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MORTALITY

Impacts of educational level and employment status on mortality for Japanese women and men: the Jichi Medical School cohort study

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Abstract. The objective of this study was to examine educational levels and employment status as independent determinants of overall and cause-specific mortality in a Japanese population. Participants were 4,301 men and 6,780 women in a multi-center community-based prospective study, and data of the baseline survey was collected between 1992 and 1995. The participants were followed up until December 31, 2002 (the average follow-up period was 9.17 years). Early termination of education was associated with an increased risk of mortality from all causes for both men and women. This tendency was more prominent in women aged 59 and younger (hazard ratio (HR) = 3.82, 95% confidence interval (CI): 1.18–12.34), after adjusting for confounding factors using the Cox proportional hazard models. Similar trends were shown for men; specifically, cardiovascular disease mortality for all men was increased by early termination of education (HR = 2.97, 95% CI: 1.17–7.52) compared to later termination. For employment status, unemployed men showed increased mortality from all causes compared to white-collar workers (HR = 1.51, 95% CI: 1.00–2.28). Female farmers and forestry workers showed reduced mortality from all causes compared to white-collar workers (HR = 0.55, 95% CI: 0.33–0.93). Male farmers and forestry workers also showed reduced mortality from cardiovascular diseases compared to white-collar workers (HR = 0.34, 95% CI: 0.14–0.82). Educational level and employment status may affect mortality for Japanese women and men.

Key words: Cohort studies, Educational level, Japanese population, Mortality

Introduction

One of the most reproducible demographic findings in modern societies is the inverse association between socio-economic status and mortality [1–5]. Several different indicators of socio-economic status have been investigated, including educational attainment, occupational class or employment status, income level, and indices based on the characteristics of residential areas [6–8].

Japanese society is generally believed to have less inequality of wealth than other developed countries. However, recent geographical analyses have shown that socio-economic status in municipalities is strongly related to regional variations in health levels, indicating higher mortality from all causes in areas of lower socio-economic status [9]. On the other hand, a recent study in Japan showed a lower impact of socio-economic inequality on regional mortality for coronary heart diseases and higher cancer mortality in urban areas [10]. Although most Japanese studies on socio-economic inequalities in mortality have relied on geographical analyses [11], a few recent studies have reported that individual educational levels were associated with mortality: individuals with lower levels of education had an increased overall risk of death among elderly populations [12] and among men in rural areas [13]. However, this Japanese individual data was limited to elderly populations or populations of men only. Furthermore, unemployment status is another important index that has a great impact on health, increasing mortality rates, and the incidence of physical and mental illness [14]. There have been few studies in Japan that have examined the effects of unemployment status on mortality using individual data.

The objective of the present study was to examine whether educational levels and employment status were associated with mortality from all causes and cause-specific mortality for Japanese women and men from a wide range of age groups. While equality of access to education has been achieved in a number of countries since World War II, women's possibilities for education have never been equivalent to those of men [15]. In addition, a previous study has shown a

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stronger association between mortality rates and socio-economic status for men than for women [9]. Therefore, there would appear to be gender differences in the ways that educational levels and employment status are associated with mortality.

Methods

The present study was initiated in 1992 as a community-based cohort study (the Jichi Medical School Cohort Study) on cardiovascular diseases in Japan. Data of the baseline survey were collected between 1992 and 1995. Ultimately 12,490 Japanese (4,911 men and 7,579 women) from 12 communities across Japan participated [16]. These 12 communities were from rural, sparsely populated areas of Japan. The mean population density (population per 1 km^2 of total land area) for the 12 communities was 198.1 (range 7.1–1018.9) and the nationwide average was 631.0 (SD = 1077.6) in 1995 [17]. In this study, individual income levels could not be obtained. However, according to a financial capability index [17], the mean for the 12 communities was 0.29 (range = 0.08–0.68) and that for municipalities in Japan was 0.49. This index indicates the economic level of a local municipality and was calculated as a mean of the standard financial revenues divided by the standard financial needs for the previous 3 years (1993–1995). The financial indices for the 12 communities were skewed toward low values.

The Health and Medical Service Law for the Aged of 1983 requires municipal governments to manage an efficient mass screening examination program concerned with the risk factors for cardiovascular diseases. The target subjects vary from community to community. In some communities all residents are included, while in others only those who are not offered physical examinations at their workplace or elsewhere are included, including recipients of Japan's National Health Insurance System. Residents aged 40–69 years were invited to participate in a mass screening examination conducted in 8 of the 12 communities. Of the remaining four communities, one invited those aged 35 years and older to participate, and the other three invited adults in other age groups as well. This resulted in people other than those in the above-defined age groups also being included in the database. The overall response rate was 65.4%. Each prospective candidate signed a consent form to participate in the study.

Participants who reported a previous history of cancer (38 men, 103 women), ischemic heart disease (131 men, 152 women), or stroke (62 men, 51 women) were excluded from the analyses to avoid prognostic effects. A total of 4,301 men and 6,780 women remained.

Mortality data from the date of entry to December 31, 2002, was collected from the Cause-of-Death Register at public health centers in each community with permission of the Agency of General Affairs and the Ministry of Health, Labor, and Welfare. Information on the cause of death was coded for the deceased participants using the 10th revision of the International Classification of Diseases (cardiovascular diseases ICD-10 codes I01–I15, I20–I25, I27, I30–I52, I60–I69, I99; cancer ICD-10 codes C00–C16, C18–C20, C22–C34, C43–C97, D00–D48) with permission from the Agency of General Affairs and the Ministry of Health, Labor, and Welfare. Participants who moved out of the communities during the observation period remained in the study until the date of their emigration (n = 369, 3.0%).

A self-administered questionnaire asked for information about socio-demographic characteristics including age, gender, marital status, alcohol consumption, smoking status, and other lifestyle factors described below. To determine the educational level, age at the completion of education was obtained. That age was categorized as "age < 15," "15 ≤ age < 18," and "age ≥ 18." Since the enactment of the School Education Law in 1947, people finish junior high school at 15 years of age, and they finish senior high school at 18 years of age.

Current occupation was obtained by having the individual select one of the following: farming or forestry, fishery, security, transportation, construction, production business, office work, professional, service industry, homemaker, retired, and unclassified. The first five occupations, from fishery to production business, were designated as blue-collar jobs, and the next four categories as white-collar jobs. The remaining occupations, from homemaker to unclassified, were designated as unemployed. Marital status was ascertained by asking whether participants were currently married. For smoking status, participants were asked whether they were a non-smoker, a former smoker, or a current smoker. For women, smoking status was categorized as non-smoker or lifetime smoker (current and former smoker). Alcohol consumption (g/day) was estimated by asking how many alcoholic beverages were consumed per day, including Japanese Sake, distilled spirits, whisky (double), beer (bottle), wine (glass), and others. For menopausal status, participants were asked whether they were pre or post-menopausal. Dietary habits were obtained with a food frequency questionnaire composed of 30 different foods most likely to be consumed, each on a graded 5-point Likert scale. Based on a factor analysis, two types of meals were considered: a summation score of a primary vegetarian diet tendency (frequent consumption of green vegetables, yellow–green vegetables, potatoes, fruits, tofu, seaweed, oranges, beans, and dried fish) and a summation score of a more western meal tendency (bread, butter, yogurt, rice, salty foods, and miso soup [the latter three are reversed items]) [18]. The physical activity index, which was developed in the

Framingham Study [19], was calculated by totaling the hours at each level of activity and multiplying this by a weight based on the oxygen consumption required for that activity.

The physical examination was given in each community after administration of the questionnaire. Height and weight were measured, and body mass index (BMI) was calculated as weight (kg)/height (m)^2. The systolic and diastolic blood pressures were also measured to classify participants as hypertensive: systolic blood pressure ≥ 160 mm Hg, diastolic blood pressure ≥ 90 mm Hg, or as shown by a clinical diagnosis based on the medical history information obtained by the questionnaire (i.e., currently being treated, have been treated in the past, or never treated). Serum total cholesterol levels (mg/dl) were also measured.

The hazard ratios of death (HRs) and 95% confidence intervals (95% CIs) from all causes, cardiovascular diseases, and cancer mortality according to age (at the time of education) and employment status were calculated using the Cox proportional hazard model. Age was always included in the models as a covariate and was stratified into younger (59 years and younger) and older groups (60 years and older) in the models of all causes of mortality. Further, because the national educational system changed after World War II, it was possible that the effect of educational attainment may differ between the groups. The potential confounding effects of marital status, alcohol consumption, smoking status, the scores of vegetarian diet tendency and western diet tendency, the physical activity index, BMI, hypertension, and total cholesterol were taken into account in the analyses. For women, menopausal status was also included in the model.

An analysis of covariance was performed to examine associations between educational level, employment status, and health indicators at the baseline, including alcohol consumption, vegetarian diet and western diet tendency scores, the physical activity index, BMI, and total cholesterol, controlling for age. A χ^2 was also calculated to examine associations between educational level, employment status, and other health indicators, including smoking status and hypertension, by performing a logit model controlling for age.

All statistical analyses were performed with the computer program PC-SAS, version 8.0.

The study design and procedures were reviewed and approved by each municipal government and the Ethics Committee for Epidemiological Research at Jichi Medical School. Each prospective candidate signed a consent form to participate in the study.

Results

The distribution of socio-demographic variables according to sex and age groups is shown in Table 1. In the follow-up period, a total of 588 deaths (349 for men and 239 for women) were observed. Totally 71 men and 64 women died from cardiovascular diseases, and 140 men and 102 women died from cancer. The average follow-up period was 9.17 years, and the person-year at risk was 101576.6.

In Table 2, age adjusted means and prevalence of specific lifestyle factors by educational level and employment status are detailed. Results showed that individuals with later termination of education had lower vegetarian and western diet tendency scores and indicated higher physical activity and lower total cholesterol for both women and men. There were no differences in prevalence of smokers and hypertension related to educational level for men (smoker: $\chi^2 = 7.49$, df = 4, $p = 0.11$; hypertension: $\chi^2 = 1.07$, df = 2, $p = 0.59$). However, women with early termination of education showed a higher prevalence of smokers ($\chi^2 = 38.09$, df = 2, $p < 0.001$), while also showing a lower prevalence of hypertension ($\chi^2 = 10.32$, df = 2, $p = 0.01$).

For employment status, female farmers and forestry workers showed tendencies of lower consumption of alcohol and a western diet, higher physical activity, and lower total cholesterol than the other groups. Their prevalence of smokers was also low ($\chi^2 = 36.30$, df = 3, $p < 0.001$), while there was no difference in prevalence of hypertension ($\chi^2 = 2.17$, df = 3, $p < 0.54$). Male farmers and forestry workers also showed lower consumption of a western diet, higher physical activity, and lower total cholesterol than other groups. Their prevalence of smokers was lower than that for white-collar and blue-collar workers, and their prevalence of non-smokers was higher than the other groups ($\chi^2 = 52.97$, df = 6, $p < 0.001$). Unemployed men showed a higher prevalence of hypertension than the other groups ($\chi^2 = 17.44$, df = 3, $p < 0.001$).

Early termination of education for women was significantly associated with an increase in all causes of mortality (Table 3). This trend was especially significant in the younger group. The hazard ratio after adjusting for possible confounders was almost identical to the age-adjusted ratio. For the elder group, this association was less significant. The hazard ratios of cardiovascular diseases and cancer showed that early completion of education tended to increase risk, but these trends did not achieve statistical significance. Female farmers and forestry workers of all ages showed a reduced mortality from all causes compared to white-collar workers, after adjusting for age, education level, and other confounders.

The same tendency was found for men (Table 4). For both younger groups and men of all ages, early completion of education was associated with an increase in all causes of mortality, after adjusting for age and employment status. Both unemployed men of all ages had increased mortality in comparison to white-collar workers. Men who completed education

Table 1. Sociodemographic variables based on the baseline survey

	Women			Men		
	All ages	59 and younger	60 and elder	All ages	59 and younger	60 and elder
Number	6,780	3,958	2,822	4,301	2,433	1,868
Mean (SD)						
Age	55.1 (11.2)	47.8 (8.6)	65.4 (4.2)	54.8 (12.0)	46.6 (8.9)	65.6 (4.7)
Alcohol consumption (g/day)	4.8 (15.9)	6.0 (16.4)	3.0 (14.9)	35.6 (37.1)	39.2 (40.3)	30.9 (32.0)
Vegetable tendency score	32.4 (5.4)	32.2 (5.3)	32.7 (5.4)	29.7 (5.7)	29.0 (5.6)	30.6 (5.8)
Western meal tendency score	13.4 (2.9)	13.9 (3.0)	12.8 (2.8)	12.4 (2.9)	12.7 (2.9)	12.0 (2.9)
Physical activity index	31.7 (5.5)	31.9 (5.9)	31.4 (4.9)	35.8 (9.5)	36.5 (10.0)	34.8 (8.7)
BMI	23.1 (3.2)	23.1 (3.2)	23.2 (3.2)	22.9 (2.9)	23.3 (2.9)	22.5 (2.8)
Total cholesterol (mg/dl)	196.8 (34.9)	191.0 (34.8)	205.1 (33.2)	185.0 (34.2)	186.7 (34.7)	182.8 (33.4)
%						
Age at finished education						
< 15 years	21.2	4.4	44.8	13.4	3.3	26.5
≥15; < 18 years	47.2	50.2	43.1	51.1	49.7	52.8
≥18 years	31.6	45.4	12.1	35.6	47.0	20.7
Marital status						
Married	91.9	94.7	88.0	91.6	88.4	95.7
Not married	8.1	5.3	12.0	8.5	11.6	4.3
Smoking status						
Current smoker*	8.3	10.0	5.9	51.3	55.4	46.0
Former smoker				27.3	21.8	34.5
Non-smoker	91.7	90.0	94.1	21.4	22.8	19.6
Occupation						
White-collar job	23.7	33.5	9.9	22.8	31.0	12.1
Blue-collar job	12.6	16.5	7.1	33.2	40.7	23.5
Farmers and forestry workers	22.6	20.3	25.9	31.8	26.4	38.9
Homemaker or unemployed	41.1	29.7	57.1	12.2	2.0	25.5
Hypertension						
Currently or formerly treated	33.7	23.9	47.4	37.3	28.7	48.3
Never treated	66.4	76.1	52.6	62.8	71.3	51.7
Menopause						
Pre	30.4	52.1	0.1			
Post	69.6	47.9	99.9			

*For women, fomer smokers were included in current smokers.

at an early age had a significantly higher increase in mortality from cardiovascular diseases than those who were older when they completed their education. Additionally, farming and forestry workers had reduced mortality from cardiovascular diseases compared to white-collar workers. These trends were the same after adjusting for the confounders. The associations between education, employment status, and cancer mortality were not statistically significant.

Discussion

Early termination of education was associated with an increased risk of mortality from all causes for both men and women. This tendency was more prominent in the group aged 59 and younger than in the group aged 60 and older for both women and men. Specifically, cardiovascular disease mortality was strongly associated with lower educational levels for men. On the other hand, unemployment status increased male mortality from all causes compared to white-collar workers. For women, farmers and forestry labors showed reduced mortality from all causes compared to white-collar workers. Male farmers and forestry laborers also showed reduced mortality from cardiovascular diseases. Associations with cancer mortality were not statistically significant, though consistent tendencies were shown for women.

Lower educational levels were associated with an increase in all causes of mortality for Japanese women and men and with an increase in cardiovascular disease mortality for men. The effect of education was more significant among younger groups than older groups, as it was in preceding studies [4, 20]. Before the enactment of the School Education Law of 1947, many children quit school at younger ages. Moreover, their ages at the time education was

Table 2. Means and prevalence of lifestyle factors by educational level and employment status

	Educational level			Employment status			
	< 15 years	≥15 – < 18 years	≥18 years	White-collar	Blue-collar	Farmers and forestry workers	Unemployed
Women							
Age adjusted mean (SE)							
Alcohol consumption (g/day)	4.3 (0.4)	5.0 (0.3)	5.0 (0.5)	7.3[a] (0.4)	5.2[b] (0.6)	3.6[c] (0.4)	3.8[c] (0.3)
Vegetable tendency score	33.2[a] (0.1)	32.4[b] (0.1)	31.4[c] (0.2)	32.6[a] (0.1)	31.2[b] (0.2)	32.7[a] (0.1)	32.6[a] (0.1)
Western meal tendency score	14.3[a] (0.1)	13.2[b] (0.1)	12.7[c] (0.1)	14.0[a] (0.1)	13.2[c] (0.1)	12.5[d] (0.1)	13.7[b] (0.1)
Physical activity index	31.0[c] (0.1)	32.1[a] (0.1)	31.6[b] (0.2)	30.2[c] (0.1)	31.4[b] (0.2)	36.2[a] (0.1)	30.1[c] (0.1)
BMI	22.5[b] (0.1)	23.4[a] (0.1)	23.5[a] (0.1)	23.2 (0.1)	23.0 (0.1)	23.1 (0.1)	23.2 (0.1)
Total cholesterol (mg/dl)	199.0[a] (0.8)	197.6[a] (0.7)	191.8[b] (1.0)	198.7[a] (0.9)	197.1[b] (1.1)	193.3[c] (0.9)	197.6[b] (0.6)
%							
Smoking status							
Current and former smoker	10.9	6.7	8.0	11.8	10.1	3.5	8.3
Non-smoker	89.1	93.3	92.0	88.2	89.9	96.5	91.7
Hypertension							
Currently or formerly treated	21.4	35.1	48.8	25.1	30.1	35.2	38.9
Never treated	78.6	64.9	51.2	74.9	69.9	64.8	61.1
Men							
Age adjusted Mean (SE)							
Alcohol consumption (g/day)	35.7 (1.0)	35.2 (0.8)	36.9 (1.7)	36.4 (1.2)	35.5 (1.0)	36.2 (1.1)	32.9 (1.8)
Vegetable tendency score	30.3[a] (0.2)	29.5[b] (0.1)	29.0[b] (0.2)	29.7[a,b] (0.2)	29.3[b] (0.2)	30.1[a] (0.2)	29.7[a,b] (0.3)
Western meal tendency score	13.0[a] (0.1)	12.2[b] (0.1)	11.7[c] (0.1)	13.1[a] (0.1)	12.4[b] (0.1)	11.6[c] (0.1)	13.3[a] (0.1)
Physical activity index	33.3[b] (0.3)	37.1[a] (0.2)	37.3[a] (0.4)	30.9[c] (0.3)	38.1[b] (0.2)	39.0[a] (0.2)	30.1[c] (0.4)
BMI	23.0[a,b] (0.1)	23.0[a] (0.1)	22.7[b] (0.1)	23.3[a] (0.1)	22.9[b] (0.1)	22.8[b] (0.1)	22.9[b] (0.1)
Total cholesterol (mg/dl)	188.2[a] (0.9)	183.8[b] (0.7)	181.5[b] (1.5)	189.6[a] (1.1)	185.0[b] (0.9)	181.9[c] (0.9)	184.6[b,c] (1.6)
%							
Smoking status							
Current smoker	54.3	50.7	44.8	52.2	58.2	46.3	43.9
Former smoker	25.8	27.1	32.2	27.2	23.6	26.7	39.2
Non-smoker	19.9	22.0	23.0	20.6	18.2	27.1	16.9
Hypertension							
Currently or formerly treated	31.6	38.9	46.0	33.4	36.0	36.4	50.0
Never treated	68.4	61.1	54.0	66.6	64.0	63.6	50.0

a, b, c, d indicate a significant difference.

Table 3. Hazard ratios (HRs) and 95% confidence interval (CI) of all causes, cardiovascular diseases, and cancer mortality associated with age at finished education and employment status for Japanese women

	Person-years			Age-adjusted HR	Adjusted HR[a]	Adjusted HR[b]
	At risk	Censored	Deceased			
All causes						
59 and younger						
Education level						
≥18 years	16304.9	1,780	17	1.00	1.00	1.00
≥15; < 18 years	18419.3	1,955	32	1.26 (0.67–2.36)	1.34 (0.71–2.52)	1.42 (0.68–3.00)
< 15 years	1569.5	164	10	3.99 (1.70–9.37)	4.48 (1.90–10.59)	3.82 (1.18–12.34)
P for trend				0.01	0.01	0.06
Employment status						
White-collar	12105.9	1,305	22	1.00	1.00	1.00
Blue-collar	6131.9	641	10	0.79 (0.38–1.68)	0.71 (0.33–1.51)	0.83 (0.34–2.01)
Farmers and forestry workers	7750.1	796	9	0.49 (0.22–1.07)	0.43 (0.20–0.96)	0.51 (0.17–1.56)
Unemployed	10305.7	1,157	18	0.80 (0.43–1.51)	0.75 (0.39–1.41)	0.93 (0.44–1.98)
60 and elder						
Education level						
≥18 years	3227.3	329	13	1.00	1.00	1.00
≥15; < 18 years	11160.6	1,146	69	1.77 (0.98–3.21)	1.87 (1.03–3.39)	1.58 (0.84–2.99)
< 15 years	11402.0	1,167	98	1.74 (0.97–3.11)	1.85 (1.03–3.31)	1.62 (0.86–3.05)
P for trend				0.16	0.11	0.23
Employment status						
White-collar	2593.3	262	18	1.00	1.00	1.00
Blue-collar	1912.8	191	9	0.67 (0.30–1.49)	0.60 (0.27–1.35)	0.57 (0.25–1.29)
Farmers and forestry workers	6824.0	696	34	0.65 (0.37–1.16)	0.61 (0.34–1.08)	0.54 (0.29–1.01)
Unemployed	14459.8	1,493	119	0.87 (0.53–1.44)	0.83 (0.50–1.37)	0.68 (0.40–1.15)
All ages						
Education level						
≥18 years	19532.2	2,109	30	1.00	1.00	1.00
≥15; < 18 years	29579.9	3,101	101	1.28 (0.85–1.92)	1.37 (0.91–2.07)	1.49 (0.92–2.39)
< 15 years	12971.4	1,331	108	1.52 (0.99–2.33)	1.65 (1.07–2.55)	1.65 (0.99–2.74)
P for trend				0.05	0.02	0.08
Employment status						
White-collar	14699.2	1,567	40	1.00	1.00	1.00
Blue-collar	8044.8	832	19	0.70 (0.41–1.21)	0.65 (0.37–1.12)	0.69 (0.38–1.25)
Farmers and forestry workers	14574.1	1,492	43	0.55 (0.35–0.85)	0.51 (0.33–0.80)	0.55 (0.33–0.93)
Unemployed	24765.4	2,650	137	0.80 (0.55–1.16)	0.76 (0.52–1.11)	0.75 (0.49–1.14)
Cardiovascular diseases						
All ages						
Education level						
≥18 years	19532.2	2,131	8	1.00	1.00	1.00
≥15; < 18 years	29579.9	3,179	23	1.04 (0.47–2.33)	1.11 (0.49–2.50)	1.04 (0.42–2.61)
< 15 years	12971.4	1,406	33	1.32 (0.59–2.94)	1.42 (0.63–3.20)	1.34 (0.52–3.47)
P for trend				0.40	0.32	0.45
Employment status						
White-collar	14699.2	1,598	9	1.00	1.00	1.00
Blue-collar	8044.8	847	4	0.63 (0.19–2.05)	0.60 (0.18–1.96)	0.75 (0.22–2.62)
Farmers and forestry workers	14574.1	1,522	13	0.63 (0.27–1.49)	0.60 (0.25–1.43)	0.83 (0.29–2.36)
Unemployed	24765.4	2,749	38	0.74 (0.35–1.59)	0.72 (0.33–1.54)	0.77 (0.31–1.88)
Cancer (all sites)						
All ages						
Education level						
≥18 years	19532.2	2,126	13	1.00	1.00	1.00
≥15; < 18 years	29579.9	3,155	47	1.46 (0.79–2.72)	1.57 (0.84–2.93)	1.87 (0.88–3.95)
< 15 years	12971.4	1,397	42	1.66 (0.85–3.26)	1.80 (0.91–3.56)	1.89 (0.84–4.29)
P for trend				0.16	0.11	0.19

Table 3. Continued

	Person-years			Age-adjusted HR	Adjusted HR[a]	Adjusted HR[b]
	At risk	Censored	Deceased			
Employment status						
White-collar	14699.2	1,588	19	1.00	1.00	1.00
Blue-collar	8044.8	842	9	0.72 (0.32–1.59)	0.65 (0.29–1.45)	0.58 (0.23–1.44)
Farmers and forestry workers	14574.1	1,516	19	0.56 (0.29–1.07)	0.52 (0.27–1.00)	0.49 (0.22–1.07)
Unemployed	24765.4	2,732	55	0.79 (0.45–1.37)	0.75 (0.43–1.31)	0.72 (0.38–1.35)

[a]Age, education level, and Employment status were taken into the model.
[b]Age, educational level, employment status, marital status, alcohol consumption (total ethanol g/day), smoking status, financial capability index, vegetable tendency, western meal tendency, physical activity, BMI, hypertension (never-treated as reference), total cholesterols, and menopausal status were taken into the model.

completed shortly after World War II may have been subject to measurement errors, which may invalidate the findings. However, the Japanese have attained a high advancement rate in secondary education during the period of economic growth since the end of World War II. Further, household economic status and the individual aptitudes of children affect the age at which education is completed [4]. Therefore, the adverse consequences of attaining low educational levels are more likely to manifest themselves in younger individuals.

Unemployment status was found to increase male mortality from all causes, indicating that employment status plays a key role in the mortality of Japanese men. Japanese geographical analyses have suggested that men's mortality is more strongly associated with other socio-economic indices, including employment [26]. On the other hand, as our results indicated that 50% of unemployed men had hypertension, individuals who already had some diseases may have been included in the unemployed group, even though individuals found to have major illnesses in the baseline data were excluded. While male identity was thought to be strongly associated with work, the healthy worker effect should be considered with regard to the relationship between employment status and health.

However, unemployed status was not found to increase female mortality. Accordingly, women's mortality was strongly associated with the respective regional average educational levels [26]. The majority of unemployed women were homemakers in this study because traditional ways of thinking, such as the idea that men should go to work while women should stay at home, are still common in Japan. In fact, in this study only 2% of the men in the younger group were unemployed, while 30% of the women were unemployed, and the majority of the unemployed women comprised homemakers. It is assumed that the husband's socio-economic status may be influential on the health of female homemakers and also that educational level may be an important indicator of women's health.

Farmers and forestry workers showed a reduced mortality from all causes for women and from cardiovascular diseases for men. Previous studies have shown that farming was protective with regard to mortality from cardiovascular diseases [21–23]. In addition, Naokola, Martikainen, and Leino [27] have shown that farmers exhibited reduced mortality from all causes, whereas forestry workers showed increased mortality, even though farmers and forestry workers are categorized into the same group in this study. Furthermore, both female and male farmers and forestry workers in this study showed several health indicators, including a lower prevalence of smoking, higher physical activity, and lower total cholesterol. Comparatively speaking, therefore, it can be concluded that rural area farmers and forestry workers may be more oriented toward healthy lifestyles and protected from mortality from diseases.

Furthermore, health-related behaviors might have been mediated between educational level and mortality. Davey Smith et al. [28] found that death from cardiovascular diseases was strongly associated with level of education, which has also been found to be related to high levels of tobacco use and poor diets. These lifestyle habits are formed during childhood and persist into adulthood, and then lead to biological differences [29]. In this study, several health indicators, such as total cholesterol and the prevalence of smokers, were low for individuals with higher educational levels. However, their prevalence of hypertension was nonetheless high. In addition, in concurrence with the results of this study, another study has indicated that the association of educational level with cardiovascular diseases is independent of other cardiovascular risk factors, including other socio-economic factors [30].

The possible limitations in this study should be mentioned. Educational achievement data should have been more comprehensive. The age at the completion of education was used as a single index for educational level. However, all socio-economic factors are not represented by education and occupation alone [4, 31–33]. In Great Britain, for example, occupational class is an important predictor of mortality [4], and in some studies in the U.S. [34], a strong inverse association between years of education and

Table 4. Hazard ratios (HRs) and 95% confidence interval (CI) of all causes, cardiovascular diseases, and cancer mortality associated with age at finished education and employment status for Japanese men

	Person-years			Age-adjusted	Adjusted	
	At risk	Censored	Deceased	HR	HR[a]	HR[b]
All causes						
59 and younger						
Education level						
≥18 years	10553.7	1,120	24	1.00	1.00	1.00
≥15; <18 years	11339.5	1,152	57	1.57 (0.96–2.58)	1.57 (0.95–2.62)	1.42 (0.82–2.46)
<15 years	761.4	73	7	2.08 (0.86–5.01)	2.13 (0.87–5.21)	1.83 (0.69–4.86)
P for trend				0.04	0.05	0.15
Employment status						
White-collar	6926.4	735	18	1.00	1.00	1.00
Blue-collar	9235.2	957	32	1.21 (0.68–2.16)	1.04 (0.57–1.88)	0.87 (0.45–1.67)
Farmers and forestry workers	6079.5	606	36	1.66 (0.93–2.95)	1.52 (0.85–2.73)	1.48 (0.77–2.87)
Unemployed	413.4	47	2	1.44 (0.33–6.24)	1.39 (0.32–6.04)	1.50 (0.34–6.69)
60 and elder						
Education level						
≥18 years	3535.2	342	45	1.00	1.00	1.00
≥15; <18 years	8895.7	853	134	1.26 (0.90–1.77)	1.28 (0.91–1.80)	1.11 (0.78–1.59)
<15 years	4407.5	412	82	1.31 (0.91–1.88)	1.33 (0.92–1.93)	1.14 (0.77–1.70)
P for trend				0.18	0.15	0.54
Employment status						
White-collar	2066.4	202	24	1.00	1.00	1.00
Blue-collar	4019.7	386	52	1.23 (0.76–2.00)	1.16 (0.71–1.89)	1.10 (0.64–1.88)
Farmers and forestry workers	6661.9	634	93	1.11 (0.71–1.74)	1.06 (0.68–1.68)	0.97 (0.58–1.60)
Unemployed	4090.4	385	92	1.55 (0.98–2.43)	1.51 (0.96–2.38)	1.48 (0.90–2.42)
All ages						
Education level						
≥18 years	14088.9	1,462	69	1.00	1.00	1.00
≥15; <18 years	20235.2	2,005	191	1.33 (1.01–1.75)	1.34 (1.01–1.78)	1.21 (0.90–1.64)
<15 years	5169.0	485	89	1.39 (1.00–1.93)	1.41 (1.01–1.96)	1.22 (0.85–1.76)
P for trend				0.05	0.05	0.28
Employment status						
White-collar	8992.8	937	42	1.00	1.00	1.00
Blue-collar	13254.9	1,343	84	1.22 (0.84–1.76)	1.12 (0.77–1.63)	0.98 (0.65–1.48)
Farmers and forestry workers	12741.4	1,240	129	1.25 (0.88–1.78)	1.18 (0.83–1.69)	1.05 (0.71–1.56)
Unemployed	4503.9	432	94	1.64 (1.11–2.41)	1.59 (1.08–2.34)	1.51 (1.00–2.28)
Cardiovascular diseases						
All ages						
Education level						
≥18 years	14088.9	1,523	8	1.00	1.00	1.00
≥15; <18 years	20235.2	2,158	38	2.18 (1.02–4.68)	2.36 (1.09–5.11)	2.48 (1.08–5.70)
<15 years	5169.0	549	25	2.75 (1.22–6.19)	3.26 (1.43–7.48)	2.97 (1.17–7.52)
P for trend				0.02	0.00	0.03
Employment status						
White-collar	8992.8	968	11	1.00	1.00	1.00
Blue-collar	13254.9	1,410	17	0.94 (0.44–2.01)	0.74 (0.34–1.60)	0.58 (0.25–1.35)
Farmers and forestry workers	12741.4	1,355	14	0.44 (0.20–0.98)	0.37 (0.16–0.82)	0.34 (0.14–0.82)
Unemployed	4503.9	497	29	1.42 (0.68–2.97)	1.27 (0.61–2.66)	0.99 (0.45–2.18)
Cancer (all sites)						
All ages						
Education level						
≥18 years	14088.9	1,500	31	1.00	1.00	1.00
≥15; <18 years	20235.2	2,117	79	1.22 (0.81–1.86)	1.17 (0.76–1.79)	0.95 (0.61–1.50)
<15 years	5169.0	543	31	1.14 (0.68–1.91)	1.08 (0.64–1.82)	0.97 (0.56–1.71)
P for trend				0.60	0.78	0.92

Table 4. Continued

	Person-years			Age-adjusted	Adjusted	
	At risk	Censored	Deceased	HR	HR[a]	HR[b]
Employment status						
White-collar	8992.8	962	17	1.00	1.00	1.00
Blue-collar	13254.9	1,387	40	1.44 (0.81–2.53)	1.38 (0.78–2.47)	1.17 (0.61–2.21)
Farmers and forestry workers	12741.4	1,315	54	1.31 (0.75–2.29)	1.29 (0.74–2.26)	1.08 (0.57–2.02)
Unemployed	4503.9	497	29	1.28 (0.68–2.40)	1.26 (0.67–2.38)	1.20 (0.60–2.37)

[a]Age, education level, and Employment status were taken into the model.
[b]Age, educational level, employment status, marital status, alcohol consumption (total ethanol g/day), smoking status, financial capability index, vegetable tendency, western meal tendency, physical activity, BMI, hypertension (never-treated as reference), and total cholesterols were taken into the model.

mortality was shown to disappear when other socio-economic factors, such as lifetime income, wealth, and occupational class, were adjusted. Income level represents material resources, potential access to different lifestyles, and a sense of security, and it is often closely associated with social class [31]. Therefore an individual's income level should also be considered. Unemployment status showed an increased risk of mortality for men. As discussed above, this may be due to the healthy worker effect or other unknown health problems.

On the other hand, our study had several strengths. The analyses were done using a large community based cohort with the accurate identification of deaths and causes of death. Moreover, bias attributable to sample attrition is implausible as the follow-up rate was high. We excluded individuals with major illnesses at baseline, which might have influenced both the exposure and outcome. Furthermore, we took into account various potential confounders.

Despite certain limitations, this study provides information concerning the effects that educational attainment and employment status have on health in Japan. The findings call for further investigations on this topic.

Appendix

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Chiba), Seishi Yamada (Wara National Health Insurance Hospital, Gifu), Takashi Yamada (Kuze Clinic, Gifu), Rika Yamaoka (Awaji-Hokudan Public Clinic, Hyogo), Hiroshi Yanagawa (Saitama Prefectural University, Saitama), and Manabu Yoshimura (Kuze Clinic, Gifu).

References

1. Schellekens J. Mortality and socio-economic status in two eighteenth-century Dutch villages. Popul Stud 1989; 43: 391–404.
2. Davey Smith G, Bartley M, Blane D. The Black Report on socioeconomic inequalities in health 10 years on. Br Med J 1990; 301: 373–377.
3. Davey Smith G, Carroll D, Rankin S. Socio-economic differentials in mortality: Evidence form Glasgow graveyards. Br Med J 1992; 305: 1554–1557.
4. Davey Smith G, Hart C, Hole D, et al. Education and occupational social class: Which is the more important indicator of mortality risk?. J Epidemiol Comm Health 1998; 52: 153–160.
5. Kunst AE, Mackenbach JP. The size of mortality differences associated with educational level in nine industrialized countries. Am J Public Health 1994; 84: 932–937.
6. Liberatos P, Link BG, Kelsey JL. The measurement of social class in epidemiology. Epidemiol Rev 1988; 10: 87–121.
7. Davey Smith G, Shipley MJ, Rose G. The magnitude and causes of socio-economic differentials in mortality: Further evidence from the Whitehall study. J Epidemiol Comm Health 1990; 44: 260–265.
8. Davey Smith G, Blane D, Bartley M. Explanations for socioeconomic differentials in mortality: Evidence from Britain and elsewhere. Eur J Pub Health 1994; 4: 131–144.
9. Fukuda Y, Nakamura K, Takano T. Municipal socioeconomic status and mortality in Japan: Sex and age differences, and trends in 1973–1998. Soc Sci Med 2004; 59: 2435–2445.
10. Fukuda Y, Nakamura K, Takano T. Cause-specific mortality differences across socioeconomic position of municipalities in Japan, 1973–1977 and 1993–1998: Increased importance of injury and suicide in inequality for ages under 75. Int J Epidemiol 2005; 34: 100–109.
11. Kunst AE. Commentary: Using geographical data to monitor socioeconomic inequalities in mortality: Experiences from Japanese studies. Int J Epidemiol 2005; 34: 110–112.
12. Fujino Y, Tamakoshi A, Iso H, et al. A nationwide cohort study of educational background and major causes of death among the elderly population in Japan. Prev Med 2005; 40: 444–451.
13. Iwasaki M, Otani T, Ohta A, Sasazawa Y, Kuroiwa M, Suzuki S. Rural-urban differences in sociodemographic, social network and lifestyle factors related to mortality of middle-aged Japanese men from the Komo-Ise cohort study. J Epidemiol 2002; 12(2): 93–104.
14. Mathers CD, Schofield DJ. The health consequences of unemployment: The evidence. Med J Australia 1998; 16: 178–182.
15. Kelly GP. Education and equality: Comparative perspective on the expansion of education and women in the post-war period. Int J Educ Dev 1990; 10: 131–141.
16. Ishikawa S, Gotoh T, Nago N, Kayaba K. The Jichi Medical School (JMS) Cohort Study: Design, baseline data and standardized mortality ratios. J Epidemiol 2002; 12: 408–417.
17. Statistic Bureau, Management and Coordination Agency, Government of Japan. Statistical Observations of Shi, Ku, Machi, Mura, 2000 [in Japanese].
18. Tsutsumi A, Kayaba K, Yoshimaru M, Sawada M, shikawa S, Sakai K, Gotoh T, Nago N, The Jichi Medical School Cohort Study Group. Association between job characteristics and health behaviors in Japanese rural workers. Int J Behav Med 2003; 10: 125–142.
19. Kennel WB, Sorlie P. Some health benefits of physical activity: The Framingham study. Arch Int Med 1979; 139: 857–861.
20. Elo IT, Preston SH. Educational differentials in mortality: United States, 1979–1985. Soc Sci Med 1996; 42: 47–57.
21. Burmeister LF, Morgan DP. Mortality in Iowa farmers and farm laborers, 1971–1978. J Occup Med 1982; 24: 898–900.
22. Gallagher RP, Threlfall WJ, Spinelli JJ, Band PR. Occupational mortality patterns among British Columbia farm workers. J Occup Med 1984; 26: 906–908.
23. Notkola VJ, Husman KH, Laukkanen VJ. Mortality among male farmers in Finland during 1979–1983. Scand J Work Environ Health 1987; 13: 124–128.
24. Nakaya T, Dorling D. Geographical inequalities of mortality by income in two developed island countries: A cross-national comparison of Britain and Japan. Soc Sci Med 2005; 60: 2865–2875.
25. Otake F. 90 nendai no syotoku-kakusa (income inequality during 1990s). The Monthly Journal of the Japan Institute of Labour 2000; 480: 2–11 [in Japanese].
26. Hasegawa T.. Japan: historical and current dimensions of health and health equity, . In: Evans T, Whitehead M, Diderichsen F, Bhuiya A and Wirth M (eds.) Challenging Inequalities in Health: From Ethics to Action. Oxford: Oxford University Press, 2001 , p. 90–103.
27. Notkola VJ, Martikainen P, Leino PI. Time trends in mortality in forestry, construction workers in Finland 1970–1985 and impact of adjustment for socioeconomic variables. J Epidemiol Comm Health 1993; 47: 186–191.
28. Davey Smith G, Ben-Shlomo Y. Geographical and social class differentials in stroke mortality—the influence of early-life factors. J Epidemiol Comm Health 1997; 51: 134–137.
29. Hinkle LE Jr., Whitney LH, Lehman EW, et al. Occupation, education, and coronary heart disease. Risk is influenced more by education and background than by occupational experiences, in the Bell System. Science 1968; 161: 238–246.
30. Qureshi AI, Suri MFK, Saad M, Hopkins LN. Educational attainment and risk of stroke and myocardial infarction. Med Sci Monit 2003; 9: CR466–CR473.
31. Backlund E, Sorlie PD, Johnson NJ. A comparison of the relationships of education and income with

mortality: The national longitudinal mortality study. Soc Sci Med 1999; 49: 1373–1384.
32. Krieger N, Williams DR, Moss NE. Measuring of social class in US public health research. Ann Rev Pub Health 1997; 18: 341–378.
33. Muller A. Education, income inequality, and mortality: A multiple regression analysis. Br Med J 2002; 324: 23–25.
34. Sorlie PD, Blacklund E, Keller JB. U.S Mortality by economic, demographic, and social characteristics: The National Longitudinal Mortality Study. Am J Public Health 1995; 85: 949–956.

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