, educational attainment could reflect key determinants of the initiation and habituation of smoking and other health behaviors, such as health literacy.⁸ Although some Japanese studies have

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investigated smoking inequalities according to socio-economic factors, such as income and occupation,^{9,10} no study has examined smoking according to education in Japan.

Recent European studies have consistently shown higher prevalence of tobacco smoking among poorly educated populations, whereas patterns of smoking prevalence in terms of sex and age groups vary across regions.¹¹ Although there is relatively rich evidence from western countries, data from Asian regions are scarce. Moreover, data on educational inequality in smoking in older persons, especially those aged 75 years or more, are scarce even worldwide.^{3,11} To start continuous monitoring of educational inequality in health, in 2010, the Comprehensive Survey of Living Conditions of People on Health and Welfare (CSLC), a large nationally representative population-based cross-sectional survey in Japan, collected information on education, in addition to health behavior indicators, including smoking status.

Thus, our objective in this study was to investigate the magnitude of educational inequality in smoking and the prevalence of current and heavy smoking according to sex, age, and education among Japanese adults. Utilizing the large nationally representative dataset, we sought to provide detailed evaluations of age- and sex-specific variations in smoking inequality in Japan, covering the whole range of adult age groups from 25 to 94 years old.

Methods

Data

We used data from a nationally representative cross-sectional survey: the 2010 CSLC, conducted by the Japanese Ministry of Health, Labour and Welfare (MHLW).¹² Out of 940,000 inhabited census tracts (the sampling unit for national census in 2005), 5510 were randomly sampled across Japan in 2010 for the collection of data from all household members within each census tract. Data were available for 228,864 households (response rate, 79.1%). Data were used with permission from MHLW. The study was reviewed and approved by the Research Ethics Committee of the Osaka Medical Center for Cancer and Cardiovascular Diseases.

Education

Levels of completed education were categorized as six groups: “junior high school (9 years of mandatory education)” was defined as persons who graduated junior high school without graduating high school; “high school (12 years of education)” was defined as persons who graduated high school without graduating further educational steps; “technical school (10–19 years of education¹³)” was defined as persons who graduated technical professional school without going to college; “2-year college (14 years of education)” was defined as persons who graduated 2-year college without going to 4-year college; “4-year university (16 years of education)” was defined as persons who graduated 4-year university without going to graduate school; “graduate school (17–22 years of education)” was defined as persons who graduated graduate school having previously graduated 4-year university.

Smoking status

Current smokers were those who smoked cigarettes regularly at the time of survey, including daily and sometimes smokers. Among daily smokers (93.8% of the current smokers in the data), heavy smokers were those who smoked more than 20 cigarettes per day.¹⁴

Statistical analysis

We analyzed Japanese adults aged 25–94 years because education status was less likely to change after 25 years of age. We compared current smoking prevalence and heavy smoking proportions among daily smokers according to sex, age, and education group. The percentages are shown with 95% confidence intervals (CIs) calculated by the Wald method. To show the summarized relationship between education and smoking, the age-adjusted smoking prevalence for young and middle-aged adults (25–64 years) was also calculated via the direct standardization method using population figures from the 2010 Japanese Census.

Following recent recommendations, to evaluate educational inequality in current and heavy smokers, we calculated multiple health disparity indicators, including absolute indicators (rate difference and between-group variance) and relative indicators (rate ratio, index of disparity, and mean log deviation),^{15–17} using HD*calc software, version 1.2.4 (the National Cancer Institute, Rockville, MD, USA).¹⁸ Detailed explanations of these indicators are given in the supplementary data (eAppendix 1) and elsewhere.^{19,20} Population weight was used to calculate measures of inequality, because the population size differed according to the education categories, reflecting educational distributions. The proportion of highly educated people in the general population has been increasing over time. Such a demographic shift has an impact on population health and needs to be considered for the assessment of inequalities. Inequality measures of index of disparity, mean log deviation, and between-group variance accounted for the population size of the groups in the calculation.

Subject numbers according to sex, age, and education group are shown in eTable 1 (for current smoking prevalence) and eTable 2 (for heavy smoking prevalence among daily smokers). To maintain precision of estimates, we did not calculate the smoking prevalence (proportion) of the groups that included fewer than 100 subjects. Although there are no convincing criteria for the sample size cut-off point, we chose a sample size of 100 based on statistical considerations of the relationship between sample size and precision. According to Machin et al,²¹ the width of a 95% CI depends on the size of the point estimate. However, a sample size of 100 can maintain at least 20% point width of the 95% CI regardless of the size of the point estimates.²¹ This choice of sample size cut-off resulted in some groups for which we did not estimate smoking prevalence (proportion). We evaluated the educational inequality in smoking where smoking prevalence (proportion) data were available for at least three education groups. All statistical analyses, except for the inequality index calculation, were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC, USA).

Results

Table 1 shows the current smoking prevalence according to sex, age, and education group in Japan. Among men aged 25–34 years, junior high school graduates had highest current smoking prevalence at 68.4% (95% CI, 66.0%–70.6%), and graduate school graduates had the lowest at 19.4% (95% CI, 17.2%–21.9%). These figures were lower in the higher age groups: among men aged 65–74 years, the corresponding figures were 27.6% (95% CI, 26.7%–28.6%) and 12.2% (95% CI, 7.9%–17.7%) for junior high school graduates and graduate school graduates, respectively. Among men aged 75–94 years, the differences in current smoking across educational categories were small, though we did not calculate the smoking prevalence of graduate school graduates in that age group because of the small sample size. A similar but steeper educational gradient in current smoking was observed among women. Among women aged 25–34 years, junior high school graduates had the highest

Table 1
Smoking prevalence according to age, sex, and education groups in 2010.

Age, years	25–34	35–44	45–54	55–64	65–74	75–84	85–94	Total	25–64 ^a
Men									
Junior high school	68.4 (66.0–70.6)	66.4 (64.2–68.5)	57.8 (55.6–60.0)	44.8 (43.5–46.0)	27.6 (26.7–28.6)	16.5 (15.6–17.3)	11.3 (10.0–12.8)	34.0 (33.5–34.6)	59.4 (58.4–60.3)
High school	55.9 (54.9–56.8)	54.9 (54.1–55.7)	50.6 (49.8–51.4)	40.2 (39.4–40.9)	24.1 (23.3–24.9)	15.9 (15.0–16.9)	9.2 (7.4–11.2)	42.5 (42.2–42.9)	50.2 (49.8–50.6)
Technical college	49.5 (47.9–51.1)	48.0 (46.4–49.6)	45.7 (43.7–47.8)	38.0 (35.6–40.4)	24.2 (20.8–27.8)	11.0 (7.6–15.2)	NS	44.4 (43.5–45.3)	44.9 (43.9–45.9)
2-year college	46.8 (43.5–50.1)	45.4 (42.5–48.3)	42.3 (39.4–45.3)	31.6 (28.6–34.7)	19.7 (15.9–23.8)	12.4 (9.4–16.0)	8.8 (4.3–15.7)	36.8 (35.4–38.1)	41.2 (39.7–42.7)
University (4-year)	36.5 (35.4–37.6)	35.8 (34.8–36.7)	35.1 (34.1–36.0)	31.4 (30.4–32.4)	19.7 (18.5–21.0)	11.2 (9.7–12.9)	8.5 (5.4–12.6)	32.2 (31.8–32.7)	34.5 (34.0–35.0)
Graduate school	19.4 (17.2–21.9)	17.1 (15.0–19.4)	16.8 (14.3–19.5)	16.6 (13.7–20.0)	12.2 (7.9–17.7)	NS	NS	17.3 (16.1–18.5)	17.4 (16.1–18.6)
Total	47.9 (47.3–48.5)	47.4 (46.9–47.9)	44.4 (43.8–44.9)	38.2 (37.7–38.7)	24.4 (23.9–25.0)	15.5 (14.9–16.1)	10.3 (9.3–11.4)	37.8 (37.6–38.1)	
Women									
Junior high school	49.3 (46.3–52.3)	47.5 (44.5–50.4)	27.4 (25.0–29.9)	13.1 (12.3–14.0)	5.7 (5.3–6.1)	3.1 (2.8–3.4)	1.9 (1.6–2.4)	8.9 (8.6–9.2)	34.2 (33.0–35.5)
High school	23.9 (23.0–24.8)	21.5 (20.9–22.2)	16.4 (15.8–17.0)	8.1 (7.8–8.5)	4.1 (3.7–4.4)	2.1 (1.8–2.4)	1.5 (1.0–2.1)	12.5 (12.3–12.7)	17.2 (16.9–17.5)
Technical college	17.5 (16.4–18.6)	16.1 (15.1–17.1)	14.2 (13.1–15.3)	9.6 (8.6–10.7)	4.2 (3.2–5.4)	2.8 (1.6–4.5)	1.1 (0.1–4.1)	13.7 (13.2–14.2)	14.1 (13.6–14.7)
2-year college	10.3 (9.4–11.1)	7.3 (6.8–7.9)	7.5 (6.9–8.2)	5.8 (5.1–6.6)	2.8 (1.9–3.9)	0.9 (0.2–2.2)	0.9 (0.0–4.7)	7.4 (7.0–7.7)	7.6 (7.3–8.0)
University (4-year)	6.6 (6.0–7.3)	5.7 (5.1–6.4)	6.1 (5.4–6.9)	5.7 (4.9–6.7)	3.7 (2.6–5.2)	3.9 (2.0–6.6)	NS	6.0 (5.6–6.3)	5.9 (5.6–6.3)
Graduate school	4.8 (2.9–7.4)	2.0 (0.7–4.3)	5.3 (2.3–10.2)	NS	NS	NS	NS	4.0 (2.8–5.4)	4.2 (2.6–5.9) ^b
Total	16.9 (16.5–17.4)	15.9 (15.6–16.3)	13.5 (13.1–13.8)	8.6 (8.3–8.9)	4.7 (4.4–4.9)	2.6 (2.4–2.9)	1.8 (1.5–2.1)	10.5 (10.4–10.6)	

NS, not shown because fewer than 100 in sample.

Values are reported as percentages (95% confidence intervals).

^a Age-adjusted rates using population figures from the 2010 Japanese Census (direct standardization method).

^b Age-adjusted rates of 25–54 years age group.

current smoking prevalence at 49.3% (95% CI, 46.3%–52.3%), and graduate school graduates had the lowest at 4.8% (95% CI, 2.9%–7.4%). Age-adjusted rates of young and middle-aged adults (25–64 years) also showed a similar gradient among both sexes.

The inequality indicators for educational inequality in current smoking according to sex and age groups are shown in Fig. 1 (corresponding values are shown in eTable 3). Compared with older age groups, such as 65–94 years, younger age groups, such as 25–54 years, had higher estimates of inequality indicators for educational inequality in smoking among both sexes, except for one outlier of the index of disparity for women aged 75–84 years.

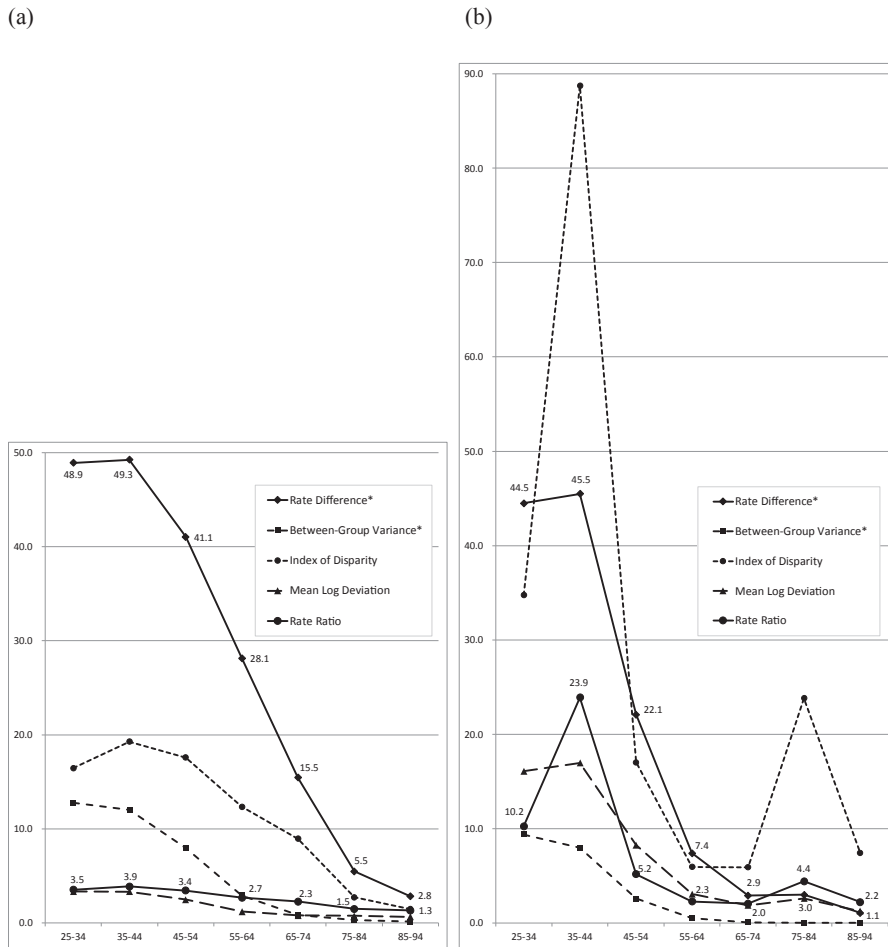
Table 2 shows the prevalence of heavy smoking (%) among daily smokers according to sex, age, and education groups. Among both men and women aged 25–44 years, prevalence of heavy smoking was highest among junior high school graduates; for example, among men aged 25–34 years, 27.7% (95% CI, 25.0%–30.5%) of daily smokers who were junior high school graduates were heavy smokers, while the prevalence was 13.6% (95% CI, 9.0%–19.4%) among graduate school graduates. Heavy smokers were most prevalent among daily smokers aged 55–64 years in both men (33.4%) and women (12.1%).

Fig. 2 shows the inequality indicators for educational inequalities in heavy smoking among daily smokers (corresponding values are shown in eTable 4). Compared with younger age groups, older age groups, especially those aged 55–84 years for men and 45–64 years for women, had lower educational inequality in heavy smoking.

Discussion

We found that educational inequalities in current and heavy smoking were apparent and large in the young population compared with older generations; these disparities were consistently shown using multiple indicators of inequality. The inequality in smoking among young women is strikingly large, calling for urgent political measures to address this disparity. Among those aged 25–44 years, junior high school graduates had considerably higher current and heavy smoking prevalence than other education groups: e.g., nearly half of young women who were junior high school graduates currently smoked (49.3%–47.5%), a rate which is dramatically higher than other education groups. Heavy smokers are also highly prevalent among junior high school graduates. Heavy smoking prevalences were the highest among those aged 55–64 years in both men and women, but the educational inequalities in heavy smoking in that group were smaller than in other age groups.

There are three potential explanations for the steep education-based gradient in smoking. First, education may capture the social class of younger generations more sharply than older generations. As in most other developed countries, junior high school graduates are a minority in the younger generations in Japan. They have a definite disadvantage in earning power, the job market, and having partners.²² The less educated among the young generations are likely to lose self-efficacy, self-stigmatize, suffer chronic psychosocial stress, and have a strong sense of relative deprivation, which may cause smoking.^{22,23} Among older generations, on the other hand, graduating only elementary school or junior high school was common. For example, being a junior high school graduate might not mean being disadvantaged for older age groups, especially those over 75 years old. Second, the large educational gradient in smoking among the young may reflect inequality in the initiation of smoking. Among men, when currently old people were young, smoking was a more common practice, and its health risks were less acknowledged. Until the 1970s, nearly 80% of Japanese men smoked.^{24,25} Although data on educational inequality in



Horizontal axis represents age in years.

*Absolute indicator for inequality

Only values of each representative absolute and relative indicator, rate difference and rate ratio, are shown in the graph.

Fig. 1. Sex- and age-specific estimates of inequality indicators for educational inequality in current smoking: (a) men and (b) women.

smoking in those periods are not available, it is plausible that highly educated people continued to smoke more in those periods than current years. Third, the opportunities to quit smoking are fewer among younger and less educated people. Although the present study indicated a snapshot of smoking in 2010, an individual's smoking trajectory is related to the accumulation of social disadvantage over the entire life-course.^{3,26} Less educated smokers may be more likely to fail at quitting and to become more addicted; thus, educational inequality in smoking among the young generation may be large. Further, those who had few opportunities to quit smoking, such as partner's and/or social cessation supports, and smoking-related diseases onset (as an opportunity to quit) through their life course, might smoke currently when they became old. Moreover, since mortality is higher among the lower socioeconomic group,²³ older people in the low-education group may be in the selected population (survivors) who tend to be non-smokers/ex-smokers. Multiple factors other than education throughout a

life-course may be associated with smoking, especially in a geriatric population; therefore, educational inequality among the old population is small. These explanations for the age differences are also consistent with the smoking epidemic pattern.⁴

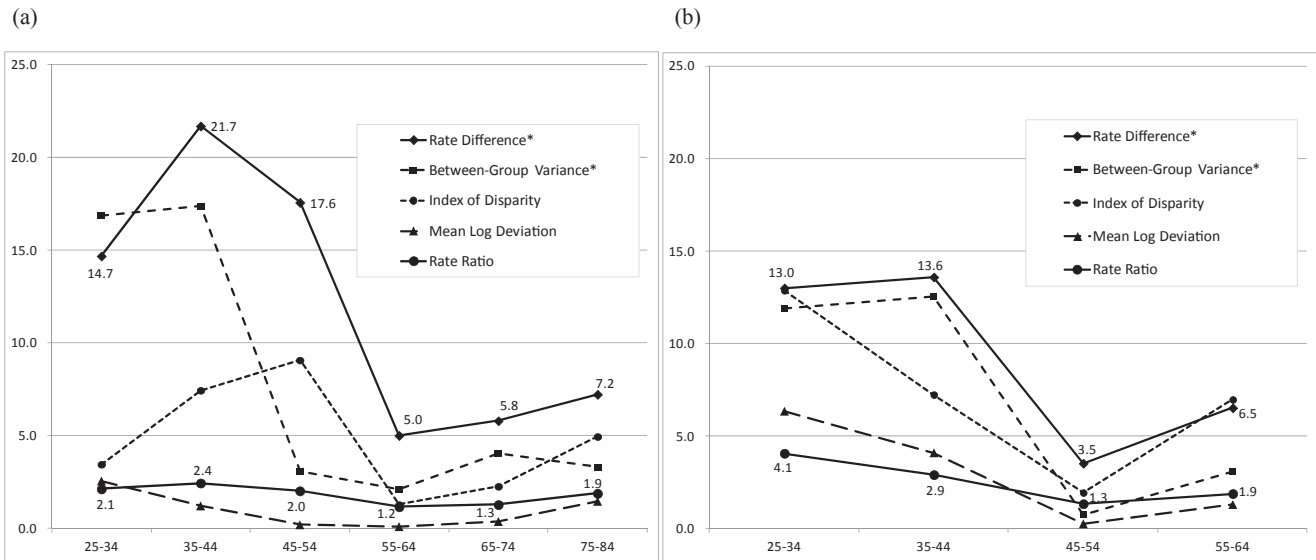
The strength of this study is the provision of data with fine resolution in terms of age groups and educational attainments; previous studies on educational inequality in smoking prevalence have used only four or fewer categories for both educational attainments and age groups.^{3,11} In the present study, the large sample size enabled us to analyze sex- and age-specific data on educational inequality in smoking using seven age groups encompassing participants 25–94 years old and six educational levels from junior high school graduates to graduate school graduates. Data on the geriatric population is especially valuable because such data are scarce worldwide.^{3,11}

Our findings are consistent with studies from the western region of the world showing an inverse association between

Table 2
Heavy smoking prevalence among daily smokers according to age, sex, and education groups in 2010.

Age, years	25–34	35–44	45–54	55–64	65–74	75–84	85–94	Total
Men								
Junior high school	27.7 (25.0–30.5)	36.7 (34.0–39.5)	34.8 (31.9–37.7)	30.7 (28.9–32.5)	20.8 (19.1–22.6)	9.0 (7.4–10.8)	7.1 (3.9–11.6)	26.3 (25.4–27.2)
High school	18.1 (17.1–19.1)	27.2 (26.2–28.2)	33.0 (31.9–34.1)	34.2 (33.1–35.4)	23.7 (22.0–25.3)	8.2 (6.4–10.3)	NS	27.6 (27.1–28.1)
Technical college	13.5 (11.9–15.2)	22.1 (20.2–24.2)	32.9 (30.0–35.9)	35.0 (31.2–39.0)	26.3 (19.1–34.7)	NS	NS	22.8 (21.7–24.0)
2-year college	14.8 (11.5–18.8)	22.8 (19.2–26.8)	31.5 (27.2–36.1)	35.7 (30.1–41.6)	NS	NS	NS	25.3 (23.2–27.4)
University (4-year)	13.0 (11.8–14.4)	22.2 (20.8–23.7)	31.7 (30.1–33.3)	33.5 (31.7–35.4)	26.6 (23.5–29.9)	15.4 (10.1–22.0)	NS	25.3 (24.5–26.1)
Graduate school	13.6 (9.0–19.4)	15.0 (10.1–21.2)	17.2 (11.1–24.9)	NS	NS	NS	NS	18.2 (15.2–21.5)
Total	17.0 (16.3–17.7)	26.0 (25.3–26.7)	32.6 (31.8–33.4)	33.4 (32.6–34.2)	23.2 (22.1–24.3)	9.2 (8.0–10.5)	7.3 (4.6–10.8)	26.3 (26.0–26.7)
Women								
Junior high school	17.2 (14.0–20.9)	20.7 (17.3–24.5)	13.9 (10.4–18.2)	13.9 (11.4–16.6)	8.6 (6.4–11.3)	8.4 (5.6–12.1)	NS	14.0 (12.8–15.3)
High school	8.1 (6.9–9.3)	11.8 (10.7–13.0)	12.2 (11.0–13.6)	11.9 (10.4–13.7)	10.7 (8.1–13.9)	5.5 (2.4–10.6)	NS	11.0 (10.4–11.6)
Technical college	7.4 (5.6–9.5)	8.4 (6.5–10.5)	10.4 (7.9–13.3)	7.4 (4.5–11.1)	NS	NS	NS	8.3 (7.3–9.5)
2-year college	6.1 (4.1–8.8)	7.1 (5.1–9.7)	11.3 (8.5–14.5)	13.3 (9.0–18.6)	NS	NS	NS	8.7 (7.4–10.1)
University (4-year)	4.2 (2.3–7.0)	8.2 (5.0–12.4)	12.3 (8.2–17.5)	10.8 (5.9–17.8)	NS	NS	NS	7.9 (6.3–9.9)
Graduate school	NS	NS	NS	NS	NS	NS	NS	NS
Total	8.5 (7.7–9.4)	11.5 (10.7–12.4)	12.0 (11.0–13.1)	12.1 (10.9–13.3)	9.4 (7.7–11.2)	7.1 (4.9–9.7)	NS	10.8 (10.3–11.2)

NS, not shown because fewer than 100 in sample.
Values are reported as percentages (95% confidence intervals).



Horizontal axis represents age in years.

*Absolute indicator for inequality

Only values of each representative absolute and relative indicator, rate difference and rate ratio, are shown in the graph.

Fig. 2. Sex- and age-specific estimates of inequality indicators for educational inequality in heavy smoking among daily smokers: (a) men and (b) women.

educational attainments and smoking prevalence. However, the age- and sex-specific trends have variations across countries or with existing data. The American surgeon general report in 2014 reported educational gradients in smoking using four education levels among adults aged 18 years or older³: 31.5% of adults (36.2% of men and 26.5% of women) who had education of less than high school smoked currently, compared with 10.4% of college graduates (11.1% for men and 9.7% for women). In Europe, an inverse association of education with smoking was also seen, especially among men in northern countries.¹¹ For men, studies in Ireland and the United Kingdom showed inequalities in all generations; studies in Finland, Denmark, Germany, Belgium, and Spain showed inequalities among middle-aged and younger men; and studies in other countries only showed inequalities among young adults. Lag time in educational inequalities in smoking between northern and

southern countries, and also a lag between women and men, were observed in the late 1990s to early 2000s in Europe and interpreted as smoking epidemic patterns (within country): first, male smoking prevalence increases, and then female smoking prevalence increases. However, female smoking in most Asian and African countries is uncommon.⁴ In the present study, we have added evidence from Japan, an Asian country. The study may contribute to a better understanding of socioeconomic patterns in the smoking epidemic in an Asian region, because the female smoking pattern in Asia is considered to be different from Europe.⁴

Limitations

There are several limitations to the study. First, the smoking variables were self-reported without biomarker validation;

however, the quality of self-reported smoking has been noted to be high.^{27,28} Nevertheless, we could not exclude the possibility that reporting error occurred and that it may be differential according to education. Second, this is a cross-sectional study, so we could not refer to causality between education and smoking, although both directions of causality were assumed.²² Third, comparison across age groups might not be simple. We compared calculated values of inequality indices between different age groups to evaluate the magnitude of educational inequality in smoking. Because evaluable levels of education were different among heavy smokers according to age group, the evaluation of the inequality would result in an underestimation among old population with fewer evaluable education levels (due to sample size). Furthermore, graduate school graduates showed the lowest prevalence in most sex and age categories, and their sample size was relatively small, especially among the old and among women. Because some inequality indicators were calculated using the lowest smoking prevalence with a wide CI, these indicators may be unstable. Fourth, we need to explain the nature of inequality indicators; inequality indicators were calculated using the smoking prevalence sequence of highest to lowest across education categories. However, the educational rank sequence was not considered in the calculation of inequality indicators.

Conclusion with policy implication

The current study provided basic data on the educational inequalities in smoking among Japanese adults, which contributes to the existing literature examining smoking inequalities according to other socio-economic positions, such as income and occupation.^{9,10} Educational inequalities in smoking, especially among young adults, have been observed in Japan as well as the rest of the world.^{3,11} In Japan, Health Japan 21 (Second term) asks for a reduction of health inequality, including smoking inequality.⁶ To achieve this goal, given the findings of this study, tobacco control measures should focus more on younger generations with low educational attainment. Several tobacco control measures, such as tobacco taxation and media campaigns, may possibly reduce smoking inequality due to socioeconomic factors and age,^{26,29–32} because the tobacco price is considered to be very low in Japan according to the affordability index³³ and anti-tobacco television media campaigns have not been conducted by the Japanese government.³⁴ We need to continue to monitor smoking prevalence and inequality and implement effective tobacco control measures to reduce smoking inequalities.

Conflicts of interest

None declared.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <http://dx.doi.org/10.1016/j.je.2016.05.007>.

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