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For Value in Health

Obesity, survival and hospital costs - findings from a screening project in Sweden

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Abstract

Objective: Our aim was (1) to estimate the costs of hospital treatment and the (2) value of lost production due to early death associated with overweight and obese patients, and then to extrapolate the findings to national costs.

Methods: We use regression models to analyze survival, expected number of days in hospital treatment for patients with different BMI and costs with data obtained from screening of 33196 middle-aged subjects living in Malmö, Sweden, and collected during a 15-year follow-up period. We subsequently scale up costs to national aggregate level using the BMI prevalence data from the screening project to the national population.

Results: The total excess hospital (somatic, psychiatric) care cost (SEK) for the national health care budget, excess as compared to normal weight patients for obese (BMI>30) and overweight weight (25<= BMI < 30) was estimated to SEK 2 155 million per annum (US$269 million, assuming $1=SEK8), or about 2.3 percent of total hospital care costs in Sweden. The corresponding indirect costs due to early death were estimated to SEK 2 935 million (US$367 million). For males at age 55 the potential hospital costs saving, excluding costs of the intervention, that could be gained by an intervention that successfully and safely could alter the weight of an obese individual to become normal weight was estimated to on average SEK 4 434 (US$ 554) per annum.

Conclusion: Hospital treatment costs are found to be higher for obese and overweight patients than for normal weight patients indicating potential cost savings especially on indirect costs by effective, safe and low cost weight-loss intervention.

Keywords: BMI, obesity, hospital bed-days, survival, costs

Abstract number of words: 262

Introduction

Obesity is a well-known risk factor for increased morbidity and premature mortality [1-4]. WHO uses the body mass index (BMI) as a criterion for defining obesity. This index is calculated as the ratio between a persons weigh in kg and the persons' length in meter squared (kg/m2). When this ratio is greater than 30 a person is defined to be obese and when the ratio take a value between 25 - 30 a person is defined to be overweight. Normal weight are defined for persons with BMI 18.5 - 25 and subjects with BMI< 18.5 as underweight [5]. In this study we will analyze hospitalization for subjects with BMI > 18.5 only.

Numerous observational studies from many populations, both in men and women, have found obesity to be associated with cardiovascular diseases, type 2 diabetes and some cancer forms, e.g. breast cancer and endometrial cancer of corpus uteri [6-9]. As a consequence of the association between obesity and increased morbidity, longer hospital stays and greater risk for complications following medical intervention, obesity is also associated with increased costs of treatment [10-16].

In the literature there are a few studies that have reported on the association between BMI and health care costs [17-19]. All these studies provide estimates of the cost of illness (COI) attributed to obesity at one point in time using the prevalence approach. The estimates are based on calculations of the total annual expenditure of a particular disease, e.g. type 2 diabetes, multiplied by an obesity-etiological fraction that measures the impact of obesity as a risk factor for type 2 diabetes. However, COI estimates based on the prevalence approach are not very useful for guiding decisions on prevention because the time dimension of the illness development is not considered. In order to provide information for decisions on prevention, the economic analysis needs to account for the time between the investments in preventing efforts and the benefits in reduced treatment costs, i.e., the time dimension. Cohort studies using the incidence approach can provide such observational information [20].

In this study we will seek to provide further evidence of the association between obesity and treatment costs. In particular we seek to address two specific questions: (1) are the hospital treatment costs for obese and overweight patients higher than for normal-weight patients and if so how much does this higher cost imply for the national Swedish health care budget, (2) are there any differences in life expectancy between obese and overweight patients from normal weight patients and if so how much is the associated costs for lost production.

Subjects and methods

Subjects

In order to answer the three questions posed, we used hospital data from medical records for middle-aged subjects of both sexes, recruited from the Malmö Prevention Project (MPP). All subjects in MPP were originally recruited from Malmö city, Sweden. Between 1974 and 1984, in all 22,444 men born between 1921 and 1949 (age range 35-51 years) and 10,533 corresponding women, constituting 70-75% of the total population in these birth cohorts (85% born in Sweden, 99% Caucasian), took part in the MPP. The project was carried out at the Department of Medicine, Malmö University Hospital, in southern Sweden. The aim of MPP was to screen the local population for cardiovascular risk factors and alcohol over-consumption. The subjects had a mean follow-up of 17 years (range 0-24 years). We have limited this study to the first 15 years of follow-up, since the proportion of patients lost to follow-up gradually accelerates beyond 15 years. Beyond 15 years we have too few observation to base our analysis on. A total of 23 365 subjects (70%) had a follow-up period of at least 15 years. Follow-up data were derived from register linkage analyses, covering a time period with expansion of the health care sector and medical treatment modalities. However, due to financial restrictions in health care in general, the mean number of days of each episode of hospitalization has gradually decreased for most common diagnostic categories. The loss of subjects to follow-up is related at least partly to mortality in about 1/3 of these subjects, as well as loss of a number of subjects that had emigrated abroad during follow-up.

Data on screening routines have previously been published as well as some follow-up analyses [21 - 24]. In Malmö city, there is only one central university hospital for the local population (250 000 inhabitants). The patients were classified into BMI Groups using the WHO criterion. Throughout this paper, BMI refers to baseline BMI. Baseline characteristics of the subjects are presented in Table 1.

Although the study was designed as a screening project for cardiovascular events we believe the BMI data generated from the study can also be used to answer the three questions that we have posed for this study. This especially so since the Swedish system of using a 10-digit personal number for all citizens, making it possible to trace persons even if they move around and will receive in-hospital care in different cities. Not many countries have the same administrative system and therefore we believe a study on the long-term economic consequences of obesity is suitable to do in Sweden.

To answer the questions that we have posed for this study we will estimate the following equation:

$H_{Aggregated}$ = f(age, sex, BMI group) (1)

where $H_{Aggregated}$ = number of days in hospital over the follow-up time, which depends on age, sex and baseline BMI group, i. e. normal weight, overweight and obese.

The cost of hospital treatment we subsequently estimate by multiply $H_{Aggregated}$ with an average cost per day of care in hospital. We use administrative prices for the costs of 24 hours hospital stay at the general medical ward and the psychiatric ward from Malmö City University Hospital. These prices were for the year 2003 SEK 3899 at the medical ward and SEK 3055 at the psychiatric ward. We use a weighted average cost of inpatient stay with weight 2/3 for the general medical ward and 1/3 for the psychiatric ward. These weights reflect roughly the pattern of admission of the screened population.

Method and Statistical analysis

The observed data on hospitalization had a very skewed distribution. There was a tendency towards a pattern of either no hospitalization at all in a given year, or frequent and in some cases lengthy hospitalization. Therefore we tried to discriminate between two subgroups without hospitalisation and with hospitalisation within a given year, and analyze the hospitalization rate in the latter one.

To obtain numerical estimate of equation (1) we use three regression equations, one for the survival time (T) (equation 2), one for the probability (Pr) of hospitalization in a given year (equation 3), and one for the number of days in hospital (H) given hospitalization (equation 4), defined as follows:

$$\ln (T(D1, D2, D3, Age)) = \alpha_1 + \alpha_2 * D1 + \alpha_3 * D2 + \alpha_4 * D3 + \alpha_5 * Age + \varepsilon_1 \quad (2)$$

$$\Pr \{H(D1, D2, D3, Age) > 0\} = (1 + \exp(\beta_1 + \beta_2 * D1 + \beta_3 * D2 + \beta_4 * D3 + \beta_5 * Age + \varepsilon_2))^{-1} \quad (3)$$

$$y(D1, D2, D3, Age) = \ln (H(D1, D2, D3, Age)) = (\gamma_1 + \gamma_2 * D1 + \gamma_3 * D2 + \gamma_4 * D3 + \gamma_4 * Age + \varepsilon_3) \quad (4)$$

For equation (2) we use an accelerated failure time model where age, two dummy variables for BMI group (D1 and D2) and one dummy variable for gender (D3) are explanatory variables, and the survival times (T) are assumed to have a Weibull distribution. This method assumes a parametric shape of the survival function, whereas non-parametric methods such as the Kaplan-Meier estimator make no such assumptions. Our approach enables the use of age as a continuous explanatory variable. The fitted parametric survival function is then used to compute the probability of survival beyond t years of follow-up time, Pr{T(D1, D2, D3, Age) > t}. In equation (3) we do a logistic regression of the probability of non-zero number of days in hospital in a given year. Finally in equation (4), we do a linear regression of the log number of days in hospital conditional on non-zero number of days. All these regression equations have age, BMI group and gender as explanatory variables. The dummy variables D1, D2 and D3 is set equal to 1 for overweight, obese and male patients respectively otherwise 0, and we divided the data into individual patient-years, so that each subject provided up to 15 years of observation. The log-transform in equation (4) necessitates the use of a smearing estimator to avoid bias when using the model to predict onto the natural scale [25].

Having obtained numerical estimates of equation (2), (3) and (4) numerical estimate of equation (1) is derived as follows:

$$H_{Aggregated}(D1, D2, D3, Age) =$$

$$\sum_{t=1}^{15} \left\{ \Pr\{ T(D1, D2, D3, Age) > t\} \;*\; \Pr\{H(D1, D2, D3, Age+t-1) > 0\} * \exp(y(D1, D2, D3, Age+t-1)+s) \right\}$$

where s is a smearing estimate for loglinear models, which is used to adjust for transformation bias and age in equation 3 and 4, is substituted with age + t - 1 to account for follow-up time.

Indirect costs we define equal to the value of production that is lost due to death before retirement age. This value we define equal to the number of years between age at death and age 65 times the annual wage including the social costs of labor (social insurance, pension etc.) of the deceased. We follow standard convention and assume that the wage reflect the value of production. We have assumed that all subjects in all BMI groups have an average wage equal to the national average by age and gender [29].

Both healthcare costs and indirect costs due to loss of production were estimated for a period of 15 years, in male and female subjects of ages 30-60, in each BMI group. We sum up the discounted costs over 15 years using a discount rate of 3%. The differences as compared to normal weights were estimated on a yearly basis.

We make a final aggregation of these costs by projecting the cost estimates onto the Swedish population. Each stratum in the population, defined by age (30-60), BMI group and gender, were multiplied by the predicted excess cost weighted by relative prevalence within the study subjects. In this context, the normal weight subjects yield zero costs in analogy with the methods described above. The resulting estimate is therefore the estimated cost due to obesity and overweight as compared to the hypothetical situation where all are normal weight.

The R language was used for statistical analyses and graphics [26].

Results

Survival pattern

Our parameter estimates of equation (22) are reported in Table 2.

Our model for survival showed that male subjects have a higher risk of death than female subjects (p<0.0001), and that the risk is higher in obese (p<0.0001) as compared to normal weight subjects. No difference was detected between overweight and normal weight subjects. In addition, the model confirms the expected result that the risk of death increases with age (p<0.0001). Predicted survival curves for 60-year old male in each BMI group are shown in Figure 1.

Hospitalization rate.

Parameter estimates of equation (33) and (44) are reported in Tables 3 and 4.

Table 4 Parameter estimates probability of having non-zero hospitalization rate, equation (3)

	Estimate	Std. Error	z value	Pr(>|z|)	
(Intercept)	-4.1119733	0.0392840	-104.67	<2e-16	***
age	0.0303135	0.0006731	45.03	<2e-16	***
bmi.groupOB	0.4188961	0.0181166	23.12	<2e-16	***
bmi.groupOW	0.1281724	0.0112593	11.38	<2e-16	***

bmi.groupUW	0.3993402	0.0353681	11.29	<2e-16	***
sexM	0.1650606	0.0117388	14.06	<2e-16	***

The logistic model, equation (33), shows the risk on non-zero hospitalization to increase with age (OR 1.031, 95% C.I. 1.029-1.032 for one year older), for male as compared to female subjects (OR 1.18, CI 1.15-1.21), for obese (OR 1.52, CI 1.47-1.58) and overweight (OR 1.14, CI 1.11-1.16) as compared to normal weight. The predicted probabilities of hospitalization are shown in Figure 2, for 60-year old male subjects in each BMI group.

Table 4 reports the parameter estimates for equation (44). The number of days in hospital increases by age ($p<0.0001$), but no statistical significant difference in hospitalization by gender. The rate was significantly higher for obese ($p=0.0024$) and significantly lower for overweight subjects ($p=0.0026$), as compared to normal subjects. Unfortunately, the predictive power of the equation is rather modest, adjusted R2 about 0. 9 %. However, in this study we are not seeking to predict the individual variation in number of days in hospital but rather the difference between groups of individuals. Our model clearly shows that there are differences in the number of days in hospital between groups of individuals with different BMI values and hence we will use this model to answer the questions that we have posed for this study. Figure 3 shows predicted number of days in hospital using equation 4 in male 60-year old subjects in each BMI group.

Expected incremental costs of hospitalization and indirect cost due to loss of production over 15 years

Using the results from equation 2 - 4 we can now estimate equation (1). The result is presented in Table 5. In this table we report the expected numbers of days in hospital for age cohorts 30-60, accumulated over 15 years along with the incremental cost of hospitalization as compared to normal weight subjects. A graphical presentation of the expected number of days in hospital for male subjects of different BMI groups is given in Figure 4. The curves in Figure 4 are generated as the product of the predicted probability of survival, the predicted probability of hospitalization and the predicted number of days in hospital. Note that the curve for overweight lies above the curves for normal weight, whereas in Figure 3 the curve for over weight lies below the curves for normal weight. The reason why the curve for over weight shifts its position in Figure 4 is that over weight patients have a higher probability of hospitalization.

The mean number of days in hospital of normal weight patients and overweight patients are, however, very similar, while obese patients have more days than normal weight. In Table 5 one may also note that the number of days in hospital increases by age in all BMI groups.

Estimates of the indirect costs due to loss of production are reported in Table 6. Overweight and normal weight being very similar, while obese have greater loss. The indirect cost of lost production increases by age up to age 50 because average annual salary (earnings) increases by age. After age 50 indirect costs declines because the number of years to retirement age 65 becomes less than 15 years.

Projecting the costs onto the Swedish population

Sweden has a population of some 3.7 million persons in the ages 30-60, and we use the cost estimates presented above to project onto this population and report the results in Table 7. The average annual hospital costs accumulated over 15 years, is estimated to 2.1 billion SEK and practically all costs (97 %) can be attributed to obese patients. Table 7 also reveals a marked gender differences in costs. The average annual hospital costs for male patients are estimated to 1.36 billion (63 % of total) and 0.81 billion (37% of total) for female patients. In Table 7 we also report our estimate of indirect costs due to death before retirement age. The indirect costs due to overweigh and obesity have the same pattern as for hospital costs although a little higher. The average annual indirect costs is estimated to 2.9 billion which is 38 % higher than our estimate of the annual costs of hospital treatment for obese and overweight patients.

Discussion

In this study we have sought to provide answers to two questions. First we raised the question if hospital treatment costs for obese and overweight are higher than for normal weight subjects. To this question we can say yes. In our statistical analysis, we found the mean expected number of days in hospitals to be significantly higher for obese and overweight patients than for normal weight patients, cf. Tables 5. This difference in number of days of care in hospital we have calculated in Table 7 translates into an aggregate costs for the Swedish Health Care Budget of some 2.1 billion SEK per annum. This figure we may now compare to another recently produced study on the problems and costs of obesity in Sweden. SBU (The Swedish Council on Technology Assessment of Health Care, 2003) have reviewed the literature on the problem and costs of obesity treatment and from this

review they assume that the costs of obesity is equal to 2 % of the total health care costs in Sweden [27]. This assumption, which is based on literature review of costs estimates of overweight and obesity produced in other countries, yields total costs of 3 billion SEK for the year 2002. This is higher than our cost estimate in this study of 2.1 billion. The reason for this is that we in our study we have only estimated the total costs of all hospital treatment and not included the costs of out-patients treatment including costs of drugs. In the Swedish health care system around 60 % of the direct health care costs are for hospital care, which would imply that out of the 3 billion estimated by SBU 1.8 billion should be for hospital care and this is lower than our costs estimate of 2.1 billion. One explanation for this discrepancy between our estimate and the estimate provided by SBU is that we in our study use panel date drawn from the population of Malmö city. Malmö is Sweden's third largest city and access and utilization of health care (hospital care) may not be fully representative for the country population. The discrepancy may also of course be due to differences in methodology. Our approach is a much more rigorous approach that the simple approach used by SBU. Nevertheless, our approach and the approach taken by SBU arrive at total costs estimates that are within reasonable margin comparability.

The second question we raised in this study was if there were any differences in survival for subjects with different BMI. To this question we can also say yes. Obese subjects were found to have a significantly lower probability of survival than normal weight subjects, cf. result Table 2. This difference in survival we have calculated in Table 7 translate into an aggregate indirect cost of lost production due to early death for the Swedish society of some 2.9 billion SEK per annum. For this estimate we have made the same assumption about the prevalence as reported for direct costs. This is a weak assumption and therefore our result must be interpreted with great care. Nevertheless, we believe the result gives a rough estimate of the magnitude of the indirect costs involved for excess morbidity found for overweight and obese patients. However, our estimate is only part of total indirect costs. There are three major reasons that give rise to indirect costs: (1) indirect costs due to death before retirement, (2) indirect costs due to early retirement on account of morbidity and (3) indirect costs due to short term absence from work on account of an illness episode. We have only estimated the indirect costs due to death before retirement age. Unfortunately, our panel data set contains no information on early retirement on account of morbidity and the extent of absence of work on account of short-term illness episodes. In Sweden it is these two causes that give rise to most of the indirect costs. According to a cost of illness (COI) report published by the National Board of Health and Social Welfare in Sweden, Socialstyrelsen (1996), cost of early retirement and costs of short-term absence from work accounted for some 80 % of total indirect costs in Sweden [28]. If we

use this ratio on our estimated indirect cost of 2.9 billion SEK on account of death before retirement, we arrive at a total indirect costs for overweight and obesity of some 14.5 billion SEK {= 2.9/(100%-80%)}.

The result in Table 5 shows the incremental costs per patient of obese and overweight subjects as compared to normal weight. This incremental cost constitutes the potential costs savings that could be gained by any therapy that could convert obese and overweight to normal weight subjects. However against this cost saving we must deduct the cost of the therapy, which is likely to be equally as high if not higher, so the potential for any net hospital costs saving to be gained seems to be rather limited. The indirect costs are substantially higher than hospital costs so there seems to be a good potential to make savings in indirect costs with a therapy that could convert obese and overweight subjects to normal weight subjects. However, to avoid the excess health-care cost of obesity a primary strategy of prevention in children and young adults based on lifestyle is the most important measure to undertake. Besides that, new drug treatment modalities should be developed for cost-effective treatment of adult obesity with a favourable long-term effectiveness and safety profile.

A major limitation of our study is that we have not been able to control for differences in diseases among the screened population. Nor did we in this study exclude subjects who reported that they smoked cigarettes or had a history of cancer. Since cancer is associated with both low and high BMI and high medical costs, it might therefore be a confounding factor to our estimation of costs. Smoking is primarily associated with low BMI and is therefore another important confounding factor in our analysis. Excluding individuals with other confounding factors, for example subjects with pre-existing coronary heart disease, stroke and type 2 diabetes, would have resulted in a reduction of the study sub-population characterized by metabolic effects of obesity.

Another limitation of our study is that we have been unable to control for differences in socio-economic status (SES) of the screened population. Unfortunately, the data set that we have used in this study contains insufficient data to lend itself to analyze the link between SES and obesity. One study on the link between SES and obesity concludes that the causality can run in both directions from low SES to obesity or from obesity to SES [30]. The conclusion made in this study was therefore that the question on causality was too complex to lend it self to the conclusion that obesity was a contributing factor for low SES. There are other common variables that link obesity and low SES.

Most studies investigating the relationship between health care costs and BMI are based on the prevalence approach and provide only a point estimate of excess costs for one single year. Such studies are, however, of limited value for assessing the value of intervention programs. For evaluation of intervention programs cohort studies, following patients over long periods and estimating the present value of potential cost savings, are more relevant. To our knowledge, our study is the first to show a statistical significant relationship between BMI and longitudinal inpatient care costs. Other cohort studies have established relationship between drug therapy costs and outpatient care costs but failed in this respect for inpatient care costs [17,19]. However, the previous study was based on a data set of 1286 subjects, selected from 7021 adults participating in a health survey, followed over a period of 9 years. Our estimates were derived from a larger data set, in which 33332 subjects, selected from a screening project involving 33346 individuals, were followed over 15 years.

In conclusion, we have found that obesity both entails a considerable health hazard and consequently gives rise to substantial hospital costs and indirect costs due to early death. In particular we have found that inpatient care costs are higher for overweight and obese patients indicating potential cost offsets especially for indirect costs by an effective and safe weight loss intervention.

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Table 1 Baseline characteristics of subjects (N)

	Normal weight		Overweight		Obese	
	Male	Female	Male	Female	Male	Female
N	12823	6662	7931	2844	1382	1068
Age group						
N<45	52,7%	28,3%	42,9%	12,1%	38,5%	10,1%
N 45-54	43,1%	40,0%	50,5%	44,4%	54,7%	40,2%
N >=55	4,2%	31,7%	6,6%	43,5%	6,8%	49,7%
	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%
Age range						
min	25.5	28.2	27.9	28.2	28.1	28.5
max	61.2	57.6	61,1	57.4	60.8	57.0
	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)	Mean(SD)
Age	43.0(6.6)	48.6(7.9)	44.7(5.4)	51.7(5.5)	45.3(6.1)	52.2(5.4)
BMI	22.6(1.6)	22.1 (1.7)	26.9(1.3)	27.0(1.4)	32.4(2.4)	33.4(3.4)
Follow-up years	18.6(3.6)	14.5(4.5	18.6(3.7)	13.2 (4.0)	17.9(4.5)	12.8(4.0)

Table 2 Parameter estimates for survival time, equation (2) estimated with N= 32710 patients

	Value	Std. Error	z value	p value Pr{>|z|}
α_1 (Intercept)	7.2398	0.10714	67.57	<0.0001
α_{Age}	-0.0571	0.00175	-32.69	<0.0001
$\alpha_{BMI = Normal}$	0			
$\alpha_{BMI = Obese}$	-0.2472	0.03306	-7.48	<0.0001
$\alpha_{BMI = Overweight}$	-0.0154	0.02112	-0.73	0.4610
$\alpha_{Sex = Female}$	0			
$\alpha_{Sex = Male}$	-0.5039	0.02990	-16.85	<0.0001
Log(scale)	-0.5286	0.01573	-33.61	<0.0001
Loglik (model)	-20828.5			
Chisq.	1567.07			

Likelihood test ratio vs intercept Chisq. ($\chi 2$) = 1567, p value < 0,0001

Table 3 Parameter estimates probability of having non-zero hospitalization rate, equation (3) estimated with N= 32710 patients (459511 patient-years)

	Estimate	Std. Error	z value	p-value Pr{>|z|}	OR§)
β_1 (Intercept)	-4.112957	0.03995	-103.36	<0.0001	
β_{Age}	0.0306225	0.0006842	44.76	<0.0001	1.031
$\beta_{BMI = Normal}$	0				
$\beta_{BMI = Obese}$	0.4182596	0.0181195	23.08	<0.0001	1.52
$\beta_{BMI = Overweight}$	0.1276276	0.0112628	11.33	<0.0001	1.14
$\beta_{Sex = Female}$	0				
$\beta_{Sex = Male}$	0.1668386	0.0119167	14.00	<0.0001	1.18

Likelihood test ratio vs intercept Chisq. ($\chi 2$) = 2852, p value < 0,0001

§) OR (odds ratio) =exp$^{\beta}$

Table 4 Parameter estimates for the log of # of days in hospital, equation (4) estimated with N= 18153 patients (41228 patient-years)

	Estimate	Std. Error	t value	p value Pr {>|t|}
γ_1 (Intercept)	0.9222788	0.0456287	20.213	<0.0001
γ_{Age}	0.0147012	0.0007916	18.571	<0.0001
$\gamma_{BMI = Normal}$	0			
$\gamma_{BMI = Obese}$	0.0659055	0.0216860	3.039	0.0024
$\gamma_{BMI = Overweight}$	-0.0412887	0.0137294	-3.007	0.0026
$\gamma_{Sex = Female}$	0			
$\gamma_{Sex = Male}$	0.0104361	0.0141413	0.738	0.46053
Adjust.R^2	0.0091			

Table 5: Mean (expected) days in hospital in normal weight, overweight and obese subjects, and excess days and costs of excess days in hospital for overweight and obese subjects as compared to normal weight (mean and 95% confidence intervals), by gender and selected age, over 15 years

	Expected days in hospital Mean days per patient			Excess days in hospital Mean days per patient (95% CI) §§)					
Age§)	Normal	Over-weight	Obese	Over-weight			Obese		
	male								
30	10.0	10.9	15.8	0.82	(0.27	1.35)	5.72	(4.10	7.62)
35	12.4	13.4	19.3	0.99	(0.32	1.64)	6.94	(5.00	9.21)
40	15.3	16.5	23.6	1.20	(0.37	1.98)	8.33	(6.02	11.02)
45	18.7	20.1	28.5	1.43	(0.43	2.37)	9.84	(7.13	13.00)
50	22.7	24.3	34.0	1.68	(0.47	2.80)	11.37	(8.23	15.02)
55	27.1	29.0	39.8	1.93	(0.50	3.24)	12.69	(9.16	16.79)
60	31.7	33.8	45.1	2.14	(0.48	3.65)	13.43	(9.61	17.88)
	female								
30	8.5	9.2	13.5	0.71	(0.22	1.17)	4.94	(3.47	6.65)
35	10.6	11.4	16.6	0.86	(0.27	1.43)	6.05	(4.29	8.10)
40	13.1	14.2	20.5	1.05	(0.32	1.75)	7.37	(5.27	9.82)
45	16.2	17.4	25.1	1.27	(0.38	2.12)	8.90	(6.40	11.80)
50	19.9	21.4	30.5	1.53	(0.44	2.55)	10.63	(7.66	14.05)
55	24.2	26.0	36.7	1.81	(0.49	3.03)	12.47	(9.00	16.45)
60	29.2	31.3	43.5	2.10	(0.54	3.55)	14.26	(10.28	18.82)
				Cost*) of excess days in hospital Mean cost per patient (95% CI)					
Age				Overweight			Obese		
	male								
30				2 369	(778	3 904)	16 567	(11 874	22 096)
35				2 883	(928	4 759)	20 130	(14 507	26 731)
40				3 479	(1 085	5 759)	24 220	(17 514	32 052)
45				4 157	(1 248	6 907)	28 733	(20 813	37 946)
50				4 897	(1 394	8 177)	33 378	(24 172	44 051)
55				5 650	(1 490	9 503)	37 572	(27 142	49 653)
60				6 328	(1 465	10 761)	40 350	(28 960	53 576)
	female								
30				2 042	(643	3 386)	14 295	(10 032	19 276)
35				2 502	(779	4 151)	17 527	(12 416	23 486)
40				3 051	(936	5 068)	21 371	(15 259	28 479)
45				3 693	(1 100	6 146)	25 857	(18 570	34 296)
50				4 434	(1 277	7 401)	30 945	(22 312	40 902)
55				5 265	(1 451	8 825)	36 452	(26 329	48 082)
60				6 149	(1 588	10 367)	41 941	(30 257	55 310)

§) We selected the age span 30 - 60 years because this age span covers the 95 % CI interval of age in our sample population.
§§) We use Boots-trap techniques to generate our 95 % CI
*) discounted at 3 %

Table 6: Mean (expected) lost years of production in normal weight, overweight and obese subjects, and excess years and costs of excess years of lost production for overweight and obese subjects as compared to normal weight (mean and 95% confidence intervals), by gender and selected age, over 15 years

	Expected lost years of production Mean lost years per patient			Excess lost years of production Mean lost years per patient (95% CI) §§)					
Age§)	Normal	Over-weight	Obese	Overweight			Obese		
	Male								
30	0.10	0.10	0.15	0.00	(0.00	0.01)	0.05	(0.04	0.06)
35	0.16	0.16	0.24	0.00	(-0.01	0.02)	0.08	(0.06	0.10)
40	0.26	0.26	0.39	0.01	(-0.01	0.03)	0.13	(0.10	0.16)
45	0.42	0.43	0.62	0.01	(-0.02	0.04)	0.21	(0.15	0.26)
50	0.66	0.68	0.99	0.02	(-0.03	0.07)	0.33	(0.24	0.41)
55	0.35	0.36	0.52	0.01	(-0.02	0.03)	0.17	(0.12	0.22)
60	0.08	0.08	0.11	0.00	(0.00	0.01)	0.04	(0.03	0.05)
	Female								
30	0.04	0.04	0.06	0.00	(0.00	0.00)	0.02	(0.01	0.03)
35	0.07	0.07	0.10	0.00	(0.00	0.01)	0.04	(0.02	0.05)
40	0.11	0.11	0.17	0.00	(-0.01	0.01)	0.06	(0.04	0.07)
45	0.18	0.18	0.27	0.00	(-0.01	0.02)	0.09	(0.06	0.12)
50	0.29	0.30	0.44	0.01	(-0.01	0.03)	0.15	(0.10	0.19)
55	0.15	0.15	0.23	0.00	(-0.01	0.02)	0.08	(0.05	0.10)
60	0.03	0.03	0.05	0.00	(0.00	0.00)	0.02	(0.01	0.02)

				Cost*) of additional lost years of production Mean cost per patient (95% CI)					
Age				Overweight			Obese		
	Male								
30				844	(-1 140	3 186)	15 212	(10 712	19 155)
35				1 251	(-2 304	4 992)	25 765	(18 167	32 128)
40				2 256	(-3 594	8 727)	43 559	(31 431	54 253)
45				3 609	(-5 933	14 107)	69 751	(50 524	86 766)
50				5 281	(-8 948	20 921)	102 662	(74 536	127 903)
55				2 957	(-5 320	11 887)	58 854	(42 392	73 486)
60				748	(-1 275	2 998)	14 436	(10 242	18 143)
	Female								
30				331	(-266	1 157)	5 129	(3 230	6 867)
35				450	(-716	1 720)	8 882	(5 763	11 737)
40				615	(-1 532	2 623)	14 814	(9 619	19 377)
45				1 228	(-1 879	4 701)	23 640	(15 846	30 910)
50				1 848	(-2 686	7 018)	34 552	(23 515	45 077)
55				1 033	(-1 547	3 948)	19 435	(13 255	25 245)
60				247	(-375	934)	4 629	(3 141	6 007)

Note: same as Table 5

Table 7: Average annual projected hospital and indirect cost (projected over 15 years), SEK mil, of overweight and obese male and female persons in the Swedish population in ages 30-60 as compared to the same population with normal weight.

	Overweight		
	Hospital cost (HC)	Indirect costs (PL)	Total
male	39,526	26,663	66,190
female	40,215	9,193	49,407
Total	66,190	35,856	102,045
	Obese		
	HC	LP	Total
male	1 320,654	2 387,908	3 708,562
female	768,904	511,690	1 280,594
Total	2 089,558	2 899,598	4 989,156
	Overweight + Obese		
	HC	LP	Total
male	1 360,181	2 414,571	3 774,752
female	809,118	520,883	1 330,001
Total	2 155,747	2 935,454	5 091,202

Note: Indirect cost measures loss of production due to early death. Costs are discounted using a 3 % discount rate

Figure 1: Estimated survival in male subjects, aged 50
(Note: the vertical scale is limited to the range 0.7 to 1.0).

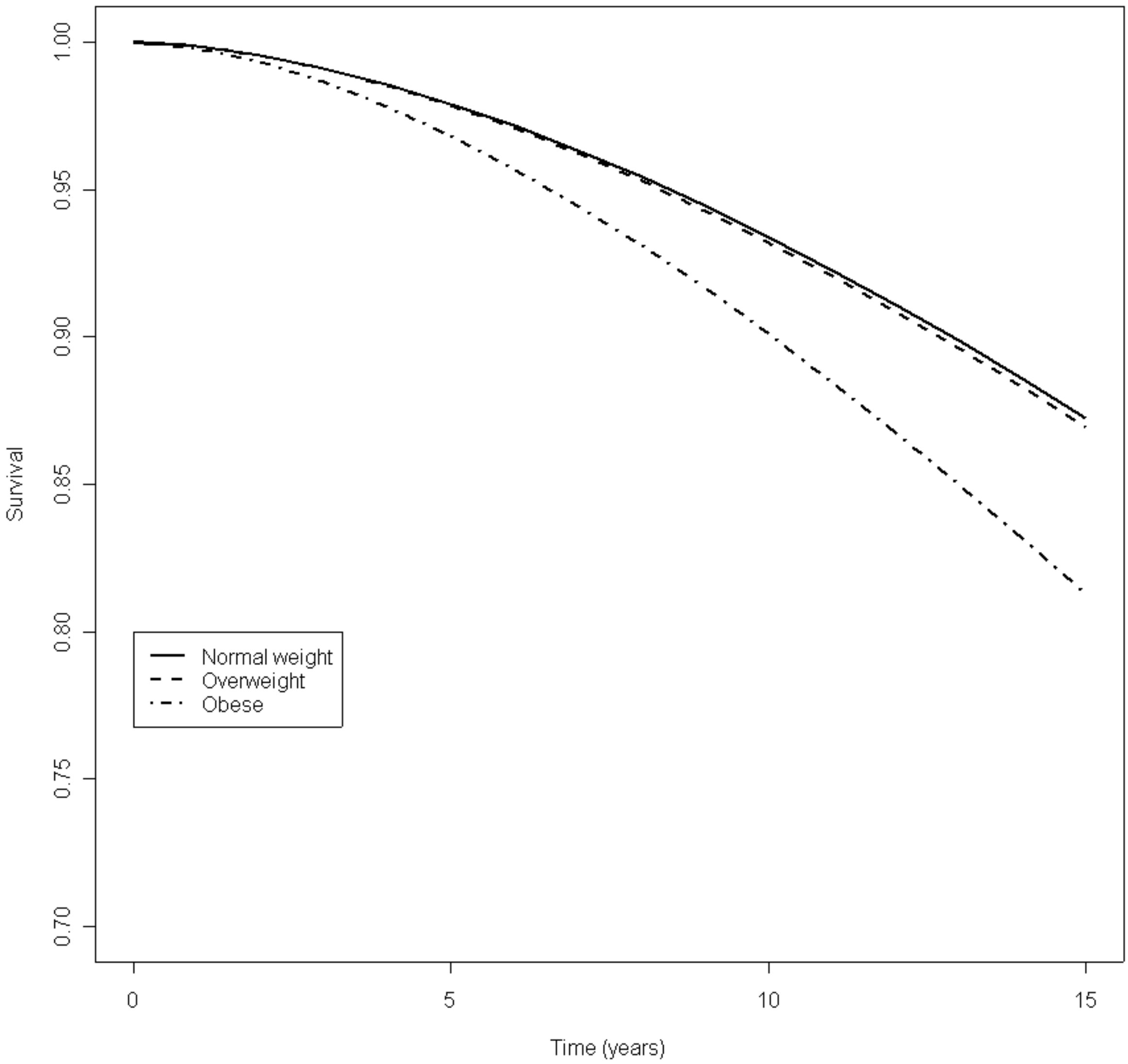

Figure 2: Estimated probability of hospitalization in male subjects, aged 50

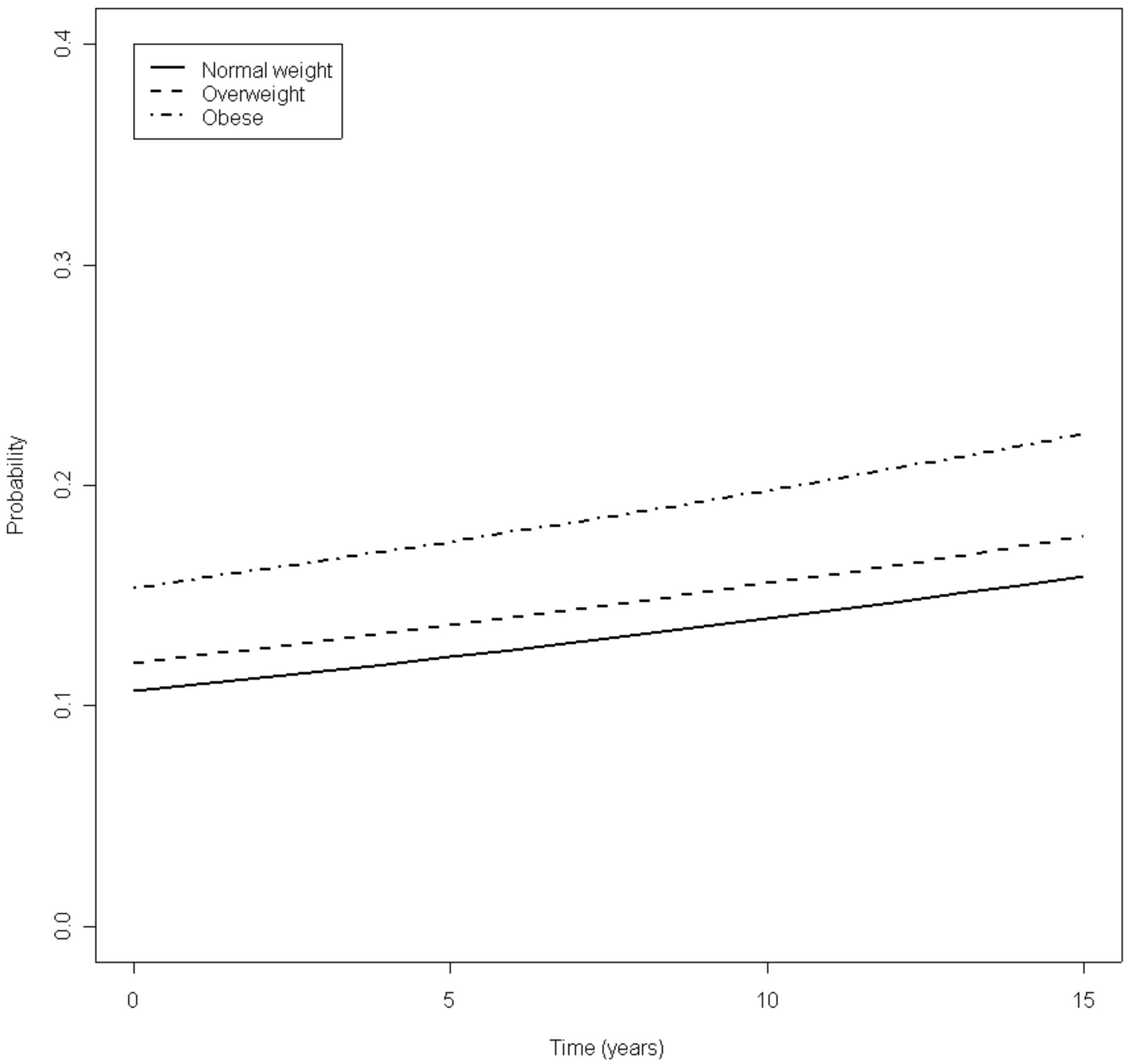

Figure 3: Predicted number of days in hospital in male subjects, aged 50

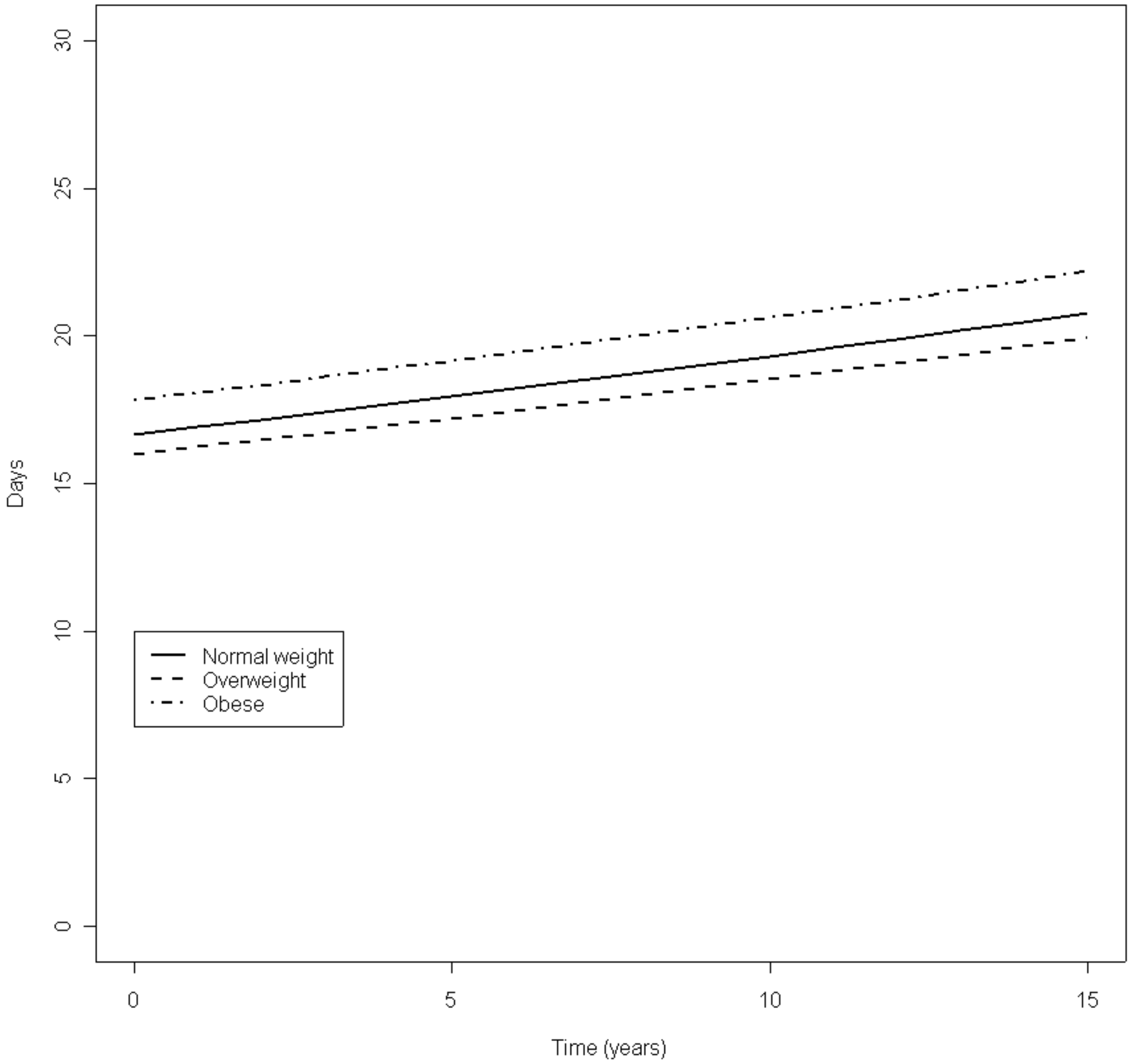

Figure 4: Expected number of accumulated days in hospital by age at beginning of period