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Country of origin and bariatric surgery in Sweden during 2001-2010

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Abstract

Background: The prevalence of obesity as well as use of bariatric surgery have increased worldwide. The aim of the present study was to investigate the potential differences in the use of bariatric surgery among Swedes and immigrants in Sweden, and whether the hypothesized differences remain after adjustment for socioeconomic factors.

Methods: A closed cohort of all individuals aged 20-64 years was followed during 2001-2010. Further analyses were performed in two periods separately (2001-2005 and 2006-2010). Age-standardized cumulative incidence rates (CR) of bariatric surgery were compared between Swedes and immigrants considering individual variables. Cox proportional hazards models were used in univariate and multivariate models for males and females.

Results: 12791 Swedes and 2060 immigrants underwent bariatric surgery. The lowest rates of bariatric surgery were found in immigrant men. The largest difference in CR between Swedes and immigrants was observed among low-income individuals (3.4 and 2.3 per 1000 individuals, respectively). Adjusted hazard ratios (HRs) were lower for all immigrants compared to Swedes, in the second period. The highest HRs were observed among immigrants from Chile and Lebanon and the lowest among immigrants from Bosnia. Except for Nordic countries, immigrants from all other European countries had a lower HR compared to Swedes.

Conclusion: Men in general and some immigrant groups had a lower HR of bariatric surgery. Moreover, the difference between Swedes and immigrants was more pronounced in individuals with low socioeconomic status (income). It is unclear if underlying barriers to receive bariatric surgery are due to patients' preferences/lack of knowledge or health care structures. Future studies are needed to examine potential causes behind these differences.

Keywords: Obesity, bariatric surgery, country of origin, immigrants, socioeconomic status.

Introduction

Similar to many other Western European countries, there has been an increase in immigration to Sweden during the last decades. In 1990, 11.3% of the total population were first-generation immigrants compared with 14.7% in 2010 [1]. During the 1950s and 1960s, the majority of immigrants came from Italy, Finland, Greece and former Yugoslavia to meet an increasing need for industrial labour, whereas immigrants during the 1970s and 1980s were mainly political refugees from Poland, Turkey, Latin America, Middle East, Asia, Africa and former Yugoslavia [2]. Thus immigrants in Sweden are very heterogeneous regarding reason for emigration, educational level, social class and health status. In general, immigrants have a higher risk for health problems compared to the majority population [2, 3]. Decline of the psychosocial status [4] and changes in lifestyle might be possible explanations. Changes in lifestyle may include unhealthy dietary patterns which might explain why many immigrant groups in Sweden have higher rates of obesity [5-7].

The prevalence of obesity, defined as body-mass index (BMI) $\geq$ 30 kg/m^2, has doubled in Sweden over the last 20 years [8, 9]. Obesity is associated with higher mortality, decreased quality of life and greater overall costs to the healthcare system due to its numerous comorbidities, such as diabetes, hypertension, cardiovascular disease, sleep apnea syndrome, and degenerative skeletal diseases [10, 11]. Morbid obesity (BMI $\geq$ 40 kg/m^2) is generally refractory to diet, exercise, and drug therapies [12, 13]. Bariatric surgery often results in substantial weight loss, resolution and/or improvement of obesity-related comorbidities, reduced mortality and improved quality of life [14-16]. In Sweden, individuals with BMI $\geq$ 40 kg/m^2 or those with BMI $\geq$ 35 kg/m^2 plus obesity associated comorbidity are eligible for bariatric surgery [17]. Studies from countries with private health care insurance systems show that although obesity is more prevalent among economically disadvantaged and ethnic

minorities, these patients undergo bariatric surgery less than expected [18-20]. Sweden has universal health care insurance which means that financial reasons should not be a major obstacle in the probability of receiving bariatric surgery. However, earlier studies show that individuals with the lowest socioeconomic status undergo bariatric surgery at a lower rate[21]. In addition, immigrants in general have a higher risk for many health problems [2, 3]. Our hypothesis is that there are, despite medical eligibility, still differences associated to country of origin and the rate of bariatric surgery in Sweden. The primary aim of the present study was to investigate the potential differences in the use of bariatric surgery by country of origin and gender in Sweden during 2001-2010. The secondary aim was to investigate whether the hypothesized differences in bariatric surgery remain after adjustment for socioeconomic factors. To our knowledge this is the first nationwide study that compares differences in bariatric surgery rates between Swedes and immigrants.

Materials and methods

Data used in this study incorporated longitudinal hospitalization data for the entire population from the Swedish Inpatient Register, provided to us by the National Board of Health and Welfare. Population-wide documentation regarding demographic and socioeconomic variables was obtained from the Total Population Register, provided to us by Statistics Sweden, the Swedish Government-owned census bureau. Additional individual-level linkages in the database included data from the national Cause of Death Register [22] and the Immigration Register (to identify dates of immigration and/or emigration). All linkages were performed by the use of an individual national identification number that is assigned to each permanent resident in Sweden for their lifetime. This number was replaced by a serial number for each person in order to provide anonymity.

The follow-up period started on January 1, 2001 and proceeded until *first* hospitalization for bariatric surgery, death, emigration or the end of the study period on December 31, 2010. Further analyses were done in two periods separately, i.e., 2001-2005 and 2006-2010, as there was a large increase in the number of surgeries during the second period. Since the analyses were done as closed cohorts, the total number of operated cases for the period 2001-2010 was not the same as the sum of the number of cases for 2001-2005 and 2006-2010.

Outcome variable

The outcome variable was bariatric surgery. We used the Swedish Inpatient Register to identify main diagnoses of obesity and operation in the study population during the study period. The International Classification of Disease (ICD) 10 were used to identify patients with a diagnosis of obesity (ICD-10, E66) [23]. The Swedish Classification of Operations and Major Procedures were used to identify patients undergoing bariatric surgery: operation codes JDF00-JDF01, JDF10-JDF11, and JDF20-JDF21. The subtypes of bariatric surgery were defined as gastroplasty (JDF00-JDF01), gastric bypass (JDF10-JDF11), and gastric banding (JDF20-JDF21). All the operated cases (events) had both an ICD code for obesity and an ICD code for bariatric surgery. .

Individual variables

The individual variables were defined at the initial year for each study period.

Gender: Male or female.

Age: Age was categorized as 20-29, 30-39, 40-49, or 50-64 years.

Family income: Family income was calculated as annual family income divided by the number of members in the family. The income calculation was weighted, taking the ages of

the family members into account. For example, children were given lower consumption weights than adults. The calculation was performed as follows: the sum of all family members' incomes was multiplied by the individual's consumption weight divided by the family members' total consumption weight [24]. The final variable was calculated as empirical quartiles from the distribution [25] and classified as low, middle-low, middle-high and high. Family's consumption weight was calculated as follows:

1.00 for the first adult, 0.51 for the second adult, 0.62 for the third adult, 0.52 for the first child (0-19 years old), and 0.42 for child nr 2 or more (0-19 years old). For example, a family that consists of one adult, and 2 children has a total consumption weight of 1.00 (adult) + 0.52 (first child) + 0.42 (second child) = 1.94.

Marital status: Individuals were classified as married/cohabitating or single.

Employment was defined as yes (including part-time employment) or no.

Predictor variable

The predictor variable was *country of birth* defined as Swedish-born and foreign-born, the latter subdivided further as described below.

The dataset included people from 64 countries and regions of birth (Supplementary Table 1). In the present study, we combined countries into 12 regions (Nordic countries, Southern Europe, Western Europe, Eastern Europe, Baltic countries, Central Europe, Africa, North America, Latin America, Asia, Russia and countries belonging to the southern part of the Soviet Union, and Other countries). Countries/country groups with more than 10 cases of obesity surgery were analysed separately. These countries included Denmark, Finland, Norway, Greece, Italy, other Southern European countries, Great Britain/Ireland, Germany,

Bosnia, former Yugoslavia, Romania, Poland, Hungary, Chile, Turkey, Lebanon, Iran and Iraq.

Statistical analysis

Age-standardized cumulative incidence rates (CR) of bariatric surgery were compared between Swedes and immigrants considering individual variables. P-values were calculated using Z-test calculators. A p-value of < 0.05 was considered statistically significant. In order to compensate for multiple comparisons, we also calculated estimates based on a 99% CI. Individuals aged 20 to 64 years at the start of follow-up were included. Age was standardized according to the age in the study population. The associations between the individual variables and bariatric surgery were analysed with Cox proportional hazards models. An advantage with this model is that individuals that are censored contribute to the analysis with their time under risk in the study. Firstly, univariate Cox regression was performed for each variable. Secondly, a multivariate Cox regression model including all variables was calculated. Separate analyses were performed for the periods 2001 to 2005 and 2006 to 2010. All analyses were performed using the SAS version 9.2 (SAS Institute, Cary, NC, USA) [26].

Ethical considerations

This study was approved by the Ethics Committee at Lund University.

Results

In the closed cohort between 2001 and 2010, a total number of 14851 individuals (12791 Swedes and 2060 immigrants) underwent bariatric surgery in Sweden. In Table 1a, the distribution of the population and cumulative rates of bariatric surgery per 1000 individuals are shown. Overall, the *lowest* rates for bariatric surgery were found in immigrants who were male and those aged 50-64 years. Age-standardized cumulative incidence rate (CR) for immigrants was slightly lower (2.7 per 1000 individuals [95% CI: 2.6-2.9]) compared to

Swedes (2.9 per 1000 individuals [95% CI: 2.9-3.0]) (although the difference was not statistically significant, p-value 0.3125), with predominance for women in both groups (4.3 and 4.5 per 1000 individuals respectively). The age-group with the highest CR was age-group 30-39 years (both Swedes and immigrants). Fifteen percent of the Swedes had a low family income compared to 34.0 % of the immigrants. The difference was statistically significant, p-value <0.05. For the variable income, the lowest CRs were found among those with highest income in both Swedes and immigrants (1.9 and 2.0, respectively), whereas the highest CRs were among those in middle-low income groups (3.6 and 3.4 respectively). The largest difference in CR between Swedes and immigrants, with respect to income group, was among low-income individuals (3.4 and 2.3 respectively; the difference was statistically significant, p-value <0.001). For marital status, the highest CR in Swedes was found in individuals who were married/cohabiting (3.6), whereas for immigrants there was no difference in CR among the two groups (2.8). For employment status, the highest CR for Swedes was among those with no employment whereas for immigrants it was among those with employment (4.4 and 2.9 respectively).

Since table 1a shows a closed cohort during a 10-year period, many of the variables, including marital status, employment and family income, might change over time. For this reason, we divide the 10-year period into two periods, 2001-2005 and 2006-2010, in order to capture the differences between these two periods. These results are shown in table 1b and 1c. The results are relatively similar to those in table 1a except for the following:

The rates of bariatric surgery were higher in the second period, i.e., 2006-2010. In this period (Table 1c), the highest CR by age group was found in Swedes aged 30-39, and in immigrants aged 40-49. The lowest CRs in Swedes and immigrants were in age group 50-64 years and 20-29 years, respectively. For income, the highest CR in the second period was among

Swedes with the lowest income, whereas in the first period the highest CR was among Swedes with a middle-low income. For immigrants, the highest CR was among those with middle-low income in both periods. The CRs for employment status in immigrants differed in the first and second period compared to the whole period 2001-2010. During the whole period, the CR was highest for those with employment, whereas in the two periods 2001-2005 and 2006-2010, there was no difference between employed and unemployed individuals.

Table 2 and 3 show hazard ratios (HRs) for bariatric surgery by different regions and countries of origin compared to Swedish-born, in men and women, respectively. HRs of bariatric surgery were analyzed in two different models, i.e., a crude model, and a fully adjusted model. In the fully adjusted model, there was no significant difference in bariatric surgery between female immigrants and Swedes. However, male immigrants had a lower HR for bariatric surgery compared to Swedes.

In table 2, the highest HR in men in the full model was among immigrants from Chile (HR 2.40 [95% CI: 1.76-3.29]) and Lebanon (HR 2.34 [95% CI: 1.65-3.31]). The lowest HRs were found in men from Bosnia (HR 0.11 [95% CI: 0.04-0.33]) and Turkey (HR 0.43 [95% CI: 0.22-0.83]). Immigrant men from Nordic countries (Denmark, Finland and Norway) had higher HRs than Swedes.

In table 3, the HRs for women were very similar to the HRs for men. In the full model, the highest HR in women was among immigrants from Chile (HR 3.77 [95% CI: 3.28-4.33]), Lebanon (HR 1.65 [95% CI: 1.31-2.07]), and Iran (HR 1.53 [95% CI: 1.31-1.80]). The lowest HRs were found in women born in Bosnia (HR 0.29 [95% CI: 0.20-0.41]) Great Britain/Ireland (HR 0.49 [95% CI: 0.24-0.98]), and Germany (HR 0.54 [95% CI: 0.35-0.83]). Among females from the Nordic countries only those from Finland and Norway had a significantly higher HRs than Swedes.

Results from the two periods 2001-2005 and 2006-2010 (men and women analyzed together), are shown in table 4. In the first period the HRs of bariatric surgery were not significantly different comparing Swedes and all immigrants whereas in the second period the HR was lower for immigrants (0.74 [95% CI: 0.71-0.78]). The highest HRs in both periods were for immigrants from Chile followed by Lebanon. The lowest HRs in both periods were found in immigrants from Bosnia followed by Germany in the first period and Great Britain-Ireland in the second period. Immigrants from the Nordic countries especially Finland, had higher HRs compared to Swedes in both periods.

Discussion

To our knowledge, no previous nationwide study has compared bariatric surgery rates in Sweden among Swedish-born individuals and immigrants. Despite Sweden's public health-insurance, we found differences in rates of bariatric surgery in different sociodemographic and country groups. In our study, the rates of bariatric surgery were lowest among those who were middle-aged and unemployed male immigrants. An American study from 2013 showed that fewer black than white males underwent bariatric surgery [27]. The highest probability to undergo bariatric surgery was found in immigrants from Chile (adjusted HR 3.77 in women and 2.40 in men) followed by Lebanon, whereas the lowest probability was found in immigrants from Bosnia (HR 0.11 for men and 0.29 for women), compared to Swedes.

Several American studies have suggested that the procedure is used inequitably according to ethnicity and socioeconomic status [18, 28, 29]. Since the rate of morbid obesity is much higher in the lowest socioeconomic status (SES) groups [19, 30], one might expect that the rate of bariatric surgery would be highest in this group. Our study showed, however, that the highest bariatric surgery rate belonged to middle-low income group in both Swedes and immigrants.

In our study, there was no significant difference in the HR for bariatric surgery in females from Sweden and females from other countries. In contrast, male immigrants had a lower HR for bariatric surgery compared to Swedes. However, there were significant differences between the different countries of origin. The overall result showed that among European immigrants, those from Nordic countries had higher HRs for bariatric surgery compared to Swedes whereas immigrants from every other country in Europe had a lower HR. Among immigrants from countries outside Europe, Chile and Lebanon had higher HRs compared to Swedes. These differences sometimes reflect the rates of obesity in certain immigrant groups but not always. In a Swedish cross sectional study [31], the prevalence ratio (PR) of obesity for women from Chile was markedly increased, corresponding to the high HR for bariatric surgery in our study. A more recent study from Sweden [5] showed, however, that immigrants from the Middle East had significantly higher odds (almost three times higher) for obesity. The present study showed different results for Middle Eastern countries: e.g., Lebanon had higher HRs for bariatric surgery whereas Iraq had similar or even lower HRs (second period) than Swedes. Although obesity rates in most other OECD Countries are higher compared to Sweden [32], the HRs for bariatric surgery were lower for almost all other OECD countries included in the present study except for Nordic countries and Chile. Among the Nordic countries, Norway has a lower obesity rate compared to Sweden and still the HR for bariatric surgery for both men and women were higher for immigrants from Norway compared to Swedes.

The process of migration involves major challenges in an individual's life such as social, familial, occupational and economic disruption, which might lead to stress and unhealthy behaviors like physical inactivity and obesity [4, 33]. Former studies show that many immigrant groups in Sweden have higher rates of obesity [5-7, 31]. As shown in this study and some other studies [6, 7], unemployment rates are higher among immigrants.

Employment status differed between Swedes and immigrants and during the first and second period. Among Swedes who had been operated, the rate of unemployment was higher compared to immigrants. It has been suggested that unemployment is also related to reduced levels of activity, which would contribute to a more sedentary lifestyle.

In countries with private insurance settings, socioeconomic factors may exert a significant influence on the probability of individuals undergoing bariatric surgery [18]. In Sweden, a country with a universal health insurance, the costs of surgery should not be a primary barrier to receiving surgery. There are other factors that should influence the selection of individuals for bariatric surgery, such as medical eligibility, i.e., rates of morbid obesity and its comorbidity in different groups. Significant differences might exist between different ethnic and socioeconomic groups in the perception of obesity and bariatric surgery, which might lead to differences in seeking bariatric surgery. The referral patterns of primary care providers might be biased by the patient's ethnicity and other factors, which may lead to altered patterns for seeking and receiving surgical intervention. Low referral rates for ethnic minorities were shown in an American study from 2007 [34]. Another study showed that African Americans and men were less likely to have been recommended bariatric surgery by their doctors [35]. In addition, several American studies have found less weight loss among non-white patients after bariatric surgery [36, 37].

Previous work suggests that ethnic minorities are less likely to undergo bariatric surgery [38]. This was also shown for the whole immigrant population in our study. On the other hand, there were large variations between different immigrant groups. The factors underlying such large variations in the use of bariatric surgery in different immigrants group are unclear. Differences in obesity rates among different ethnical groups could probably influence the rate of bariatric surgery. Another explanation is that obesity is culturally, socially and economically more stigmatizing for some immigrants than others who have a more positive

body image and larger social acceptance for obesity, which may lead to lower weight loss goals. Some cultures may have higher ideal body weights and desire less weight loss than others. Thus, the motivation to seek potentially risky weight loss treatments such as bariatric surgery may differ among different subgroups of immigrants. These cultural differences could be more prevalent among low SES immigrants and could therefore be a potential explanation behind our findings. An American study showed that quality of life (QOL) was higher among African American compared to Caucasian patients with obesity [35] and that patients seeking weight loss treatment tended to have poorer QOL than obese persons in the community [39]. It is also possible that some individuals with very low SES do not even have the knowledge about alternative weight loss procedures and thus not demanding them. Another possible explanation is that lower rates of bariatric surgery among low SES immigrants might reflect cultural differences in preferences regarding surgical treatment in general. An American study from 2007 showed negative patient perceptions of bariatric surgery among African American women [40]. Furthermore, some immigrants may choose to undergo bariatric surgery in their country of origin instead of in Sweden. Healthy migration bias, i.e., those who chose to migrate are healthier individuals compared to those who do not migrate [41], might be another reason for lower rates of bariatric surgery among some immigrant groups.

Previous study results, regarding ethnicity and inequalities in access to health care, indicate underlying socioeconomic diversity and differences in health care delivery [42]. For this reason, unadjusted results among ethnic minorities have to be interpreted with caution. Santry et al. reported that ethnicity did not influence access to bariatric surgery and that surgeon decisions did not contribute to race and gender disparities in bariatric surgery. Patients' age, BMI and social support were most influential [43]. This suggests that factors other than surgeon's discretion might result in race and gender disparities in bariatric surgery. Another

study from United Kingdom showed that bariatric surgery are provided equally to ethnic minority groups [44].

Generally, obstacles in receiving bariatric surgery are complex and are a combination of individual evaluation of health and appearance, primary care physicians and surgeon's selection and health care structural factors.

This study shows social disparities in Sweden with a social gradient in obesity surgery, and it is likely that major mechanisms underlying these disparities are broadly similar across many Western countries. Moreover, around 26% of the population is 1st or 2nd generation immigrants from all parts of the world. This has resulted in an ethnically and culturally diverse population, thereby increasing the generalizability of the results.

Limitations and strengths:

Our results must be interpreted in the context of its limitations. Firstly, we were not able to include BMI or other anthropometric parameters as variables, which made it impossible to directly compare the rate of bariatric surgery and morbid obesity according to country of birth. Secondly, the study lacks comparable information about incidence rates of obesity and bariatric surgery in the country of origin. In addition, although income was included, we could not include educational level in our study since data on education was missing for many immigrants, especially those newly arrived. The limitations of the study are, however, balanced by its strengths. To our knowledge, this is the first nationwide study, which included all patients that underwent bariatric surgery in Sweden during a 10-years period. Another important strength of our study is that it was based on hospitalization data and the Swedish Inpatient Register, which is very complete and has been extensively validated in previous studies [45]. Thirdly, the analyses took several sociodemographic variables into account. Finally, both men and women were included and analyzed separately.

Conclusion

The results of the present study present interesting findings. Even in countries like Sweden, with universal health insurance, men, some immigrant groups and individuals with low socioeconomic status are underrepresented among those who receive bariatric surgery. It is unclear if underlying barriers to receive bariatric surgery are due to patients' preferences/lack of knowledge or health care structures. Future studies, including qualitative studies, are needed to examine potential causes behind differences by sociodemographic factors, focusing on patients, doctors and structural barriers. Public awareness about morbid obesity as a health problem rather than a cosmetic issue should also be increased. Healthcare providers should be aware of indications and benefits of bariatric surgery in order to refer medically eligible patients for bariatric surgery.

Contributors

All authors contributed to the conception and design of the study; JS and KS contributed to the acquisition of data; all authors contributed to the analysis and interpretation of data; EM drafted the manuscript; and all authors revised it critically and approved the final version. All authors had full access to all of the data (including statistical reports and tables) and take responsibility for the integrity of the data and the accuracy of their analysis.

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Conflict of Interest

None.

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Table 1a. Distribution of population, number of obesity surgery events, and age-standardized cumulative rates (per 1000) of obesity surgery, 2001-2010

	Born in Sweden								Immigrants							
	Population		Events		CR				Population		Events		CR			
	No.	%	No.	%	CR	95% CI		P-value*	No.	%	No.	%	CR	95% CI		P-value
Total population (%)	4379014		12791		2.9	2.9	3.0		722289		2060		2.7	2.6	2.9	0.3125
Gender																
Men	2236593	51.1	3199	25.0	1.4	1.4	1.5	<0.001	353925	49.0	423	20.5	1.1	1.0	1.3	<0.001
Women	2142421	48.9	9592	75.0	4.5	4.4	4.6	-	368364	51.0	1637	79.5	4.3	4.1	4.5	-
Age (years)																
20-29	919931	21.0	3332	26.0	3.6	3.5	3.7	-	142112	19.7	425	20.6	3.0	2.7	3.3	-
30-39	1035269	23.6	4917	38.4	4.7	4.6	4.9	<0.001	195823	27.1	721	35.0	3.7	3.4	4.0	0.001
40-49	957560	21.9	3106	24.3	3.2	3.1	3.4	<0.001	181245	25.1	623	30.2	3.4	3.2	3.7	0.027
50-64	1466254	33.5	1436	11.2	1.0	0.9	1.0	<0.001	203109	28.1	291	14.1	1.4	1.3	1.6	<0.001
Family income (quartiles)**																
Low income	482322	11.0	1923	15.0	3.4	3.3	3.6	<0.001	261460	36.2	701	34.0	2.3	2.1	2.5	<0.001
Middle–low income	1258896	28.7	5082	39.7	3.6	3.5	3.7	<0.001	196786	27.2	710	34.5	3.4	3.1	3.6	<0.001
Middle–high income	1311858	30.0	3588	28.1	2.9	2.8	3.0	<0.001	147263	20.4	431	20.9	3.1	2.8	3.4	<0.001
High income	1325938	30.3	2198	17.2	1.9	1.8	2.0	-	116780	16.2	218	10.6	2.0	1.7	2.3	-
Marital status																
Married/cohabiting	1894071	43.3	4595	35.9	3.6	3.5	3.7	-	373628	51.7	1034	50.2	2.8	2.6	3.0	-
Never married, Widowed, or divorced	2484943	56.7	8196	64.1	3.0	3.0	3.1	<0.001	348661	48.3	1026	49.8	2.8	2.6	3.0	0.164
Employment status																
No	927820	21.2	3399	26.6	4.4	4.2	4.5	<0.001	326556	45.2	874	42.4	2.7	2.5	2.8	0.011
Yes	3451194	78.8	9392	73.4	2.7	2.6	2.7	-	395733	54.8	1186	57.6	2.9	2.7	3.1	-

*P-values are calculated according to reference group in each category (shown with "-"), for Swedes and immigrants separately.

**Annual Family income in Swedish crowns: Low income 0-92000; Middle-low income 92001-121500; Middle-high income 121501-161000; High income more than 161000.

Table 1b. Distribution of population, number of obesity surgery events, and age-standardized cumulative rates (per 1000) of obesity surgery.2001-2005

	Born in Sweden	Immigrants

	Population		Events		CR				Population		Events		CR			
	No.	%	No.	%	CR	95% CI		P-value*	No.	%	No.	%	CR	95% CI		P-value
Total population (%)	4379014		2695		0.6	0.6	0.6		722289		471		0.6	0.6	0.7	
Gender																
Men	2236593	51.1	625	23.2	0.3	0.3	0.3	<0.001	353925	49.0	87	18.5	0.2	0.2	0.3	<0.001
Women	2142421	48.9	2070	76.8	1.0	0.9	1.0	-	368364	51.0	384	81.5	1.0	0.9	1.1	-
Age (years)																
20-29	919931	21.0	529	19.6	0.6	0.5	0.6	-	142112	19.7	59	12.5	0.4	0.3	0.5	-
30-39	1035269	23.6	1030	38.2	1.0	0.9	1.1	<0.001	195823	27.1	153	32.5	0.8	0.7	0.9	<0.001
40-49	957560	21.9	682	25.3	0.7	0.7	0.8	<0.001	181245	25.1	155	32.9	0.9	0.7	1.0	<0.001
50-64	1466254	33.5	454	16.8	0.3	0.3	0.3	<0.001	203109	28.1	104	22.1	0.5	0.4	0.6	0.198
Family income (quartiles)**																
Low income	482322	11.0	403	15.0	0.7	0.7	0.8	<0.001	261460	36.2	140	29.7	0.5	0.4	0.6	0.485
Middle–low income	1258896	28.7	1108	41.1	0.8	0.7	0.8	<0.001	196786	27.2	177	37.6	0.9	0.7	1.0	<0.001
Middle–high income	1311858	30.0	778	28.9	0.6	0.6	0.7	<0.001	147263	20.4	98	20.8	0.7	0.5	0.8	0.050
High income	1325938	30.3	406	15.1	0.3	0.3	0.4	-	116780	16.2	56	11.9	0.5	0.4	0.6	-
Marital status																
Married/cohabiting	1894071	43.3	1085	40.3	0.8	0.7	0.8	-	373628	51.7	244	51.8	0.6	0.6	0.7	-
Never married, Widowed, or divorced	2484943	56.7	1610	59.7	0.6	0.6	0.7	0.002	348661	48.3	227	48.2	0.7	0.6	0.8	0.974
Employment status																
No	927820	21.2	866	32.1	1.1	1.1	1.2	<0.001	326556	45.2	224	47.6	0.7	0.6	0.8	0.306
Yes	3451194	78.8	1829	67.9	0.5	0.5	0.5	-	395733	54.8	247	52.4	0.6	0.5	0.7	-

* P-values are calculated according to reference group in each category (shown with "-"), for Swedes and immigrants separately.

**Annual Family income in Swedish crowns: Low income 0-92000; Middle-low income 92001-121500; Middle-high income 121501-161000; High income more than 161000.

Table 1c. Distribution of population, number of obesity surgery events, and age-standardized cumulative rates (per 1000) of obesity surgery, 2006-2010

	Born in Sweden								Immigrants							
	Population		Events		CR				Population		Events		CR			
	No.	%	No.	%	CR	95% CI		P-value*	No.	%	No.	%	CR	95% CI		P-value
Total population (%)	4373452		10769		2.5	2.4	2.5		835443		1776		2.1	2.0	2.2	
Gender																
Men	2237855	51.2	2695	25.0	1.2	1.2	1.3	<0.001	409283	49.0	370	20.8	0.9	0.8	1.0	<0.001
Women	2135597	48.8	8074	75.0	3.8	3.7	3.9	-	426160	51.0	1406	79.2	3.2	3.1	3.4	-
Age (years)																
20-29	880059	20.1	1793	16.6	2.0	1.9	2.1	-	184386	22.1	260	14.6	1.4	1.2	1.6	-
30-39	976909	22.3	3698	34.3	3.8	3.7	3.9	<0.001	215699	25.8	548	30.9	2.5	2.3	2.8	<0.001
40-49	991420	22.7	3293	30.6	3.3	3.2	3.4	<0.001	207932	24.9	573	32.3	2.8	2.5	3.0	<0.001
50-64	1525064	34.9	1985	18.4	1.3	1.2	1.4	<0.001	227426	27.2	395	22.2	1.7	1.6	1.9	0.009
Family income (quartiles)**																
Low income	913344	20.9	3402	31.6	3.3	3.2	3.4	<0.001	389845	46.7	800	45.0	2.1	1.9	2.2	<0.001
Middle–low income	1110900	25.4	3379	31.4	3.1	3.0	3.2	<0.001	192884	23.1	529	29.8	2.7	2.5	2.9	<0.001
Middle–high income	1158073	26.5	2487	23.1	2.1	2.1	2.2	<0.001	143114	17.1	292	16.4	2.0	1.7	2.2	<0.001
High income	1191135	27.2	1501	13.9	1.3	1.2	1.4	-	109600	13.1	155	8.7	1.4	1.2	1.6	-
Marital status																
Married/cohabiting	1796063	41.1	4173	38.8	3.0	2.9	3.1	-	420449	50.3	914	51.5	2.1	1.9	2.2	-
Never married, Widowed, or divorced	2577389	58.9	6596	61.2	2.6	2.5	2.6	<0.001	414994	49.7	862	48.5	2.1	2.0	2.3	0.338
Employment status																
No	853303	19.5	3025	28.1	4.4	4.3	4.6	<0.001	380233	45.5	779	43.9	2.1	2.0	2.3	0.163
Yes	3520149	80.5	7744	71.9	2.2	2.1	2.2	-	455210	54.5	997	56.1	2.1	2.0	2.2	-

* P-values are calculated according to reference group in each category (shown with "-"), for Swedes and immigrants separately.

**Annual Family income in Swedish crowns: Low income 0-92000; Middle-low income 92001-121500; Middle-high income 121501-161000; High income more than 161000.

Table 2. Hazard ratios (HR) of bariatric surgery in male immigrants

	Crude					Adjusted model*		
Birth country	Population	Cases	HR	95 % CI		HR	95 % CI	
Swedish	2236593	3199	ref.			Ref.		
Nordic countries	82847	138	**1.32**	**1.11**	**1.56**	**1.46**	**1.23**	**1.73**
Denmark	12353	22	1.45	0.95	2.20	**1.56**	**1.03**	**2.38**
Finland	58123	91	**1.21**	**0.98**	**1.49**	**1.37**	**1.11**	**1.69**
Norway	11072	21	**1.61**	**1.05**	**2.48**	**1.65**	**1.08**	**2.54**
Southern Europe	15422	11	0.61	0.34	1.10	0.62	0.34	1.12
Greece	4968	1	0.17	0.02	1.18	0.18	0.03	1.28
Italy	3080	4	1.08	0.40	2.87	1.16	0.44	3.10
Other Southern European countries	2155	3	1.13	0.36	3.49	1.10	0.36	3.43
Western Europe	25585	18	**0.57**	**0.36**	**0.91**	**0.61**	**0.39**	**0.97**
Great Britain-Ireland	8980	6	0.57	0.25	1.26	0.55	0.25	1.24
Germany	11205	9	0.63	0.33	1.21	0.73	0.38	1.40
Eastern Europe	53488	24	**0.32**	**0.22**	**0.48**	**0.31**	**0.21**	**0.47**
Bosnia	18326	3	**0.12**	**0.04**	**0.36**	**0.11**	**0.04**	**0.33**
Yugoslavia	26147	18	**0.49**	**0.31**	**0.78**	**0.49**	**0.31**	**0.78**
Romania	4067	3	0.54	0.18	1.68	0.52	0.17	1.63
Baltic Countries	2100	2	0.78	0.20	3.12	0.92	0.23	3.69
Central Europe	12540	16	0.95	0.58	1.55	0.94	0.57	1.53
Poland	10220	14	1.01	0.60	1.70	0.97	0.58	1.64
Hungary	4826	4	0.62	0.23	1.66	0.71	0.27	1.90
Africa	25243	11	**0.35**	**0.19**	**0.62**	**0.31**	**0.17**	**0.56**
North America	6092	5	0.76	0.32	1.83	0.72	0.30	1.73
Latin America	18470	50	**2.02**	**1.53**	**2.67**	**1.76**	**1.33**	**2.33**
Chile	10827	40	**2.71**	**1.98**	**3.70**	**2.40**	**1.76**	**3.29**
Asia	98931	135	1.01	0.85	1.19	0.90	0.75	1.08
Turkey	13957	9	**0.46**	**0.24**	**0.89**	**0.43**	**0.22**	**0.83**
Lebanon	9025	33	**2.66**	**1.89**	**3.75**	**2.34**	**1.65**	**3.31**
Iran	22972	31	0.99	0.70	1.41	0.91	0.64	1.30
Iraq	22065	39	1.27	0.93	1.75	1.13	0.82	1.56
Russia	3505	3	0.68	0.22	2.12	0.63	0.20	1.94
Others	4876	6	1.03	0.46	2.30	0.88	0.39	1.96
All immigrants	353925	423	0.91	0.83	1.01	**0.90**	**0.81**	**0.99**

HR = hazard ratios; CI = confidence interval

Bold type: 95% CI does not include 1.00. Underline: 99% CI does not include 1.00.

*Adjusted for age, marital status, family income, and employment status.

Table 3. Hazard ratios (HR) of bariatric surgery in female immigrants

	Crude					Adjusted model*		
Birth country	Population	Cases	HR	95 % CI		HR	95 % CI	
Swedish	2142421	9592	ref.			Ref.		
Nordic countries	100827	450	1.07	0.97	1.17	**1.32**	**1.20**	**1.45**
Denmark	10611	40	0.93	0.68	1.27	1.05	0.77	1.43
Finland	75490	339	1.05	0.95	1.18	**1.37**	**1.23**	**1.53**
Norway	13436	69	**1.30**	**1.03**	**1.65**	**1.40**	**1.10**	**1.77**
Southern Europe	9390	37	1.05	0.76	1.45	1.01	0.73	1.39
Greece	3166	13	1.09	0.63	1.87	1.10	0.64	1.90
Italy	1372	6	1.13	0.51	2.51	1.15	0.51	2.55
Other Southern European countries	1487	11	**1.85**	**1.02**	**3.34**	1.70	0.94	3.06
Western Europe	18949	36	**0.48**	**0.35**	**0.66**	**0.53**	**0.38**	**0.74**
Great Britain-Ireland	4346	8	**0.50**	**0.25**	**0.99**	**0.49**	**0.24**	**0.98**
Germany	10772	20	**0.45**	**0.29**	**0.70**	**0.54**	**0.35**	**0.83**
Eastern Europe	52714	137	**0.59**	**0.50**	**0.70**	**0.49**	**0.41**	**0.58**
Bosnia	18276	30	**0.37**	**0.26**	**0.53**	**0.29**	**0.20**	**0.41**
Yugoslavia	24603	82	**0.75**	**0.61**	**0.94**	**0.65**	**0.53**	**0.81**
Romania	4908	17	0.81	0.50	1.30	0.71	0.44	1.14
Baltic Countries	3453	8	0.56	0.28	1.13	0.54	0.27	1.08
Central Europe	23806	56	**0.54**	**0.42**	**0.70**	**0.55**	**0.42**	**0.71**
Poland	20858	50	**0.55**	**0.42**	**0.73**	**0.55**	**0.42**	**0.73**
Hungary	4801	18	0.88	0.55	1.40	0.99	0.62	1.57
Africa	19948	49	**0.61**	**0.46**	**0.81**	**0.44**	**0.33**	**0.58**
North America	4953	26	**1.55**	**1.05**	**2.27**	1.41	0.96	2.07
Latin America	19131	261	**3.25**	**2.88**	**3.68**	**2.61**	**2.31**	**2.95**
Chile	10427	207	**4.64**	**4.04**	**5.33**	**3.77**	**3.28**	**4.33**
Asia	98002	510	**1.21**	**1.11**	**1.33**	**0.88**	**0.80**	**0.96**
Turkey	12229	68	1.26	0.99	1.60	0.93	0.73	1.18
Lebanon	7084	75	**2.45**	**1.95**	**3.08**	**1.65**	**1.31**	**2.07**
Iran	18591	156	**1.97**	**1.68**	**2.30**	**1.53**	**1.31**	**1.80**
Iraq	16110	110	**1.57**	**1.30**	**1.89**	1.07	0.89	1.30
Russia	8391	31	0.87	0.61	1.24	0.73	0.51	1.03
Others	3999	18	1.18	0.74	1.87	0.91	0.57	1.44
All immigrants	368364	1637	1.06	1.00	1.11	0.96	0.91	1.01

HR = hazard ratios; CI = confidence interval

Bold type: 95% CI does not include 1.00. Underline: 99% CI does not include 1.00.

*Adjusted for age, marital status, family income, and employment status.

Table 4. Hazard ratios (HR) of bariatric surgery in immigrants, 2001-2005 and 2006-2010

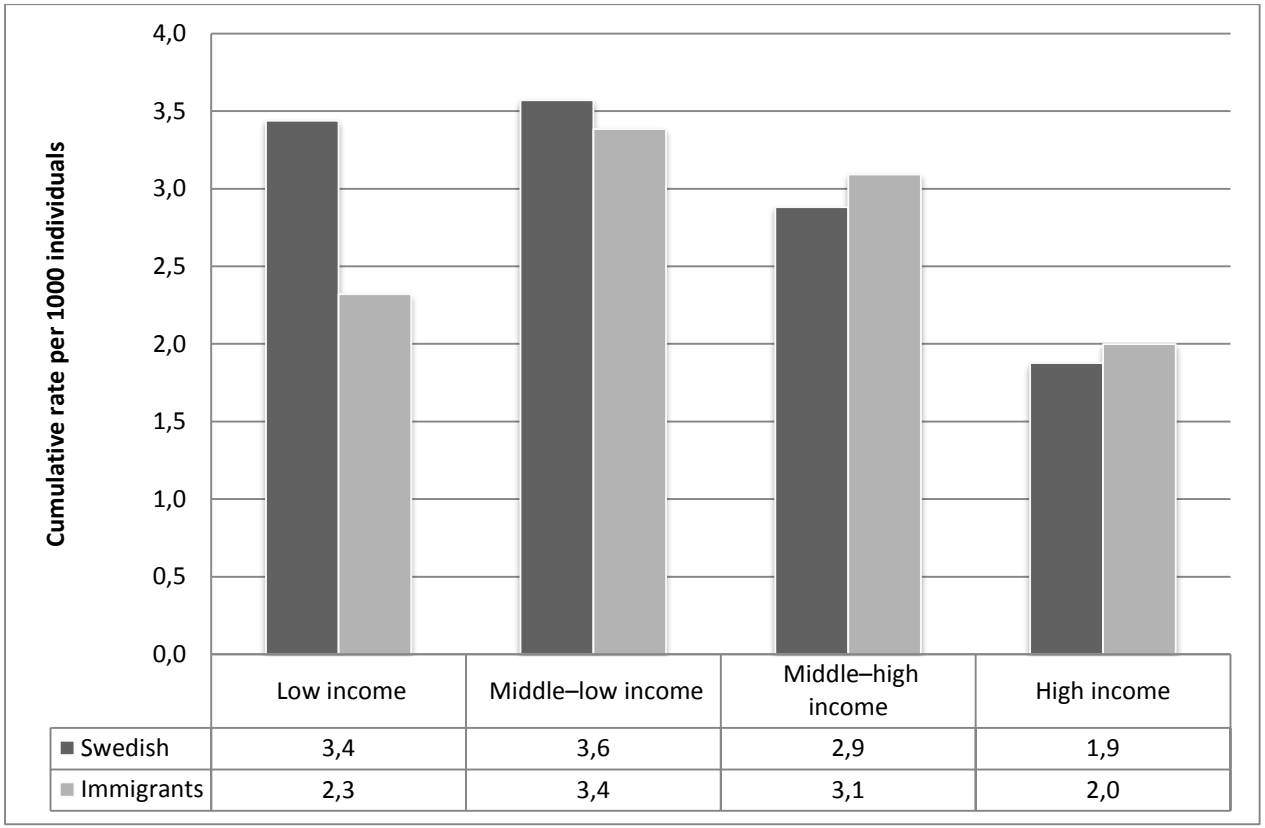
	2001-2005					2006-2010				
Birth country	Population	Cases	HR*	95 % CI		Population	Cases	HR*	95 % CI	
Swedish	4379014	2695	ref.			4373452	10769	ref.		
Nordic countries	183674	135	**1.21**	**1.02**	**1.44**	161503	462	**1.18**	**1.07**	**1.29**
Denmark	22964	10	0.76	0.41	1.41	26658	52	0.81	0.61	1.06
Finland	133613	100	**1.24**	**1.01**	**1.52**	107693	329	**1.28**	**1.14**	**1.42**
Norway	24508	23	1.46	0.97	2.20	24571	78	1.24	0.99	1.55
Southern Europe	24812	11	0.76	0.42	1.38	24947	41	**0.70**	**0.51**	**0.94**
Greece	8134	2	0.41	0.10	1.63	7170	13	0.77	0.45	1.33
Italy	4452	2	0.91	0.23	3.64	4208	8	0.89	0.45	1.78
Other Southern European countries	3642	4	1.76	0.66	4.69	4016	13	1.26	0.73	2.16
Western Europe	44534	12	**0.49**	**0.28**	**0.87**	46711	46	**0.43**	**0.32**	**0.57**
Great Britain-Ireland	13326	3	0.45	0.14	1.39	14856	12	**0.39**	**0.22**	**0.69**
Germany	21977	4	**0.32**	**0.12**	**0.85**	22049	28	**0.51**	**0.36**	**0.75**
Eastern Europe	106202	40	**0.50**	**0.36**	**0.68**	122515	137	**0.38**	**0.32**	**0.45**
Bosnia	36602	5	**0.17**	**0.07**	**0.42**	42278	32	**0.26**	**0.18**	**0.36**
Yugoslavia	50750	29	0.77	0.54	1.12	58141	76	**0.44**	**0.35**	**0.55**
Romania	8975	5	0.75	0.31	1.79	10175	19	0.63	0.40	0.99
Baltic Countries	5553	0				7658	13	**0.50**	**0.29**	**0.85**
Central Europe	36346	23	0.81	0.54	1.22	45735	54	**0.39**	**0.30**	**0.51**
Poland	31078	20	0.80	0.52	1.25	40636	50	**0.40**	**0.30**	**0.53**
Hungary	9627	8	1.35	0.67	2.70	8597	15	0.68	0.41	1.12
Africa	45191	8	**0.24**	**0.12**	**0.47**	61530	60	**0.32**	**0.25**	**0.41**
North America	11045	11	1.60	0.89	2.90	11908	27	0.90	0.62	1.31
Latin America	37601	68	**2.39**	**1.88**	**3.05**	44432	278	**2.16**	**1.91**	**2.43**
Chile	21254	59	**3.76**	**2.90**	**4.87**	22932	209	**3.30**	**2.87**	**3.78**
Asia	196933	144	0.89	0.75	1.07	268748	589	**0.69**	**0.63**	**0.75**
Turkey	26186	17	0.82	0.51	1.33	30786	60	**0.64**	**0.49**	**0.82**
Lebanon	16109	26	**2.00**	**1.35**	**2.96**	19432	87	**1.43**	**1.16**	**1.77**
Iran	41563	53	**1.71**	**1.30**	**2.26**	48470	161	1.15	0.99	1.35
Iraq	38175	32	1.04	0.73	1.48	60667	154	**0.79**	**0.67**	**0.92**
Russia	11896	7	0.63	0.30	1.32	20107	33	**0.45**	**0.32**	**0.63**
Others	8875	4	0.64	0.24	1.70	11052	21	0.69	0.45	1.05
All immigrants	722289	471	0.92	0.83	1.02	835443	1776	**0.74**	**0.71**	**0.78**

HR = hazard ratios; CI = confidence interval

Bold type: 95% CI does not include 1.00. Underline: 99% CI does not include 1.00.

*Adjusted for age, gender, marital status, family income, and employment status.

Supplementary figure: Age-standardized cumulative rates (per 1000) of bariatric surgery in Swedes and immigrants by family income, 2001-2010



	Low income	Middle–low income	Middle–high income	High income
Swedish	3,4	3,6	2,9	1,9
Immigrants	2,3	3,4	3,1	2,0