Prediction of an Increase in Healthcare Expenditure associated with Cardiovascular Risk Factor Status

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Abstract

The burden of rising healthcare expenditure is a social problem in Japan.We assessed the possible role of cardiovascular risk factor evaluation in predicting future increases in healthcare expenditure. The study subjects comprised 2, 317 participants who were previously included in the health check-up survey of 2001. Subjects were free of cardiovascular, renal, and liver diseases and had not required hospitalization or long-term care in the 12-month period after April 2001 (baseline period). Their healthcare expenditure (medical and long-term care expenditure) was tracked from April 2002 to September 2007 (follow-up period). The increase in monthly average healthcare expenditure from baseline to follow-up (Δmonthly-expenditure) was analyzed on the basis of the cardiovascular risk factor status at baseline. After adjusting for other risk factors, optimal blood pressure (<120/80 mmHg) was associated with a small Δmonthly-expenditure for both men (−16, 967 yen vs. normal blood pressure, P = 0.023) and women (−5, 945 yen vs. grade 1 hypertension, P = 0.038); meanwhile, low high-density lipoprotein (HDL) cholesterol (≤1.01 mmol/L) in men (30, 776 – 34, 190 yen vs. higher-level categories, P ≤0.002) and overweight (body mass index ≥25.0 kg/m^2) in women (5, 581 yen vs. body mass index = 18.5–<22.0 kg/m^2, P = 0.034) were associated with a large Δmonthly-expenditure. Preventing blood-pressure elevation could contribute to mitigating future increases in healthcare expenditure. Low HDL cholesterol in men and overweight in women could be indicators to identify high-risk subjects with deteriorating health conditions that would lead to large increases in healthcare expenditure.

Introduction

In a rapidly aging community such as that in Japan, the burden of rising healthcare expenditure is a significant social problem. According to Japanese government statistics for 2007, the annual medical expenditure was approximately 33 trillion yen; of this, expenses related to cardiovascular disease were approximately 5.3 trillion yen .[1)] In addition, cerebrovascular disease is the leading cause of long-term care in Japan, accounting for 26% of all cases requiring long-term care.[2)] Given the large burden of cardiovascular disease on healthcare services, controlling cardiovascular risk factors has become a major public health concern [3,4)] in reducing the economic burden of healthcare expenditure.

Several studies have reported that people with one or more cardiovascular risk factors have incurred large medical expenditures. [5-9)] None of these studies, however, has focused on changes in medical expenditure; furthermore, long-term care expenditure has not been included in the investigations. To mitigate future increases in healthcare expenditure, it would be helpful to find subjects whose healthcare expenditure is expected to greatly increase. The purpose of the present study was to clarify how cardiovascular risk factors are associated with future increases in healthcare expenditure.

Materials and Methods

Subjects

The study areas were Tsunan town and Sekikawa village, both in the Niigata Prefecture, Japan. According to the 2000 national census, the population aged ≥40 years was 7, 983 in Tsunan and 4, 828 in Sekikawa. Subjects were selected from 3, 896 people aged ≥40 who had participated in the official population-based health checkup program in 2001.

Initially, 3, 039 people were selected for whom information on medical expenditure for the entire 12 months of the fiscal year (FY) 2001 (April to March of the following year) was available from the municipal government office. From this group, the following people were excluded: those who had been hospitalized or who had received long-term care in FY2001; those for whom follow-up data on medical expenditure was unavailable due to withdrawal from the National Health Insurance (NHI) system; those with a history of cerebrovascular, heart, liver, or renal diseases; and those for whom height, weight, or serum lipid concentration data were missing at baseline. The remaining 2, 317 people (925 men and 1, 392 women) comprised the subjects of the present study.

Healthcare expenditure

Until the medical insurance system in Japan was partially revised in April 2008, in principle all Japanese citizens held one of two types of health insurance. One was insurance for employees and their dependents; the other was the NHI, for all other citizens such as farmers, the self-employed, people living on pensions, the unemployed, and their dependents. In 2001, medical-expenditure data for residents aged ≥70 years, regardless of their insurance type, and medical-expenditure data for residents in the NHI system who were <70 years old were managed by the municipality government office; these medical expenditures can be tracked through this database.

All people aged ≥40 years in Japan also belong to the Long-Term Care Insurance system; again, long-term care expenditure covered by that system can be assessed by reviewing the municipal database. In the present study, “healthcare expenditure" is defined as the combined total of medical and long-term care expenditure. The expenditure data from April 2001 to September 2007 was provided by the study areas' respective municipality government offices.

As a baseline healthcare expenditure (baseline expenditure), the monthly healthcare expenditure for each subject was calculated for the entire 12 months of FY2001. Since people who had been hospitalized or had received long-term care during this period were excluded from the present study, the baseline expenditure did not include expenditure for such healthcare services. As follow-up data, the monthly healthcare expenditure (follow-up expenditure) was calculated for each FY and for the entire period from April 2002 to September 2007. (FY2007 included only the period from April to September for the present study). The value obtained by subtracting the baseline expenditure from the follow-up expenditure was the index of increase in healthcare expenditure (Δmonthly-expenditure).

The impact of cardiovascular risk factors on healthcare expenditure was investigated by comparing the baseline expenditure and the Δmonthly-expenditure with the baseline data for the cardiovascular risk factors. In this study, healthcare expenditure is shown in Japanese yen.

All data were received in an anonymous format, and data linkage was performed using unique identifiers specific to each individual. The study protocol was reviewed and approved by the ethics committee of the Niigata University School of Medicine.

Baseline cardiovascular risk factor assessments

Baseline health checkups based on the standardized procedures of the Niigata Prefecture were conducted from April to November of 2001 in Tsunan and from June to July of 2001 in Sekikawa. Public health nurses interviewed participants on their medical history, smoking status, and alcohol- drinking habits; they also measured their height, weight, and blood pressure, and took blood samples. Body mass index (BMI) was calculated and subjects with BMI ≥25 kg/m^2 were considered overweight. Blood pressure was measured with a mercury sphygmomanometer and was classified according to the 1999 World Health Organization and International Society of Hypertension criteria (1999 WHO/ISH criteria) .[10)] The levels of serum total cholesterol, serum high-density lipoprotein (HDL) cholesterol, serum triglycerides, plasma glucose, and hemoglobin A_{1C} (HbA_{1C}) were measured from the blood samples. Serum triglyceride and plasma glucose levels, which are strongly affected by fasting, were categorized in quintiles for each of the fasting subjects (i.e., >10 h after eating) and postprandial subjects, and integrated categories were used in the analysis. The quintile categories for serum triglyceride levels were ≤0.69, 0.70–0.90, 0.91–1.14, 1.15–1.59, and 1.60+ mmol/L for fasting values and ≤0.88, 0.89–1.19, 1.20–1.53, 1.55–2.13, and 2.14+ mmol/L for postprandial values; those for plasma glucose were ≤4.72, 4.78–4.89, 4.94–5.17, 5.22–5.56, and 5.61+ mmol/L for fasting values and ≤5.17, 5.22–5.72, 5.78–6.33, 6.39–7.22, and 7.28+ mmol/L for postprandial values.

Statistical analysis

Since the distribution of serum triglyceride levels was log-normal, mean ± standard deviation (SD) values were calculated with log-transformed values; exponentially transformed back values are shown as geometric mean ×/÷ geometric SD. Age-adjusted and multivariable linear regression models were applied by sex to estimate the differences in the mean values of healthcare expenditure data for the respective categories of cardiovascular risk factors from the reference category. In analyzing the baseline expenditure, the age-adjusted model was adjusted for age at 5-year interval categories; the multivariable model was also adjusted for treated hypertension (present/absent), history of diabetes (present/absent), history of hyperlipidemia (present/absent), smoking status (current/former/never), alcohol-drinking habit (habitual/occasional/none), blood pressure (optimal/high-normal/normal/grade-1 or grade-2+ hypertension, according to 1999 WHO/ISH criteria), BMI (<18.5, 18.5 to <22.0, 22.0 to <25.0, 25.0+ kg/m^2), serum total cholesterol (<4.63, 4.65–5.14, 5.17–5.66, 5.68–6.18, 6.20+ mmol/L), serum HDL cholesterol (<4.63, 4.65–5.14, 5.17–5.66, 5.68–6.18, 6.20+ mmol/L), serum triglycerides (quintile), and plasma glucose (quintile). In analyzing Δmonthly-expenditure, the baseline expenditure (continuous) and follow-up period (continuous in months) were also adjusted in both models. Although the distribution of the baseline expenditure and that of Δmonthly-expenditure were biased toward low values, actual values were used rather than log-transformed values in the statistical analysis, as in previous studies.[11-13)]Reasons why we used non-transformed values for healthcare expenditure were 1) log-transformed values are also not normal and 2) we need to estimate differences in mean healthcare expenditure values between groups using a parametric statistical procedure (linear regression analysis) which can be applied for non-normally distributed variables under the central limit theorem. SPSS 11.0J for Windows (SPSS Japan Inc, Tokyo, Japan) was used in all analyses, and two-tailed *P*-values of <0.05 were considered to be statistically significant.

Results

At baseline, the mean ages of men and women were 67.0 years and 67.7 years, respectively (Table 1). About 25% of both men and women had received treatment for hypertension and 3–4% had a history of diabetes. A history of hyperlipidemia was observed at a higher frequency in women (11.3%) than in men (2.6%). About 50% of the men were current smokers, and more than 50% were habitual drinkers; the majority of women were neither smokers nor drinkers.

The baseline expenditure—the monthly healthcare expenditure in FY2001—was 10, 339 yen, and the healthcare expenditure later increased (Table 2). The average monthly healthcare expenditure was 25, 280 yen for the overall follow-up period, and the mean Δmonthly-expenditure was 14, 941 yen.

The baseline expenditure was significantly higher for both men and women who had received treatment for hypertension; it was also significantly higher among women with a history of diabetes or hyperlipidemia (Table 3). Among men, the baseline expenditure was significantly lower for current smokers than for subjects who had never smoked and for habitual drinkers than for non-drinkers. In the age-adjusted model, but not in the multivariable model, baseline expenditure was significantly higher than that of the reference categories for both men and women who were overweight, for men with serum total cholesterol levels of 5.17–5.66 mmol/L, and for women with plasma glucose and triglycerides in the fourth and fifth quintiles.

For both men and women, Δmonthly-expenditure was generally higher in subjects with normal or higher blood pressure than in those with optimal blood pressure (Table 4). Accordingly, optimal blood pressure was associated with small Δmonthly-expenditure for both men (−16, 967 yen vs. normal blood pressure, multivariable *P* = 0.023) and women (−5, 945 yen vs. grade 1 hypertension, multivariable *P* = 0.038). For men, multivariable adjusted Δmonthly-expenditure was significantly higher for former smokers than for subjects who had never smoked (26, 793 yen, multivariable *P* = 0.002), and for subjects in the lowest serum HDL cholesterol category (≤1.01 mmol/L) than for those in any other category (30, 776 to 34, 190 yen, multivariable *P* ≤ 0.002). Overweight (BMI ≥25.0 kg/m^2) was significantly related to a large Δmonthly-expenditure for women (5, 581 yen vs. BMI = 18.5–<22.0 kg/m^2, *P* = 0.034). For women, a history of hyperlipidemia was significantly associated with a small Δmonthly-expenditure (-6, 423 yen, multivariable *P* = 0.043).

For men with low HDL cholesterol levels, there was a large Δmonthly-expenditure only for those aged 65 years or older (Table 5); for overweight women, however, there were no differences according to age (Table 6).

Discussion

We found that the Δmonthly-expenditure of subjects with optimal blood pressure was lower than that of subjects with higher blood pressure levels, for both men and women. For men, the Δmonthly-expenditure was found to be large among those with HDL cholesterol levels ≤1.01 mmol/L. Overweight was associated with a large Δmonthly-expenditure, but only for women.

As for the baseline expenditure, the finding of a high healthcare expenditure for overweight people was in agreement with the findings of earlier studies.[5-9] The statistical significance of this relation was lost in the multivariable analysis. This difference in the statistical significance between age-adjusted and multivariable models suggest that the treatment of overweight-related metabolic disorders—such as hypertension, diabetes, and dyslipidemia—would contribute to a great extent to high baseline expenditure for overweight subjects. As for the large Δmonthly-expenditure among overweight women, these metabolic disorders might have become apparent during the observation period, and drug therapy could have been initiated for non-treated subjects at baseline. Since overweight and the female sex are risk factors for knee osteoarthritis[14,15] and falling[16-20], these orthopedic disorders might also have occurred during the follow-up period and contributed to the increased Δmonthly-expenditure in women.

Unlike the case with women, overweight was not associated with a large Δmonthly-expenditure for men. Since overweight-related metabolic disorders are asymptomatic, overweight men receiving medical treatment at baseline might have ceased to continue with their treatment. Furthermore, a small Δmonthly-expenditure in subjects with a history of hyperlipidemia was observed only among women. Women, but not men, without a history at baseline might have started to take medicine during the follow-up once they have been found to have lipid disorders. Thus, these sex-dependent differences in the results may suggest a sex-based difference in the health-care seeking behavior.

Low HDL cholesterol is a major risk factor for ischemic heart disease. [21-25] The risk of ischemic heart disease is higher in men than in women, and the risk increases with age [22,25]; these may be the reasons why, in the present study, low HDL cholesterol was associated with a large Δmonthly-expenditure only in the case of elderly men. Unlike other treatable cardiovascular risk factors, such as high levels of serum total cholesterol, plasma glucose, and blood pressure [10, 22, 25-27], low levels of serum HDL cholesterol is not considered to be a factor requiring drug treatment in Japan unless some comorbid lipid disorders exist. Accordingly, the serum HDL cholesterol level is less likely to have been confounded by medical treatment. Thus, low HDL cholesterol might be directly related to the elevated risk of ischemic heart disease, which would lead to large increases in healthcare expenditure.

It is likely that non-treated subjects at baseline might have started drug treatment later time. Surprisingly, with regard to blood pressure levels, Δmonthly-expenditure was the largest in men with normal blood pressure, which suggests that they may have started medical treatment after the development of hypertension. Some women with grade-1 hypertension may also have started medication. Preventing blood pressure elevation becomes important to decelerating the rise in healthcare expenditure.

With regard to the smoking habit, both baseline expenditure and Δmonthly-expenditure were not significantly different between current smokers and subjects who had never smoked: this result seems to contradict the results of previous reports, which have shown a higher medical expenditure in current smokers.[28-30)] In the present study, both baseline expenditure and Δmonthly-expenditure were the highest among former smokers, which suggests that some smokers had quit smoking because of health problems. Consequently, the proportion of unhealthy subjects among current smokers may have been low at baseline as a result of their having moved out of this category. Similarly, with regard to alcohol- drinking habit, non-drinkers may have included people who had quit drinking for health reasons. Because of such probable biases, no conclusion can be reached with regard to the effects of smoking and alcohol-drinking on healthcare expenditure.

Since this study was a cohort study using previously accumulated data, there are several limitations. First, the baseline data from health checkups had not been obtained for the purpose of analyzing its relationship with healthcare expenditure, so the treatment status for conditions other than high blood pressure could not be ascertained. Second, we could not obtain information on diseases for which a healthcare expenditure was incurred because there was no database containing this information. Therefore, we had to speculate on the types of diseases that caused healthcare expenditure to increase. To solve these problems, a programmed follow-up study involving the collection and analysis of structured information will be necessary.

In conclusion, overweight in women and low HDL cholesterol in men may be related to large increases in healthcare expenditure. These conditions could be used as indicators to identify subjects who require intervention to prevent rising healthcare expenditure. A small increase in healthcare expenditure in men and women with optimal blood pressure may suggest the importance of a preventive approach for blood pressure elevation.

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Table 1. Baseline characteristics of subjects

	Men (n=925)		Women (n=1392)	
Age(years)	67	± 10.9	67.7	± 9.9
Treated hypertension	226	(24.4)	377	(27.1)
History of diabetes mellitus	34	(3.7)	44	(3.2)
Histofy of hyperlipidemia	24	(2.6)	157	(11.3)
Smoking				
Never	445	(48.1)	1343	(96.8)
Former	99	(10.7)	3	(0.2)
Current	379	(41.0)	41	(3.0)
Missing	2	(0.2)	5	(0.4)
Alcohol drinking				
None	247	(26.7)	1187	(85.3)
Occasional	119	(12.9)	124	(8.9)
Habitual[a]	546	(59.0)	74	(5.3)
Missing	13	(1.4)	7	(0.5)
Body mass index(kg/m^2)	22.5	± 2.9	23.3	± 3.2
Systolic blood pressure(mmHg)	134	± 18.8	132	± 18.2
Diastolic blood pressure(mmHg)	77	± 10.6	74.5	± 10.5
Serum total cholesterol (mmol/L)	4.87	± 0.83	5.37	± 0.81
Serum HDL-cholesterol (mmol/L)	1.46	± 0.41	1.55	± 0.38
Triglyceride(mmol/L)				
Fasting[b]	1.06	×/÷ 1.68	1.04	×/÷ 1.59
Post-prandial[c]	1.4	×/÷ 1.78	1.39	×/÷ 1.64
Plasma glucose (mmol/L)				
Fasting[b]	5.25	± 0.92	5.22	± 0.95
Post-prandial[c]	6.73	± 2.32	6.26	± 1.65

Data are mean ± standard deviation or number (%), except for triglyceride for which data of corresponding mean ± standard deviation of the logarithmic values are described.

[a] Drink alcoholic beverages almost every day.

[b] Includes 189 men and 210 women, and c includes736 men and 1, 182 women.

Table 2. Monthly healthcare expenditure and Δmonthly-expenditure for each fiscal year and overall follow-up period

Fiscal year	Total				Men				Women			
	n	Mean	±	SD	n	mean	±	SD	n	mean	±	SD
Monthly healthcare costs (Yen/person)												
2001	2317	10339	±	13070	925	10487	±	14356	1392	10241	±	12144
2002	2317	16638	±	46994	925	18313	±	62260	1392	15525	±	33150
2003	2289	22417	±	87047	916	23882	±	119576	1373	21439	±	55658
2004	2245	22842	±	52438	890	24082	±	63710	1355	22028	±	43481
2005	2202	26626	±	60099	870	26537	±	59356	1332	26685	±	60602
2006	2157	29751	±	63026	843	31357	±	66487	1314	28721	±	60706
2007[b]	2097	32628	±	81331	809	38869	±	100863	1288	28709	±	65924
2002-2007	2317	25280	±	58112	925	27751	±	78087	1392	23639	±	39567
Δmonthly-costs[b] (Yen/person)												
2001	2317	0	(reference)		925	0	(reference)		1392	0	(reference)	
2002	2317	6299	±	44749	925	7827	±	60169	1392	5284	±	30442
2003	2289	12094	±	85518	916	13411	±	117834	1373	11215	±	54166
2004	2245	12591	±	50806	890	13825	±	62492	1355	11781	±	41379
2005	2202	16431	±	58621	870	16366	±	57930	1332	16474	±	59089
2006	2157	19620	±	61644	843	21281	±	65016	1314	18554	±	59381
2007[b]	2097	22520	±	80348	809	28772	±	99691	1288	18593	±	65073
2002-2007	2317	14941	±	56091	925	17265	±	76027	1392	13397	±	37320

Healthcare expenditure included total medical expenditure and long-term care expenditure; for the fiscal-year 2001, inpatient medical expenditure and long-term care expenditure were not included, because those subjects who had incurred such expenditure in that fiscal year were excluded from the study subjects.

[a] Differences in monthly health-care expenditure from fiscal-year 2001.

Fiscal year: April to the following March. [b] Data in the initial 6 months were available in the fiscal-year 2007.

Table 3. Baseline cardiovascular risk factor status and healthcare expenditure in the fiscal-year 2001: estimated differences from each reference category, using general linear models

	Men									Women								
	Monthly healthcare expenditure (Yen/person)		Estimated difference from the reference category							Monthly healthcare expenditure (Yen/person)		Estimated difference from the reference category						
			Age-adjusted			Multivariable						Age-adjusted			Multivariable			
	n	mean ± SD	mean	(95% CI)	*P*	mean	(95% CI)	*P*		n	mean ± SD	mean	(95% CI)	*P*	mean	(95% CI)	*P*	
Treated Hypertension																		
No	699	8257 ± 13595	0	(reference)		0	(reference)			1015	8017 ± 9967	0	(reference)		0	(reference)		
Yes	226	17382 ± 14488	8532	(6398 , 10666)	<0.001	9119	(6843 , 11396)	<0.001		377	16230 ± 15112	8172	(6767 , 9577)	<0.001	7130	(5661 , 8600)	<0.001	
History or diabetes mellitus																		
No	891	10315 ± 14369	0	(reference)		0	(reference)			1348	9850 ± 11700	0	(reference)		0	(reference)		
Yes	34	14986 ± 13441	4237	(-655 , 9129)	0.089	2642	(-2270 , 7555)	0.291		44	22229 ± 18203	12298	(8746 , 15851)	<0.001	10904	(7429 , 14380)	<0.001	
History of hyperlipidemia																		
No	901	10320 ± 14362	0	(reference)		0	(reference)			1235	9293 ± 11298	0	(reference)		0	(reference)		
Yes	24	16762 ± 12907	6411	(627 , 12195)	0.030	4592	(-1150 , 10334)	0.117		157	17703 ± 15564	7951	(5983 , 9919)	<0.001	6442	(4500 , 8384)	<0.001	
Smoking																		
Never	445	12173 ± 16530	0	(reference)		0	(reference)			1343	10341 ± 12235	0	(reference)		0	(reference)		
Former	99	13882 ± 16504	1660	(-1434 , 4753)	0.293	2513	(-591 , 5616)	0.112		3	7097 ± 12292	-2582	(-16245 , 11081)	0.711	-3760	(-16555 , 9036)	0.564	
Current	379	7645 ± 9876	-4167	(-6132 , -2201)	<0.001	-2689	(-4749 , -629)	0.011		41	8393 ± 9089	433	(-3439 , 4305)	0.826	1141	(-2537 , 4818)	0.543	
Drinking habit																		
None	247	12434 ± 16901	0	(reference)		0	(reference)			1187	10587 ± 12311	0	(reference)		0	(reference)		
Occasional	119	9229 ± 11254	-2482	(-5665 , 701)	0.126	-3174	(-6295 , -52)	0.046		124	7628 ± 9701	-1953	(-4231 , 325)	0.093	-1650	(-3798 , 498)	0.132	
Habitual	546	9920 ± 13748	-2219	(-4388 , -51)	0.045	-2759	(-5028 , -490)	0.017		74	9820 ± 13017	509	(-2371 , 3388)	0.729	981	(-1749 , 3711)	0.481	
Body mass index, kg/m^2																		
<18.5	75	7781 ± 11328	-2421	(-6008 , 1166)	0.186	-2323	(-5877 , 1231)	0.200		79	8482 ± 10469	-514	(-3402 , 2374)	0.727	-26	(-2759 , 2707)	0.985	
18.5–<22.0	334	10002 ± 13530	0	(reference)		0	(reference)			430	8958 ± 10806	0	(reference)		0	(reference)		
22.0–<25.0	344	10297 ± 13808	490	(-1673 , 2653)	0.656	-602	(-2848 , 1644)	0.599		491	9905 ± 12243	490	(-1070 , 2050)	0.538	164	(-1321 , 1650)	0.828	
25.0+	172	12986 ± 17585	3219	(582 , 5857)	0.017	2087	(-833 , 5007)	0.161		392	12424 ± 13399	2877	(1224 , 4531)	<0.001	1400	(-232 , 3033)	0.093	

Blood pressure																
Optimal	193	10175 ± 16164	0	(reference)		0	(reference)		344	9496 ± 11603	0	(reference)		0	(reference)	
Nomal	227	9071 ± 13075	-1413	(-4149 , 1323)	0.311	-2412	(-5114 , 290)	0.080	317	9095 ± 10973	-716	(-2561 , 1129)	0.446	-1189	(-2937 , 558)	0.182
High-Nomal	126	11065 ± 15018	407	(-2813 , 3627)	0.804	-1256	(-4426 , 1915)	0.437	269	10110 ± 11954	-66	(-2007 , 1874)	0.947	-1339	(-3184 , 506)	0.155
Grade1 hypertension	287	11673 ± 14348	639	(-1993 , 3271)	0.634	-2379	(-5095 , 336)	0.086	355	11721 ± 13346	1364	(-474 , 3202)	0.146	-1218	(-2993 , 557)	0.179
Grade2+ hypertension	92	10140± 12248	-1277	(-4859 , 2306)	0.485	-4412	(-8071 , -753)	0.018	107	11454 ± 13041	1405	(-1253 , 4064)	0.300	-347	(-2900 , 2205)	0.790
Serum total cholesterol, mmol/L (mg/dL)																
– 4.63 (–179)	373	9514 ± 12411	0	(reference)		0	(reference)		256	9266 ± 10762	0	(reference)		0	(reference)	
4.65 – 5.14 (180 – 199)	229	11111 ± 15720	1571	(-773 , 3916)	0.189	339	(-2109 , 2786)	0.786	309	10278 ± 11485	747	(-1248 , 2742)	0.463	-293	(-2226 , 1639)	0.766
5.17 – 5.66 (200 – 219)	170	12081 ± 17064	2685	(103 , 5267)	0.042	1941	(-772 , 4654)	0.161	353	10269 ± 12250	576	(-1374 , 2526)	0.562	-1137	(-3089 , 814)	0.253
5.68 – 6.18 (220 – 239)	107	9873 ± 11668	710	(-2398 , 3818)	0.654	333	(-2968 , 3635)	0.843	261	11400 ± 13978	1621	(-470 , 3711)	0.129	211	(-1902 , 2323)	0.845
6.20 (240) +	46	10797 ± 16497	2741	(-1660 , 7142)	0.222	1457	(-3090 , 6004)	0.530	213	11400 ± 13978	286	(-1917 , 2488)	0.799	-1136	(-3428 , 1156)	0.331
Serum HDL-cholesterol, mmol/L (mg/dL)																
– 1.01 (–39)	101	9687 ± 12447	0	(reference)			(reference)		95	12716 ± 13643	0	(reference)		0	(reference)	
1.03 – 1.27 (40 – 49)	231	10889 ± 14553	1398	(-1942 , 4738)	0.412	2123	(-1253 , 5498)	0.217	224	10225 ± 11825	-2478	(-5364 , 409)	0.092	-1766	(-4530 , 999)	0.210
1.29 – 1.52 (50 – 59)	260	10379 ± 14205	1132	(-2164 , 4428)	0.500	2832	(-714 , 6377)	0.117	403	9635 ± 11365	-2955	(-5645 , -26)	0.031	-667	(-3374 , 2039)	0.629
1.55 – 1.78 (60 – 69)	163	10390 ± 15051	1022	(-2522 , 4566)	0.572	3083	(-881 , 7048)	0.127	338	10436 ± 13114	-2066	(-4803 , 670)	0.139	1126	(-1739 , 3992)	0.441
1.81 (70) +	170	10673 ± 14829	1242	(-2278 , 4762)	0.489	2835	(-1228 , 6898)	0.171	332	10081 ± 11769	-2082	(-4828 , 664)	0.137	1313	(-1733 , 4359)	0.398
Serum triglyceride, quintlile[a]																
1st	197	11020 ± 15884	0	(reference)		0	(reference)		271	9195 ± 10771	0	(reference)		0	(reference)	
2nd	197	10524 ± 14614	-676	(-3505 , 2152)	0.639	-1268	(-4106 , 1570)	0.381	272	9852 ± 11529	549	(-1463 , 2561)	0.593	436	(-1494 , 2366)	0.658
3rd	158	9457 ± 12712	-1634	(-4640 , 1372)	0.286	-2988	(-6120 , 144)	0.061	299	8076 ± 11110	-1278	(-3248 , 691)	0.203	-1153	(-3107 , 801)	0.247

4th	173	11665 ± 14900	348	(-2607 , 3302)	0.817	-639	(-3837 , 2560)	0.695	288	12007 ± 13381	2518	(531 , 4504)	0.013	1176	(-903 , 3255)	0.267
5th	200	9719 ± 13261	-789	(-3664 , 2086)	0.590	-2229	(-5688 , 1230)	0.206	262	12257 ± 13266	2582	(537 , 4626)	0.013	1489	(-830 , 3809)	0.208
Plasma glucose, quintile[b]																
1st	184	9179 ± 13419	0	(reference)		0	(reference)		308	8445 ± 10496	0	(reference)		0	(reference)	
2nd	158	10821 ± 13115	1626	(-1427 , 4678)	0.296	754	(-2248 , 3756)	0.622	297	10390 ± 12697	1716	(-203 , 3635)	0.080	1489	(-337 , 3315)	0.110
3rd	176	9699 ± 15958	433	(-2531 , 3398)	0.774	21	(-2879 , 2921)	0.988	292	9565 ± 11205	701	(-1235 , 2637)	0.478	486	(-1358 , 2331)	0.605
4th	170	10454 ± 15644	624	(-2376 , 3623)	0.683	90	(-2877 , 3057)	0.953	271	10729 ± 11785	1893	(-87 , 3872)	0.061	1113	(-765 , 2991)	0.245
5th	237	11888 ± 13602	2123	(-672 , 4918)	0.136	1650	(-1161 , 4462)	0.250	224	12805 ± 14503	4126	(2034 , 6218)	<0.001	1990	(-45 , 4025)	0.055

SD, standard deviation; CI, confidence interval

Age-adjusted model adjusted for age, and the multivariable model was further adjusted for all variables in this table.

Blood pressure levels classified according to the 1999 criteria of the World Health Organization and International Society of Hypertension.

[a] <0.69, 0.70–0.90, 0.91–1.14, 1.15–1.59, and 1.60+ mmol/L for over 10-h fasting status, and <0.88, 0.89–1.19, 1.20–1.53, 1.55–2.13, and 2.14+ mmol/L for postprandial status.

[b] <4.72, 4.78–4.89, 4.94–5.17, 5.22–5.56, and 5.61+ mmol/L for over 10-h fasting status, and <5.17, 5.22–5.72, 5.78–6.33, 6.39–7.22, and 7.28+ mmol/L for postprandial status.

Table 4. Baseline cardiovascular risk factor status and Δmonthly-expenditure: estimated differences from each reference

	Men								Women							
	Δmonthly-expenditure[a] (Yen/person)		Estimated difference from the reference category						Δmonthly-expenditure[a] (Yen/person)		Estimated difference from the reference category					
			Age-adjusted			Multivariable					Age-adjusted			Multivariable		
	n	mean ± SD	mean	(95% CI)	*P*	mean	(95% CI)	*P*	n	(95% CI)	mean	(95% CI)	*P*	mean	(95% CI)	*P*
Treated Hypertension																
No	699	13926 ± 35425	0	(reference)		0	(reference)		1015	12306 ± 32821	0	(reference)		0	(reference)	
Yes	226	27591 ± 140365	11157	(-714 , 23028)	0.065	10862	(-1860 , 23584)	0.094	377	16337 ± 47283	3	(-4653 , 4658)	0.999	-284	(-5077 , 4509)	0.907
History or diabetes mellitus																
No	891	16715 ± 76541	0	(reference)		0	(reference)		1348	13014 ± 36702	0	(reference)		0	(reference)	
Yes	34	31673 ± 60159	12906	(-12665 , 38477)	0.322	9478	(-17057 , 36014)	0.483	44	25152 ± 52081	9974	(-1127 , 21075)	0.078	8764	(-2363 , 19890)	0.123
History of hyperlipidemia																
No	901	17001 ± 76185	0	(reference)		0	(reference)		1235	13915 ± 37880	0	(reference)		0	(reference)	
Yes	24	27181 ± 70617	12449	(-17910 , 42807)	0.421	11341	(-19726 , 42408)	0.474	157	9330 ± 32397	-7205	(-13423 , -986)	0.023	-6423	(-12650 , -196)	0.043
Smoking																
Never	445	15093 ± 37030	0	(reference)		0	(reference)		1343	13264 ± 36583	0	(reference)		0	(reference)	
Former	99	37375 ± 209023	25101	(8847 , 41355)	0.003	26793	(10020 , 43566)	0.002	3	8463 ± 4701	-1743	(-41674 , 38187)	0.932	-2750	(-43146 , 37646)	0.894
Current	379	14484 ± 32648	921	(-9537 , 11378)	0.863	-86	(-11260 , 11089)	0.988	41	10393 ± 20811	202	(-11113 , 11517)	0.972	192	(-11419 , 11802)	0.974
Drinking habit																
None	247	29369 ± 135584	0	(reference)		0	(reference)		1187	13360 ± 36161	0	(reference)		0	(reference)	
Occasional	119	12240 ± 25794	-9607	(-26265 , 7051)	0.258	-12912	(-29810 , 3986)	0.134	124	12417 ± 39575	2574	(-4099 , 9246)	0.449	2607	(-4185 , 9400)	0.452
Habitual	546	13039 ± 35499	-12156	(-23518 , -793)	0.036	-13648	(-25944 , -1352)	0.030	74	11637 ± 30936	850	(-7571 , 9270)	0.843	1466	(-7153 , 10085)	0.739
Body mass index, kg/m^2																
<18.5	75	20975 ± 42546	-9014	(-27863 , 9835)	0.348	-7853	(-27098 , 11391)	0.423	79	18944 ± 54982	4358	(-4414 , 13129)	0.330	2795	(-5835 , 11426)	0.525
18.5–<22.0	334	21559 ± 117246	0	(reference)		0	(reference)		430	10454 ± 29077	0	(reference)		0	(reference)	
22.0–<25.0	344	15284 ± 36770	-2833	(-14172 , 8506)	0.624	-8821	(-20948 , 3306)	0.154	491	12969 ± 36096	3241	(-1497 , 7980)	0.180	3624	(-1066 , 8314)	0.130
25.0+	172	11267 ± 29699	-6901	(-20759 , 6957)	0.329	-14792	(-30568 , 983)	0.066	392	16045 ± 42052	6050	(1007 , 11092)	0.019	5581	(422 , 10741)	0.034
Blood pressure																
Optimal	193	9683 ± 30360	0	(reference)		0	(reference)		344	7999 ± 20221	0	(reference)		0	(reference)	

Nomal	227	23882 ± 138613	14787	(524 , 29050)	0.042	16967	(2359 , 31575)	0.023	317	11013 ± 27940	1715	(-3869 , 7299)	0.547	1396	(-4126 , 6917)	0.620
High-Nomal	126	18535 ± 40173	9232	(-7544 , 26007)	0.280	11302	(-5815 , 28420)	0.195	269	13227 ± 34649	3478	(-2393 , 9349)	0.245	2985	(-2843 , 8813)	0.315
Grade1 hypertension	287	17171 ± 40733	6165	(-7561 , 19891)	0.378	7909	(-6776 , 22594)	0.291	355	18944 ± 50038	7089	(1505 , 12672)	0.013	5945	(319 , 11571)	0.038
Grade2+ hypertension	92	15393 ± 36884	1981	(-16690 , 20652)	0.835	4479	(-15333 , 24290)	0.657	107	19843 ± 54526	6464	(-1587 , 14515)	0.115	2018	(-6044 , 10079)	0.623
Serum total cholesterol, mmol/L (mg/dL)																
– 4.63 (–179)	373	21430 ± 111494	0	(reference)		0	(reference)		256	15649 ± 50846	0	(reference)		0	(reference)	
4.65 – 5.14 (180 – 199)	229	18560 ± 38502	-595	(-12884 , 11693)	0.924	-1576	(-14789 , 11636)	0.815	309	12886 ± 28813	-2865	(-8909 , 3179)	0.353	-3567	(-9677 , 2543)	0.252
5.17 – 5.66 (200 – 219)	170	11968 ± 37004	-4741	(-18335 , 8852)	0.494	-4368	(-19061 , 10324)	0.560	353	10834 ± 31863	-4831	(-10732 , 1069)	0.108	-4790	(-10955 , 1375)	0.128
5.68 – 6.18 (220 – 239)	107	11669 ± 31902	-2270	(-18567 , 14028)	0.785	438	(-17408 , 18283)	0.962	261	15352 ± 37288	-205	(-6544 , 6134)	0.949	247	(-6436 , 6930)	0.942
6.20 (240) +	46	9627 ± 21913	-3037	(-26101 , 20026)	0.796	-5990	(-30551 , 18572)	0.632	213	13287 ± 37546	-1753	(-8421 , 4916)	0.606	-3676	(-10920 , 3567)	0.320
Serum HDL-cholesterol, mmol/L (mg/dL)																
– 1.01 (–39)	101	45853 ± 206503	0	(reference)		0	(reference)		95	16653 ± 44824	0	(reference)		0	(reference)	
1.03 – 1.27 (40 – 49)	231	13805 ± 32221	-28163	(-45471 , -10855)	0.001	-30776	(-49033 , -12518)	<0.001	224	11912 ± 29132	-5148	(-13905 , 3609)	0.249	-5466	(-14203 , 3270)	0.220
1.29 – 1.52 (50 – 59)	260	14273 ± 37190	-29978	(-47040 , -12916)	<0.001	-33842	(-53016 , -14669)	<0.001	403	12734 ± 36353	-2973	(-11150 , 5204)	0.476	-2917	(-11461 , 5628)	0.503
1.55 – 1.78 (60 – 69)	163	10852 ± 25914	-30762	(-49141 , -12383)	0.001	-34190	(-55665 , -12716)	0.002	338	13627 ± 38363	-2815	(-11120 , 5489)	0.506	-2863	(-11911 , 6185)	0.535
1.81 (70) +	170	15704 ± 40408	-29023	(-47244 , -10801)	0.002	-34117	(-56078 , -12156)	0.002	332	14041 ± 40022	-1743	(-10077 , 6591)	0.682	-2902	(-12520 , 6716)	0.554
Serum triglyceride, quintile[b]																
1st	197	20309 ± 44308	0	(reference)		0	(reference)		271	14446 ± 43100	0	(reference)		0	(reference)	
2nd	197	12864 ± 30189	-3287	(-18030 , 11456)	0.662	-3183	(-18510 , 12143)	0.684	272	11490 ± 23531	-3966	(-10092 , 2160)	0.204	-3005	(-9105 , 3095)	0.334
3rd	158	24943 ± 164003	11896	(-3806 , 27599)	0.137	10465	(-6489 , 27419)	0.226	299	18076.5 ± 45210	2999	(-2996 , 8995)	0.327	4148	(-2023 , 10319)	0.188
4th	173	17070 ± 44409	2707	(-12699 , 18112)	0.730	-2485	(-19748 , 14779)	0.778	288	11290 ± 35495	-3875	(-9934 , 2184)	0.210	-4584	(-11151 , 1983)	0.171

5th	200	12703 ± 31406	1389	(-13616 , 16393)	0.856	-8873	(-27569 , 9823)	0.352	262	11271 ± 34172	-3248	(-9500 , 3005)	0.308	-3678	(-11023 , 3667)	0.326
Plasma glucose, quintile[c]																
1st	184	10715 ± 28081	0	(reference)		0	(reference)		308	10367 ± 27495	0	(reference)		0	(reference)	
2nd	158	15651 ± 39162	4003	(-11913 , 19919)	0.622	3285	(-12917 , 19487)	0.691	297	11844 ± 3116	840	(-5010 , 6691)	0.778	1030	(-4746 , 6806)	0.727
3rd	176	13804 ± 32043	-1002	(-16458 , 14453)	0.899	-3685	(-19344 , 11973)	0.644	292	12516 ± 32617	891	(-5002 , 6784)	0.767	203	(-5623 , 6029)	0.945
4th	170	14373 ± 32408	-221	(-15850 , 15408)	0.978	-1727	(-17745 , 14291)	0.832	271	14639 ± 37191	1437	(-4606 , 7479)	0.641	1046	(-4896 , 6987)	0.730
5th	237	28070 ± 138990	11225	(-3361 , 25811)	0.131	10556	(-4633 , 25745)	0.173	224	19271 ± 56936	5163	(-1242 , 11568)	0.114	2441	(-3994 , 8876)	0.457

SD, standard deviation; CI, confidence interval

Age-adjusted model adjusted for age, monthly healthcare cost in the fiscal year FY2001, and duration of follow-up. The multivariable model was further adjusted for all variables in this table.

[a] Calculated by the following formula: (monthly healthcare cost during FY2002–2007) − (monthly healthcare cost in FY2001).

[b] <0.69, 0.70–0.90, 0.91–1.14, 1.15–1.59 and 1.60+ mmol/L for over 10-h fasting status, and <0.88, 0.89–1.19, 1.20–1.53, 1.55–2.13, and 2.14+ mmol/L for postprandial status.

[c] <4.72, 4.78–4.89, 4.94–5.17, 5.22–5.56, and 5.61+ mmol/L for over 10-h fasting status, and <5.17, 5.22–5.72, 5.78–6.33, 6.39–7.22, and 7.28+ mmol/L for postprandial status.

Table 5. Baseline serum high-density cholesterol levels and Δmonthly-expenditure by age in men

	Δmonthly-expenditure			Estimated difference from standard category													
				Age-adjusted							Multivariable						
	n	mean	±SD	mean	(	95%CI			)	*P*	mean	(	95%CI			)	*P*
40–64 years old																	
– 1.01mmol/L (–39mg/dL)	30	15371	± 37074	0	(	reference			)		0	(	reference			)	
1.03 – 1.27 (40 – 49)	79	6403	± 18354	-8056	(	-19315	,	3204	)	0.160	-4416	(	-16736	,	7904	)	0.481
1.29 – 1.52 (50 – 59)	85	7948	± 36980	-5064	(	-16238	,	6109	)	0.373	921	(	-12107	,	13950	)	0.889
1.55 – 1.78 (60 – 69)	54	6525	± 19600	-7064	(	-19003	,	4875	)	0.245	1795	(	-12854	,	16444	)	0.810
1.81 (70) +	51	4399	± 15339	-7944	(	-20017	,	4129	)	0.196	1819	(	-13314	,	16953	)	0.813
≥65 year old																	
– 1.01mmol/L (–39mg/dL)	71	58733	± 244506	0	(	reference			)		0	(	reference			)	
1.03 – 1.27 (40 – 49)	152	17652	± 36929	-34800	(	-59539	,	-10062	)	0.006	-37904	(	-63828	,	-11980	)	0.004
1.29 – 1.52 (50 – 59)	175	17346	± 37008	-40918	(	-65148	,	-16688	)	0.001	-47018	(	-74119	,	-19918	)	0.001
1.55 – 1.78 (60 – 69)	109	12995	± 28369	-40902	(	-67127	,	-14676	)	0.002	-45553	(	-76009	,	-15098	)	0.003
1.81 (70) +	119	20549	± 46475	-38615	(	-64363	,	-12866	)	0.003	-47772	(	-78462	,	-17083	)	0.002

SD, standard deviation; CI, confidence interval

Age-adjusted model adjusted for age, monthly healthcare expenditure in the fiscal year 2001, and duration of follow-up. The multivariable model was further adjusted for all variables in Table 4.

Table 6. Baseline body mass index and Δmonthly-expenditure by age in women

	Δmonthly-expenditure			Estimated difference from standard category													
				Age-adjusted							Multivariable						
	n	mean	±SD	mean	(	95%CI			)	*P*	mean	(	95%CI			)	*P*
40–64 years old																	
<18.5 kg/m^2	17	2639	± 8050	-696	(	-11628	,	10236	)	0.900	-2096	(	-9204	,	5012	)	0.562
18.5–<22.0	148	3729	± 9696	0	(	reference			)		0	(	reference			)	
22.0–<25.0	158	6670	± 14602	2765	(	-2157	,	7686	)	0.270	2594	(	-647	,	5835	)	0.116
25.0+	116	11644	± 37120	8005	(	2645	,	13364	)	0.004	4925	(	1215.1	,	8636	)	0.009
≥65 year old																	
<18.5 kg/m^2	62	23414	± 61270	4887	(	-6455	,	16229	)	0.398	2453	(	-9223	,	14130	)	0.680
18.5–<22.0	282	13984	± 34717	0	(	reference			)		0	(	reference			)	
22.0–<25.0	333	15957	± 42359	3672	(	-2870	,	10214	)	0.271	4149	(	-2548	,	10847	)	0.224
25.0+	276	17895	± 43891	5111	(	-1778	,	11999	)	0.146	5089	(	-2159	,	12337	)	0.169

SD, standard deviation; CI, confidence interval

Age-adjusted model adjusted for age, monthly healthcare expenditure in the fiscal year 2001, and duration of follow-up. The multivariable model was further adjusted for all variables in Table 4.