Burden of Cardiovascular Risk Factors on the Frequency of Medical Consultations Among Japanese National Health Insurance Beneficiaries

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SUMMARY

Background：Data from the Organization for Economic Co-operation and Development（OECD）show that Japan among OECD countries has the highest average number of medical consultations. The present study estimates the burden of cardiovascular risk factors on the frequency of medical consultations among Japanese National Health Insurance beneficiaries.

Methods and Results：We analyzed data from 3,648 individuals aged 40-74 years who had participated in health checks that were linked to monthly medical expenditure records with billing dates. The odds ratios（ORs）of factors for the prevalence of frequent medical consultations were calculated using a multivariable logistic regression analysis. The population attributable fractions（PAF）of each factor for such prevalence defined as over 12 medical consultations per year were also calculated as days. The odds ratios of hypertension, dyslipidemia and diabetes were 2.5（95% confidence interval（CI）：2.1, 2.9）, 2.3（95% CI：1.9, 2.7）and 2.3（95% CI：1.7, 3.1）, respectively and the PAF were 29.0%, 20.5%, and 5.8%, respectively. The odds ratios of hypertension in men and women were 2.6（95% CI：2.2, 3.3）and 2.6（95% CI：2.1, 3.2）, respectively with PAF of 33.4% and 27.4%, respectively.

Conclusions：Hypertension imposes the largest burden on the frequency of medical consultations among examined factors. Therefore, preventing incident hypertension might be the most important factor influencing medical expenditures.

Key Words：hypertension, population attributable fraction, medical cost, outpatient

INTRODUCTION

Increasing medical expenses have become a significant problem in various countries[1]. The estimated expenditure for national medical care in Japan during 2008 was 36.8% for inpatients and 53.2% for outpatients（including pharmacy）and these costs are expected to continuously increase[2]. Outpatient care that includes medical consultations and drug costs comprise over half of the national medical care expenditure in Japan. The Organization for Economic Co-operation and Development（OECD）data for 2009 show that the average number of medical consultations per individual per year in Japan is 13.4, compared with 6.5 in other OECD countries. The Japanese average is the highest among OECD countries and over three-fold that in the USA[1]. Over half of the national medical care expenditure on outpatients was for individuals

aged over 65 years[3]. Elderly outpatients generally have chronic diseases that require frequent treatment such as hypertension, renal failure and cardiac ischemia, metabolic syndrome, chronic obstructive pulmonary and liver diseases[4]. The number of patients with lifestyle-related diseases has increased in Japan; thus, measures have been implemented to reduce the incidence of such diseases. One measure that has been implemented since 2008 is that all insured individuals aged 40-74 years are obligated to undergo annual health checks (and if necessary, health guidance) to focus on preventing lifestyle-related diseases and metabolic syndrome[5]. These diseases require continuous medication and can lead to even more serious conditions that impose further medical expense. Evidence to support a decision to prioritize certain controllable risk factors is required since health care resources are limited.

Many studies have addressed the burden of risk factors such as hypertension[6~9], obesity[10,11], diabetes mellitus[12~14], cardiovascular disease[15,16], serum alanine aminotransferase levels[17], chronic kidney disease[18], proteinuria[19], alcohol consumption[20] and smoking habit[21,22] on medical care expenditure for various categories of inpatients, outpatients and pharmacies. The proportion of medical care expenditure across these three categories (inpatients, outpatients and pharmacies) is highest for diseases of the circulatory system such as hypertension, cardiac ischemia and cerebrovascular diseases[23]. The highest burden on medical care expenditures of outpatients is unknown because most surveys used medical expenditure records that depended on one main diagnosis among several. Selection and concentration are needed because resources for disease prevention such as budgets, public health nurses and physicians are limited. However, modifiable cardiovascular risk factors among outpatients who frequently consult physicians have not been comprehensively analyzed. Thus, the most critical factor for controlling the incremental burden of outpatients has remained unknown. Specific health checks focus on preventable hypertension, diabetes and dyslipidemia that are risk factors for cardiovascular disease. Thus, the present study examines the burden of each factor on the frequency of outpatient consultations among Japanese National Health Insurance beneficiaries.

METHODS

Data collection

Data were collected from Japanese beneficiaries of the National Health Insurance (NHI) system in Shimotsuke, Japan. The study area comprised 59,392 (29,433 men, 29,959 women) residents and 26,466 (13,344 men, 13,122 women) of them were aged 40-74 years in 2009. A total of 15,568 (26.1%) residents were NHI beneficiaries, of whom 9,803 (37.0%) were aged 40-74 years. We enrolled 3,648 (13.8%) (1,544 men and 2,104 women) beneficiaries aged 40-74 years who had undergone health checks between April 2009 and March 2010. The essential examination items measured during the health checkups included blood pressure, serum triglycerides, high-density lipoprotein cholesterol, fasting blood sugar or hemoglobin A_{1c}, and abdominal circumference as an index of visceral fat obesity. The Tochigi Public Health Service Association and several medical institutions conducted health checks. Accuracy control at all of these institutions was under external investigations by appropriate agencies such as the Japan Medical Association and each institution also implemented regular internal investigations. The Tochigi Public Health Service Association examined 1,619 persons and 2,029 were examined at 26 medical institutions. The beneficiaries were linked to health check data by personal code, gender, birthday and address code.

Health check data and medical expenditure records that included the number of medical consultations as outpatients were collected from the Shimotsuke City Government. The data were depersonalized to ensure anonymity.

The institutional review board of Dokkyo Medical University School of Medicine approved the study protocol.

Frequency of medical consultations

The outpatients were linked to monthly medical expenditure records with billing dates between May 2009 and April 2010. The medical consultation dates on most of the linked medical expenditure records were between April 2009 and March 2010 (Japanese fiscal year). Medical expenditure records included the number of outpatient medical consultations expressed

Table 1　Characteristics of study subjects

	Total		Men		Women		p-value
	n	Ave.±SD	n	Ave.±SD	n	Ave.±SD	
Age（years）	3648	64.6±7.9	1544	65.0±7.9	2104	64.3±7.8	0.0095
BMI（kg/m²）	3648	23.3±3.3	1544	23.7±2.9	2104	23.0±3.5	＜.0001
Abdominal Circumference（cm）	3647	83.6±8.9	1544	85.1±7.9	2103	82.5±9.4	＜.0001
Systolic Blood Pressure（mmHg）	3648	129.8±16.4	1544	131.5±15.7	2104	128.6±16.8	＜.0001
Diastolic Blood Presure（mmHg）	3648	76.3±10.5	1544	78.1±10.2	2104	75.0±10.5	＜.0001
HDL Cholesterol（mg/dL）	3647	63.5±17.0	1544	57.8±15.4	2103	67.7±16.8	＜.0001
Triglycerides（mg/dL）	3648	113.8±68.6	1544	127.1±83.3	2104	104.0±53.4	＜.0001
LDL Cholesterol（mg/dL）	3648	124.8±28.9	1544	120.4±28.3	2104	128.0±28.8	＜.0001
Fasting Blood Glucose（mg/dL）	3311	99.6±18.9	1386	103.2±22.2	1925	96.9±16.3	＜.0001
HbA1c（%）	338	5.8±0.8	159	5.9±0.9	179	5.7±0.6	0.0265

p-value：tested by t-test

HbA1c（%）：the data is presented as National Glycohemoglobin Standardization Program（NGSP）

as days. We defined ≥12 medical outpatient consultations between May 2009 and April 2010 as frequent. We therefore presumed that outpatients consult physicians at least once a month.

Statistical analysis

Hypertension was defined as systolic blood pressur ≥140 mmHg and/or diastolic blood pressure ≥90 mmHg according to the World Health Organization（WHO）classification[24,25] or use of anti-hypertensive medication. Dyslipidemia was defined as serum triglycerides ≥150 mg/dL and/or high-density lipoprotein cholesterol ＜40 mg/dL according to the Third Report of the National Cholesterol Education Program（NCEP）Expert panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults（ATP III）[26] or the use of anti-dyslipidemic medication. Diabetes was defined according to the WHO classification as fasting plasma glucose ≥126 mg/dL[27] and/or hemoglobin A_{1c} ≥6.1% according to the Japan Diabetes Society（JDS）[28,29] or the use of anti-diabetic medication. Values for HbA_{1c}（%）were estimated as National Glycohemoglobin Standardization Program（NGSP）equivalent values（%）and were calculated using the formula HbA_{1c}（%）＝HbA_{1c}（JDS）（%）＋0.4%, considering the relational expression of HbA_{1c}（JDS）（%）determined according to previous Japanese standard substance and measurement methods and HbA_{1c}（NGSP）[30].

The odds ratios（OR）of each risk factor for the fre-

quency of medical consultations were calculated using a multivariable logistic regression analysis. The population attributable fractions（PAF）of each risk factor for the frequency of medical consultations were calculated using the formula：

$$PAF = 1 - \sum \frac{p}{OR}$$

where p is the proportion of exposure, and OR is the odds ratio.

The PAF is most commonly defined as a proportional reduction in average disease risk over a specified interval that would be achieved by eliminating the exposure of interest from the population while the distributions of other risk factors in the population remain constant. This can also be interpreted as diseases over a specific period that would be prevented by eliminating the exposure, assuming that exposure is causal[31].

All data were analyzed using the statistical package SAS 9.1.

RESULTS

Table 1 shows the characteristics of patients who completed health checks and had medical expenditures records. The mean age of the patients was 64.6（men, 65.0；women, 64.3）years. Mean values for BMI, abdominal circumference, systolic blood pressure, diastolic blood pressure, triglycerides, fasting blood glucose and HbA_{1c} were statistically higher in men than in women（all p＜0.05）, whereas those for HDL- and

Table 2 Odds ratios and PAF for prevalence of outpatient consultations（≥12 days/year）according to hypertension, dyslipidemia, and diabetes*

	Factor	proportion of exposure（%）	odds ratio adjusted for age（95% CI）[†]			PAF（%）[‡]	odds ratio adjusted for all（95% CI）[†]			PAF（%）[‡]
Total										
	hypertension	48.8	3.03	(2.51 −	3.66)	32.67	2.47	(2.12 −	2.88)	29.04
	dyslipidemia	37.0	2.82	(2.30 −	3.46)	23.88	2.25	(1.91 −	2.65)	20.54
	diabetes	10.2	4.31	(2.73 −	6.79)	7.83	2.29	(1.68 −	3.13)	5.75
Men										
	hypertension	54.3	3.18	(2.44 −	4.15)	37.19	2.60	(2.17 −	3.27)	33.4
	1dyslipidemia	38.5	2.19	(1.66 −	2.89)	20.90	1.93	(1.51 −	2.45)	8.49
	diabetes	14.3	5.35	(2.99 −	9.60)	11.64	2.57	(1.75 −	3.77)	8.74
Women										
	hypertension	44.7	3.18	(2.42 −	4.18)	30.64	2.58	(2.08 −	3.20)	27.40
	dyslipidemia	35.9	4.09	(2.96 −	5.66)	27.15	2.67	(2.12 −	3.37)	22.49
	diabetes	7.2	3.62	(1.75 −	7.52)	5.20	2.49	(1.44 −	4.32)	4.30

*hypertension：SBP≥140 mmHg or DBP≥90 mmHg or medicated, dyslipidemia：150 mg/dl≥Triglycerides or HDL Cholesterol<40 mg/dl or medicated, diabetes：Fasting Blood Glucose ≥126 mg/dl or A_{1c}≥6.5 or medicated（National Glycohemoglobin Standardization Program）.

[†]Calculated by logistic regression analysis all：age, hypertension, dyslipidemia, diabetes.

[‡]PAF：Population attributable fraction.

LDL-cholesterol were statistically higher in women than in men（p<0.05）.

Table 2 shows the multivariable OR and PAF of risk factors for the frequency of medical consultations. The multivariable OR of hypertension was highest among men and overall. The ORs for hypertension, dyslipidemia, diabetes and the frequency of medical consultations associated with each factor among men were 2.6（95% CI：2.2, 3.3）, 1.9（95% CI：1.5, 2.5）, 2.6（95% CI：1.8, 3.8）, respectively. These values for women were 2.6（95% CI：2.1, 3.2）, 2.7（95% CI：2.1, 3.4）and 2.5（95% CI：1.4, 4.3）, respectively. The OR for hypertension was 2.5（95% CI：2.1, 2.9）for the men and women combined. On the other hand, the PAF of hypertension was highest in men and in women, as well as in the total. The PAF of hypertension for frequent medical consultations was 33.4%, 27.4% and 29.0% in men, women and in the total of both, respectively.

DISCUSSION

To the best of our knowledge, this is the first study to show that among the three measured factors（hypertension, dyslipidemia and diabetes）hypertension imposed the highest burden on the frequency of medi-

cal consultations within the Japanese NHI system. Therefore, incident hypertension could be the most critical risk factor affecting medical economics in Japan.

Many studies have revealed the burden of risk factors such as hypertension[6~9,32,33], obesity[10,34], diabetes mellitus[12~14], cardiovascular disease[15] on medical care expenditure for one or more categories of inpatients, outpatients and pharmacy worldwide. However, few studies have examined the frequency of medical consultations in terms of cardiovascular disease（CVD）risk factors.

A Japanese survey of patients estimated that 471, 147 and 93 outpatients/100,000 individuals/day were associated with hypertensive disease, diabetes mellitus and hyperlipidemia, respectively[23]. Another study of medical expenditure taken from NHI records found that 11,869 and 3,393 outpatients/100,000 beneficiaries/day were associated with hypertension and diabetes mellitus, respectively[35]. These findings revealed that the estimated rate of outpatients with hypertension was higher than that of other risk factors. However, the patients in these studies were surveyed at a fixed point, and the study using medical expenditure records depended on one main diagnosis among sever-

al diagnoses. Therefore, the results of these studies might not show the actual frequency of medical consultations for specific diseases. Our study of the frequency of medical consultations intended to clarify which diseases were treated most frequently and we identified hypertension as the most common condition among outpatients. A 10-year follow-up study of 4,191 Japanese NHI beneficiaries aged 40-69 years found that outpatient medical expenditures for hypertension-related conditions are increasing regardless of the grade of hypertension（pre-hypertension, Stages 1 and 2）[7]. Therefore, hypertension should be prevented rather than controlled to reduce hypertension- related medical expenditures.

The American Heart Association estimated that the prevalence of hypertension in the USA is 73（males, 34；females, 39）million, meaning that almost one third of all adults≥20 years of age is hypertensive. The prevalence of physician-diagnosed diabetes mellitus is 15.1（males, 7.6；females, 7.5）million, 7.3% in adults and 10.1% in adults if undiagnosed diabetes is included[36]. The Behavioral Risk Factor Surveillance （BRFFS）of non-institutionalized adults in the USA found that the estimated prevalences of hypertension and diabetes are 28.3% and 8.1%, respectively, in those≥18 years of age[37]. The American Heart Association projected that the population with hypertension will increase from 33.9% to 37.3% and that the estimated medical cost of hypertension would triple between 2010 and 2030[36]. Although these values were not compared with other factors, hypertension is also the major factor associated with medical consultations and medications for outpatients in other countries[38~40]. Thus, hypertension should be prevented worldwide.

Hypertension is recognized as the most expensive factor associated with CVD, because it leads to complications such as heart failure, coronary heart disease and stroke[15,41,42]. Another cohort study in Japan found that obese participants（BMI≥25）had a higher prevalence of hypertension, hypercholesterolemia and diabetes mellitus and that the prevalence of hypertension among those who were obese was substantially high[10]. In fact, BMI is associated with physician visits[42,43]. Accordingly, some obese patients would undergo medical consultations due to hypertension, diabetes or dyslipidemia. The medical costs to treat patients with both

hypertension and diabetes or more factors would be higher[44,45].

The present study has several limitations. Firstly, possible selection bias might not have been ruled out due to the low rate of participation in health checks （37.0%）. Thus, the generalizability of the data might be uncertain. However, the Japanese National Health and Nutrition Survey 2008[46] found that the proportions of men, women and the total of both aged 40-74 years with hypertension（systolic and/or diastolic blood pressure of≥140 and≥90 mmHg, respectively, or prescribed with anti-hypertensive medication） were 58.4%, 44.4% and 50.2%（present study, 54.3%, 44.7% and 48.8%）, respectively. The proportions of obese（abdominal circumference for men and women, ≥85 and≥90 cm, respectively）men, women and both were 56.3%, 20.7% and 36.6%（present study, 49.8%, 20.3% and 32.8%）, respectively. The selection bias might be small because the proportions of hypertension and obesity in the present study were similar to those of the Japanese National Health and Nutrition Survey. Secondly, PAF is affected by prevalence of diseases in the population. The individuals in the present study who attended health checks might differ from the general population. For example, those who undergo health checks might be healthier than those who do not. Thus, PAF might be underestimated due to an underestimated population of exposure values and ORs. However, this suggests that the PAF for hypertension in the present study are lower than that for the total number of beneficiaries. Thirdly, the age distribution of the individuals in the present study differed from that of the entire Japanese population. Among people aged 40-74 years, the proportion of those aged over 65 years in the present study was 57.6%, which is higher than the 26.4% in the general Japanese population. The ratio of elderly people who are NHI beneficiaries is generally higher because of an eligibility requirement for NHI（that is, farmers, self-employed, retirees and their dependents）. Furthermore, the incidence of diseases increases due to aging among elderly people. However, PAFs were adjusted for age and all factors（hypertension, dyslipidemia, diabetes）；thus, it might not be significantly influenced by the age distribution of the studied individuals. Fourthly, this study focused on total dates of medical

consultations ; therefore, consultations for other diseases might have been included. However, we consider that most medical consultations were for chronic diseases due to the focus on frequent medical consultations (≥12 days/year) in this study. Moreover, the PAF of hypertension was calculated using a multivariable regression analysis adjusted for other factors (dyslipidemia, diabetes) as complications of hypertension. For the reasons stated above, we believe that the high frequency of medical consultation for hypertension was mainly caused by treatment for hypertension.

The incidence of hypertension increases with age. Therefore, the number of hypertensive patients is likely to increase as the Japanese population rapidly ages. This study shows that the prevention of incident hypertension can control excessive increases in medical expenses. Diet (such as low-salt) and aerobic and other types of exercise to prevent hypertension also simultaneously help to prevent other life-style related diseases such as diabetes and dyslipidemia. Accordingly, measures aimed at preventing hypertension will become even more important in the future.

CONCLUSION

Medical consultations due to hypertension impose a larger burden on the Japanese National Health Insurance system than the risk factors of dyslipidemia and diabetes. Therefore, prevention of incident hypertension could be the most critical factor involved in the control of escalating medical expenditures.

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