

# Socioeconomic Costs of Overweight and Obesity in Korean Adults

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This study was conducted to estimate the socioeconomic costs of overweight and obesity in a sample of Korean adults aged 20 yr and older in 2005. The socioeconomic costs of overweight and obesity include direct costs (inpatient care, outpatient care and medication) and indirect costs (loss of productivity due to premature deaths and inpatient care, time costs, traffic costs and nursing fees). Hypertension, diabetes mellitus, dyslipidemia, ischemic heart disease, stroke, colon cancer and osteoarthritis were selected as obesity-related diseases. The population attributable fraction (PAF) of obesity was calculated from national representative data of Korea such as the National Health Insurance Corporation (NHIC) cohort data and the 2005 Korea National Health and Nutrition Examination Survey (KNHANES) data. Direct costs of overweight and obesity were estimated at approximately US\$1,081 million equivalent (men: US\$497 million, women: US\$584 million) and indirect costs were estimated at approximately US\$706 million (men: US\$527 million, women: US\$178 million). The estimated total socioeconomic costs of overweight and obesity were approximately US\$1,787 million (men: US\$1,081 million, women: US\$706 million). These total costs represented about 0.22% of the gross domestic product (GDP) and 3.7% of the national health care expenditures in 2005. We found the socioeconomic costs of overweight and obesity in Korean adults aged 20 yr and older are substantial. In order to control the socioeconomic burden attributable to overweight and obesity, effective national strategies for prevention and management of obesity should be established and implemented.

**Key Words:** Obesity; Overweight; Socioeconomic costs; Direct costs; Indirect costs

## INTRODUCTION

Obesity is a state of an excess of body fat that causes increased risk of metabolic derangement (1, 2). World Health Organization (WHO) estimated that globally in 2005, approximately 1.6 billion adults were overweight and at least 400 million adults were obese. They also predicted that by 2015, approximately 2.3 billion adults would be overweight and more than 700 million would be obese. Obesity prevalence has been constantly increasing in Korea, too. According to the Korea National Health and Nutrition Examination Survey (KNHANES) data, obesity (body mass index [BMI]  $\geq 25$  kg/m<sup>2</sup>) prevalence in Korea increased from 26.3% (male, 25.0%; female, 27.0%) in 1998 to 31.7% (male, 35.1%; female, 28.0%) in 2005. In 1997, WHO anticipated that obesity, along with smoking, would be the most serious public health problem, which threatens the health of world population, in the 21st century (3). Must et al. (4) reported that the prevalence of obesity-related comorbidities such as type 2 diabetes mellitus, high blood pressure, and osteoarthritis, was increased along with increasing severity of overweight and obesity in adults aged 25 yr and older, who participated in the Third National Health and Nutrition Examination Survey (NHANES). The disease burden associated with obesity is not only a problem lim-

ited to Western developed countries anymore but has increased to a serious level also in Asia-Pacific countries including Korea. The Asia-Pacific Cohort Studies Collaboration reported that the population attributable fraction (PAF) of overweight and obesity ranged from 0.8%-9.2% for coronary heart disease mortality, 0.2%-2.9% for hemorrhagic stroke mortality, and 0.9%-10.2% for ischemic stroke mortality in 14 Asia-Pacific countries (5).

Increase in the prevalence of obesity and obesity-related diseases leads to the growth of socioeconomic burden. According to previous studies, patients with obesity had 25%-52% higher medical care costs than normal-weighted individuals (6-8). Medical care costs attributable to obesity was reported to account for 2.0%-7.0% of national health care expenditures in Western developed countries (9). The direct costs for obesity in the USA in 1995 were estimated to be approximately 70 billion US dollars, which exceeded estimates of the direct costs for coronary artery disease, hypertension and diabetes mellitus (10). According to a study in Sweden, the obese women had 1.5-1.9 times higher sick-leave during 1 yr compared to the general Swedish women. And, approximately 10% of the total cost of loss of productivity due to sick-leave and disability pensions in Swedish women was related to obesity and obesity-related diseases (11). Obesity also brings about premature death and disability, which

lead to loss of labor productivity (12, 13). Popkin et al. (14) estimated the indirect costs of obesity due to premature death, premature disability and sick-leave in China in 2000 to be 43.6 billion US dollars (3.58% of the gross national product [GNP]).

The socioeconomic costs of obesity in Korean adults were first estimated by Jeong et al. (15) using 1998 KNHANES data. They reported that the estimated costs attributable to obesity in Korea ranged from US\$170 million equivalent to \$350 million (exchange rate in 1998: 1,209 Korean Won for 1 US dollar), which were considerably smaller than those in Western developed countries. However, because the prevalences of obesity and obesity-related diseases in Korea have been constantly increasing, the socioeconomic costs of obesity in Korean adults are anticipated to have increased rapidly as well. Yet, there has been no study on this issue in Korea since 1998. Thus, this study was conducted to estimate the socioeconomic costs attributable to overweight and obesity in Korean adults in 2005, in which KNHANES was most recently carried out.

## MATERIALS AND METHODS

### Selection of obesity-related diseases

We selected hypertension (ICD-10 code: I10), diabetes mellitus (E10-E14), dyslipidemia (E78), ischemic heart disease (I20-I25),

stroke (I60-I64), breast cancer (C50), colon cancer (C18-C21) and osteoarthritis (M15-M19) as obesity-related diseases because previous studies (9) demonstrated that obesity has the etiological role on these diseases and these diseases were also investigated in 2005 KNHANES. However, breast cancer was excluded from obesity-related diseases because relative risk of obesity on breast cancer was not high.

### Calculation of population attributable fraction (PAF)

We used the PAF of obesity in order to allocate the proportion attributable to obesity in the total costs of obesity-related diseases. The PAF of obesity is calculated using the formula;  $PAF = P \times (RR-1) / [P \times (RR-1) + 1]$ , where P is the prevalence of overweight and obesity and RR is the relative risk of overweight and obesity on obesity-related diseases. That is, the PAF of obesity is explained by the prevalence of obesity and the relative risk of obesity. The RRs and PAFs of obesity on obesity-related diseases in male and female were presented in Table 1 and 2.

### Prevalence of obesity

The prevalence of obesity in Korean adults aged 20 yr and older was obtained from the raw data of 2005 KNHANES, to which was applied the weight value. We defined BMI of 18.5-22.9 kg/m<sup>2</sup> as normal weight, 23-24.9 kg/m<sup>2</sup> as overweight, 25-29.9 kg/m<sup>2</sup> as

**Table 1.** RR and PAF on obesity-related diseases of obesity status (men)

Diseases	BMI (kg/m <sup>2</sup> )	Inpatient care		Outpatient care		Total	
		RR (95% CI)	PAF	RR (95% CI)	PAF	RR (95% CI)	PAF
Hypertension	23-24.9	1.299 (1.135-1.485)	0.062	1.513 (1.488-1.539)	0.101	1.506 (1.482-1.532)	0.100
	25-29.9	2.072 (1.830-2.345)	0.209	2.078 (2.045-2.112)	0.209	2.068 (2.036-2.102)	0.208
	≥ 30	2.830 (1.944-4.120)	0.059	3.203 (3.054-3.360)	0.070	3.179 (3.033-3.332)	0.070
	Subtotal		0.329		0.381		0.378
Diabetes mellitus	23-24.9	1.276 (1.119-1.456)	0.057	1.410 (1.373-1.447)	0.083	1.406 (1.371-1.443)	0.082
	25-29.9	1.909 (1.689-2.158)	0.183	1.916 (1.869-1.964)	0.184	1.901 (1.855-1.948)	0.181
	≥ 30	4.878 (3.697-6.435)	0.117	3.297 (3.081-3.529)	0.073	3.300 (3.087-3.527)	0.073
	Subtotal		0.357		0.340		0.336
Ischemic heart disease	23-24.9	1.241 (1.173-1.312)	0.050	1.174 (1.143-1.206)	0.037	1.173 (1.142-1.204)	0.037
	25-29.9	1.444 (1.366-1.526)	0.098	1.347 (1.311-1.383)	0.079	1.347 (1.312-1.383)	0.079
	≥ 30	2.065 (1.749-2.439)	0.035	1.574 (1.437-1.724)	0.019	1.585 (1.451-1.732)	0.020
	Subtotal		0.184		0.135		0.135
Stroke	23-24.9	1.102 (1.034-1.174)	0.022	1.138 (1.093-1.185)	0.029	1.134 (1.091-1.179)	0.029
	25-29.9	1.190 (1.116-1.269)	0.045	1.274 (1.224-1.327)	0.063	1.261 (1.213-1.311)	0.060
	≥ 30	1.575 (1.281-1.938)	0.019	1.455 (1.265-1.673)	0.015	1.482 (1.298-1.692)	0.016
	Subtotal		0.086		0.108		0.105
Colon cancer	23-24.9	1.209 (1.091-1.340)	0.044	1.129 (1.041-1.226)	0.028	1.098 (1.041-1.159)	0.021
	25-29.9	1.265 (1.140-1.404)	0.061	1.196 (1.101-1.299)	0.046	1.133 (1.073-1.197)	0.032
	≥ 30	1.314 (0.895-1.929)	-	1.405 (1.053-1.874)	0.014	1.152 (0.936-1.418)	-
	Subtotal		0.105		0.087		0.053
Osteoarthritis	23-24.9	1.247 (1.039-1.497)	0.052	1.106 (1.090-1.122)	0.023	1.105 (1.089-1.121)	0.023
	25-29.9	1.804 (1.521-2.141)	0.165	1.207 (1.189-1.224)	0.048	1.205 (1.187-1.222)	0.048
	≥ 30	3.205 (2.031-5.057)	0.070	1.317 (1.248-1.389)	0.011	1.315 (1.247-1.387)	0.011
	Subtotal		0.287		0.082		0.081
Dyslipidemia	23-24.9	1.504 (1.104-2.049)	0.100	1.379 (1.343-1.416)	0.077	1.391 (1.356-1.428)	0.079
	25-29.9	1.637 (1.200-2.234)	0.135	1.643 (1.601-1.686)	0.136	1.663 (1.622-1.706)	0.140
	≥ 30	1.505 (0.475-4.768)	-	2.048 (1.884-2.226)	0.035	2.061 (1.900-2.236)	0.035
	Subtotal		0.235		0.248		0.255

PAF, population attributable fraction; RR, relative risk; CI, confidence interval.

obesity I and over 30 kg/m<sup>2</sup>s as obesity II. These BMI cut-offs were recommended for Asians by WHO (16). In this study, 27.4% of men and 22.0% of women were diagnosed as overweight, 31.5% of men and 24.6% of women as obese I, 3.6% of men and 3.4% of women as obese II.

PAFs of overweight, obesity I and obesity II were calculated separately and the sum of calculated PAFs was presented as the total PAF of obesity on obesity-related diseases.

### Relative risk

The data source for calculation of the RR was the National Health Insurance Corporation (NHIC) cohort data. NHIC provides biennial health examinations to the entire Korean population aged 40 yr and older. The NHIC cohort was composed of the participants of health examinations of NHIC performed in 2000 who repeatedly participated in health examinations in 2002 or 2004. Subjects, who did not have any previous history of obesity-related diseases and were judged as healthy men in 2000, were only enrolled in this study. Subjects who had problem in qualification as insured persons or who had some errors in computerized data, were excluded additionally. The payment data to them

by NHIC from 1999 to 2006 was obtained. The total number of the participants of health examinations of NHIC was 5,099,737. Among them, 3,026,483 and 2,958,706 individuals were again undergone health examinations in 2002 and in 2004, respectively. Finally, 1,910,194 individuals were included in this study (men, 65.4%; women, 34.5%).

The RRs of overweight, obesity I and obesity II were estimated using the Cox proportional hazard model upon the first occurrence of payment for outpatient care, inpatient care and either, respectively. Each RR was adjusted for age, smoking status, alcohol consumption, frequency of meat intake, exercise, family medical history, household income, diabetes mellitus, hypertension, hypercholesterolemia, and so on. If any RRs of obesity on obesity-related diseases were interpreted as statistically insignificant, they were not included in calculation of PAF.

### Estimation of costs

The socioeconomic costs of obesity can include direct costs, indirect costs and intangible costs. Intangible costs such as pain, suffering and decreased quality of life, which are very important problems to patients, are omitted in most studies on cost of ill-

**Table 2.** RR and PAF on obesity-related diseases of obesity status (women)

Diseases	BMI (kg/m <sup>2</sup> )	Inpatient care		Outpatient care		Total	
		RR (95% CI)	PAF	RR (95% CI)	PAF	RR (95% CI)	PAF
Hypertension	23-24.9	1.405 (1.164-1.695)	0.082	1.434 (1.400-1.468)	0.087	1.424 (1.391-1.457)	0.085
	25-29.9	1.831 (1.534-2.185)	0.170	1.916 (1.873-1.959)	0.184	1.896 (1.854-1.938)	0.180
	≥ 30	2.546 (1.740-3.723)	0.050	2.797 (2.665-2.935)	0.058	2.783 (2.654-2.918)	0.058
	Subtotal		0.302		0.329		0.324
Diabetes mellitus	23-24.9	1.354 (1.068-1.716)	0.072	1.333 (1.283-1.386)	0.068	1.336 (1.286-1.388)	0.069
	25-29.9	2.345 (1.906-2.886)	0.248	1.838 (1.773-1.906)	0.171	1.828 (1.764-1.894)	0.169
	≥ 30	5.188 (3.705-7.264)	0.126	2.747 (2.554-2.955)	0.057	2.727 (2.537-2.930)	0.056
	Subtotal		0.446		0.296		0.294
Ischemic heart disease	23-24.9	1.300 (1.172-1.441)	0.062	1.186 (1.139-1.235)	0.039	1.188 (1.142-1.236)	0.040
	25-29.9	1.406 (1.270-1.556)	0.091	1.295 (1.244-1.348)	0.068	1.295 (1.245-1.347)	0.068
	≥ 30	1.765 (1.409-2.210)	0.026	1.494 (1.357-1.645)	0.017	1.510 (1.375-1.657)	0.017
	Subtotal		0.178		0.124		0.125
Stroke	23-24.9	1.127 (1.030-1.234)	0.027	1.122 (1.063-1.185)	0.026	1.125 (1.068-1.185)	0.027
	25-29.9	1.136 (1.039-1.241)	0.032	1.198 (1.136-1.263)	0.046	1.199 (1.140-1.262)	0.047
	≥ 30	1.438 (1.175-1.760)	0.015	1.246 (1.093-1.420)	0.008	1.244 (1.098-1.410)	0.008
	Subtotal		0.074		0.081		0.082
Colon cancer	23-24.9	1.157 (1.968-1.384)	-	1.027 (0.897-1.175)	-	1.089 (1.026-1.155)	0.019
	25-29.9	1.231 (1.033-1.468)	0.054	1.028 (0.898-1.177)	-	1.018 (0.957-1.083)	-
	≥ 30	1.735* (0.412-1.310)	-	0.618 (0.391-0.977)	-	0.912 (0.765-1.089)	-
	Subtotal		0.054		-		0.019
Breast cancer	23-24.9	0.982 (0.870-1.109)	-	1.031 (0.936-1.136)	-	1.023 (0.930-1.126)	-
	25-29.9	0.908 (0.797-1.034)	-	0.927 (0.834-1.029)	-	0.914 (0.824-1.014)	-
	≥ 30	0.697 (0.460-1.057)	-	0.695 (0.496-0.973)	-	0.694 (0.498-0.967)	-
	Subtotal		-		-		-
Osteoarthritis	23-24.9	1.308 (1.111-1.541)	0.064	1.196 (1.177-1.215)	0.041	1.195 (1.177-1.214)	0.041
	25-29.9	2.375 (2.060-2.738)	0.253	1.441 (1.419-1.464)	0.098	1.439 (1.417-1.461)	0.097
	≥ 30	5.710 (4.531-7.195)	0.139	1.870 (1.800-1.942)	0.029	1.863 (1.794-1.935)	0.029
	Subtotal		0.455		0.168		0.167
Dyslipidemia	23-24.9	1.298 (0.745-2.260)	-	1.221 (1.180-1.263)	0.046	1.231 (1.191-1.272)	0.048
	25-29.9	1.633 (0.968-2.755)	-	1.425 (1.379-1.473)	0.095	1.432 (1.387-1.479)	0.096
	≥ 30	1.824 (0.552-6.022)	-	1.551 (1.431-1.681)	0.019	1.621 (1.500-1.751)	0.021
	Subtotal		-		0.160		0.165

PAF, population attributable fraction; RR, relative risk; CI, confidence interval.

ness because it is difficult to quantify these costs in monetary terms. These costs were not included in this study. Direct costs include hospitalization, outpatient visits and medication for the purpose of prevention and treatment of obesity and obesity-related diseases. However, it is quite difficult to estimate precisely the costs for management of obesity itself, which is not covered by the national health insurance in Korea and is done in outside of the formal health care system. Costs for management of obesity-related diseases were only included as direct costs in this study. Loss of productivity due to premature deaths and admission, time costs, traffic costs and nursing fees were measured as indirect costs in this study.

### Direct costs

Direct costs were composed of costs for inpatient care, outpatient care and medication. They were calculated from the payment data of NHIC, 2005 using formula 1. Costs, not insured by NHIC, were not included in these data. So, the proportion of not-insured, self-imposed costs in 2005, which was reported in an investigation (17), was reflected in this study. However, the proportions of not-insured, self-imposed costs on all obesity-related diseases were not reported in the investigation. Those were substituted with the average proportion of not-insured, self-imposed costs on all the investigated diseases. The proportions of not-insured, self-imposed costs for medication were totally applied by the average proportion of not-insured, self-imposed costs for the all investigated medication because those were not investigated separately for each disease.

$$\text{Formula 1) Direct costs} \\ = (\sum H_{ij} \times PAF_{ij}) / (1 - \alpha_i)$$

$i = 1, 2, \dots, n^{\text{th}}$  disease

$j = 1$  if male,  $2$  if female

$H_{ij}$  = Costs for inpatient care, outpatient care or medication to treat 'i' disease in 'j' sex

$PAF_{ij}$  = population attributable fraction of obesity on 'i' disease in 'j' sex

$\alpha$  = the proportion of not-insured, self-imposed costs on the 'i' disease

### Indirect costs: Loss of productivity due to premature deaths

Costs by premature deaths due to obesity-related diseases were estimated by calculation of present value of lost future earning via formula 2. According to the data of the Korea National Statistical Office, total 56,633 individuals died of all obesity-related diseases in adults aged 20 yr and older in 2005 (18). The number of death attributable to obesity was calculated through multiplication the number of deaths due to each obesity-related disease by total PAF for each disease. Future earnings were calculated within wages and future earnings after 2005 were assumed to be

the same as 2005. In addition, future earnings were discounted to the present values by the rate of 6%. The discount rate of 6% has been used generally in healthcare project (19). The average monthly wage income of Korean adults aged 20 yr and older in 2005 was US\$ 2,084 men and US\$1,383 for women (exchange rate in 2005: 1,013 Korean Won for 1 US dollar). Labor force participation rate and employment rate were 80.3% and 96.1% for men and 53.1% and 96.7% for women, respectively (20).

$$\text{Formula 2) Loss of productivity due to premature deaths} \\ = (I_j \times \sum PAM_{ij} \times P_j \times E_j) / (1 + r)^n$$

$I_j$  = Average annual wage income of 'j' sex

$PAM_{ij}$  = Number of death attributable to obesity via 'i' disease in 'j' sex

$P_j$  = Labor force participation rate of 'j' sex

$E_j$  = Employment rate of 'j' sex

$r$  = The discount rate

$n$  = Expected years of life lost

### Indirect costs: Loss of productivity due to inpatient care

Loss of productivity due to hospitalization was calculated with days of inpatient care due to each obesity-related disease and the average daily wage income via formula 3. Total number of days of inpatient care due to all obesity-related diseases in adults aged 20 yr and older was approximately 7.88 million days in 2005. The average daily wage income of Korean adults aged 20 yr and older in 2005 was US\$ 83 equivalent for men and US\$55 for women.

$$\text{Formula 3) Loss of productivity due to inpatient care} \\ = I_{jd} \times \sum N_{ij} \times D_{ij} \times PAF_{ij} \times P_j \times E_j$$

$I_{jd}$  = Average daily wage income of 'j' sex

$N_{ij}$  = Total number of case of inpatient care with 'i' disease in 'j' sex

$D_{ij}$  = Average days per case of inpatient care with 'i' disease in 'j' sex

### Indirect costs: Time costs

Time costs were calculated with time spent for hospital admission and outpatient treatment and the average wage income per minute via formula 4. Time spent for hospital admission for each disease in each sex was investigated in 2005 KNHANES. Time spent for outpatient treatment included time spent for visiting physician, waiting time for outpatient treatment and treating time. In 2005 KNHANES, time spent for visiting physician was investigated, but the others were not investigated. So, waiting time for outpatient treatment was substituted with data investigated in 1998 KNHANES and treating time was assumed to be 3 min. The average wage income per minute of Korean adults aged 20 yr and older in 2005 was US\$ 0.17 for men and US\$ 0.12

for women.

Formula 4) Time costs

$$= [(MIN_{inij} \times \Sigma N_{ij}) + (MIN_{onij} \times \Sigma O_{ij})] \times I_{jm} \times PAF_{ij} \times P_j \times E_j$$

MIN<sub>inij</sub> = minutes spent per hospital admission with ‘i’ disease in ‘j’ sex

MIN<sub>onij</sub> = minutes spent per outpatient treatment with ‘i’ disease in ‘j’ sex

O<sub>ij</sub> = Total number of case of outpatient care with ‘i’ disease in ‘j’ sex

I<sub>jm</sub> = Average wage income per minute of ‘j’ sex

**Indirect costs: Traffic costs**

The traffic costs included two-way traffic costs of outpatients, inpatients and caregivers of inpatients and were calculated via formula 5. In 2005 KNHANES, two-way traffic costs of outpatients and inpatients were investigated, but the other was not investigated. So, those of caregivers of inpatients was substituted with adjusted values, investigated in 1995 Korea National Health Examination & Health Behavior Survey, by 1.7, the increase rate of traffic fee during 10 yr.

Formula 5) Traffic costs

$$= (TCon \times \Sigma O_{ij}) \times PAF_{ij} + [(TCin + TCcg) \times \Sigma N_{ij}] \times PAF_{ij}$$

TCon = Average two-way transportation costs of outpatients

TCin = Average two-way transportation costs of inpatients

TCcg = Average two-way transportation costs of caregivers of inpatients

**Indirect costs: Nursing fees**

The nursing fees were investigated in 2005 KNHANES and were calculated via formula 6. It was investigated in 2005 KNHANES that nursing fees were paid only in colon cancer (US\$ 340) in men, and stroke (US\$ 877), colon cancer (US\$ 237), and osteoarthritis (US\$ 494) in women.

Formula 6) Nursing fees

$$= \Sigma N_{ij} \times NC_{ij} \times PAF_{ij}$$

NC<sub>ij</sub> = Average nursing costs per case of inpatient care with ‘i’ disease in ‘j’ sex

**RESULTS**

**Direct costs**

Costs for inpatient care attributable to overweight and obesity in Korean adults aged 20 yr and older were estimated (Table 3) at about US\$265 million equivalent (men, US\$108 million; women, US\$157 million). Inpatient care cost for ischemic heart disease occupied the largest proportion in these costs in men and inpatient care cost for osteoarthritis did in women. The estimated costs for outpatient care attributable to overweight and obesity were approximately US\$300 million equivalent (men, US\$133 million; women, US\$167 million). Costs for medication attributable to overweight and obesity were estimated to be approximately US\$516 million (men, US\$256 million; women, US\$260 million). Hypertension made the largest contribution to costs for both outpatient care cost and medication attributable to overweight and obesity in both sexes. The total direct costs of overweight and obesity were estimated at about US\$1,081 million (men, US\$497 million; women, US\$584 million). The direct costs of overweight and obesity due to hypertension were the highest in both sexes. Costs for medication attributable to overweight and obesity were larger than costs for inpatients care or outpatient care.

**Indirect costs**

Loss of productivity due to premature deaths attributable to overweight and obesity was estimated (Table 4) at approximately US\$444 million (men, US\$374 million; women, US\$70 million). Diabetes mellitus were the most important pathway of costs due to obesity-attributed premature deaths in both sexes. The estimated amount of loss of productivity due to hospitalization attributable to overweight and obesity obesity-related diseases was approximately US\$74 million (men, US\$44 million; women, US\$29 million). Hospitalization due to diabetes mellitus was the

**Table 3.** Direct costs of obesity

(unit: US\$1,000 equivalent)

Diseases	Inpatient care			Outpatient care			Pharmaceuticals			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total
HTN	3,459	5,423	8,882	68,346	82,389	150,734	143,507	153,026	296,533	215,312	240,837	456,149
DM	21,424	26,040	47,465	44,559	37,034	81,592	81,701	71,523	153,224	147,684	134,596	282,281
OA	6,977	77,764	84,742	5,585	38,142	43,728	1,844	15,810	17,654	14,407	131,717	146,123
IHD	42,139	24,156	66,295	4,751	3,716	8,466	12,924	8,464	21,388	59,813	36,336	96,149
Stroke	21,673	19,694	41,367	4,163	2,944	7,107	9,149	6,123	15,272	34,985	28,761	63,746
Colon cancer	12,095	4,175	16,269	2,705	0	2,705	1,010	0	1,010	15,809	4,175	19,984
Dyslipidemia	75	0	75	3,086	2,535	5,621	5,758	5,037	10,795	8,919	7,572	16,491
Total	107,842	157,252	265,094	133,194	166,758	299,953	255,892	259,984	515,877	496,930	583,994	1,080,923

HTN, hypertension; DM, diabetes mellitus; IHD, ischemic heart disease; OA, osteoarthritis.

Table 4. Indirect costs of obesity

(unit: US\$1,000 equivalent)

Diseases	Loss of productivity due to premature deaths	Loss of productivity due to admission	Time costs	Traffic costs	Nursing fees	Total
<b>Men</b>						
HTN	14,692	7,378	25,666	11,798	0	59,534
DM	179,821	17,983	15,826	38,302	0	251,934
IHD	73,022	4,659	1,609	6,103	0	85,393
Stroke	90,939	8,980	622	2,107	0	102,649
Colon cancer	15,057	2,769	173	1,255	1,670	20,924
OA	19	2,037	1,055	895	0	4,005
Dyslipidemia	312	564	938	1,184	0	2,997
Subtotal	373,863	44,369	45,889	61,644	1,670	527,435
<b>Women</b>						
HTN	4,605	3,014	14,120	12,080	0	33,819
DM	29,598	7,749	5,203	17,551	0	60,102
IHD	13,224	675	444	2,162	0	16,506
Stroke	20,514	10	373	2,201	6,450	39,667
Colon cancer	1,678	472	7	420	415	2,990
OA	89	7,431	3,549	6,066	7,113	24,248
Dyslipidemia	14	0	408	701	0	1,122
Subtotal	69,723	29,471	24,104	41,181	13,978	178,456
<b>Total</b>						
HTN	19,297	10,392	39,787	23,878	0	93,353
DM	209,421	25,732	21,030	55,853	0	312,036
IHD	86,247	5,335	2,053	8,266	0	101,899
Stroke	111,453	19,109	996	4,309	6,450	142,316
Colon cancer	16,735	3,241	179	1,673	2,086	23,914
OA	108	9,468	4,604	6,961	7,113	28,253
Dyslipidemia	326	564	1,345	1,885	0	4,119
Subtotal	443,585	73,840	69,993	102,823	15,649	705,891

HTN, hypertension; DM, diabetes mellitus; IHD, ischemic heart disease; OA, osteoarthritis.

Table 5. Total socioeconomic costs of obesity

(unit: US\$1,000 equivalent)

Diseases	Direct cost			Indirect cost			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
DM	147,684	134,596	282,281	251,934	60,102	312,036	399,618	194,698	594,317
HTN	215,312	240,837	456,149	59,534	33,819	93,353	274,846	274,656	549,502
Stroke	34,985	28,761	63,746	102,649	39,667	142,316	137,634	68,428	206,062
IHD	59,813	36,336	96,149	85,393	16,506	101,899	145,206	52,842	198,047
OA	14,407	131,717	146,123	4,005	24,248	28,253	18,413	155,964	174,377
Colon cancer	15,809	4,175	19,984	20,924	2,990	23,914	36,733	7,166	43,899
Dyslipidemia	8,919	7,572	16,491	2,997	1,122	4,119	11,915	8,694	20,610
Subtotal	496,930	583,994	1,080,923	527,435	178,456	705,891	1,024,364	762,449	1,786,814

HTN, hypertension; DM, diabetes mellitus; IHD, ischemic heart disease; OA, osteoarthritis.

most important cause of these costs in men and hospitalization due to stroke was in women. Time costs attributable to obesity was estimated to be about US\$70 million (men, US\$46 million; women, US\$24 million) and transportation costs attributable to overweight and obesity were estimated to be approximately US\$103 million (men, US\$62 million; women, US\$41 million). Hypertension made the largest contribution to time costs of overweight and obesity and diabetes mellitus most largely contributed to transportation costs of overweight and obesity. Nursing fees attributable to overweight and obesity were estimated at about US\$16 million (men, US\$2 million; women, US\$14 million). The total indirect costs of overweight and obesity were estimat-

ed to be approximately US\$706 million (men, US\$527 million; women, US\$178 million). The indirect costs of overweight and obesity due to diabetes mellitus were the highest in both sexes. The indirect costs of overweight and obesity were larger in men than in women.

#### Total socioeconomic costs

The estimated total socioeconomic costs of overweight and obesity in Korean adults aged 20 yr and older were approximately US\$1,787 million equivalent (men, US\$1,081 million; women, US\$706 million). Costs for diabetes mellitus occupied the largest proportion in the total costs attributable to overweight and obesity in

**Table 6.** Total socioeconomic costs of obesity by obesity grade

(unit: US\$1,000 equivalent)

Obesity grade	Direct cost			Indirect cost			Total		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Overweight	129,081	141,443	270,514	139,168	70,839	210,007	268,249	212,282	480,521
Obesity I	272,327	327,874	600,208	293,380	83,142	376,522	565,707	411,016	976,730
Obesity II	95,522	114,677	210,201	94,887	24,475	119,362	190,410	139,151	329,563
Subtotal	496,930	583,994	1,080,923	527,435	178,456	705,891	1,024,365	762,450	1,786,814

Overweight, 23-24.9 kg/m<sup>2</sup>; Obesity I, 25-29.9 kg/m<sup>2</sup>; Obesity II, ≥ 30 kg/m<sup>2</sup>.

men and costs for hypertension did in women (Table 5). The estimated total socioeconomic costs of obesity in Korean adults aged 20 yr and older were approximately US\$1,306 million and those of overweight were approximately US\$481 million (Table 6).

## DISCUSSION

This study estimated the socioeconomic costs of overweight and obesity in Korean adults aged 20 yr and older in 2005. The estimated total costs were approximately US\$1.8 billion equivalent (direct costs: US\$1.1 billion, indirect costs: US\$0.7 billion). These total costs represented about 0.22% of the gross domestic product (GDP) and 3.7% of the national health care expenditures in 2005. Diabetes mellitus and hypertension were the two main contributors to the socioeconomic costs of overweight and obesity.

A previous study (15) on the same issue presented that the socioeconomic cost of overweight and obesity (BMI ≥ 23 kg/m<sup>2</sup>) in Korean adults in 1998 were approximately US\$350 million equivalent (0.094% of GDP, 1.88% of the total national health care expenditures). The socioeconomic costs of overweight and obesity has increased 4-5 times during these 7 yr. Even if the growth of GDP and the national health care expenditures in Korea was considered, increase of these costs was more than 2 times. It is thought that the rapid increase in the prevalence of obesity in Korea has led to the increase of the socioeconomic costs attributable to obesity.

According to a previous study (9), obesity accounts for 5.5%-7.0% of national health care expenditures in the USA and 2.0%-3.5% in other Western developed countries. The estimated medical-care costs attributable to obesity were approximately 2.3% of the national health-care expenditures, which were similar to those in other Western developed countries than the USA. These results imply that the economic burden attributable to obesity in Korea is getting bigger like Western countries.

The socioeconomic costs of obesity can be classified into tangible costs and intangible costs. Intangible costs are very important problems to patients such as pain, suffering, and anxiety and are usually measured in terms of quality of life. Although there are several studies (21-23) that estimated intangible costs of diseases, these costs are omitted in most studies on cost of illness because it is difficult to quantify these costs in monetary terms. For estimation of intangible costs, organized and metic-

ulous investigation on the quality of life of study subjects should be planned. However, because this study was made of secondary data, intangible costs could not be included in this study.

The medical care costs attributable to obesity can be classified into costs for management of obesity-related diseases and costs for management of obesity itself. And, these costs can be divided into costs expended within the formal health care system and costs expended in outside of the formal health care system, respectively. Costs for management of obesity itself is rapidly increasing in Korea. The amount of sales of anti-obesity drugs has increased from US\$60 million equivalent in 2005 to US\$81 million in 2007 (exchange rate in 2007, 938 Korean Won for 1 US dollar) in Korea (22). However, management of obesity is not covered by the national health insurance in Korea and a lot of Koreans utilize services for weight loss in outside of the formal health care system. Therefore, data on the costs for management of obesity itself could not be obtained. Besides the diseases defined as obesity-related diseases in this study, various diseases including gallbladder disease and endometrial cancer can be considered as obesity-related diseases. However, only diseases investigated in 2005 KNHANES were selected as obesity-related diseases in this study. These limitations of study methods made the socioeconomic cost of overweight and obesity underestimated in this study. Therefore, it is thought that the real costs of obesity may be superior to US\$1.8 billion equivalent, the estimated cost of obesity of this study. That PAF of obesity was calculated from national representative data such as NHIC cohort data and 2005 KNHANES data, is one of strengths of this study. The PAF of obesity calculated in this study can be utilized in researches on the relationship between obesity and obesity-related diseases in Asian including Korean.

We found the socioeconomic costs of overweight and obesity in Korean adults aged 20 yr and older were substantial. Also, this study showed the socioeconomic burden of obesity (US\$1,306 million equivalent) was much bigger than that of overweight (US\$481 million). This study might be a good evidence for benefits of prevention and management of obesity. In order to control the socioeconomic burden attributable to overweight and obesity, effective national strategies for prevention and management of obesity should be established and implemented. The results of this study are expected to make a contribution to plan and execution of obesity-related public health policy.

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## AUTHOR SUMMARY

## Socioeconomic Costs of Overweight and Obesity in Korean Adults

Jaе Heon Kang, Baek Geun Jeong, Young Gyu Cho, Hye Ryoung Song and Kyung A Kim

We estimated the socioeconomic costs of overweight and obesity in Korean adults in 2005. Hypertension, diabetes mellitus, dyslipidemia, ischemic heart disease, stroke, colon cancer and osteoarthritis were selected as obesity-related diseases. The estimated total socioeconomic costs of overweight and obesity were approximately \$1,787 million. These total costs represented about 0.22% of the gross domestic product and 3.7% of the national health care expenditures in 2005.