A Study About Medical Costs Of Hyperlipidemia Associated With Obesity

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Citation

M Furukawa. *A Study About Medical Costs Of Hyperlipidemia Associated With Obesity*. The Internet Journal of Health. 2007 Volume 7 Number 2.

Abstract

We estimated the medical costs of hyperlipidemia that could be avoided by decreasing the percentage of obese individuals in Japan. Data from the National Health and Nutrition Survey were used to determine the percentage of individuals with hyperlipidemia among those with a risk factor of BMI(kg/m^2) equal to or greater than a certain level. Population attributable fraction (PAF) was used for the estimation. Our study suggests that the different criteria for the risk factor of BMI are associated with a marked difference in the percentage of hyperlipidemic individuals, and that the change in the BMI-based criteria for obesity is associated with a substantial increase or decrease in avoidable medical costs of hyperlipidemia.

INTRODUCTION

Obesity is now identified as a global health problem in both developed and developing countries [1,2,3,4,5,6,7,8]. Japan is not an exception. Yoshiike et al. [9] investigated the change in the proportion of obese individuals in Japanese adults from 1976 to 1995 and reported that the body mass index (BMI) in men increased by 0.44 over a period of 10 years.

Obesity is clearly associated with a variety of health problems, and the Examination Committee of Criteria for Obesity Disease in Japan, the Japan Society for the Study of Obesity, specifies lipid metabolism disorders and diabetes mellitus as health problems caused by or related to obesity requiring weight loss. It is also known that the incidence of health problems increases as the degree of obesity increases. Robert et al. [4] conducted the National Health and Nutrition Examination Surveys (NHANES) I to III and showed that increased BMI was associated with an increased incidence of obesity-related disorders. The National Institutes of Health also indicates that the incidence of low HDL cholesterolemia and hypertension is markedly higher in individuals with a BMI of 30 or more [10].

Association of the degree of obesity and health problems has direct implication for medical costs. Charles et al. [11] analyzed the relationship between the degree of obesity and annual medical costs, number of inpatient days, number of outpatient visits, and medication costs in members of a health maintenance organization in the United States. Compared with individuals with a BMI of 20 to 24.9, annual medical costs were 25% greater in individuals with a BMI of 30 to 34.9 and 44% greater in those with a BMI of 35 or more. Kim et al. [12] and David et al. [13] also reported that medical costs increased in individuals with higher BMI in the United States. Daniel et al. [14] found a positive correlation between BMI and medical service use in Australia. Kuriyama et al. [15] reported similar results in Japanese individuals. Compared with individuals with a BMI of 21.0 to 22.9, total medical costs were 1.10 times greater in overweight individuals with a BMI of 25 to 29.9 and 1.22 times greater in obese individuals with a BMI of 30 or more, indicating increased total medical costs with increasing BMI. However, their studies did not focus on obesity-related disorders such as hyperlipidemia or estimate the impact of obesity on total medical costs.

In Japan, only one anti-obesity drug is now covered by national health insurance, and reimbursement is based on a very strict criterion of BMI of 35 or more. However, analysis of the relationship between BMI and medical costs of obesity-related disorders is very important in the context of multiple anti-obesity drugs under clinical development in Japan, possibility of review of the criteria for health insurance coverage of the anti-obesity drug, and an increase in the number of obese individuals.

The present study focused on the medical costs of hyperlipidemia, a common complication of obesity. Data from the National Health and Nutrition Survey were used to

determine the percentage of individuals with hyperlipidemia among those with a risk factor of BMI equal to or greater than a certain level. The objective of the study was to estimate the medical costs of hyperlipidemia that could be avoided by decreasing the percentage of obese individuals and provide evidence useful in reviewing the criteria for health insurance coverage in the future.

METHODS

The present study analyzed data from the National Health and Nutrition Survey in 2001. Assessment of obesity was based on BMI (kg/m $_2$), a standard measure used by the World Health Organization (WHO) $_{1,16}$ and Japan Society for the Study of Obesity.

BMI, a typical measure of obesity, is calculated as weight in kilograms divided by height in meters squared. For analysis of medical costs of hyperlipidemia associated with obesity, samples were identified for which data on height and body weight required for calculation of BMI and triglycerides were available. Pregnant or nursing women were excluded from the analysis because their condition had some effects on BMI. The diagnostic criteria for hyperlipidemia established by the Japan Atherosclerosis Society are total cholesterol levels of at least 220 mg/dl, LDL cholesterol levels of at least 140 mg/dl, or triglyceride levels of at least 150 mg/dl. According to this diagnostic criteria for hyperlipidemia, individuals with triglyceride levels of 150 mg/dl or more were considered hyperlipidemic and those with triglyceride levels less than 150 mg/dl were considered non-hyperlipidemic.

To estimate the proportion of medical costs for individuals with the risk factor of BMI equal to or greater than a certain level, population attributable fraction (PAF) was used according to previous studies $_{17,18,19,20,21,22,23}$. PAF is calculated by the following formula:

$$PAF = P_{\square} (RR - 1) \div [1 + \{P_{\square} (RR - 1)\}]$$

$P_{\square}$ represents the proportion of individuals with a given risk factor and indicates the proportion of overweight and obese individuals in the present study. RR indicates a relative risk of disease associated with overweight or obesity. Thus, RR is defined as the rate of disease among individuals with a given risk factor divided by the rate of disease among those without.

Medical costs that could be avoided by eliminating the risk factor of BMI equal to or greater than a certain level may be estimated by multiplying the total medical costs by PAF. In the present study, a total of six levels of BMI ranging from 25 to 30 in one-step increments were examined as a potential risk factor. The medical costs of hyperlipidemia that could be avoided by eliminating the risk factor were calculated from PAF and data on inpatient and outpatient medical costs of hyperlipidemia in 2001. The inpatient and outpatient medical costs of hyperlipidemia were calculated by subtracting medical costs of diabetes mellitus from medical costs of endocrine, nutrition, and metabolic disease in fiscal 2001, which were obtained from the fiscal 2003 database of statistical survey on national medical expenditures stored in the Ministry of Health, Labour and Welfare Statistical Database System.

Analysis was performed on total population (15 years of age or older), middle age group (45 to 64 years), and older age group (65 years or older), which were in accordance with the age groups used in the survey on national medical expenditures.

RESULTS

Table 1 shows descriptive statistics for samples used for the analysis of medical costs of hyperlipidemia by age group. The mean BMI was about 23 in all age groups. However, the maximum BMI was very high with 37.64, 37.02, and 45.96 in the middle age group, the older age group, and the total population, respectively. The mean triglyceride level was as high as 145.65 in the middle age group.

Figure 1

Table 1: Descriptive statistics

age groups	the number of samples		Mean	Standard deviation	Minimum	Maximum
middle age group	2175	BMI(kg/m^2)	23.55	3.27	8.93	37.64
(45 to 64 years)		triglyceride(mg/dl)	145.65	95.26	26.00	1020.00
older age group	1684	BMI(kg/m^2)	23.32	3.34	13.03	37.02
(65 years or older)		triglyceride(mg/dl)	139.11	82.94	27.00	764.00
total population	5433	BMI(kg/m^2)	23.14	3.42	8.93	45.96
(15 years of age or older)		triglyceride(mg/dl)	135.56	91.80	23.00	1300.00

Table 2 shows the number and percentage of individuals with or without risk factors of BMI above certain levels among the samples used for the analysis of medical costs of hyperlipidemia. It also shows the number and percentage of hyperlipidemic and non-hyperlipidemic individuals.

Figure 2

Table 2: The number and percentage of individuals with or without risk factors

risk factor	age groups	with risk factors					without risk factors				
		persons	%	type	persons	%	persons	%	type	persons	%
BMI of 25 or more	middle age group	672	30.9	HL	353	16.2	1503	69.1	HL	414	19.0
				Non-HL	319	14.7			Non-HL	1089	50.1
	older age group	481	28.6	HL	207	12.3	1203	71.4	HL	339	20.1
				Non-HL	274	16.3			Non-HL	864	51.3
	total population	1471	27.1	HL	709	13.0	3962	72.9	HL	936	17.2
				Non-HL	762	14.0			Non-HL	3026	55.7
BMI of 26 or more	middle age group	453	20.8	HL	253	11.6	1722	79.2	HL	514	23.6
				Non-HL	200	9.2			Non-HL	1208	55.5
	older age group	311	18.5	HL	135	8.0	1373	81.5	HL	411	24.4
				Non-HL	176	10.5			Non-HL	962	57.1
	total population	1001	18.4	HL	504	9.3	4432	81.6	HL	1141	21.0
				Non-HL	497	9.1			Non-HL	3291	60.6
BMI of 27 or more	middle age group	311	14.3	HL	179	8.2	1864	85.7	HL	588	27.0
				Non-HL	132	6.1			Non-HL	1276	58.7
	older age group	214	12.7	HL	91	5.4	1470	87.3	HL	455	27.0
				Non-HL	123	7.3			Non-HL	1015	60.3
	total population	696	12.8	HL	358	6.6	4737	87.2	HL	1287	23.7
				Non-HL	338	6.2			Non-HL	3450	63.5
BMI of 28 or more	middle age group	202	9.3	HL	115	5.3	1973	90.7	HL	652	30.0
				Non-HL	87	4.0			Non-HL	1321	60.7
	older age group	145	8.6	HL	63	3.7	1539	91.4	HL	483	28.7
				Non-HL	82	4.9			Non-HL	1056	62.7
	total population	475	8.7	HL	250	4.6	4958	91.3	HL	1395	25.7
				Non-HL	225	4.1			Non-HL	3563	65.6
risk factor	age groups	with risk factors					without risk factors				
		persons	%	type	persons	%	persons	%	type	persons	%
BMI of 29 or more	middle age group	130	6.0	HL	74	3.4	2045	94.0	HL	693	31.9
				Non-HL	56	2.6			Non-HL	1352	62.2
	older age group	103	6.1	HL	46	2.7	1581	93.9	HL	500	29.7
				Non-HL	57	3.4			Non-HL	1081	64.2
	total population	321	5.9	HL	170	3.1	5112	94.1	HL	1475	27.1
				Non-HL	151	2.8			Non-HL	3637	66.9
BMI of 30 or more	middle age group	87	4.0	HL	50	2.3	2088	96.0	HL	717	33.0
				Non-HL	37	1.7			Non-HL	1371	63.0
	older age group	62	3.7	HL	29	1.7	1622	96.3	HL	517	30.7
				Non-HL	33	2.0			Non-HL	1105	65.6
	total population	209	3.8	HL	113	2.1	5224	96.2	HL	1532	28.2
				Non-HL	96	1.8			Non-HL	3692	68.0

Note) hyperlipidemic individuals (HL), triglyceride ≥ 150mg/dl / non-hyperlipidemic individuals (Non-HL), triglyceride < 150mg/dl

According to the classification of obesity developed by the Japan Society for the Study of Obesity, obesity is defined as a BMI of 25 or more. According to the definition, the percentage of individuals with the risk factor of BMI of 25 or more was 30.9% in the middle age group, 28.6% in the older age group, and 27.1% in the total population. The percentage of hyperlipidemic individuals with a triglyceride level of 150 mg/dl or more and the BMI risk factor was 16.2% in the middle age group, 12.3% in the older age group, and 13.0% in the total population.

According to the classification of obesity established by WHO, obesity is defined as a BMI of 30 or more [1,16]. According to the classification, the percentage of individuals with the risk factor of BMI of 30 or more was 4.0% in the middle age group, 3.7% in the older age group, and 3.8% in the total population. Hyperlipidemic individuals with the risk factor accounted for 2.3% of the middle age group, 1.7% of the older age group, and 2.1% of the total population.

Table 3 shows the medical costs of hyperlipidemia that could be avoided by eliminating the risk factor of BMI equal to or greater than a certain level. Analysis of medical costs of hyperlipidemia showed that the costs for individuals with the risk factor of BMI of 25 or more accounted for 21.89% of overall costs in the middle age group and amounted to 40.694 billion yen, including inpatient and outpatient medical costs. The analysis also showed that the costs accounted for 13.09% of overall costs in the older age group and amounted to 31.265 billion yen, including inpatient and outpatient medical costs. The corresponding figures were 21.97% and 121.696 billion yen in the total population.

Figure 3

Table 3: The medical costs of hyperlipidemia that could be avoided by eliminating the risk factor

		the medical costs of hyperlipidemia (%)	the medical costs of hyperlipidemia (billion yen)		
			inpatient and outpatient	inpatient	outpatient
BMI of 25 or more	middle age group	21.89	40.694	3.568	37.126
	older age group	13.09	31.265	6.112	25.167
	total population	21.97	121.696	18.107	103.589
BMI of 26 or more	middle age group	15.36	28.548	2.503	26.045
	older age group	7.67	18.335	3.584	14.758
	total population	14.97	82.917	12.337	70.580
BMI of 27 or more	middle age group	10.55	19.607	1.719	17.888
	older age group	4.54	10.834	2.118	8.721
	total population	10.27	56.862	8.461	48.402
BMI of 28 or more	middle age group	6.29	11.694	1.025	10.668
	older age group	3.20	7.654	1.496	6.161
	total population	7.07	39.171	5.828	33.343
BMI of 29 or more	middle age group	3.90	7.258	0.636	6.622
	older age group	2.46	5.874	1.148	4.728
	total population	4.70	26.050	3.876	22.174
BMI of 30 or more	middle age group	2.62	4.878	0.428	4.450
	older age group	1.69	4.042	0.790	3.254
	total population	3.14	17.408	2.590	14.818

Analysis of the medical costs of hyperlipidemia showed that the costs for individuals with the risk factor of BMI of 30 or more accounted for 2.62% of overall costs in the middle age group and amounted to 4.878 billion yen, including inpatient and outpatient medical costs. The analysis also showed that the costs accounted for 1.69% of overall costs in the older age group and amounted to 4.042 billion yen, including inpatient and outpatient medical costs. The corresponding figures were 3.14% and 17.408 billion yen in the total population.

DISCUSSION

First, the criteria for obesity should be reviewed. The WHO defines obesity as a BMI of 30 or more [1], although the validity remains controversial [16]. For Japanese individuals, the Japan Society for the Study of Obesity has established the criteria for obesity as a BMI of 25 or more. However, individuals with a BMI of 25 or more do not always require weight loss from a medical point of view. Thus, obesity

disease is defined as a medical condition that is "actually or potentially accompanied by health problems caused by or related to obesity and thus medically requires weight loss." With consideration of the criteria established by WHO and Japan Society for the Study of Obesity, the present study performed analysis based on risk factors of BMI levels of 25 to 30.

In the analysis of hyperlipidemia, individuals are hyperlipidemic when they had triglyceride levels of 150 mg/dl or more, which was one of the diagnostic criteria for hyperlipidemia established by the Japan Atherosclerosis Society. It should be noted, however, that the analytical results in the present study were underestimated because the Japan Atherosclerosis Society defines hyperlipidemia as an increase in one or more of the components of total cholesterol, LDL cholesterol, and triglycerides.

As Table 2 shows the percentage of individuals with risk factors, hyperlipidemic individuals with a BMI of 25 or more accounted for 13.0% of the total population (15 years or older), and those with a BMI of 30 or more accounted for 2.1%, indicating an at least six-fold difference. Analyses of the middle age group (45 to 64 years) and the older age group (65 years or older) revealed an about seven-fold difference. These findings suggest that different criteria for the risk factor of BMI are associated with a marked difference in the percentage of hyperlipidemic individuals.

Some previous studies [11,12,13,14,15,24,25,26,27,28] of obesity-related medical costs in countries other than Japan reported that obesity was responsible for 0.8% to 6.2% of the total medical costs in Europe and the United States. For Japanese individuals, Kuriyama et al. [15] analyzed medical costs attributable to overweight (BMI of 25 or more) or obesity and reported that the costs represented 3.2% of the total. However, their study analyzed the impact of obesity on total medical costs and did not focus on the medical costs of obesity-related disorders. As shown in Table 3, our study provided the percentage of medical costs of hyperlipidemia for individuals with a BMI equal to or greater than a certain level in the total costs of hyperlipidemia and also presented inpatient and outpatient medical costs.

On the basis of the criteria established by the Japan Society for the Study of Obesity, the medical costs of hyperlipidemia associated with the risk factor of BMI of 25 or more accounted for about one-fifth of the total medical costs of hyperlipidemia, with 21.97% in the total population and 21.89% in the middle age group. In light of the percentage of medical costs of hyperlipidemia in the total medical costs and the current criteria for obesity (BMI of 25 or more), management of obesity is essential for reducing medical costs. The relatively lower percentage of 13.09% in the older age group compared with other age groups may be explained by the relatively lower percentage of obese individuals in the older age group compared with other age groups.

The criteria for obesity established by WHO, European and American countries, shows that the percentage of medical costs of hyperlipidemia associated with the risk factor of BMI of 30 or more in the total costs of hyperlipidemia was 3.14% in the total population, 2.62% in the middle age group, and as low as 1.69% in the older age group. These figures were substantially different from those calculated based on the current criteria for obesity of BMI of 25 or more as described above. In other words, these results imply that change in the BMI-based criteria for obesity is associated with a substantial increase or decrease in avoidable medical costs of hyperlipidemia. Thus, the criteria for health insurance coverage for treatment of obesity should be carefully determined with consideration of health insurance finances.

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