Table 1
Baseline characteristics of the Ohsaki Study subjects in 1995, Japan

	Non-participants	Study participants	*P*-value[a]	Overweight/Obesity[b]		Hypertension[c]		Hyperglycemia[d]		Dyslipidemia[e]	
				(−)	(+)	(−)	(+)	(−)	(+)	(−)	(+)
N	38,915	12,340		8152	4188	7158	5182	11,292	1048	6790	5550
Age (year) (SD)	61.0 (10.6)	61.1 (9.4)	0.25	61.2 (9.6)	61.0 (8.9)	59.1 (9.7)	63.9 (8.2)	60.8 (8.3)	64.0 (8.3)	60.5 (9.8)	61.8 (8.9)
Male (%)	49.4	43.0	<0.0001	45.5	38.2	41.7	44.8	41.6	58.2	47.1	38.0
Current smoker (%)	30.0	22.3	<0.0001	24.7	17.7	23.0	21.3	21.6	30.3	23.9	20.4
Current drinker (%)	42.1	42.6	<0.0001	43.6	40.8	41.3	44.4	42.0	49.6	47.9	36.2
Overweight/obesity (%)	28.7[f]	28.8[f]	0.75	0.0[b]	100.0[b]	27.8[b]	42.5[b]	33.7[b]	36.1[b]	27.9[b]	41.4[b]
Hypertension (%)	27.5[g]	23.8[g]	<0.0001	36.6[c]	52.5[c]	0.0[c]	100.0[c]	41.0[c]	52.5[c]	39.5[c]	45.1[c]
Hyperglycemia (%)	7.2[h]	4.7[h]	<0.0001	8.2[d]	9.0[d]	7.0[d]	10.6[d]	0.0[d]	100.0[d]	7.9[d]	9.2[d]
Dyslipidemia (%)	–	–		39.9[e]	54.9[e]	42.6[e]	48.3[e]	44.6[e]	48.9[e]	0.0[e]	100.0[e]

SD denotes standard deviation.
[a] Variables were compared between study participants and non-participants by the *t*-test or the χ^2 test, as appropriate.
[b] Measured Body Mass Index ≥25.0.
[c] Blood pressure ≥140/90 mm Hg or self-report of taking antihypertensive medication.
[d] Casual blood glucose ≥150 mg/dl or self-reported history of diabetes.
[e] Casual serum cholesterol ≥220 mg/dl, or HDL <40 mg/dl, or self-report of taking lipid-lowering medication.
[f] Body Mass Index calculated by self-reported weight/(height*height) ≥25.0.
[g] Self-reported history of hypertension.
[h] Self-reported history of diabetes.

Of the 12,340 study participants, 12,054 (97.7%), 4215 (34.2%), and 12,047 (97.6%) used total, inpatient, and outpatient medical care and had more than zero costs for the 6-year period. During the follow-up, 584 subjects (4.7%) died and 921 (7.5%) were lost to follow-up. Table 1 shows the baseline characteristics of the subjects in terms of presence/absence of overweight/obesity, hypertension, hyperglycemia, and dyslipidemia. Cardiovascular risk factors were often present together in the same individual. Among the study participants, 39.1% had no risk factor, 39.3% had a single risk factor, and 21.6% had two or more risk factors. In comparison with those without overweight/obesity, those with overweight/obesity had a higher prevalence of the other three cardiovascular risk factors and were less likely to be current smokers or current drinkers. Also, hypertension, hyperglycemia, and dyslipidemia were associated with a higher prevalence of the other three cardiovascular risk factors.

Table 2 shows the adjusted monthly medical costs of the subjects in terms of presence/absence of these cardiovascular risk factors. The adjusted mean total and outpatient medical costs among overweight/obese subjects were significantly higher than those among subjects who were not overweight/obese (P=0.013, 0.030, respectively). The mean inpatient cost among overweight/obese subjects was higher than that among subjects who were not overweight/obese, but the difference was not significant (P=0.068). The adjusted mean total, inpatient, and outpatient medical costs among subjects with hypertension were significantly higher than among subjects without hypertension (P <0.0001, 0.0008, <0.0001). The adjusted mean total, inpatient, and outpatient medical costs among subjects with hyperglycemia were significantly higher than among subjects without hyperglycemia (P <0.0001, 0.0004, <0.0001). There was no difference in total, inpatient, and outpatient medical costs between subjects with and without dyslipidemia (P=0.74, 0.50, 0.55).

Table 2
Adjusted monthly medical costs by the presence/absence of the cardiovascular risk factors in the Ohsaki Study, Japan, 1996–2001

		N	Adjusted inpatient cost[a], $		Adjusted outpatient cost[a], $		Adjusted total cost[a], $		Increasing rate (%)
			(95%CI)	*P*-value	(95%CI)	*P*-value	(95%CI)	*P*-value	
Overweight/obesity[b]	(−)	8152	87.1 (78.8–95.5)	(Referent)	139.5 (135.4–143.6)	(Referent)	226.6 (216.9–236.3)	(Referent)	(Referent)
	(+)	4188	100.6 (88.9–112.3)	0.068	147.4 (141.6–153.2)	0.030	248.0 (234.4–261.6)	0.013	9.4
Hypertension[c]	(−)	7158	81.5 (72.5–90.5)	(Referent)	122.0 (117.6–126.4)	(Referent)	203.5 (193.0–213.9)	(Referent)	(Referent)
	(+)	5182	105.8 (95.1–116.4)	0.0008	170.1 (164.8–175.3)	<0.0001	275.9 (263.5–288.2)	<0.0001	35.6
Hyperglycemia[d]	(−)	11,292	88.0 (80.9–95.0)	(Referent)	137.8 (134.3–141.3)	(Referent)	225.8 (217.6–234.0)	(Referent)	(Referent)
	(+)	1048	131.8 (108.4–155.1)	0.0004	189.4 (177.9–200.9)	<0.0001	321.1 (294.0–348.2)	<0.0001	42.2
Dyslipidemia[e]	(−)	6790	93.8 (84.7–103.0)	(Referent)	141.3 (136.7–145.8)	(Referent)	235.1 (224.5–245.7)	(Referent)	(Referent)
	(+)	5550	89.1 (79.0–99.2)	0.50	143.3 (138.3–148.3)	0.55	232.4 (220.6–244.2)	0.74	−1.1

CI denotes confidence interval. The plus (+) denotes the presence of each of the index risk factors. The minus (−) denotes the absence of each of the index risk factors.
[a] Tested by analysis of covariance (ANCOVA) using non-log-transformed data on charges adjusted by age at baseline (continuous variable), sex, smoking (current smoker, past smoker, or never smoker), alcohol drinking (current drinker, past drinker, or never drinker), and comorbid condition of other three cardiovascular risk factors.
[b] Body Mass Index ≥25.0.
[c] Blood pressure ≥140/90 mm Hg or self-report of taking antihypertensive medication.
[d] Casual blood glucose ≥150 mg/dl or self-reported history of diabetes.
[e] Casual serum cholesterol ≥220 mg/dl, or HDL <40 mg/dl, or self-report of taking lipid-lowering medication.

Table 3
The joint impact of cardiovascular risk factors upon medical costs in the Ohsaki Study, Japan, 1996–2001

No. of risks	N	Person-months	Inpatient costs						Outpatient costs	
			Adjusted cost[a], $				Risk-attributable costs[b], $	RAC%[c] (%)	Adjusted cost[a], $	
				(95%CI)	P-value	Increasing rate (%)				(95%CI)
0	4821	323,036	76.2	(65.3–87.1)	(Referent)	(Referent)			117.2	(111.9–122.6)
1										
Overweight/obesity[d]	1839	123,039	82.8	(65.2–100.4)	0.99	8.7	812,054	1.1	120.4	(111.8–129.0)
Hypretension[e]	2661	177,066	95.3	(80.6–110.0)	0.47	25.1	3,381,967	4.5	161.9	(154.7–169.1)
Hyperglycemia[f]	349	23,080	126.7	(86.6–166.8)	0.25	66.3	1,165,524	1.5	160.2	(140.5–179.9)
2										
Overweight/obesity[d]+ Hypretension[e]	1971	131,829	111.1	(94.2–128.1)	0.017	45.8	4,600,825	6.1	170.1	(161.8–178.4)
Overweight/obesity[d]+ Hyperglycemia[f]	149	10,117	105.4	(44.2–166.7)	0.98	38.3	295,418	0.4	173.4	(143.4–203.5)
Hypretension[e]+ Hyperglycemia[f]	321	20,718	134.7	(92.7–176.7)	0.13	75.8	1,211,976	1.6	223.5	(202.9–244.1)
3										
Overweight/obesity[d]+ Hypretension[e]+ Hyperglycemia[f]	229	15,173	158.2	(108.7–207.7)	0.034	107.6	1,244,169	1.6	211.2	(186.9–235.5)
Total	12,340	824,056					12,711,934	16.8		

CI denotes confidence interval. RAC% denotes percentage of risk-attributable medical costs.

[a] Tested by analysis of covariance (ANCOVA) adjusted by age at baseline (continuous variable), sex, smoking (current smoker, past smoker, or never smoker), and alcohol drinking (current drinker, past drinker, or never drinker).

[b] The increment in medical costs attribute to cardiovascular risk factors were calculated by multiplying the adjusted excess costs by the number of person-months observed.

[c] The proportion of medical costs in the entire cohort that would not occur if no one had cardiovascular risk factors, which were calculated by dividing the risk-attributable medical costs by the total medical costs for entire cohort during the 6-years of observation period.

[d] Body Mass Index ≥25.

[e] Blood pressure ≥140/90 mm Hg or self-report of taking antihypertensive medication.

[f] Casual blood glucose ≥150 mg/dl or self-reported history of diabetes.

Table 3 lists the monthly mean medical costs according to the combination of cardiovascular risk factors. Medical costs increased significantly as the number of risk factors increased. Subjects without any of overweight/obesity, hypertension, and hyperglycemia (the 'no-risk-factor' group) had an adjusted mean total medical cost of $193.4 per month. Relative to this group, among subjects who had one risk factor, the presence of overweight/obesity alone was associated with a 5.1% increase in total medical costs, but this was not statistically significant; the presence of hypertension alone was associated with a 33.0% significant increase in total medical costs, and the presence of hyperglycemia alone was associated with a 48.3% significant increase. The combinations of overweight/obesity+hypertension, overweight/obesity+hyperglycemia, and hypertension+hyperglycemia were associated with 45.4%, 44.2%, and 85.2% increases in total medical costs, respectively. Subjects who had all three risk factors had total medical costs that were 91.0% higher than those of the no-risk-factor group.

During the 6-year observation period, the whole study population consumed medical costs totaling $192.6 million (824,056 person-months). Risk-attributable medical costs for each risk category were estimated by multiplying the excess cost and the person-months for each risk category observed. For example, the risk-attributable total medical cost for overweight/obesity alone was estimated by multiplying the adjusted total excess cost per individual who had the single risk factor of overweight/obesity ($9.8) by the associated person-months (123,039 person-months). By multiplying these values, it was estimated that a medical cost of $1.2 million (0.6%) was attributable to this risk factor. Although the degree of increase in medical cost per individual was greater among subjects with hyperglycemia alone than among subjects with hypertension alone, the RAC% for hyperglycemia alone was smaller than that for hypertension because of its lower prevalence. Total RAC% was 17.2%. RAC% for inpatient medical care was 16.8%, and that for outpatient care was 17.5%. There was no notable interaction between risk categories and age or sex in adjusted mean total cost.

For sensitivity analysis, we redefined overweight/obesity, hypertension, hyperglycemia, and dyslipidemia and re-estimated the economic impact of these factors (Table 4). Among subjects who had BP ≥140/90 mm Hg, 42.2% reported taking antihypertensive medication. Among subjects who had a casual blood glucose level of ≥150 mg/dl, 32.0% reported a history of diabetes. Among subjects who had a casual serum cholesterol level of ≥220 mg/dl or HDL <40 mg/dl, 4.0% reported taking lipid-lowering medication. Self-reporting of antihypertensive medication and a self-reported history of diabetes, and a BMI of ≥30 were associated with significantly increased total medical cost (P <0.0001, <0.0001, 0.0030, respectively). Subjects who self-reported taking lipid-lowering

				Total costs					
		Risk-attributable costs[b], $	RAC%[c] (%)	Adjusted cost[a], $				Risk-attributable total costs[b], $	RAC%[c] (%)
P-value	Increasing rate (%)				(95%CI)	*P*-value	Increasing rate (%)		
(Referent)	(Referent)			193.4	(180.8–206.0)	(Referent)	(Referent)		
0.99	2.7	393,723	1.3	203.2	(182.8–223.6)	0.99	5.1	1,204,956	0.6
0.0010	38.1	7,914,864	6.8	257.2	(240.1–274.3)	<0.0001	33.0	11,298,260	5.9
<0.0001	36.7	992,427	0.8	286.9	(240.3–333.5)	0.038	48.3	2,157,869	1.1
0.0074	45.1	6,973,743	6.0	281.2	(261.5–300.9)	<0.0001	45.4	11,575,527	6.0
0.0003	48.0	568,579	0.5	278.9	(207.7–350.0)	0.28	44.2	864,735	0.4
<0.0001	90.7	2,202,274	1.9	358.3	(309.5–407.0)	<0.0001	85.2	3,415,376	1.8
<0.0001	80.2	1,426,243	1.2	369.4	(311.9–426.9)	<0.0001	91.0	2,670,227	1.4
		20,471,853	17.5					33,186,950	17.2

medication had a higher mean cost than those with a serum cholesterol level of <220 mg/dl and HDL ≥40 mg/dl and who did not self-report taking lipid-lowering medication, but the difference was not significant ($P=0.76$). Among subjects who did not self-report a history of diabetes, those who had a blood glucose level of ≥150 mg/dl and <200 mg/dl had a significantly higher mean total cost than those who had a blood glucose level of <150 mg/dl ($P=0.017$).

Discussion

Mean medical cost among subjects who were overweight/obese, hypertensive, and hyperglycemic was 91.0% higher than that among subjects without any of these three risk factors, after adjustment for a variety of potential confounders. In this cohort, 17.2% of the total medical cost was attributable to these three cardiovascular risk factors.

One cohort study in Korea (Jee et al., 2001) and one cohort study in the U.S. (Anderson et al., 2000) have estimated RAC % for combination of cardiovascular risk factors in terms of total medical costs. Anderson et al., based on a prospective observation of a large employee cohort in the U.S., reported the RAC% for obesity, hyperglycemia, and hypertension of 6.3% (Anderson et al., 2000). In their study, dyslipidemia was not associated with any increase in medical cost. Jee et al. (2001) found that the RAC% for obesity, hyperglycemia, and hypertension was 10.4% for men and 5.5% for women, using a large employee cohort in Korea. In the present study, the RAC% for overweight/obesity, hyperglycemia, and hypertension was 17.2%, and was thus higher than in the previous studies. This may have been partly due to the fact that the previous studies were based on observations of healthy young workers; the impact of cardiovascular risk factors upon medical costs would become larger with age. In addition, as these previous studies excluded subjects who became too ill to work during the follow-up, they would have underestimated the impact of cardiovascular risks upon medical costs.

The result of sensitivity analysis (Table 4) showed that being on treatment at the baseline rather than having a raised level of risk factors without treatment was associated with higher cost. Especially in hyperglycemia, most of the costs associated with hyperglycemia were attributable to diabetes rather than pre-diabetic hyperglycemia.

Study limitations and strengths

The present study had a number of strengths. First, we followed up a large population-based cohort retaining the elderly and those who became ill during follow-up. In our cohort, only 921 subjects (7.5%) withdrew from the NHI and were thus lost to follow-up because of emigration. Second,

Table 4
Adjusted monthly medical costs by the cardiovascular risk status in the Ohsaki Study, Japan, 1996–2001

		N	Adjusted cost[a], S (95%CI)	P-value	Increasing rate (%)
Overweight/Obesity	Body Mass Index <25	8152	226.6 (216.8–236.3)	(Referent)	(Referent)
	Body Mass Index ≥25 and <30	3747	242.3 (228.0–256.7)	0.17	7.0
	Body Mass Index ≥30	421	299.9 (257.2–342.5)	0.0030	32.4
Hypertension	Without self-report of taking antihypertensive medication				
	Systolic BP <140 mm Hg and diastolic BP <90 mm Hg	7158	202.9 (192.5–213.3)	(Referent)	(Referent)
	Systolic BP ≥140 mm Hg or diastolic BP ≥91 mm Hg	2247	223.0 (204.6–241.4)	0.15	9.9
	Self-report of taking antihypertensive medication	2935	317.7 (301.3–334.1)	<0.0001	56.6
Hyperglycemia	Without self-reported history of diabetes				
	Casual blood glucose <150 mg/dl	11,292	225.8 (217.6–234.0)	(Referent)	(Referent)
	Casual blood glucose ≥150 mg/dl and <200 mg/dl	354	296.6 (250.2–343.0)	0.017	31.4
	Casual blood glucose ≥200 mg/dl	111	255.9 (173.2–338.6)	0.89	13.3
	Self-reported history of diabetes	583	348.5 (312.2–384.8)	<0.0001	54.4
Dyslipidemia	Without self-report of taking lipid-lowering medication				
	Casual serum cholesterol <220 mg/dl and HDL ≥40 mg/dl	6790	235.1 (224.5–245.7)	(Referent)	(Referent)
	Casual serum cholesterol ≥220 mg/dl or HDL <40 mg/dl	5328	231.4 (219.4–243.4)	0.9	−1.6
	Self-report of taking lipid-lowering medication	222	256.5 (198.0–315.1)	0.76	9.1

CI denotes confidence interval. BP denotes blood pressure. HDL denotes high-density lipoprotein.

[a] Tested by analysis of covariance (ANCOVA) using non-log-transformed data on charges adjusted by age at baseline (continuous variable), sex, smoking (current smoker, past smoker, or never smoker), alcohol drinking (current drinker, past drinker, or never drinker), and comorbid condition of other three cardiovascular risk factors.

because NHI claim files were obtained directly from the local NHI Association and included almost all available medical treatment, our charge calculation was accurate. Third, in this study, the joint impact of cardiovascular risk factors was analyzed after adjustment for a variety of potential confounders.

Our study also had some limitations. Among all this study population, participation rate in the annual health check-up was as low as 33.3%. However, the participation rate in the annual health check-up was similar to that for Japan as a whole. According to the Ministry of Health, Labour and Welfare, the participation rate in the annual health check-up in Japan was 36.5% in 1995. Second, only 24.1% of the study population participated in the annual health check-up and had no prior history of cancer, stroke, or myocardial infarction and were available for the present study. The present study subjects were less likely to be hypertensive and hyperglycemic and might have been healthier than the rest of the study population. Therefore, we might have underestimated the RAC% because of the lower prevalence of cardiovascular risk factors in these individuals. Third, the present study does not prove whether prevention of these cardiovascular risk factors can reduce medical costs. Further interventional strategies could reduce these cardiovascular risk factors and potentially lower medical costs. Fourth, we did not identify individual reasons for medical treatment, and thereby we were unable to distinguish treatment costs from comorbid costs. However, each of the cardiovascular risk factors was associated with an increase not only in outpatient medical costs but also inpatient medical cost. In Japan, because hypertension and obesity rarely become main reasons for hospitalization, inpatient costs mainly reflect the costs of comorbidity. Moreover, the fact that RAC% for inpatient care was comparable to RAC% for outpatient care (16.8% vs. 17.5%) implies that overweight/obesity, hypertension, and hyperglycemia are related to not only high prescription costs for treatment of the primary disease but also severe medical events requiring inpatient treatment.

Conclusion

We have demonstrated that 17.2% of medical costs are attributable to overweight/obesity, hypertension, and hyperglycemia. These cardiovascular risk factors could have a large impact on health care resources in rural Japan.

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References

Anderson, D.R., Whitmer, R.W., Goetzel, R.Z., Ozminkowski, R.J., Dunn, R.L., Wasserman, J., Serxner, S., Health Enhancement Research Organization (HERO) Research Committee, 2000. The relationship between modifiable health risks and group-level health care expenditures. Health Enhancement Research Organization (HERO) Research Committee. Am. J. Health Promot. 15, 45–52.

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

Brown, J.B., Nichols, G.A., Glauber, H.S., Bakst, A.W., 1999. Type 2 diabetes: incremental medical care costs during the first 8 years after diagnosis. Diabetes Care 22, 1116–1124.

Chenoweth, D., 2004. The medical cost of high serum cholesterol in Harris County, Texas. Tex. Med. 100, 50–53.

Chobanian, A.V., Bakris, G.L., Black, H.R., Cushman, W.C., Green, L.A., Izzo Jr., J.L., Jones, D.W., Materson, B.J., Oparil, S., Wright Jr., J.T., Roccella, E.J., National Heart, Lung, and Blood Institute Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, National High Blood Pressure Education Program Coordinating Committee, 2003. The seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure: the JNC 7 report. JAMA 289, 2560–2572.

Daviglus, M.L., Liu, K., Greenland, P., Dyer, A.R., Garside, D.B., Manheim, L., Lowe, L.P., Rodin, M., Lubitz, J., Stamler, J., 1998. Benefit of a favorable cardiovascular risk-factor profile in middle age with respect to Medicare costs. N. Engl. J. Med. 339, 1122–1129.

Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults, 2001. Executive summary of the third report of the national cholesterol education program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III). JAMA 285, 2486–2497.

Ford, E.S., Giles, W.H., Dietz, W.H., 2002. Prevalence of the metabolic syndrome among US adults: findings from the third National Health and Nutrition Examination Survey. JAMA 287, 356–359.

Fries, J.F., Koop, C.E., Beadle, C.E., Cooper, P.P., England, M.J., Greaves, R.F., Sokolov, J.J., Wright, D., The Health Project Consortium, 1993. Reducing health care costs by reducing the need and demand for medical services. N. Engl. J. Med. 329, 321–325.

Goetzel, R.Z., Anderson, D.R., Whitmer, R.W., Ozminkowski, R.J., Dunn, R.L., Wasserman, J., 1998. The relationship between modifiable health risks and health care expenditures. An analysis of the multi-employer HERO health risk and cost database. The Health Enhancement Research Organization (HERO) Research Committee. J. Occup. Environ. Med. 40, 843–854.

Greenland, P., Knoll, M.D., Stamler, J., Neaton, J.D., Dyer, A.R., Garside, D.B., Wilson, P.W., 2003. Major risk factors as antecedents of fatal and nonfatal coronary heart disease events. JAMA 290, 891–897.

Haffner, S., Taegtmeyer, H., 2003. Epidemic obesity and the metabolic syndrome. Circulation 108, 1541–1545.

Hodgson, T.A., Cohen, A.J., 1999. Medical care expenditures for diabetes, its chronic complications, and its comorbidities. Prev. Med. 29, 173–186.

Hogan, P., Dall, T., Nikolov, P., American Diabetes Association, 2003. Economic costs of diabetes in the US in 2002. Diabetes Care 26, 917–932.

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. Int. J. Epidemiol. 30, 616–621.

Jee, S.H., O'Donnell, M.P., Suh, I., Kim, I.S., Korea Medical Insurance Corporation, 2001. The relationship between modifiable health risks and future medical care expenditures: the Korea Medical Insurance Corporation (KMIC) Study. Am. J. Health Promot. 15, 244–255.

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. Int. J. Obes. Relat. Metab. Disord. 26, 1069–1074.

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

Lynch, W.D., Chikamoto, Y., Imai, K., Lin, T.F., Kenkel, D.S., Ozminkowski, R.J., Goetzel, R.Z., 2005. The association between health risks and medical expenditures in a Japanese corporation. Am. J. Health Promot. 19, 238–248.

Nakamura, K., Okamura, T., Kanda, H., Hayakawa, T., Kadowaki, T., Okayama, A., Ueshima, H., Health Promotion Research Committee of the Siga National Insurance Organizations, 2005. Impact of hypertension on medical economics: a 10-year follow-up study of national health insurance in Shiga, Japan. Hypertens. Res. 28, 859–864.

Nichols, G.A., Brown, J.B., 2005. Higher medical care costs accompany impaired fasting glucose. Diabetes Care 28, 2223–2229.

Oliva, J., Lobo, F., Molina, B., Monereo, S., 2004. Direct health care costs of diabetic patients in Spain. Diabetes Care 27, 2616–2621.

Organisation for Economic Co-operation and Development, 2005. OECD Health Data 2005: Statistics and Indicators for 30 Countries 2005 Edition. OECD Publishing (CD-ROM).

Quesenberry Jr., C.P., Caan, B., Jacobson, A., 1998. Obesity, health services use, and health care costs among members of a health maintenance organization. Arch. Intern. Med. 158, 466–472.

Raebel, M.A., Malone, D.C., Conner, D.A., Xu, S., Porter, J.A., Lanty, F.A., 2004. Health services use and health care costs of obese and nonobese individuals. Arch. Intern. Med. 164, 2135–2140.

Ray, G.T., Collin, F., Lieu, T., Fireman, B., Colby, C.J., Quesenberry, C.P., Van den Eeden, S.K., Selby, J.V., 2000. The cost of health conditions in a health maintenance organization. Med. Care Res. Rev. 57, 92–109.

SAS Institute Inc., 2004. SAS/STAT 9.1 User's Guide. SAS Institute Inc, Cary, NC.

Schauffler, H.H., D'Agostino, R.B., Kannel, W.B., 1993. Risk for cardiovascular disease in the elderly and associated Medicare costs: the Framingham. Study. Am. J. Prev. Med. 9, 146–154.

Selby, J.V., Ray, G.T., Zhang, D., Colby, C.J., 1997. Excess costs of medical care for patients with diabetes in a managed care population. Diabetes Care 20, 1396–1402.

Stamler, J., Dyer, A.R., Shekelle, R.B., Neaton, J., Stamler, R., 1993. Relationship of baseline major risk factors to coronary and all-cause mortality, and to longevity: findings from long-term follow-up of Chicago cohorts. Cardiology 82, 191–222.

Stamler, J., Stamler, R., Neaton, J.D., Wentworth, D., Daviglus, M.L., Garside, D., Dyer, A.R., Liu, K., Greenland, P., 1999. Low risk-factor profile and long-term cardiovascular and noncardiovascular mortality and life expectancy: findings for 5 large cohorts of young adult and middle-aged men and women. JAMA 282, 2012–2018.

Thompson, D., Wolf, A.M., 2001. The medical-care cost burden of obesity. Obes. Rev. 2, 189–197.

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. J. Epidemiol. 8, 258–263.

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 Cohort Study. Int. J. Epidemiol. 32, 809–814.

Wilson, P.W., D'Agostino, R.B., Levy, D., Belanger, A.M., Silbershatz, H., Kannel, W.B., 1998. Prediction of coronary heart disease using risk factor categories. Circulation 97, 1837–1847.

World Health Organization, 2000. Obesity. Preventing and Managing the Global Endemic. WHO Technical Report Series no 894. WHO, Geneva.

（2）学会発表

[学会発表]

1. 辻　一郎，大森　芳，島津太一，賓澤　篤，栗山進一．
基本健康診査成績と医療費との関連−大崎国保研究から−．
第27回日本医学会総会，大阪，2007年．

ひと−S04　人間ドックの費用対効果 −なにがいくらでどこまでできるか−

●日時／4月7日(土)9:00〜11:00　●場所／(桂)リーガロイヤルホテル2F（第1・3会場）

1 基本健康診査成績と医療費との関連−大崎国保コホート研究から−

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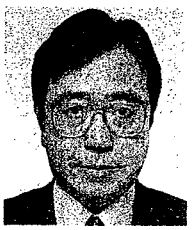

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肥満、高血圧、高血糖は、相互に合併しやすく、合併することで循環器疾患の発生リスクが相乗的に高まることが報告されている。その結果として医療費も相乗的に増加すると思われるが、そのデータは乏しい。追跡調査により、基本健康診査成績がその後7年間の医療費に及ぼす影響を分析した。

対象は、平成6年10月に宮城県大崎保健所管内に居住していた40〜79歳の国民健康保険加入者で生活習慣アンケート調査に回答した者52,029名（回収率：94.6%）のうち、平成7年度基本健康診査を受診した16,683名である。

基本健康診査の結果から、肥満（Body Mass Index 25以上）、高血圧（血圧値140/90mmHg以上または高血圧既往あり）、高血糖（血糖値150mg/dl以上または糖尿病既往歴あり）の有無を判定し、それらの組み合せ別に、平成8年1月から同14年12月までの医療費を比較した。

性・年齢・喫煙・飲酒で補正した1月あたり平均医療費は、肥満・高血圧・高血糖のいずれも該当しない群（受診者の39.1%）で19,343円（95% 信頼区間：18,890-19,796）であった。その群に比べて、肥満、高血圧、高血糖のいずれか1つある群の医療費は、それぞれ1.05倍、1.30倍、1.42倍となった。同様に、肥満と高血圧のある群では1.40倍、肥満と高血糖のある群では1.34倍、高血圧と高血糖のある群では1.75倍であった。肥満・高血圧・高血糖のすべてある群（受診者の1.9%）の医療費は1.99倍であった。

肥満・高血圧・高血糖という動脈硬化危険因子の集積は、医療費をも相乗的に増加させる。健診後に適切な事後指導や治療を行うことの重要性が示唆された。

（３）新聞報道

［新聞報道］

1．日本経済新聞，2007年4月8日．

肥満・高血圧・高血糖ご注意

医療費は2倍に

東北大調査

肥満、高血圧、高血糖の三つを併せ持つ人は、まったく持たない人に比べ医療費が二倍かかることが東北大学の辻一郎教授らの調査で分かった。日本医学会総会で七日、発表した。

調査は宮城県北部の大崎保健所管内に住む四十―七十九歳の約一万六千七百人を対象に一九九六年―二〇〇二年までの医療費を比べた。一カ月あたりの医療費は肥満や高血圧、高血糖のいずれにも当てはまらない人の平均が一万九千三百四十三円。三つ全部に該当する人の平均は三万八千五百二十一円と約二倍。いずれか一つが当てはまる人では肥満のみの人が一・〇五倍、高血圧が一・三倍、高血糖が一・四二倍。二つが当てはまるケースでは肥満と高血圧の組み合わせが一・四倍、肥満と高血糖が一・三四倍、高血圧と高血糖が一・七五倍だった。

肥満や高血圧、高血糖は運動不足や不規則な生活が原因。こうした状態が複数あると動脈硬化を招き、心筋梗塞（こうそく）や脳梗塞になりやすくなる。糖尿病などが発症する危険性が高まる。

辻教授は「生活習慣を改善すれば心筋梗塞などは予防でき、医療費も大幅に減る」と強調している。

2．日本経済新聞，2007年5月21日．

喫煙・肥満で医療費増える？

3年かけ5万人分析

厚労省研究班、平均余命も

たばこを吸う人や肥満の人と、そうでない人とでは一生涯にかかる医療費がどちらが高いかを明らかにする国の大規模比較研究が近くスタートする。欧米でも未決着の研究テーマ。五万人超の住民データを分析し三年後メドに結論を出す。

担当するのは、東北大学の辻一郎教授や奈良女子大学の高橋裕子教授を中心とする厚生労働省研究班。辻教授らは一九九五年から宮城県に住む四十―七十九歳の約五万二千人を対象に生活習慣や医療費などを追跡調査しており、このデータを使う。

喫煙、肥満、運動不足、飲酒過多、高血圧、高血糖などの有無を分析、各項目と医療費との関係を割り出す。さらに住民があと何年生きることができるかを示す平均余命との関係も導き出し、一生涯の医療費を推定する。

これまでに肥満、高血圧、高血糖のすべてに該当する人は、まったく該当しない人に比べ一カ月当たりの医療費が二倍かかることが分かっている。心筋梗塞（こうそく）や糖尿病などの発症リスクが高くなるのが理由。

ただ、喫煙や肥満で余命は短くなるとみられ、長生きの非喫煙者などより一生涯の医療費は安くなるという見方もある。

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「生活習慣・健診結果が生涯医療費に及ぼす影響に関する研究」
（H19−政策−一般−026）

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