# Clinical characteristics of patients undergoing primary bariatric surgery in the United Kingdom based on the National Bariatric Surgery Registry

# Clinical characteristics of patients undergoing primary bariatric surgery in the United Kingdom based on the National Bariatric Surgery Registry

Running title: Baseline characteristics of bariatric surgery patients

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**“What is already known about this subject?”**

- 28% of the adult population in the United Kingdom have obesity
- A very small proportion of people eligible for bariatric surgery in the United Kingdom actually receive it in the National Health Service

**“What this study adds?”**

- This paper highlights the difference between the patients receiving primary bariatric surgery in the National Health Service (NHS) and the self-pay pathway in the burden of comorbid disease, and the interventions they receive
- Mean patient age in NHS patients having surgery was higher, and they had much more obesity-related disease than self-pay patients.
- Gastric bypass was the most commonly performed primary NHS bariatric operation, but sleeve gastrectomy predominated in self-pay patients

**ABSTRACT**

Baseline demographic characteristics and operations undertaken for patients having bariatric surgery in the United Kingdom are largely unknown. This study aimed to describe the profile of patients having primary bariatric surgery in the National Health Service (NHS) or by self-pay and associated operations performed for both pathways. The National Bariatric Surgery Registry dataset for 5 years between January 2015 and December 2019 was used. 34 580 patients underwent primary bariatric surgery, of which 75.9% were NHS patients. Mean patient age and initial body mass index were significantly higher for NHS compared to self-pay patients (mean age 45.8±11.3 (SD) vs 43.0±12.0 years and initial body mass index 48.0±7.9 vs 42.9±7.3 kg/$m^2$, $p<0.001$). NHS patients were more likely to have obesity-related complications: prevalence of type 2 diabetes mellitus 27.7% vs 8.3%, hypertension 37.1% vs 20.1%, obstructive sleep apnoea 27.4 vs 8.9%, severely impaired functional status 19.3% vs 13.9%, musculoskeletal pain 32.5% vs 20.1% and being on medication for depression 31.0% vs 25.9% (all $p<0.001$). Gastric bypass was the most commonly performed primary NHS bariatric operation 57.2%, but sleeve gastrectomy predominated in self-pay patients 48.7% (both $p<0.001$). In contrast to self-pay patients, NHS patients are receiving bariatric surgery only once they are older and at a much more advanced stage of obesity-related disease complications.

## INTRODUCTION

Obesity is a serious and growing public health issue in the United Kingdom (UK), with latest reports from the Health Survey England 2018 stating that 28% of the adult population have obesity, indicated by a body mass index (BMI) >30kg/$m^2$, and a further 36% have overweight (BMI >25kg/$m^2$),[1] some of the highest rates in Europe. A further 1.8% of males and 4.4% of females (total 3.2%) are estimated to have a BMI of 40kg/$m^2$ or more.[1] This high prevalence places a large proportion of the UK's adult population at risk of developing obesity-related complications, including type 2 diabetes mellitus (T2DM).

Bariatric surgery, or surgery for obesity, is supported by the National Institute of Health and Care Excellence (NICE) as a clinically- and cost-effective treatment for people with BMI 35kg/$^2$ or more with disease that can improve with weight loss, or 40kg/$m^2$ or more without additional disease.[2] The BMI thresholds for people with T2DM and of specific ethnicities (e.g. South Asians) are lower. To highlight the remarkable health gains made to a range of obesity-related diseases, such as T2DM, from surgical weight loss, bariatric surgery societies worldwide e.g. British Obesity and Metabolic Surgery Society have added the phrase 'metabolic surgery' to their names, and the term bariatric-metabolic surgery is commonly used.[3]

Compared to other countries with similar health services, a very small proportion of people eligible for bariatric surgery in the UK actually receive it in the NHS, equating to about 5 500 patients per year.[4,5] Accurate information regarding the operated population could help clinicians and commissioners of health services plan services more effectively.

The UK's National Bariatric Surgery Registry (NBSR) has recorded demographic information on the operated population since 2009.[4] Data collection, storage and analysis pertaining to the registry have previously been published.[6] The NBSR is a UK wide registry which contains information on patient demographics, comorbidities, type of surgery undertaken, complications and outcomes. All NHS units are required to enter data as part of the publicly available Consultant Outcomes Publications, records are validated for completion upon patient discharge, and case ascertainment is checked against Hospital Episode Statistics, processes managed by the NBSR Committee.[4] Surgeons are strongly encouraged to input data for self-pay patients.

The first aim of this report was to describe the clinical characteristics of patients receiving primary bariatric surgery in the NHS using data from the NBSR over a 5-year period. The second aim was to compare them to self-pay patients.

## MATERIALS AND METHODS

*National Bariatric Surgery Registry (NBSR)*

Age was recorded as of the date of surgery. Baseline data were recorded at presentation in the bariatric surgery clinic, with the exception of BMI which was calculated at presentation to the obesity medicine clinic, which initiates referrals for surgery. Obesity-related disease was defined as being on daily medication or on treatment, and cardiovascular disease defined as diagnosis of atherosclerosis (includes angina, myocardial infarction, coronary artery bypass graft, stroke, claudication). American Society of Anesthesiologists (ASA) grades were recorded. Two composite risk scores were collected. The Obesity Surgery-Mortality Risk Score combines age, sex, BMI hypertension and known venous thromboembolism (VTE) risk and predicts perioperative mortality.[7] The Edmonton Obesity Staging System (EOSS) predicts long-term mortality according to severity of baseline obesity-related disease in patients not having bariatric surgery.[8] The NBSR dataset was mapped to the EOSS as previously published.[6] Patient consent was not obtained because these were routinely generated clinical data. All entries are anonymised to comply with the data governance regulations, and data collection for this analysis was performed in compliance with the Declaration of Helsinki.

Comparisons were made between NHS and self-pay patients undergoing primary surgery for age, initial BMI, clinical characteristics and type of operation undertaken between January 2015 – December 2019.

*Statistical Analysis*

Data were expressed as mean ± standard deviation (SD). Comparative analyses were undertaken using Chi Square and Kruskal-Wallis test and a p value of 0.05 was taken as statistically significant. The hypothesis that there were differences amongst NHS and self-pay patients was tested using multivariate binary logistic regression analyses. Variables were initially tested for association with undergoing NHS or self-pay surgery individually. All variables recorded in the NBSR database with a completion rate of >90% were included into a multivariate model (Table S1). At this univariable analyses, any variable that was statistically significant ($p<0.05$) was entered into a multivariate model. Time series regression models were also undertaken to determine whether there were trends over time between the groups. Analyses were carried out using Statistical Package for the Social Sciences (SPSS) IBM version 28.

## RESULTS

*Demographic characteristics of NHS and self-pay patients*

34 580 patients comprising 26 248 NHS (75.9%) patients and 8 332 (24.1%) self-pay patients underwent primary bariatric surgery over the 5 years of the study, with mean age of 45.1±11.5 years and mean initial BMI of 46.8±1.5 kg/m$^2$. Mean age and BMI were higher and there were more obesity-related diseases (all p<0.001) in NHS patients than self-pay patients, and clinically similar VTE risk (Table 1, Figure S1). The mean age of NHS patients was unchanged over the study period. However, the mean age of self-pay patients decreased from 44.0 to 41.9 years (p<0.001). For both NHS and self-pay patients, the proportions with BMI>40kg/m$^2$ were unchanged over the study period. No changes over time were observed for mean BMI for either group. Factors most predominantly associated with undergoing NHS surgery were initial BMI ≥50 kg/m$^2$ 35.0% vs 15.0%, OR 6.32 (95% CI: 5.57-7.16); T2DM 27.7% vs 8.3%, OR 4.20 (95% CI: 3.79-4.65); and OSA 27.4% vs 8.9%, OR 3.49 (95% CI: 3.13-3.89), all p<0.001 (Table 2). Data completion rates were ≥90.1% for all variables (range 90.1% - 100%) (Table S1), apart from PCOS (<50%).

NHS patients had higher rates of ASA grades III/IV, and higher rates of moderate/high risk OS-MRS class and EOSS stages 2 or more (all p<0.001) than self-pay patients (Table 1). The proportion of patients with ASA grade III/IV increased in NHS patients during the study period from 32.9% in 2015 to 45.3% in 2019, with a similar trend in the self-pay group 11.2% vs 18.6% (both p<0.001).

*Demographic characteristics of female and male patients*

The majority of patients were female (27 320 (79.0%) versus 7 260 (21.0%) males,

p<0.001). Mean age and initial BMI were significantly higher for males compared to females (44.6±11.5 vs 47.4±11.1 years and 46.6±7.9 vs 47.7±8.6 kg/$m^2$ respectively, p=<0.001) (Table 3). Males had significantly higher prevalence of T2DM, hypertension and OSA, cardiovascular disease and VTE risk factors (all p<0.001). Females had significantly higher prevalence of asthma, musculoskeletal pain, gastroesophageal reflux disease and depression (all p<0.001). Males had significantly higher rates of ASA grade III/IV and higher rates of EOSS stage 2 or more. These differences were observed in both the NHS and self-pay patients (Table 3).

Examples of prevalence of obesity-related disease according to age are shown (Figure 1). There was a significantly higher prevalence of OSA with increasing age for both sexes, which was more marked for males. The prevalence of musculoskeletal pain significantly increased and functional status deteriorated with age for both sexes and was worse for females. In every age group depression was significantly more prevalent in females, with a peak prevalence for both sexes in the age group 45-54 years. A significantly higher proportion of males compared to females underwent NHS surgery (80.2 vs 74.8%, p=<0.001).

*Procedure undertaken*

In all 5 years of the study, a form of gastric bypass was the most commonly performed NHS procedure, with a non-significant decrease in its use from 59.4% (3 132/5 274) in 2015 to 57.8% (3 183/5 510) in 2019 (p=0.09) (Figure S2). The use of the Roux-en-Y procedure declined significantly from 55.4% (2 922/5 274) in 2015 to 45.9% (2 530/5 510) in 2019 (p=<0.001), and the one anastomosis gastric bypass procedure became significantly more frequent, 4.0% (210/5 274) in 2015 to 11.9%

(653/5 510) in 2019 (p=<0.001). Comparing 2015 to 2019, the proportion of vertical sleeve gastrectomy operations increased significantly from 35.2% (1 855/5 274) to 38.6% (2 125/5 510) (p<0.001), whilst the use of gastric banding decreased significantly from 5.3% (281/5 274) to 3.5% (195/5 510) (p<0.001). In self-pay patients, the use of vertical sleeve gastrectomy increased significantly from 41.0% (549/1 339) to 54.1% (832/1 539) (p<0.001), whilst the use of gastric banding decreased significantly from 31.1% (417/1 339) to 18.0% (277/1 539) (p<0.001). The proportion of any variant of the gastric bypass remained stable (26.8% (359/1 339) vs 26.9% (414/1 539), p=0.957), with a significant increase in prevalence of the one anastomosis gastric bypass procedure in the self-pay group (1.6% (21/1 339) vs 7.5% (115/1 539), p<0.001).

## DISCUSSION

This study quantifies the striking differences between the NHS and self-pay patients recorded as having bariatric surgery in the UK, with NHS patients being older, having a higher BMI at presentation and with more obesity-related disease. By far the majority of patients having surgery were female, whilst in both groups, males were older had higher BMI and obesity-related complications.

Since older age is generally associated with increasing BMI it appears that NHS patients are being referred later in the disease process and have a higher prevalence of T2DM.[9] Thus, NHS patients might be described as having more 'metabolic surgery' whereas self-pay patients are having 'bariatric surgery', at an earlier stage of obesity. A possible reason for NHS patients being older than self-pay patients is the requirement for NHS patients to spend 1-2 years in obesity medicine clinics ('Tier 3') before referral for surgical assessment.[10] The average time spent in obesity medicine clinics is not known. NICE guidance [2] and NICE-accredited multi-collegiate and specialty association guidance on expeditious and timely assessment and management in obesity medicine clinics do not specify waiting times.[11,12] It is clear from the available literature, that the sooner patients are operated, the better the outcomes in terms of obesity-related complications.[13,14,15] Yet, the NBSR data suggest that bariatric surgery is used very late in the patient journey in obesity services.

According to UK population data, females account for two thirds of people with a BMI >40kg/m$^2$ (4% vs 2% in males) compared to 77.8% females having bariatric surgery in the NHS.[1] Similar low access for males is seen globally, with little known about the reasons.[16] Males present once they have established disease, and bariatric

surgery is either not recommended or seen as high risk. Similar sex differences are seen in patients willing to take part in trials of Liraglutide for T2DM or weight loss, with male proportions ranging from 32% to 64% in recruited patients.[17, 18] Access for males to bariatric surgery should be increased and further research is needed to explore why there is such inequity.

Depression is associated with obesity and poor quality of life.[19, 20] The high prevalence of depression in our study is in keeping with the findings of patients with major psychiatric comorbidity attending specialist obesity clinics in the UK.[21] In that study, there was no difference in prevalence of depression between the sexes, in contrast to the much greater prevalence of depression in females in the general population.[22] In our study the prevalence of depression in males overall was similar to the general population. In a previous study of patients having bariatric surgery in the UK there was also a large burden of depression, but sex differences were not examined.[23] Our data show the prevalence of depression treated with medication increased markedly in females up to the age group 45-54 years, suggesting a large burden of mental health disorders particularly in NHS patients. We speculate that depressive illness could increase during the long assessment time from initial referral until surgery in NHS patients.

The ASA grades and OS-MRS groups indicated potentially higher operative risk for NHS and male patients. However, 30-day postoperative mortality in NHS patients is known to be very low, around 0.08%, likely due to the use of laparoscopic surgery and careful preoperative optimisation.[24] A higher EOSS stage has been shown to correlate inversely with long-term survival.[8] Over 86% of NHS patients were EOSS

stage 2 and above, indicating established multi-organ disease, a much higher proportion than self-pay patients. To our knowledge, this is the largest study describing EOSS stage in patients undergoing bariatric surgery. Allocating an EOSS stage may be useful for multidisciplinary teams prioritising which patients to refer for bariatric surgery.

NHS patients are also older with a mean age of 45.8 years and heavier, with a mean presentation BMI of 48.0 kg/m$^2$, compared to patients in European countries where bariatric surgery was nearly all publicly funded during the relevant timeframe. Thus, in Sweden, Norway and the Netherlands, registry data indicate mean ages of 41.0-43.8 years and BMIs of 41.2–43.3 kg/m$^2$.[25] The rates of obesity-related disease at presentation in these countries are also much lower than in the NHS for T2DM (12.1-21.9%), hypertension (24.6-34.6%), OSA (9.8-18.0%) and GORD (10.1-13.7%), with the exception of musculoskeletal pain (20.9-43.7%), where the rate is similar. In fact, the observed characteristics of patients in these European countries are very similar to self-pay patients in the UK.

The per capita rate of NHS surgery, about 9/100 000 in the 2010s,[5] is substantially less than in the comparator countries, despite the fact that rates of obesity in the UK are much higher. In 2015/2016 in Sweden, Norway and the Netherlands, surgery rates were 61.4/100 000, 55.6/100 000 and 65.1/100 000 population respectively.[25] NHS patients are even older and heavier than in the USA, an insurance funded system (mean age 44.8 years, mean BMI 44.5 kg/m$^2$),[26] where the rate of obesity is one of the highest in the world and the per capita rate of surgery was estimated at 78/100 000 in 2019.[27] The rate of NHS surgery is very low by comparison, with less

than 1% of those eligible receiving surgery. This is despite proven health benefit and superior cost-effectiveness of bariatric surgery compared to e.g. joint replacement surgery, and other procedures where the cost-effectiveness is unknown, that are readily available in the NHS. Similar findings of higher age and BMI at presentation are observed in other countries, e.g. Germany, that also have low rates of bariatric surgery.[28]

NHS bariatric surgery patients have much higher BMIs than patients in obesity medicine clinics (mean BMI 42.5 kg/m$^2$), and therefore it seems that only patients with severe disease are referred for surgery.[29] Unknowns include the volume of patients seen in obesity medicine clinics and the rate of referral for surgery. Reasons why the clinical benefits of surgery do not translate into better access are unclear. In some units, this may be due to patients being turned down because of inability to achieve a predetermined weight loss target as a prerequisite for surgical referral. Lack of knowledge of the referring provider regarding safety and effectiveness of bariatric surgery is seen as an important barrier for referral for surgical assessment.[30] Another major barrier is the stigmatisation of obesity which is pervasive amongst the public, healthcare professionals and commissioners.[31] We speculate that stigma and / or bias may affect and delay referrals by health professionals, compared to the ready access patients have who choose bariatric surgery via self-pay, outside of the NHS.

All types of bariatric surgery can be very effective, however there is no agreement on how to personalise the choice of surgery depending on patient characteristics. The marked decrease in Roux-en-Y gastric bypass over time in NHS patients, largely due to an increase in the one anastomosis variant, is notable. By comparison, for self-pay

patients, sleeve gastrectomy increased, largely at the expense of gastric banding. Patient and surgeon preference for different procedures may be helped by large, pragmatic, multicentre randomised controlled trials such as the By-Band-Sleeve study due to report in 2023.[32]

The study has several strengths. The NBSR is the only source of information about BMI and baseline obesity-related disease at presentation. Although the NHS collects data on the number of bariatric procedures according to a set of specific codes in association with obesity, BMI and baseline disease are not recorded. Case ascertainment into the NBSR was very high (98%) compared to NHS data.[4] Data completeness for most variables was over 90% and there were no differences in completion rates between NHS and self-pay patients. Limitations include the lack of information regarding the absolute number and therefore case ascertainment of self-pay patients. Other data that are not captured include reasons for having bariatric surgery, indicators of socioeconomic status and metrics of mental health.

This is the most up-to-date description of the clinical characteristics of patients undergoing bariatric surgery in the UK. Patients having surgery in the NHS were older, heavier and had more obesity-related complications compared to both self-paying patients in the UK, and patients in other European countries. These data could be used to change the way healthcare professionals and commissioners perceive bariatric surgery, and consider it as an option much earlier in the patient journey.

## CONFLICTS OF INTEREST STATEMENT

There is no conflict of interest for any of the authors.

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## TABLES

**TABLE 1**.

| | | NHS (N=26 248) | Self-pay (N=8 332) | P-value |
|---|---|---|---|---|
| Mean age (years) ± SD | | 45.8 ± 11.3 | 43.0 ± 12.0 | <0.001 |
| Age distribution (years) | 18 – 30 | 10.4 | 17.7 | <0.001 |
| | 31 – 40 | 21.8 | 24.1 | <0.001 |
| | 41 – 50 | 31.4 | 29.8 | <0.001 |
| | 51 – 60 | 27.2 | 22.2 | <0.001 |
| | 60+ | 9.2 | 6.2 | <0.001 |
| Sex (male) | | 22.2 | 17.2 | <0.001 |
| Caucasian ethnicity | | 87.6 | 88.7 | 0.008 |
| Mean initial BMI ($kg/m^2$) ± SD | | 48.0 ± 7.9 | 42.9 ± 7.3 | <0.001 |
| Initial BMI distribution ($kg/m^2$) | < 35 | 1.3 | 10.9 | <0.001 |
| | 35 - 39.9 | 10.8 | 28.5 | <0.001 |
| | 40 - 49.9 | 52.9 | 45.6 | <0.001 |
| | ≥50 | 35.0 | 15.0 | <0.001 |
| T2DM | | 27.7 | 8.3 | <0.001 |
| Hypertension | | 37.1 | 20.1 | <0.001 |
| OSA | | 27.4 | 8.9 | <0.001 |
| Asthma | | 20.7 | 12.2 | <0.001 |
| Functional Status | Can climb 3 flights of stairs | 32.3 | 46.1 | <0.001 |
| | Can climb 1 flight of stairs | 48.4 | 40.0 | <0.001 |
| | Can climb half a flight of stairs | 16.4 | 13.3 | <0.001 |
| | Wheelchair / house bound | 2.9 | 0.6 | <0.001 |
| Cardiovascular disease | | 5.0 | 2.0 | <0.001 |
| VTE risk factors | | 14.2 | 15.2 | 0.030 |
| Musculoskeletal pain | | 32.5 | 20.1 | <0.001 |
| GORD | | 26.8 | 17.3 | <0.001 |
| PCOS | | 12.4 | 9.3 | <0.001 |
| Depression | | 31.0 | 25.9 | <0.001 |
| ASA grade | III | 39.8 | 16.8 | <0.001 |
| | IV | 0.7 | 0.1 | <0.001 |
| OS-MRS score | Low Risk (0-1) | 52.3 | 69.3 | <0.001 |
| | Moderate Risk (2-3) | 43.5 | 28.7 | <0.001 |

| | | | | |
|---|---|---|---|---|
| | High Risk (4-5) | 4.2 | 2.0 | <0.001 |
| EOSS stage | Stage 0 | 5.4 | 17.4 | <0.001 |
| | Stage 1 | 7.7 | 14.3 | <0.001 |
| | Stage 2 | 67.3 | 54.1 | <0.001 |
| | Stage 3 | 16.6 | 13.6 | <0.001 |
| | Stage 4 | 3.0 | 0.6 | <0.001 |

**TABLE 2.**

| | | Adjusted OR | CI (95%) | P-value |
|---|---|---|---|---|
| Age at surgery (years) (Ref: 18-30) | 31-40 | 1.14 | 0.99-1.33 | 0.072 |
| | 41-50 | 0.97 | 0.89-1.04 | 0.083 |
| | 51-60 | 1.21 | 1.17-1.31 | <0.001 |
| | 60+ | 1.53 | 1.37-1.72 | <0.001 |
| Sex (Ref: Female) | Male | 0.91 | 0.84-0.99 | 0.024 |
| Ethnicity (Ref: Caucasian) | African/Afro-Caribbean | 1.48 | 1.32-1.65 | <0.001 |
| | Asian | 0.66 | 0.54-0.81 | <0.001 |
| | Chinese | 1.81 | 1.53-2.14 | <0.001 |
| | Other/Not Recorded | 2.45 | 0.68-8.82 | 0.172 |
| Initial BMI ($kg/m^2$) (Ref: <35) | 35-39.9 | 1.50 | 1.37-1.67 | <0.001 |
| | 40-49.9 | 3.17 | 2.87-3.49 | <0.001 |
| | ≥50 | 6.32 | 5.57-7.16 | <0.001 |
| T2DM | | 4.20 | 3.79-4.65 | <0.001 |
| Hypertension | | 1.45 | 1.34-1.57 | <0.001 |
| OSA | | 3.49 | 3.13-3.89 | <0.001 |
| Asthma | | 1.65 | 1.51-1.79 | <0.001 |
| Impaired functional status (Ref: Yes) | No | 1.20 | 1.03-1.31 | 0.019 |
| Cardiovascular Disease | | 1.45 | 1.18-1.77 | <0.001 |
| VTE risk factors | | 1.93 | 1.58-2.31 | <0.001 |
| Musculoskeletal pain | | 1.54 | 1.42-1.65 | <0.001 |
| GORD | | 1.47 | 1.36-1.59 | <0.001 |
| Depression | | 1.18 | 1.11-1.26 | 0.029 |

**TABLE 3.**

| | | NHS Female (N=20 423) | NHS Male (N=5 825) | P-value | Self-pay Female (N=6 897) | Self-pay Male (N=1 435) | P-value |
|---|---|---|---|---|---|---|---|
| Mean age (years) ± SD | | 45.2 ± 11.3 | 48.0 ± 10.8 | <0.001 | 42.6 ± 11.9 | 44.9 ± 12.1 | <0.001 |
| Age distribution (years) | 18 - 30 | 11.4 | 6.8 | <0.001 | 18.5 | 13.5 | <0.001 |
| | 31 - 40 | 23.1 | 17.3 | <0.001 | 24.4 | 22.5 | 0.130 |
| | 41 - 50 | 31.0 | 32.7 | 0.17 | 29.8 | 29.6 | 0.890 |
| | 51-60 | 26.1 | 31.1 | <0.001 | 21.7 | 24.8 | <0.001 |
| | 60+ | 8.4 | 12.1 | <0.001 | 5.6 | 9.6 | <0.001 |
| Caucasian ethnicity | | 87.2 | 88.8 | 0.003 | 89.9 | 82.1 | <0.001 |
| Mean initial BMI ($kg/m^2$) ± SD | | 47.9 ± 7.6 | 48.5 ± 8.6 | 0.10 | 42.6 ± 7.2 | 44.4 ± 7.3 | <0.001 |
| Initial BMI distribution ($kg/m^2$) | < 35 | 1.2 | 1.5 | 0.10 | 11.7 | 7.2 | <0.001 |
| | 35 – 39.9 | 10.5 | 11.8 | 0.003 | 29.3 | 24.3 | <0.001 |
| | 40 – 49.9 | 54.2 | 48.6 | <0.001 | 44.9 | 48.9 | <0.001 |
| | ≥50 | 34.1 | 38.1 | <0.001 | 14.1 | 19.6 | <0.001 |
| T2DM | | 23.9 | 41.1 | <0.001 | 6.7 | 15.7 | <0.001 |
| Hypertension | | 32.8 | 51.8 | <0.001 | 17.2 | 34.4 | <0.001 |
| OSA | | 19.2 | 44.5 | <0.001 | 6.2 | 22.2 | <0.001 |
| Asthma | | 22.4 | 14.8 | <0.001 | 12.8 | 9.3 | <0.001 |
| Impaired functional status | | 19.0 | 20.3 | 0.02 | 14.3 | 11.8 | 0.010 |
| Cardiovascular disease | | 3.6 | 9.8 | <0.001 | 1.4 | 4.9 | <0.001 |
| VTE risk factors | | 13.8 | 15.8 | <0.001 | 14.8 | 17.0 | 0.040 |
| Musculoskeletal pain | | 33.3 | 29.6 | <0.001 | 20.7 | 17.5 | <0.001 |
| GORD | | 27.9 | 22.9 | <0.001 | 17.5 | 16.2 | 0.220 |
| Depression | | 33.6 | 21.9 | <0.001 | 28.6 | 12.5 | <0.001 |
| ASA grade | III | 36.9 | 50.7 | <0.001 | 15.3 | 23.6 | <0.001 |
| | IV | 0.6 | 1.1 | <0.001 | 0.1 | 0.2 | 0.460 |
| OS-MRS score | 0-1 | 62.8 | 15.2 | <0.001 | 77.4 | 29.1 | <0.001 |
| | 2-3 | 35.9 | 70.0 | <0.001 | 22.0 | 61.9 | <0.001 |
| | 4-5 | 1.3 | 14.8 | <0.001 | 0.6 | 9.0 | <0.001 |
| EOSS stage | 0 | 5.8 | 4.1 | <0.001 | 17.5 | 17.0 | 0.680 |
| | 1 | 8.5 | 5.0 | <0.001 | 14.9 | 11.3 | <0.001 |
| | 2 | 66.5 | 70.3 | <0.001 | 53.0 | 59.5 | <0.001 |
| | 3 | 16.4 | 17.5 | 0.04 | 14.0 | 11.6 | 0.020 |
| | 4 | 2.8 | 3.1 | 0.19 | 0.6 | 0.6 | 0.680 |

## TABLE AND FIGURE LEGENDS

**TABLE 1.** Baseline characteristics and risk scores of NHS and self-pay patients undergoing primary bariatric surgery (N=34 580). N (%) unless specified. BMI, Body Mass Index; T2DM, Type 2 Diabetes Mellitus; OSA, Obstructive Sleep Apnoea; VTE, Venous ThromboEmbolism; GORD, Gastro-Oesophageal Reflux Disease; PCOS, Polycystic Ovary Syndrome; ASA, American Society of Anaesthesiologists; OS-MRS, Obesity Surgery-Mortality Risk Score; EOSS, Edmonton Obesity Staging System. Comorbidities are % on daily medication or treatment.

**TABLE 2.** Multivariate logistic regression of factors associated with undergoing primary NHS bariatric surgery. OR, Odds Ratio; CI, Confidence Interval; Ref, Reference; BMI, Body Mass Index; T2DM, Type 2 Diabetes Mellitus; OSA, Obstructive Sleep Apnoea; VTE, Venous ThromboEmbolism; GORD, Gastro-Oesophageal Reflux Disease. Impaired functional status defined as inability to climb 1 flight of stairs. Reference set as absence of comorbidity unless otherwise defined.

**TABLE 3.** Baseline characteristics of females and males undergoing primary Bariatric Surgery in NHS or Self-Pay (N=34 580). N (%) unless specified. BMI, Body Mass Index; T2DM, Type 2 Diabetes Mellitus; OSA, Obstructive Sleep Apnoea; VTE, Venous Thrombo-Embolism; GORD, Gastro-Oesophageal Reflux Disease; PCOS, Polycystic Ovary Syndrome; ASA, American Society of Anaesthesiologists; OS-MRS, Obesity Surgery-Mortality Risk Score; EOSS, Edmonton Obesity Staging System. Comorbidities are % on daily medication or treatment. Impaired functional status defined as inability to climb 1 flight of stairs.

**FIGURE 1.** Baseline prevalence of selected obesity-related diseases according to age group in females (N=27 320) and males (N=7 260) undergoing primary bariatric surgery. (A) Obstructive Sleep Apnoea (OSA), (B) Musculoskeletal pain on medication, (C) Impaired functional status defined as inability to climb 1 flights of stairs (D) Depression on medication. * indicates P-value <0.05.