Ⅲ．研究成果の刊行に関する一覧表

（１）論文発表

研究成果の刊行に関する一覧表

[論文発表]

1) Kuriyama S, Hozawa A, Ohmori K, Suzuki Y, Nishino Y, Fujita K, Tsubono Y, Tsuji I.
Joint impact of health risks on health care charges:7-year follow-up of National Health Insurance beneficiaries in Japan (the Ohsaki Study).
Preventive Medicine, 2004;39:1194-1199.

2) Anzai Y, Kuriyama S, Nishino Y, Takahashi K, Ohkubo T, Ohmori K, Tsubono Y, Tsuji I.
Impact of alcohol consumption upon medical care utilization and costs in men: 4-year observation of National Health Insurance beneficiaries in Japan.
Addiction, 2005;100:19-27.

3) Ohmori K, Kuriyama S, Hozawa A, Ohkubo T, Tsubono Y, Tsuji I.
Modifiable factors for the length of life with disability before death: mortality retrospective study in Japan.
Gerontology, 2005;51:186-191.

4) Hozawa A, Shimazu T, Kuriyama S, Tsuji I.
Benefit of home blood pressure measurement after a finding of high blood pressure at community screening.
Journal of Hypertension, 2006;24(7):1265-1271.

5) 鈴木寿則, 坪野吉孝, 栗山進一, 寳澤 篤, 大森 芳, 遠藤 彰, 辻 一郎.
レセプト全傷病登録による糖尿病の合併症の医療費分析.
日本公衆衛生雑誌, 2005;52:652-663.

6) 栗山進一, 島津太一, 寳澤 篤, 矢部美津子, 田崎美記子, 物永葉子, 境 道子, 三浦千早, 伊藤文枝, 伊藤孝子, 矢部初枝, 新田幸恵, 鈴木玲子, 藤田和樹, 永富良一, 辻 一郎.
適正減量を目指した糖尿病予防の個別健康教育における強力介入群と通常介入群の比較.
日本公衆衛生雑誌, 2006;53:122-132.

7) 辻 一郎.
介護予防のねらいと戦略.
社会保険研究所, 東京, 2006.

8) Ohmori-Matsuda K, Kuriyama S, Hozawa A, Nakaya N, Shimazu T, Tsuji I.
The joint impact of cardiovascular risk factors upon medical costs.
Preventive Medicine, 2007 Feb 6 [Epub ahead of print].

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Preventive Medicine 39 (2004) 1194–1199

Preventive Medicine

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Joint impact of health risks on health care charges: 7-year follow-up of National Health Insurance beneficiaries in Japan (the Ohsaki Study)

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Available online 10 June 2004

Abstract

Background. The objective of this study was to examine the joint impact of modifiable health-risk factors such as smoking, obesity, and physical inactivity on direct health care charges.

Method. We conducted a population-based prospective cohort study, with follow-up from 1995 to 2001. The participants were Japanese National Health Insurance (NHI) beneficiaries (26,110 men and women aged 40–79 years).

Results. 'No risk' group defined as never-smoking, body mass index (BMI) 20.0–24.9 kg/m^2, and walking for ≥1 h/day had mean health care charges of $171.6 after adjustment for potential confounders. Compared with this group, the presence of smoking (SM; ever-smoking) alone, obesity alone (OB; BMI ≥ 25.0 kg/m^2), or physical inactivity (PI; walking for <1 h/day) alone were associated with a 8.3%, 7.1%, or 8.0% increase in health care charges, respectively. The combinations of the risks of SM and OB, SM and PI, OB and PI, and SM and OB and PI were associated with a 11.7%, 31.4%, 16.4%, and 42.6% increase in charges, respectively.

Conclusion. Interventions to improve modifiable health-risk factors may be a cost-effective approach for reducing health care charges as well as improving people's health.

Keywords: Cohort studies; Health care charges; Japan; Joint exposure; Obesity; Physical inactivity; Smoking

Introduction

Smoking, obesity, and physical inactivity are related to a variety of chronic diseases such as cardiovascular disease [1–4], cancer [5,6], type II diabetes mellitus [7,8], and hypertension [9], which are major public health hazards [10–12] and impose a financial burden on health care systems. It is therefore essential that analyses of the impact of lifestyle on health care charges are used by the medical and public health communities and by policy makers to identify targets for expenditure reduction through cost-effective management programs and treatments.

The association between individual health risks and health care charges has been investigated [13–33], and the results are consistent with an association between the risk and increased health care charges. We also have provided evidence about real and substantial health care charge differences between subjects who have a health-risk factor and those who do not. Male smokers incurred 11% more medical charges than never smokers (subjects who have never smoked, as opposed to those who had smoked and given up) [34]. The mean total charges were 9.8% greater among subjects with a body mass index (BMI) of 25.0–29.9 and 22.3% greater among those with a BMI of 30.0 or more, relative to those with a BMI of 21.0–22.9 [35]. Per-person health care charges in those walking \for less than 1 h per day was 11% higher than for those walking for 1 h per day or more [36]. Nevertheless, an individual often possesses two or more health risks simultaneously and the combined risks may interact with each

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doi:10.1016/j.ypmed.2004.04.033

other. However, the data available regarding the joint impact of health risks on health care charges are limited. To our knowledge, only one study has investigated this, and that study was based on a prospective cohort design and followed the subjects for 1.5 years [37].

To examine the joint impact of smoking, obesity, and physical inactivity on health care charges, we conducted a population-based prospective cohort study in rural Japan. Our data were derived from a 7-year prospective observation of National Health Insurance (NHI) beneficiaries. The strengths of this study include a large sample size (n = 26,110) and a long follow-up of 7 years, coverage of almost all aspects of medical care under the NHI system, 100% monitoring of medical care utilization from claim history files, and comprehensive health and lifestyle information for each subject at baseline.

Method

Health insurance system in Japan

Health insurance is compulsory for everyone living in Japan, and is provided by one of two systems [38]; the first is for employees and their dependents, the second is a community-based health insurance system mainly used by farmers, the self-employed, pensioners, and their dependents. This second system is called the National Health Insurance (NHI) plan and covers 35% of the Japanese population. The NHI covers almost all aspects of medical treatment, including diagnostic tests, medication, surgery, supplies and materials, payment of physicians and other personnel, and most dental treatment. It also covers the home care services provided by physicians and nurses, but not by other professionals, such as home health aides. When medical providers treat a patient, they receive a copayment from the patient and then file a claim with the local NHI association for reimbursement. Payment to medical providers is made on a fee-for-service basis, where the price of each service is determined by a uniform national fee schedule. The local NHI association has a peer-review system to determine the level of reimbursement.

Study cohort

The details of the Ohsaki NHI Cohort study have been previously described [39,40]. In brief, this prospective cohort study started in January 1995, when we delivered a self-administered questionnaire on various health habits to all NHI beneficiaries, aged 40–79 years, living in the catchment area of Ohsaki Public Health Center, Miyagi Prefecture, northeast Japan (n = 54,996). Ohsaki Public Health Center, a local government agency, provides preventive health services for the residents of 14 municipalities in Miyagi Prefecture. The questionnaires were delivered to and collected from the subjects' residences by members of public health officials in each municipality. This procedure yielded a high response rate of 95% (n = 52,029). We excluded 774 subjects because they had withdrawn from the NHI before January 1, 1995, when we started the prospective collection of NHI claim history files. Thus, 51,255 subjects formed the study cohort. The study protocol was reviewed and approved by the Ethics Committee of Tohoku University School of Medicine. We considered the return of self-administered questionnaires signed by the subjects to imply their consent to participate in the study.

Exposure data

The questionnaire, which was used as a baseline survey, consisted of 93 items concerning 10 factors: past medical history, family medical history, physical health status, smoking habits, drinking habits, dietary habits (food frequency questionnaire), occupation, marital status, education, and reproductive history of the women. We defined current or former smokers as "smokers" according to the definition of "ever" or "never".

In assessing the obesity, we used the BMI, which is body weight adjusted for height. The baseline survey included questions on body weight and height; BMI was then calculated as the weight divided by the square of the height (kg/m^2). We grouped the subjects into two categories: BMI of 20.0–24.9 and BMI of 25.0 or more. We defined "obesity" as a BMI 25.0 or more because a BMI of 25.0 is the standard cutoff point for defining overweight individuals [41].

We evaluated the validity of the self-reported body weight and height measurements. Among the study subjects, 14,883 had their body weight and height measured during basic health examinations provided by local governments in 1995. The Pearson's correlation coefficients (r) for the self-reported and measured values were 0.96 for body weight, 0.93 for body height, and 0.88 for BMI. Thus, the self-reported weight and height measurements from the baseline questionnaire were considered sufficiently valid.

In assessing physical activity, we chose to focus on walking because it is the most common type of physical activity performed by middle-aged and older individuals in rural Japan. The question on walking time was worded as "How long do you walk a day, on average?", and the subjects were asked to choose one of three options: 30 min or less, between 30 min and 1 h, and 1 h or more. This assessment did not distinguish between household activities, occupational physical activities and leisure-time activities. We defined "physical inactivity" as a walking time of less than 1 h a day because almost half of the subjects walked 1 h or more per day (48.4% walked 1 h or more; 26.0% walked between 30 min and 1 h; 25.7% walked 30 min or less). The validity and reproducibility of this walking questionnaire has been reported elsewhere [42].

The subjects were finally classified into eight categories according to the presence of the three risk factors of smoking, obesity, or physical inactivity and their combinations.

Follow-up

We prospectively collected data on medical care utilization and its charges for all individuals in the cohort for the period from January 1, 1995, to the date of withdrawal from the NHI because of death, emigration, or loss of NHI qualification, or the end of the study period (December 31, 2001), by obtaining their NHI claims history files from the local NHI Association. When a beneficiary is withdrawn from the NHI, the date and reason are entered in the NHI withdrawal history files. Both NHI claims and withdrawal history files were linked to our baseline survey data files, using each beneficiary's identification number as the key code.

We excluded the subjects who had a BMI of less than 20.0 in the analysis in the present study to exclude a bias caused by lean subjects who had lost their weight by occult diseases (n = 8,953). In addition, we excluded from analysis those subjects who were capable of only moderate to low, but not vigorous activity, to exclude a bias caused by physically inactive subjects who could not walk because of their physical condition (n = 11,371). The physical functioning status of each subject was assessed using the six-item physical function measure of the Medical Outcome Study (MOS) Short-Form General Health Survey [43]. This measure examines the extent to which health interferes with a variety of physical activities ranging from strenuous exercise to basic self-care. The validity and reliability of the MOS questionnaire have been fully established [43–45]. Based on their responses, the subjects were classified into three groups: those who were able to perform vigorous activity (MOS score of 5–6), those who were capable of moderate, but not vigorous activity (MOS score of 2–4), and those considered to be of low physical ability (MOS score of 0–1).

We also excluded those subjects from our analysis who did not provide information about either smoking history, body weight, body height, or physical activity (n = 4,821). Thus, we analyzed 26,110 subjects (14,908 men and 11,202 women).

Assessment of health care charges

Monthly values for each subject were calculated by dividing the charges combined throughout the observation by the number of months observed. We used monthly values rather than cumulative values to avoid underestimating medical care utilization and charges for subjects who died or emigrated.

Statistical analysis

We chose, as did Hornbrook et al. [46] and Brown et al. [47], an ordinary least-squares model based on non-log-transformed data because the results in the original dollar units are more easily interpretable and because total charges for groups can be estimated from mean per-person charges. The impact of smoking, obesity, and physical inactivity on monthly per capita total health care charges were examined by analysis of covariance (ANCOVA). In these analyses, we regarded the following data as covariates: sex, age (continuous variable), alcohol drinking status (never, former, currently drinking less than 450 g ethanol/week, currently drinking 450 g ethanol or more/week), history of cancer, myocardial infarction, or stroke.

All statistical analyses were performed using SAS software [48]. We used approximate variance formulae to calculate the 95% confidence intervals (CI). All of the statistical tests that we report were two-sided. A level of $P < 0.05$ was accepted as statistically significant. In this paper, monetary values are converted to U.S. dollars ($) using an exchange rate of $1.00 = 120 Japanese yen (rate as at 2003). We adjusted all health care charges to reflect 1995 prices.

Table 1
Baseline characteristics of the Ohsaki Study subjects by health-risk categories in 1995, Japan

Health-risk categories			Number of subjects	Women (%)	Mean age (SD)	Alcohol intake more than 450 g/week (%)	History of cancer (%)	History of myocardial infarction (%)	History of stroke (%)
Smoking[a]	Obesity[b]	Inactivity[c]							
–	–	–	4191	75.5	57.5 (9.7)	0.4	2.2	1.2	0.6
+	–	–	4834	7.1	57.8 (10.4)	2.6	1.9	1.8	0.8
–	+	–	1962	73.7	58.1 (9.1)	0.5	2.1	1.9	0.7
–	–	+	4403	80.3	58.2 (9.9)	0.5	2.7	1.3	0.6
+	+	–	1646	9.1	56.1 (9.8)	3.9	1.2	3.0	1.1
+	–	+	4635	9.9	58.4 (10.7)	3.5	2.1	2.8	1.6
–	+	+	2357	79.3	58.7 (9.3)	0.6	2.6	2.1	1.0
+	+	+	2082	11.4	56.9 (10.5)	4.2	1.3	2.7	1.4

SD denotes standard deviation.
[a] Current and former smokers.
[b] Body mass index [weight (kg)/height (m)^2] more than or equal to 25.0.
[c] Time spent walking less than 1 h a day.

Results

Table 1 shows the baseline characteristics of the subjects according to the eight health-risk categories. Women were less likely to smoke and excess drinkers were more likely to be men. There were no apparent differences in mean age, the proportion of having history of cancer, myocardial infarction, or stroke among the health-risk categories.

Of 26,110 subjects, 25,249 (96.7%) used medical care and had nonzero charge for 7 years. During the follow up, 4.4% of the participants (1,161 subjects) died. The proportion of subjects who died in the different health-risk categories (shown in Tables 1–3), no risk, smokers, obese, physically inactive, smoker + obese, smoker + physical inactivity, obese + physical inactivity, and smoker + obese + physically inactive, were 8.1%, 23.8%, 4.6%, 11.4%, 6.5%, 28.6%, 6.2%, and 10.9%, respectively. A total of 11.7% of the participants (3,065 subjects) were lost to follow-up. The proportion of subjects who were lost to follow-up in the different health-risk categories (as listed above) were 18.4%, 17.0%, 8.1%, 19.2%, 6.2%, 15.0%, 9.8%, and 6.4%, respectively.

Table 2
Estimates of the independent contributions to health care charges of health risk categories, based on linear regression in the Ohsaki Study, Japan, 1995–2001

Variables			Parameter estimate	Standard error
Intercept			−344.9	31.1
Age (continuous variable)			9.7	0.4
Sex (women)			−35.1	10.6
Alcohol drinking status				
Never			referent	–
Former			128.9	15.0
Currently drinking 1–449 g ethanol/week			−14.1	8.8
Currently drinking ≥450 g ethanol/week			8.2	27.1
History of diseases (presence or absence)				
Cancer			115.4	24.7
Myocardial infarction			124.3	25.7
Stroke			95.9	36.9
Health-risk categories				
Smoking[a]	Obesity[b]	Inactivity[c]		
–	–	–	referent	–
+	–	–	14.2	13.9
–	+	–	12.2	15.6
–	–	+	13.6	12.3
+	+	–	20.0	17.9
+	–	+	53.8	13.9
–	+	+	28.1	14.7
+	+	+	73.1	16.6

[a] Current and former smokers.
[b] Body mass index [weight (kg)/height $(m)^2$] more than or equal to 25.0.
[c] Time spent walking less than 1 h a day.

Table 3
Average monthly health care charges over 7 years by health-risk categories in the Ohsaki Study, Japan, 1995–2001

Health-risk categories			Health care charges	95% Confidence interval	Increasing rate (%)
Smoking[a]	Obesity[b]	Inactivity[c]	(U.S.$)		
–	–	–	171.6	153.2, 190.1	
+	–	–	185.8	168.3, 203.3	8.3
–	+	–	183.8	157.9, 209.8	7.1
–	–	+	185.3	166.9, 203.6	8.0
+	+	–	191.7	163.3, 220.0	11.7
+	–	+	225.4	207.8, 243.1	31.4
–	+	+	199.8	175.7, 223.8	16.4
+	+	+	244.7	219.5, 270.0	42.6
P value			<0.001		

Adjusted for sex, age (continuous variable), alcohol drinking (never, former, 1–449, or ≥450 g ethanol/week), history of cancer, myocardial infarction, or stroke.
Tested by analysis of covariance (ANCOVA) for mean health care charges.
[a] Current and former smokers.
[b] Body mass index [weight (kg)/height $(m)^2$] more than or equal to 25.0.
[c] Time spent walking less than 1 h a day.

Table 2 gives the results of regressing per capita per month health care charges categorized by age, sex, alcohol drinking status, history of diseases, and health-risk categories. Age, sex (women), former alcohol drinking, history of diseases (cancer, myocardial infarction, or stroke), and exposure to physical inactivity alone, smoking + physical inactivity, smoking + obesity + physical inactivity were significant predictors of the charges in the multivariate model.

Table 3 lists the monthly per capita total health care charges according to the health-risk categories. Health care charges increased significantly as the number of health risks increased. Never-smokers with a BMI of less than 25.0 and who walked for more than 1 h a day (defined as the 'no risk' group) had mean monthly health care charges of $171.6 (95% CI, 153.2–190.1) after adjustment for sex, age, alcohol drinking, history of cancer, myocardial infarction, or stroke. Relative to this group, among those who had only one health risk, the presence of smoking was associated with a 8.3% increase in health care charges, obesity was associated with an 7.1% increase, and physical inactivity with a 8.0% increase. The combinations of smoking + obesity, smoking + physical inactivity, and obesity + physical inactivity were associated with a 11.7%, 31.4%, and 16.4% increase in health care charges, respectively. Physically inactive obese smokers had mean monthly health care charges that were 42.6% greater than those for the no risk group.

There was no notable gender difference in these findings. Median charges were much lower than mean charges; thus, we carried out a further analysis of the data after log transformation. The findings from the transformed data (not shown) were consistent with those from the non-log-transformed analyses.

Discussion

Our prospective cohort study demonstrates that physically inactive obese smokers had mean monthly health care charges that were 42.6% greater than those for the no risk group after adjustment for sex, age, alcohol drinking, history of cancer, myocardial infarction, or stroke. The combination of smoking, obesity, and physical inactivity as risk factors appears to have more than an additive (multiplicative) effect on health care charges. The combination of smoking and physical inactivity also seems to have the same effect. These data provide useful evidence on which to base targets for expenditure reduction through cost-effective management programs and treatments.

Our study had several methodological advantages. We followed up a large number of subjects ($n = 26,110$) over a 7-year period. Our charge calculation was accurate because we obtained NHI Claim History files directly from the local NHI Association, which includes almost all available medical treatment. The study subjects were sufficiently representative of the target population because the response rate was 95%. We analyzed the joint impact of smoking, obesity, and physical inactivity on health care charges after adjustment of a variety of potentially confounding variables such as sex, age, alcohol drinking, history of cancer, myocardial infarction, or stroke. Under the NHI system, differences in individuals' access to medical care according to socioeconomic status are unlikely.

Another advantage to our study was the adequate control for physical functioning status by MOS scores. Some people are unable to walk because of illness or disability, which is a strong determinant of health care charges. We attempted to minimize this bias by excluding subjects who were capable of only moderate, but not vigorous activity (MOS score of 2–4), and those who considered to be of low physical ability (MOS score of 0–1). Because of this methodological advantage, it is plausible to interpret that the strong impact of physical inactivity on health care charges described here cannot be explained only by the interrelationship between physical function and walking.

Although many studies have investigated the association between individual health risks and health care charges, few studies have demonstrated the impact of a combination of health risks on the magnitude of health care charges. Our results are consistent with those of Pronk et al. [37], whose prospective study, to our knowledge, is the only one that has demonstrated the joint impact of smoking, obesity, and physical inactivity on the magnitude of health care charges. Their short-term (1.5 year) observation data indicate that never-smokers with a BMI of 25 kg/m^2 who participated in physical activity on 3 days per week would have mean annual health care charges 49% lower than those of physically inactive smokers with a BMI of 27.5 kg/m^2. Our results are derived from a long-term observation of 7 years.

Our methodology imposed some limitations on the study. First, we used self-administered weight and height at enrollment to calculate BMI. Although self-administered weight and height are highly correlated with measured weight and height in the present study, a small, generally systematic, error exists—an overestimation of height and underestimation of weight, especially at higher weights [49]. Thus, our measure of BMI probably underestimated the true BMI of overweight subjects, which might make our estimates of the effects of modifiable risks on charges conservative. Second, the measure of physical activity was simple. We asked the subjects to report only the time spent walking, and we neither ask for the pace of walking nor did we distinguish between walking for exercise and nonexercise. Thus, there is a possibility that we could not fully examine the effect of walking and other physical activities. However, because walking is the most common type of physical activity performed by middle-aged and older individuals in rural Japan, these effects may be relatively small. Third, the present study does not prove whether changing health risks can reduce health care charges. Further interventional studies are needed to fully clarify whether behavior change intervention strategies could lower health care charges along with health-risk reduction.

Our results indicate that joint exposure to health risks contribute substantially to higher health care charges. Primary prevention of smoking, reduced excess body weight, and increased physical activity appear to have a tremendous potential to maximize health returns relative to health care charges, as well as to improve the general health of the individual.

Acknowledgments

This study was supported by a Health Sciences Research Grant for Health Services (H10-025), Ministry of Health, Labour and Welfare, Japan. The authors are grateful to Dr. S. Hisamichi for his valuable comments; to Dr. A. Sasaki for his managing the project site; to Y. Nakata, M. Wagatsuma, R. Taneichi, and T. Mogi for their helpful secretarial assistance.

References

[1] Blanco-Cedres L, Daviglus ML, Garside DB, Liu K, Pirzada A, Stamler J, et al. Relation of cigarette smoking to 25-year mortality in middle-aged men with low baseline serum cholesterol: the Chicago Heart Association Detection Project in Industry. Am J Epidemiol 2002;155:354–60.

[2] Blair SN, Brodney S. Effects of physical inactivity and obesity on morbidity and mortality: current evidence and research issues. Med Sci Sports Exerc 1999;31:646–62 [Suppl.].

[3] Wood D. Joint European Societies Task Force. Established and emerging cardiovascular risk factors. Am Heart J 2001; 141(Suppl. 2):49–57.

[4] Greenlund KJ, Giles WH, Keenan NL, Croft JB, Mensah GA. Physician advice, patient actions, and health-related quality of life in second-

ary prevention of stroke through diet and exercise. Stroke 2002; 33:565–71.
[5] Peto J. Cancer epidemiology in the last century and the next decade. Nature 2001;411:390–5.
[6] Giovannucci E, Ascherio A, Rimm EB, Colditz GA, Stampfer MJ, Willett WC. Physical activity, obesity, and risk for colon cancer and adenoma in men. Ann Intern Med 1995;122:327–34.
[7] Diabetes prevention program research group. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. N Engl J Med 2002;346:393–403.
[8] Hu FB, Manson JE, Stamper MJ, Colditz G, Liu S, Solomon CG, et al. Diet, lifestyle, and the risk of type 2 diabetes mellitus in women. N Engl J Med 2001;345:790–7.
[9] Hayashi T, Tsumura K, Suematsu C, Okada K, Fujii S, Endo G. Walking to work and the risk for hypertension in men: the Osaka Health Survey. Ann Intern Med 1999;130:21–6.
[10] Villeneuve PJ, Morrison HI, Craig CL, Schaubel DE. Physical activity, physical fitness, and risk of dying. Epidemiology 1998; 9:626–31.
[11] Jacobs Jr DR, Adachi H, Mulder I, Kromhout D, Menotti A, Nissinen A, et al. Cigarette smoking and mortality risk: twenty-five-year follow-up of the seven countries study. Arch Intern Med 1999; 159:733–40.
[12] Andersen LB, Schnohr P, Schroll M, Hein HO. All-cause mortality associated with physical activity during leisure time, work, sports, and cycling to work. Arch Intern Med 1996;276:1039–47.
[13] Keeler EB, Manning WG, Newhouse JP, Sloss EM, Wasserman J. The external costs of a sedentary life-style. Am J Public Health 1989; 79:975–81.
[14] Colditz GA. Economic costs of obesity and inactivity. Med Sci Sports Exerc 1999;31:S663–7 [Suppl.].
[15] Stearns SC, Bernard SL, Fasick SB, Schwartz R, Konrad TR, Ory MG, et al. The economic implications of self-care: the effect of lifestyle, functional adaptations, and medical self-care among a National sample of Medicare beneficiaries. Am J Public Health 2000;90:1608–12.
[16] Colditz GA. Economic costs of obesity. Am J Clin Nutr 1992; 55:503S–7S [Suppl.].
[17] Wolf AM, Colditz GA. The cost of obesity: the US perspective. PharmacoEconomics 1994;5(Suppl. 1):34–7.
[18] Seidell JC, Deerenberg I. Obesity in Europe: prevalence and consequences for use of medical care. PharmacoEconomics 1994; 5(Suppl. 1):38–44.
[19] Segal L, Carter R, Zimmet P. The cost of obesity: the Australian perspective. PharmacoEconomics 1994;5(Suppl. 1):45–52.
[20] Black DR, Sciacca JP, Coster DC. Extremes in body mass index: probability of healthcare expenditures. Prev Med 1994; 23:385–93.
[21] Lévy E, Lévy P, Pen CL, Basdevant A. The economic cost of obesity: the French situation. Int J Obes Relat Metab Disord 1995;19:788–92.
[22] Gorsky RD, Pamuk E, Williamson DF, Shaffer PA, Koplan JP. The 25-year health care costs of women who remain overweight after 40 years of age. Am J Prev Med 1996;12:388–94.
[23] Wolf AM, Colditz GA. Social and economic effects of body weight in the United States. Am J Clin Nutr 1996; 63:466S–9S [Suppl.].
[24] Heithoff KA, Cuffel BJ, Kennedy S, Peters J. The association between body mass and health care expenditures. Clin Ther 1997; 19:811–20.
[25] Swinburn B, Ashton T, Gillespie J, Cox B, Menon A, Simmons D, et al. Health care costs of obesity in New Zealand. Int J Obes Relat Metab Disord 1997;21:891–6.
[26] Wolf AM, Colditz GA. Current estimates of the economic cost of obesity in the United States. Obes Res 1998;6:97–106.
[27] Quesenberry Jr CP, Caan B, Jacobson A. Obesity, health services use, and health care costs among members of a Health Maintenance Organization. Arch Intern Med 1998;158:466–72.
[28] Birmingham CL, Muller JL, Palepu A, Spinelli JJ, Anis AH. The cost of obesity in Canada. CMAJ 1999;160:483–8.
[29] Detournay B, Fagnani F, Phillippo M, Pribil C, Charles MA, Sermet C, et al. Obesity morbidity and health care costs in France: an analysis of the 1991–1992 Medical Care Household Survey. Int J Obes Relat Metab Disord 2000;24:151–5.
[30] Thompson D, Brown JB, Nichols GA, Elmer PJ, Oster G. Body mass index and future healthcare costs: a retrospective cohort study. Obes Res 2001;9:210–8.
[31] Miller LS, Zhang X, Novotny T, Rice DP, Max W. State estimates of Medicaid expenditures attributable to cigarette smoking, fiscal year 1993. Public Health Rep 1998;113:140–51.
[32] Hodgson TA. Cigarette smoking and lifetime medical expenditures. Milbank Q 1992;70:81–125.
[33] Daviglus ML, Kiang L, Greenland P, Dyer AR, Garside DB, Manheim L, et al. Benefit of a favorable cardiovascular risk-factor profile in middle age with respect to medicare costs. N Engl J Med 1998;339:1122–9.
[34] Izumi Y, Tsuji I, Ohkubo T, Kuwahara A, Nishino Y, Hisamichi S. Impact of smoking habit on medical care use and its costs: a prospective observation of National Health Insurance beneficiaries in Japan. Int J Epidemiol 2001;30:616–21.
[35] Kuriyama S, Tsuji I, Ohkubo T, Anzai Y, Takahashi K, Watanabe Y, et al. Medical care expenditure associated with body mass index in Japan: the Ohsaki Study. Int J Obes Relat Metab Disord 2002; 26:1069–74.
[36] Tsuji I, Takahashi K, Nishino Y, Ohkubo T, Kuriyama S, Watanabe Y, et al. Impact of walking upon medical care expenditure in Japan: the Ohsaki Study. Int J Epidemiol 2003;32:809–14.
[37] Pronk NP, Goodman MJ, O'Connor PJ, Martinson BC. Relationship between modifiable health risks and short-term health care charges. JAMA 1999;282:2235–9.
[38] Health and Welfare Statistics Association. 2001 Kokumin Eisei no Doko (Trends in Nation's Health, Japan). Tokyo: Health and Welfare Statistics Association; 2001. In Japanese.
[39] Tsuji I, Nishino Y, Ohkubo T, Kuwahara A, Ogawa K, Watanabe Y, et al. A prospective cohort study on National Health Insurance Beneficiaries in Ohsaki, Miyagi Prefecture, Japan: study design, profiles of the subjects and medical cost during the first year. J Epidemiol 1998;8:258–63.
[40] Tsuji I, Kuwahara A, Nishino Y, Ohkubo T, Sasaki A, Hisamichi S. Medical cost for disability: a longitudinal observation of National Health Insurance beneficiaries in Japan. J Am Geriatr Soc 1999; 47:470–6.
[41] Physical status: the use and interpretation of anthropometry: report of a WHO expert committee. WHO Tech Rep Ser 1995; 854:312–409.
[42] Tsubono Y, Tsuji I, Fujita K, Nakaya N, Hozawa A, Ohkubo T, et al. Validation of walking questionnaire for population-based prospective studies in Japan: comparison with pedometer. J Epidemiol 2002; 12:305–9.
[43] Stewart AL, Hays RD, Ware JE. The MOS Short-form General Health Survey: reliability and validity in a patient population. Med Care 1988;26:724–35.
[44] Stewart AL, Greenfield S, Hays RD, Wells K, Rogers WH, Berry SD, et al. Functional status and well-being of patients with chronic conditions. Results from the Medical Outcomes Study. JAMA 1989;262: 907–13.
[45] Ware JE, Bayliss MS, Rogers WH, Kosinski M, Tarlov AR. Differences in 4-year health outcomes for elderly and poor: chronically ill patients treated in HMO and free-for-service systems. Results from the Medical Outcomes Study. JAMA 1996; 276:1039–47.
[46] Hornbrook MC, Goodman MJ. Adjusting health benefit contributions to reflect risk. In: Hornbrook MC, editor. Advances in Health Economics and Health Services Research. Greenwich, CT: JAI Press Inc.; 1991. p. 41–76.
[47] Brown JB, Pedula KL, Bakst AW. The progressive cost of complications in type 2 diabetes mellitus. Arch Intern Med 1999;159:1873–80.
[48] SAS Institute Inc. SAS/STAT User's Guide, Release 8.2 edition. Cary, NC: SAS Institute Inc.; 2000.
[49] Niedhammer I, Bugel I, Bonenfant S, Goldberg M, Leclerc A. Validity of self-reported weight and height in the French GAZEL cohort. Int J Obes Relat Metab Disord 2000;24:1111–8.

FOR DEBATE

Impact of alcohol consumption upon medical care utilization and costs in men: 4-year observation of National Health Insurance beneficiaries in Japan

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Submitted 12 May 2003;
initial review completed 29 September 2003;
final version accepted 12 July 2004

ABSTRACT

Aims The purpose of the present study was to examine the association between alcohol consumption and in-patient and out-patient care utilization and its costs, respectively.

Design and participants The present data were derived from a 4-year prospective observation of National Health Insurance beneficiaries in rural Japan. A total of 17 497 men aged 40–79 years were analysed, after excluding subjects who at the baseline reported having had at least one of four chronic diseases: stroke, myocardial infarction, liver disease and cancer. Alcohol intake was classified into five groups, not including ex-drinkers: life-long abstainers and ethanol intakes of 1–149 g/week, 150–299 g/week, 300–449 g/week, and ≥450 g/week.

Findings The hospital days and in-patient care cost showed a U-shaped relationship with alcohol consumption. In-patient cost was highest for those consuming more than 450 g/week [£74.96, 95% confidence interval (CI): 54.39, 95.52] and for life-long abstainers (£69.16, 95% CI: 62.08, 77.83), and lowest for those consuming 150–299 g/week (£51.69, 95% CI: 45.33, 58.04). In-patient use by age specific analysis also showed a U-shape at all ages, and was lowest for those consuming 1–149 g/week in youngest age group. In contrast, the number of physician visits and out-patient cost showed an inverse linear relationships with alcohol consumption.

Conclusions This study suggests that in-patient use shows a U-shaped curve and out-patient use shows an inverse linear relationship to alcohol consumption.

KEYWORDS Alcohol drinking, health care costs, health care services, prospective studies.

INTRODUCTION

Many studies have reported a J- or U-shaped relation between alcohol consumption and all-cause mortality [1,2], including Japanese populations [3–5]. In addition, excessive drinking is an established risk factor for diseases such as liver cirrhosis, alcohol-related cancers, stroke and hypertension [6].

Because excessive alcohol consumption is associated with an increased risk of mortality and adverse health consequences, it is reasonable to assume a causal association between alcohol consumption and increased usage

 doi:10.1111/j.1360-0443.2004.00874.x

and the cost of medical care. Although an inverse relationship between alcohol consumption and out-patient care use has been observed consistently among previous studies [7–14], no conclusion has been reached about the association between alcohol consumption and the utilization of in-patient care [7,10,12–20]. Previous studies have reported five major patterns regarding the association between alcohol consumption and in-patient care use—linearly positive, [18,19] J-shaped, [15,19] U-shaped, [16,17] inverse J-shaped, [10,12,20] or linearly inverse [7,10,12–14]. The inconsistency among the studies would have been attributable partly to certain study limitations; hypothetical, cross-sectional or retrospective observations, small sample sizes, subjects who had limited socio-economic status, not separating life-long abstainers from ex-drinkers.

In order to examine fully the impact of alcohol consumption on the use and cost of in-patient and out-patient care, it is necessary to follow-up a large-scale population-based cohort for a sufficiently long period during which every member has equal access to medical care services. The purpose of the present study was to examine the association between alcohol consumption and in-patient and out-patient care utilization and its costs, respectively. The impact of alcohol consumption upon health may vary depending on the diagnosis of the diseases [15,17,21] and the latter may influence the use of in-patient or out-patient care. Furthermore, out-patient care use is, in general, influenced more by patients' care-seeking behavior than by in-patient care use [11]. We therefore conducted separate analyses of in-patient and out-patient use. The present data were derived from a 4-year prospective observation of National Health Insurance (NHI) beneficiaries in rural Japan, known as the Ohsaki NHI Cohort Study [22]. The strengths of this study include a large sample size ($n = 17\,497$), coverage of almost all medical care under the NHI system, perfect monitoring of medical care utilization by linkage with claim history files and comprehensive health and life-style information for each subject at the baseline survey.

MATERIALS AND METHODS

The health insurance system in Japan

Health insurance is compulsory for everyone living in Japan, and is provided by one of two systems [22]; the first is for employees and their dependents, the second is a community-based health insurance system used mainly by farmers, the self-employed, pensioners and their dependents. This second system is called the National Health Insurance (NHI) plan and covers 35% of the Japanese population. The NHI covers almost all aspects of medical treatment, including diagnostic tests, medication, surgery, supplies and materials, payment of physicians and other personnel and most dental treatment. It also covers the home-care services provided by physicians and nurses, but not by other professionals, such as home-health aides. When medical providers treat a patient, they receive a co-payment from the patient and then file a claim with the local NHI association for reimbursement. Payment to medical providers is made on a fee-for-service basis, where the price of each service is determined by a uniform national fee schedule. The local NHI association has a peer-review system to determine the level of reimbursement.

Study setting and design

The setting and design of the Ohsaki NHI Cohort Study has been reported in detail elsewhere [22–26]. In brief, a baseline questionnaire survey was distributed to all NHI beneficiaries aged 40–79 years living in the catchment area of the Ohsaki Public Health Center, Miyagi Prefecture, Japan, between October and December 1994. This study was approved by the Tohoku University School of Medicine Ethics Committee.

The baseline survey questionnaire included socio-demographics, medical history, physical functioning and health-related life-style factors such as smoking, alcohol consumption, dietary habits and physical activity.

Trained survey personnel visited the study subjects, informing them of the study objectives and their right to decline, and asked them to complete the questionnaire if they consented. The survey personnel revisited subjects to collect the questionnaire about 1 week later. From among 54 996 eligible individuals, 52 029 (95%) responded. We excluded 774 subjects because they had withdrawn from the NHI before 1 January 1995, when we started prospective collection of NHI claim history files; thus 51 255 subjects formed the study cohort.

Study subjects

Because women in this cohort seldom drank, we limited our analysis to men ($n = 24\,574$). Of those, we excluded 1830 subjects who failed to answer some of the questions in the alcohol consumption questionnaire. We also excluded subjects who, at baseline, reported having had at least one episode of either stroke, myocardial infarction, liver disease or cancer ($n = 3361$). In a previous study it was suggested that alcohol abstainers include two distinct groups, life-long abstainers and ex-drinkers, and that ex-drinkers had worse health than life-long abstainers [27,28]. We therefore excluded ex-drinkers ($n = 1886$) from the analysis. The remaining 17 497 subjects were finally analysed.

Study variables

The impact of alcohol consumption on monthly medical care utilization and costs was examined. All life-style information was derived from the responses to the self-completed questionnaire in the 1994 baseline survey. The question on the amount of drinking by each subject was worded as: 'Do you drink alcoholic beverages?' and the subjects were asked to choose one of three options to describe their status: current drinker, former drinker or life-long abstainer. Current drinkers reported their frequency of consumption as one of four categories: almost daily, 3–4 days/week, 1–2 days/week and <1 day/week. Furthermore, they were asked which types and amounts of alcoholic beverages were consumed in a day; this information was recorded as '5 *go* or more', '4 *go*', '3 *go*', '2 *go*', '1 *go*' or 'less than 1 *go*' (a *go* is a traditional unit in Japan equal to approximately 180 mL of sake, containing 23 g of ethanol). Weekly ethanol consumption was calculated by multiplying the amount of ethanol consumed per day by the frequency of drinking per week. Alcohol intake was classified into five groups: life-long abstainers and current ethanol intakes of 1–149 g/week, 150–299 g/week, 300–449 g/week and ≥450 g/week.

Multivariate models included the following variables as covariates, as there was an association between alcohol consumption and the following variables: (1) age: continuous variable; (2) smoking status: never, ever smoked, currently smoking; (3) body mass index (BMI): weight, kg/height, m^2 (<21.0, 21.0–24.9 and ≥25.0 kg/m^2); and (4) time spent walking per day: <30 minutes, 30 minutes–1 hour, ≥1 hour.

Outcome measures

Data on medical care utilization and costs were collected prospectively for all individuals in the cohort between January 1995 and December 1998. The NHI claims history files were obtained from the Miyagi NHI Association. Claims history files included the beneficiary's ID number, the number of days and cost of out-patient care and the number of days and cost for in-patient care. Information on the diagnosis related to each episode of medical care was not available.

When a beneficiary was withdrawn from the NHI because of death or emigration, the date and reasons were recorded on the NHI withdrawal history file. From this file, survival and emigration status could be identified for all the study subjects. Both NHI claims and withdrawal history files were linked with our baseline survey data file based on the beneficiary's ID number as the key code. In order to protect the subjects' privacy, their names were deleted from the data files used for analysis.

Statistical analysis

The impact of alcohol consumption on per-month per-capita medical costs (in-patient and out-patient), hospital days and number of physician visits was examined by analysis of covariance (ANCOVA). Per-month values for each subject were calculated by dividing the accumulated values through observation by the number of months observed. We examined per-month values rather than accumulated values to avoid underestimating the medical care use and costs of the subjects who died or emigrated.

In this paper, monetary values are converted to pounds sterling (£) using an exchange rate of £1.00 = 180 Japanese Yen (2003 rate). Approximate variance formulae were used to calculate 95% confidence intervals (CI): differences at $P < 0.05$ were regarded as statistically significant. All statistical calculation was performed using SAS software (version 8.2, SAS Institute, Cary, NC, USA) [29].

RESULTS

Characteristics of the subjects

Table 1 lists the baseline characteristics of the subjects by categories of alcohol intake. The highest proportion of current drinkers (38.6%) were in the category consuming 1–149 g/week, and the proportions decreased with higher alcohol consumption. The mean age was highest for life-long abstainers, and decreased with the amount of alcohol consumed. Alcohol consumption was associated with cigarette smoking, BMI and walking time: the proportion of current smokers increased with alcohol consumption, and the proportions of those who had a BMI of more than 25.0 and those who walked for less than 30 minutes per day were greater among current drinkers consuming more than 450 g/week.

Among the subjects, 5355 men (30.6%) attended health check-ups provided by the municipality in 1995, and we compared the self-reported alcohol consumption at the baseline survey with the data from liver function tests obtained at the health check-up. Table 2 lists the mean levels of aspartate aminotransferase (AST), alanine aminotransferase (ALT) and γ-glutamyltransferase (GGT), according to the categories of self-reported alcohol consumption. A linear relationship was observed between the values from all liver function tests and the self-reported alcohol consumption level (P for trend: $P < 0.0001$). This relationship did not change after logarithmic transformation of the values. This finding suggests that the data for self-reported drinking habits at the baseline survey were sufficiently valid and accurate.

Table 1 Baseline characteristics by categories of alcohol intake in 17 497 men, Ohsaki NHI Cohort Study, Japan, in 1994.

	Life-long abstainers	*Current drinkers (g/week)*			
		1–149	*150–299*	*300–449*	*450 ≥*
Number of subjects (%)	3352 (19.2)	6749 (38.6)	5086 (29.1)	1823 (10.4)	487 (2.8)
Age (SD[a])	60.6 (10.7)	58.9 (10.7)	57.8 (9.9)	54.3 (9.4)	52.7 (9.4)
Smoking (%)					
Current	47.9	51.5	63.3	72.2	75.8
Ex-smoker	22.8	25.1	22.9	17.9	15.2
Never	29.3	23.4	13.7	9.9	9.0
BMI[b] (%)					
<21.0	21.8	20.0	18.9	20.4	21.5
21.0–24.9	53.5	54.6	55.8	52.8	50.3
≥25.0	24.7	25.4	25.3	26.8	28.2
Walking (%)					
<30 minutes/day	28.0	25.7	24.6	26.4	35.9
30–1 hour	24.1	24.6	23.5	19.6	17.8
≥1 hour/day	47.9	49.8	51.9	54.0	46.3

[a]SD, standard deviation. [b]BMI, body mass index.

Table 2 Liver functions data of the subjects by categories of alcohol intake in 5355 men, Ohsaki NHI Cohort Study, Japan, 1995.

	Life-long abstainers	*Current drinkers (g/week)*				
		1–149	*150–299*	*300–449*	*450 ≥*	*P-value*
Number of subjects(%)	937 (16.2)	2306 (40.0)	1624 (28.2)	411 (7.1)	77 (1.3)	
AST[a] mean (SD[b])	24.7 (9.0)	25.5 (9.4)	28.3 (17.1)	32.3 (21.9)	36.4 (28.4)	<0.001[c,d]
ALT[e] mean (SD[b])	22.6 (13.4)	22.5 (13.2)	24.4 (22.9)	28.1 (21.4)	32.0 (27.8)	<0.001[c,d]
GGT[f] mean (SD[b])	22.9 (18.5)	32.7 (31.9)	50.5 (58.5)	83.7 (97.5)	107.7 (143.8)	<0.001[c,d]

[a]AST, aspartate aminotransferase; [b]SD, standard deviation; [c]tested by analysis of variance (ANOVA); [d]P for trend < 0.0001; [e]ALT, alanine aminotransferase; [f]GGT, serum g-glutamyltransferase.

Drinking habits and medical costs

Per-capita per-month hospital days and in-patient cost showed U-shaped relationships with alcohol consumption, both for crude data and after adjustment for age, smoking status, BMI and walking (Table 3). Hospital days and in-patient cost were highest for subjects consuming more than 450 g/week (0.56 days, 95% CI: 0.40, 0.72; £74.96, 95% CI: 54.39, 95.52) and for life-long abstainers (0.58 days, 95% CI: 0.52, 0.64; £69.16, 95% CI: 62.08, 77.83), and lowest for subjects consuming 150–299 g/week (0.37 days, 95% CI: 0.32, 0.42; £51.69, 95% CI: 45.33, 58.04).

Out-patient care use did not show a U-shaped curve, but an inverse linear relationship with alcohol consumption for both crude data and after adjustment (*P* for trend: $P < 0.0001$). Per-month visits and per-month costs were highest for life-long abstainers (£78.31, 95% CI: 74.04, 82.57), and decreased with higher alcohol consumption.

Table 4 lists in-patient and out-patient use by age specific analysis. Per-capita per-month hospital days and in-patient cost showed a U-shaped relationship with alcohol consumption at all ages, but in-patient cost was lowest for those consuming 1–149 g/week in the less than 49 age group. Number of physician visits and out-patient costs also showed an inverse linear relationship with alcohol consumption among parts of all age groups.

DISCUSSION

This 4-year prospective observation study confirmed a U-shaped relationship between alcohol consumption and in-patient care use. In contrast, there was an inverse linear association between alcohol consumption and out-patient care use.

Our study had several methodological strengths. Under the NHI system, differences in access to medical care due to socio-economic status are unlikely. We followed-up a large number of subjects ($n = 17{,}497$) for 4 years. Because we collected a variety of life-style

Table 3 Per-capita per-month medical care utilization and its costs by alcohol intake categories in 17 497 men, Ohsaki NHI Cohort Study, Japan, 1995–98.

		Current drinkers (g/week)				
	Life-long abstainers	*1–149*	*150–299*	*300–449*	*450 ≥*	*P-value*
In-patient care						
Number of hospital days (95% CI[a])						
Crude	0.63 (0.56, 0.70)	0.45 (0.40, 0.50)	0.36 (0.30, 0.41)	0.36 (0.26, 0.45)	0.46 (0.28, 0.64)	<0.0001[b]
Adjusted mean[d]	0.58 (0.52, 0.64)	0.44 (0.39, 0.48)	0.37 (0.32, 0.42)	0.44 (0.36, 0.52)	0.56 (0.40, 0.72)	<0.0001[b]
Medical cost (£) (95% CI[a])						
Crude	77.12 (67.79, 86.45)	59.67 (53.09, 66.24)	50.63 (43.06, 58.21)	47.77 (35.12, 60.43)	58.94 (34.45, 83.43)	<0.0001[b]
Adjusted mean[d]	69.16 (62.08, 77.83)	57.97 (52.46, 63.47)	51.69 (45.33, 58.04)	60.03 (49.34, 70.72)	74.96 (54.39, 95.52)	<0.01[b]
Out-patient care						
Number of physician visits (95% CI[a])						
Crude	2.07 (1.99, 2.16)	1.90 (1.84, 1.96)	1.77 (1.70, 1.84)	1.35 (1.24, 1.47)	1.24 (1.02, 1.46)	<0.0001[b,c]
Adjusted mean[d]	1.87 (1.79, 1.94)	1.83 (1.78, 1.88)	1.82 (1.76, 1.88)	1.72 (1.63, 1.82)	1.74 (1.55, 1.93)	0.21[b,c]
Medical cost (£) (95% CI[a])						
Crude	85.97 (80.23, 91.71)	71.81 (67.76, 75.85)	65.10 (60.44, 69.76)	46.83 (39.05, 54.61)	45.58 (30.52, 60.63)	<0.0001[b,c]
Adjusted mean[d]	78.31 (74.04, 82.57)	69.37 (66.39, 72.36)	66.94 (63.49, 70.38)	60.21 (54.42, 66.01)	62.79 (51.65, 73.94)	<0.0001[b,c]

[a]CI, confidence interval; [b]tested by analysis of covariance (ANCOVA); [c]P for trend < 0.05; [d]adjusted for age (continuous variable), smoking status (never, ever or current), BMI (<21.0, 21–24.9, = 25.0), walking (<30 minutes, 30 minutes-1 hour or = 1 hour/day).

Table 4 Age-specific analysis of per-capita per-month medical care utilization and its costs by alcohol intake categories in 17 497 men, Ohsaki NHI Cohort Study, Japan, 1995–98.

			Current drinkers (g/week)				
	Age	*Life-long abstainers*	*1–149*	*150–299*	*300–449*	*450≥*	*P-value*
In-patient care							
Number of hospital days[a] (95%CI[b])							
	≤49	0.34 (0.23, 0.44)	0.15 (0.09, 0.22)	0.16 (0.09, 0.24)	0.19 (0.09, 0.30)	0.32 (0.14, 0.50)	0.026[c]
	50–59	0.45 (.034, 0.56)	0.27 (0.20, 0.35)	0.25 (0.17, 0.33)	0.28 (0.16, 0.40)	0.33 (0.08, 0.57)	0.045[c]
	≥60	0.78 (0.69, 0.87)	0.66 (0.59, 0.73)	0.52 (0.44, 0.60)	0.61 (0.45, 0.78)	0.82 (0.47, 1.18)	0.0009[c]
Medical cost (£)[a] (95%CI [b])							
	≤49	23.95 (15.19, 32.72)	13.20 (7.73, 18.67)	14.91 (8.66, 21.15)	27.61 (18.93, 36.30)	27.69 (12.46, 42.91)	0.018[c]
	50–59	57.86 (43.09, 72.63)	36.66 (26.63, 46.69)	33.14 (22.20, 44.08)	38.56 (21.97, 55.16)	42.68 (9.81, 75.56)	0.11[c]
	≥60	101.82 (89.33, 114.31)	91.04 (81.74, 100.35)	77.21 (66.15, 88.27)	76.73 (54.21, 99.26)	124.98 (76.64, 173.32)	0.019[c]
Out-patient care							
Number of physician visits[a] (95%CI[b])							
	≤49	0.87 (0.79, 0.96)	0.79 (0.74, 0.85)	0.75 (0.69, 0.82)	0.71 (0.62, 0.79)	0.77 (0.62, 0.92)	0.094[c,d]
	50–59	1.29 (1.16, 1.41)	1.31 (1.22, 1.39)	1.33 (1.24, 1.42)	1.26 (1.12, 1.40)	1.15 (0.88, 1.43)	0.76[c]
	≥60	2.71 (2.60, 2.84)	2.63 (2.54, 2.72)	2.54 (2.43, 2.64)	2.26 (2.05,2.48)	2.19 (1.72, 2.65)	0.0015[c,d]
Medical cost (£)[a] (95%CI[b])							
	≤49	40.80 (32.89, 48.72)	31.86 (26.92, 36.79)	27.59 (21.96, 33.23)	24.57 (16.73, 32.41)	26.07 (12.32, 39.81)	0.039[c,d]
	50–59	57.17 (46.84, 67.49)	53.82 (46.81, 60.83)	49.33 (41.68, 56.98)	43.50 (31.89, 55.10)	44.76 (21.79, 67.74)	0.42[c]
	≥60	109.59 (103.84, 115.35)	96.75 (92.46, 101.04)	93.39 (88.29, 98.49)	78.38 (68.01, 88.77)	80.12 (57.84, 102.39)	0.0001[c,d]

[a]Adjusted for smoking status (never, ever or current), BMI (<21.0, 21–24.9, ≥25.0), walking (<30 minutes, 30 minutes-1 hour or = 1 hour/day); [b]CI, confidence interval; [c]tested by analysis of covariance (ANCOVA); [d]P for trend <0.05.

information at the baseline survey, we were able to analyse the impact of alcohol consumption on medical cost after adjustment for possible confounders. Self-reporting of alcohol consumption was sufficiently valid and accurate, as evidenced by the high correlation with objective data from liver function tests (AST, ALT and GGT). The representativeness of our study was confirmed fully in a previous paper [22].

The association between alcohol consumption and use of in-patient care was inconsistent in previous studies, which is attributable partly to study limitations. First, most previous studies were based on hypothetical [18], cross-sectional [7,13,16] or retrospective [12,14,17] study designs. Secondly, some studies involved small sample sizes [10,20]. Thirdly, socio-economic status might have confounded the association between alcohol consumption and medical care use [30,31]; for example, some excessive drinkers might not have used medical care because they were un- or underinsured. Fourthly, most of the studies did not separate life-long abstainers from ex-drinkers [7,10,13,15,19,20], and a study by Tsubono *et al.* suggests that epidemiological studies of alcohol and total mortality may overestimate the lower risk in moderate drinkers if they do not separate life-long abstainers from ex-drinkers [32]. Some previous studies showed that abstainers had extremely high in-patient care use, but this could be explained by the fact that the abstainer group of ex-drinkers presumably includes people who ceased alcohol consumption because of illness (related or unrelated to drinking) [7,10,13,15,19,20].

Our study is a large-scale population-based cohort study in which every member had equal access to medical care services, and ex-drinkers were excluded as study subjects. This methodological advantage suggests that our finding of a U-shaped curve for in-patient use is more reliable than findings of previous studies. Furthermore, in-patient cost was lowest for individuals consuming 1–149 g/week in the less than 49 age group, followed by those consuming 150–299 g/week with an increase in age. Young people might be expected to show a stronger effect of alcohol consumption in relation to medical care utilization because of the smaller influence of chronic diseases unassociated with alcohol consumption. Moreover, the data for the less than 49-year age group showed the same tendency as the J- or U-shaped mortality curve [1–5].

Because out-patient care use is influenced more by patients' care-seeking behaviour [11], the association between alcohol consumption and in-patient care use may provide an appropriate clue to the question of whether alcohol consumption has beneficial or harmful effects. This 4-year prospective observation study confirmed a U-shaped relationship between alcohol consumption and in-patient care use. Our data support the known substantial health and social risks of consuming large amounts of alcoholic beverages. Armstrong *et al.* demonstrated that light drinkers (<1 drink/month) had a morbidity experience similar to that of life-long abstainers. Thus the suggestion that life-long abstainers might differ from light drinkers in some unknown way with respect to illness risk might not be plausible. Therefore, the higher in-patient cost among life-long abstainers than among light drinkers might indicate a beneficial effect of light drinking. A meta-analysis has demonstrated a beneficial influence of alcohol on coronary heart disease, ischaemic stroke and diabetes mellitus [6]. Furthermore, San José *et al.* have reported a U-shaped relationship between alcohol consumption and psychosocial health parameters such as perceived general health, health complaints, chronic conditions, mobility complaints, pain complaints, sleeping complaints, social isolation, emotional complaints and lack of energy complaints, that may indicate an influence of alcohol intake on health [33]. The U-shaped relationship observed in our study might reflect this association. Although alcohol consumption may have some beneficial effects, alcohol consumption increases the risk for some types of cancer, hypertension, haemorrhagic cancer, cirrhosis of the liver, etc. [6]. Thus, the present U-shaped association might have been the result of a heterogeneous relationship between alcohol consumption and health problems. Given that heterogeneity, we believe that public health recommendations for promotion of alcohol drinking to reduce medical care costs is not a reasonable strategy. Any encouragement of light or moderate drinking should be based on the characteristics of each individual.

In contrast to in-patient care use, out-patient use showed a linear inverse relationship with alcohol consumption. Past studies have also shown that use of out-patient care decreased with alcohol consumption [7–14]. There are several possible explanations for our results. First, alcohol consumption is associated positively with acute conditions such as road injuries, injuries due to falls, fires, excessive cold, drowning, occupational and machine injuries and suicide [6], which would yield more in-patient needs than out-patient needs. These acute conditions might partly explain the inverse linear association. Secondly, alcohol consumption is associated positively with depressive disorders [6]. People with depression are less likely to seek medical care in the early stage of their disease, which would lead to less use of out-patient care. Thirdly, although every individual had equal access to medical care services in our study, their financial status might have influenced their care-seeking behaviour. A person with a poor income, who may tend to be a heavy drinker, would be less likely to visit a physician. Future prospective studies should therefore exercise care in adopting a wider variety of information at the baseline survey, including financial status.

Our study had another limitation. The 4-year follow-up period was probably not long enough. Consequently, we might have underestimated the health risks of those who were currently consuming a large amount of alcohol. However, we did observe a U-shaped relationship between alcohol consumption and in-patient cost.

The amount of alcohol consumed in Japan has been increasing rapidly since the end of World War II [34], and the current per-capita consumption of 6.6 l is almost the same as that of the United States (6.7 l) and United Kingdom (8.1 l) [35].

In conclusion, this large-scale prospective study, using a health insurance system providing every member with equal access to medical care services, demonstrated that days of hospitalization and in-patient care cost had a U-shaped relationship with alcohol consumption, and that the number of physician visits and out-patient cost had an inverse linear relationship with alcohol consumption.

Acknowledgements

This study was supported by a Health Sciences Research Grant from the Ministry of Health and Welfare, Japan (Research on Health Services: H10-025) and a Research Grant to a JSPS Research Fellow (T.O.) from the Ministry of Education, Science and Culture of Japan.

References

1. Anderson, P., Cremona, A., Paton, A., Turner, C. & Wallace, P. (1993) The risk of alcohol. *Addiction*, **88**, 1493–1508.
2. San Jose, B. (2003) Alcohol consumption and mortality: comparison between countries and meta-analyses. *European Journal of Epidemiology*, **18**, 603–605.
3. Tsugane, S., Fahey, M. T., Sasaki, A. S. & Baba, S. for the JPHC Study Group. (1999) Alcohol consumption and all-cause and cancer mortality among middle-aged Japanese men; seven-year follow-up of the JPHC study cohort I. *American Journal of Epidemiology*, **150**, 1201–1207.
4. Kono, S., Ikeda, M., Ogawa, M., Tokudome, S., Nishizumi, M. & Kuratsune, M. (1986) Alcohol and mortality: a cohort study of male Japanese physicians. *International Journal of Epidemiology*, **15**, 527–532.
5. Miyazaki, M. & Une, H. (2001) Japanese alcoholic beverage and all cause mortality in Japanese adult men. *Journal of Epidemiology*, **11**, 219–223.
6. Rehm, J., Room, R., Graham, K., Monteiro, M., Gmel, G. & Sempos, C. T. (2003) The relationship of average volume of alcohol consumption and patterns of drinking to burden of disease: an overview. *Addiction*, **98**, 1209–1228.
7. Wetzler, H. P. & Cruess, D. F. (1985) Self-reported physical health practices and health care utilization: findings from the National Health Interview survey. *American Journal of Public Health*, **75**, 1329–1330.
8. Rice, C. & Duncan, D. F. (1995) Alcohol use and reported physician visits in older adults. *Preventive Medicine*, **24**, 229–234.
9. Kunz, J. L. (1997) Alcohol use and reported visits to health professionals: an exploratory study. *Journal of Studies on Alcohol*, **58**, 474–479.
10. Armstrong, M. A., Midanik, L. T. & Klatsky, A. L. (1998) Alcohol consumption and utilization of health services in a health maintenance organization. *Medical Care*, **36**, 1599–1605.
11. Cryer, P. C., Jenkins, L. M., Cook, A. C., Ditchburn, J. S., Harris, C. K., Davis, A. R. & Peters, T. J. (1999) The use of acute and preventative medical services by a general population: relationship to alcohol consumption. *Addiction*, **94**, 1523–1532.
12. Rice, D. P., Conell, C., Weisner, C., Hunkeler, E. M., Fireman, B. & Hu, T. W. (2000) Alcohol drinking patterns and medical care use in an HMO setting. *Journal of Behavioral Health Services Research*, **27**, 3–16.
13. Artalejo, F. R., Manzazo, B. A., Gualler-Casetillon, P., Mendizabal, M. T. P., Enriquez, J. G. & Calero, J. R. (2000) The association of tobacco and alcohol consumption with the use of health care services in Spain. *Preventive Medicine*, **31**, 554–561.
14. Hunkeler, E. M., Hung, Y., Rice, D. P., Weisner, C., Weisner, C. & Hu, T. (2001) Alcohol consumption patterns and health care costs in an HMO. *Drug and Alcohol Dependence*, **64**, 181–190.
15. Klatsky, A. L., Friedman, G. D. & Siegelaub, A. B. (1981) Alcohol use and cardiovascular disease: the Kaiser-Permanente experience. *Circulation*, **64** (Suppl. III), 32–41.
16. Longnecker, M. P. & Macmahon, B. (1988) Associations between alcoholic beverage consumption and hospitalization, 1983 National Health Interview Survey. *American Journal of Public Health*, **78**, 153–156.
17. Armstrong, M. A. & Klatsky, A. K. (1989) Alcohol use and later hospitalization experience. *Medical Care*, **27**, 1099–1108.
18. Muller, A. (1996) Alcohol consumption and community hospital admissions in the United States: a dynamic regression analysis, 1950–92. *Addiction*, **91**, 231–242.
19. Andreasson, S. & Brandt, L. (1997) Mortality and morbidity related to alcohol. *Alcohol and Alcoholism*, **32**, 173–178.
20. Haapanen-Niemi, N., Miilunpalo, S., Vuori, I., Pasanen, M. & Oja, P. (1999) The impact of smoking, alcohol consumption, and physical activity on use of hospital services. *American Journal of Public Health*, **89**, 691–698.
21. Blose, J. O. & Holder, H. D. (1991) Injury-related medical care utilization in a problem drinking population. *American Journal of Public Health*, **81**, 1571–1575.
22. Tsuji, I., Nishino, Y., Ohkubo, T., Kuwahara, A., Ogawa, K., Watanabe, Y., Tsubono, Y., Bando, T., Kanemura, S., Izumi, Y., Sasaki, A., Fukao, A., Nishikori, M. & Hisamichi, S. (1998) A prospective cohort study on National Health Insurance Beneficiaries in Ohsaki, Miyagi Prefecture, Japan: study design, profiles of the subjects and medical cost during the first year. *Journal of Epidemiology*, **8**, 258–263.
23. Tsuji, I., Kuwahara, A., Nishino, Y., Ohkubu, T., Sasaki, A. & Hisamichi, S. (1999) Medical cost for disability: a prospective observation of National Health Insurance Beneficiaries in Japan. *Journal of the American Geriatrics Society*, **47**, 470–476.
24. Izumi, Y., Tsuji, I., Ohkubo, T., Kuwahara, A., Nishino, Y. & Hisamichi, S. (2001) Impact of smoking habit on medical care use and its costs: a prospective observation of National Health Insurance beneficiaries in Japan. *International Journal of Epidemiology*, **30**, 616–621.

25. Kuriyama, S., Tsuji, I., Ohkubo, T., Anzai, Y., Takahashi, K., Watanabe, Y., Nishino, Y. & Hisamichi, S. (2002) Medical care expenditure associated with body mass index in Japan: the Ohsaki study. *International Journal of Obesity*, 26, 1069–1074.
26. Tsuji, I., Takahashi, K., Nishino, Y., Ohkubo, T., Kuriyama, S., Watanabe, Y., Anzai, Y., Tsubono, Y. & Hisamichi, S. (2003) Impact of walking upon medical care expenditure in Japan: the Ohsaki Study. *International Journal of Epidemiology*, 32, 809–814.
27. Cryer, P. C., Saunders, J., Jenkins, L. M., Neale, H., Cook, A. C. & Peters, T. J. (2001) Clusters within a general adult population of alcohol abstainers. *International Journal of Epidemiology*, 30, 756–765.
28. Green, C. A. & Polen, M. R. (2001) The health and health behavior of people who do not drink. *American Journal of Preventive Medicine*, 21, 298–305.
29. SAS Institute, Inc. (2000) *SAS/STAT User's Guide*, Release 8.2 edn. Cary, NC: SAS Institute, Inc.
30. Fillmore, K. M., Golding, J. M., Graves, K. L., Kniep, S., Leino, E. V., Romelsjo, A., Shoemaker, C., Ager, C. R., Allebeck, P. & Ferrer, H. P. (1998) Alcohol consumption and mortality. I. Characteristics of drinking groups. *Addiction*, 93, 183–203.
31. Makela, P. (1999) Alcohol-related mortality as a function of socio-economic status. *Addiction*, 94, 867–886.
32. Tsubono, Y., Yamada, S., Nishino, Y., Tsuji, I. & Hisamichi, S. (2001) Choice of comparison group in assessing the heath effects of moderate alcohol consumption. *Journal of the American Medical Association*, 286, 1177–1178.
33. San Jose, B., van de Mheen, H., van Oers, J. A., Mackenbach, J. P. & Garretsen, H. F. (1999) The U-shaped curve: various health measures and alcohol drinking patterns. *Journal of Studies on Alcohol*, 60, 725–731.
34. Health and Welfare Statistics Association. (2001) Kokumin Eisei no Doko [Trends in the nation's health]. *Health and Welfare Statistics Association*, 48, 88–89 [in Japanese].
35. Bureau of Internal Revenue Taxation Department Alcoholic Beverage Tax Division (2002) *Sake no siori* [Alcohol Booklet]. [available at: http://www.nta.go.jp/category/sake/10/h14/siori.htm] [in Japanese].

Clinical Section

Gerontology

Gerontology 2005;51:186–191
DOI: 10.1159/000083992

Received: June 18, 2004
Accepted: August 19, 2004

Modifiable Factors for the Length of Life with Disability before Death: Mortality Retrospective Study in Japan

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Key Words
Disability · Lifestyles · Compression of morbidity · Elderly

Abstract
Background: Past studies have measured and described the length of life with disability before death, but there has been no study of the relationship between modifiable lifestyle factors and duration of disability. ***Objective:*** To examine whether there are modifiable factors influencing the length of life with disability before death. ***Methods:*** The study was designed as a retrospective observation of the deceased who had earlier been enrolled in a prospective cohort study. During the follow-up period (1996–1999), we documented 781 deaths among those who were 70–79 years of age at the baseline survey in 1994 (n = 10,216). In 2000, we interviewed family members of the deceased about the duration of the subjects' disability before death (n = 655). ***Results:*** The median duration of disability before death was approximately 6 months. Both higher Body Mass Index (BMI) and shorter time spent walking were significantly associated with an increased risk of long-term disability (more than 6 months). The odds ratios of long-term disability were 1.3 in those with BMI 20–25 and 2.1 in those with BMI >25, compared with BMI <20. The odds ratios of long-term disability were 1.3 in those walking for 0.5–0.9 h/day and 1.7 in those walking for <0.5 h/day, compared with those walking for >1.0 h/day. These relationships were unchanged after stratification for causes of death. ***Conclusion:*** Weight control and walking in later life may shorten the length of life with disability before death.

Introduction

In an era when human life expectancy is approaching its biological limits [1], increasing attention is being paid to the quality of the last months of life [2]. Fear of death is often joined by fears of disability or institutionalization [3]. We would all like to remain independent until the very last days of our lives, and thus decrease the length of life with disability.

To provide strategies for disability prevention among the elderly, past epidemiological studies have identified a number of risk factors for the incidence of disability in later life [4–10]. Although a lower incidence of disability may imply postponement of its onset [11], it has not been proven whether lowering the incidence of disability leads to a shortening of the period of disability.

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Recently, a number of studies described the temporal patterns of functional decline before death, from either retrospective surveys of bereaved families or periodical observation of dying subjects [2, 3, 12–14]. These studies have described the different patterns of the time-course of disability before death in accordance with comorbid conditions and causes of death. No study has yet examined whether there are any modifiable factors related to the length of life with disability before death. If we could identify these factors, we could devise strategies to shorten morbidity and thus enhance the quality of the last months of life.

Our objective was therefore to examine whether there were any modifiable factors related to the length of life with disability before death. For this purpose, we conducted an interview survey of the family members of the deceased who had been enrolled earlier in a prospective cohort study.

Methods

Study Design

This study was a retrospective observation of the deceased who had been enrolled in a prospective cohort study. Study data were derived from the Ohsaki National Health Insurance (NHI) beneficiaries' cohort study, the design of which has already been reported in detail [15].

In 1994, we conducted a baseline survey of the NHI beneficiaries in a rural Japanese community. The response rate of those aged 70–79 years at baseline was 94.0%. From 1996 to 1999, we followed up the survival status of the participants (n = 10,216) and documented 781 deaths. With official permission from the government, we investigated the causes and dates of death of all the deceased. In accordance with the 10th edition of the International Classification of Diseases (ICD-10), we excluded 29 subjects who had died from external causes (ICD-10; V01-Y98). We then attempted to contact the family members of the remaining 752 subjects. We were unable to locate 44, but we contacted the family members of the remaining 708, explained the purpose of the study, and asked for participation in an interview survey to be conducted between February and March 2000. Finally, 655 families (93.0%) gave their consent to be interviewed.

This study was approved by the Ethics Committee of the Tohoku University Graduate School of Medicine.

Assessment of Lifestyle

In the baseline survey carried out in 1994, we assessed health-related lifestyle with a self-completion questionnaire. Body mass index (BMI) was calculated as the self-reported weight (kg)/height^2 (m) and then classified into three categories: <20, 20–25, >25. The criteria for BMI were developed from earlier studies showing their association with greater disability [16]. Tobacco smoking status was classified as current smoker, past smoker, or had never smoked. Subjects were asked: 'How long do you walk a day, on average?', and could choose one out of three options to answer: <30 min, 30 min to 1 h, and >1 h. The validity of the questionnaire on walking had already been established [17]. We also asked the subjects whether they were able to independently perform basic activities of daily living (ADL) tasks such as eating.

Outcome Measures

In 2000, we conducted structured interviews of families of the deceased regarding the disability status of the subjects before death. We asked whether they had been able to perform the four ADL tasks (eating, toileting, dressing, and bathing) at each of the following 6 time points before death: 1 week, 1 month, 3 months, 6 months, 1 year, and 3 years. The interviewers typically asked: 'Was he/she able to eat (or other task) by himself/herself 1 week (or other period) prior to death?'

We defined the length of life with disability before death as the duration from the time when a subject became unable to perform at least one of four ADL tasks independently to the time when he/she died.

Statistical Analysis

First, we examined the association between cause of death and the length of life with disability. We classified the underlying cause of death into four groups: death due to cancer (ICD-10; C00-97, D37-48), death due to stroke (I60-69), death due to ischemic heart disease (IHD) (I20-25), and others.

We then examined the relationship between health-related lifestyle and the length of life with disability before death. Since disability at baseline could influence baseline behaviors, in this analysis we limited to the 594 subjects who had been independent from the ADL angle at the time of the baseline survey. We arbitrarily defined 'long-term disability' as being disabled for more than 6 months before death, as this was the closest to the median value. To determine the associations between lifestyle and risk of long-term disability, we used a multivariate logistic regression after adjusting for sex, age at death, cause of death, baseline physical functioning status, and history of arthritis, osteoporosis, hypertension, or diabetes mellitus.

We also conducted stratified analyses of the relative risk of long-term disability before death according to cause of death – death from cancer, IHD or stroke, and other causes.

p values for tests of linear trends were estimated by using each category as a continuous variable. We used approximate variance formulas to calculate the 95% confidence interval (CI). All analyses were conducted with SAS software version 8.02 (SAS Institute, Cary, N.C., USA) [18].

Results

Among the deceased whose families gave their consent to cooperate with our interview survey (n = 655), 62.0% were men. The mean age at death was 78.4 years. The most common cause of death was cancer (32.5% of the total deaths), followed by stroke (18.9%) and IHD (9.3%). The distributions of causes of death among the study subjects was consistent with the national data for Japan: according to the Vital Statistics of Japan for 1998 among