29 Obesity and perioperative cardiac arrest in NAP7



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Key findings

- The NAP7 Activity Survey shows that, over the past decade, the median body mass index (BMI) of the surgical population has increased substantially. The median BMI of patients cared for by anaesthetists is in the overweight category and 59% of patients are overweight or obese.
- The highest proportional increase in weight is in the higher BMI categories (> 35 kg m^{-2}).
- These trends are even more marked in the obstetric population cared for by anaesthetists.
- In the Activity Survey, airway, breathing, circulatory and metabolic complications increased as BMI rose, especially as BMI greater than 50 kg m^{-2}.
- Obesity was not a major signal in cases of perioperative cardiac arrest reported to NAP7, but there are several caveats:
  - As 34% of the population has a BMI greater than 30 kg m^{-2}, it is not a surprise that the cohort of patients with a BMI greater than 30 kg m^{-2} who had a cardiac arrest differs little from the overall population, as these patients comprise a significant proportion of the whole population.
  - Patients with a BMI greater than 40 kg m^{-2} accounted for 41 of 881 patients (4.6%, 1 in 22) who had a perioperative cardiac arrest. Small numbers make robust themes with increasing BMI difficult to extract.
- Themes that did emerge relating to obesity included poor preoperative risk assessment, a higher proportion of postoperative events (50% of cardiac arrests in patients with BMI > 40 kg m^{-2}) and an increase in hypoxaemia, and possibly pulmonary embolus as a cause of cardiac arrest.
- Patients with a BMI above 40 kg m^{-2} who had a cardiac arrest were less likely than others to have received regional anaesthesia and more likely to have received neuraxial anaesthesia and sedation as sole techniques. A reduction in use of regional anaesthesia in patients with high BMI was also seen in the Activity Survey.
- Patients with a BMI above 40 kg m^{-2} had poorer outcomes at the time of cardiac arrest than other patients (return of spontaneous circulation [ROSC] 63% vs 75%) and survival at the time of reporting to NAP7 (54% vs 59%)
- In only two clinical areas of practice was obesity a key theme:
  - Obesity impacted on airway management mostly as BMI rose above 35 kg m^{-2} with increased rates of intubation. However, when a supraglottic airway (SGA) was used, the proportion that were second-generation differed little as BMI rose.
  - Patients with obesity were approximately two-fold overrepresented in cardiac arrests with an airway and breathing cause, many of which occurred in the post-surgery phase, highlighting this as a high-risk period for these patients.
  - In obstetrics, the rise in BMI of patients was more severe than in other specialties. Patients who had a perioperative cardiac arrest were disproportionately overweight or obese, accounting for 62% of the obstetric anaesthetic population and 75% of cardiac arrests.
- The quality of care of patients with higher BMIs was judged to be good less often and poor more often than for other patients. This was especially notable for patients with BMI above 40 kg m^{-2} (good before cardiac arrest 34% vs 48% in all patients) and poor 29% (vs 11%), overall care good in 37% (vs 53%) and poor in 7.3% (vs 2.1%).
- Obesity continues to grow as a national problem and has medical, logistical and operational consequences that can only be addressed by national initiatives. These likely impact patients with a BMI above 35 kg m^{-2} and certainly above 40 kg m^{-2} more than those with a BMI of 25–35 kg m^{-2}.

What we already know

The prevalence of obesity continues to increase throughout the United Kingdom. The most recent health survey for England (NHS Digital 2022) found that men were more likely than women to be overweight or obese, with 68% of men and 59% of women overweight or obese. Rates of obesity of up to 60% are predicted (Lobstein 2007). It is therefore of no surprise that it is common for anaesthetists in any clinical specialty or healthcare location to manage this group of patients for almost any type of surgical intervention.

Obesity is defined by BMI (weight divided by height squared). A BMI greater than 25 kg m^{-2} is classed as overweight, and over 30 kg m^{-2} as obese (Table 29.1). Although BMI has its limitations (eg relative muscle mass, fat distribution), it is a widely-used and easy measurement. Of more use is to define the location of fat distribution. It is well known that the central abdominal distribution is associated with greater cardiac risk than a more peripheral fat distribution (Powell-Wiley 2021).

Obesity is a multisystem disorder associated with many pathologies that increase perioperative risks. These include:

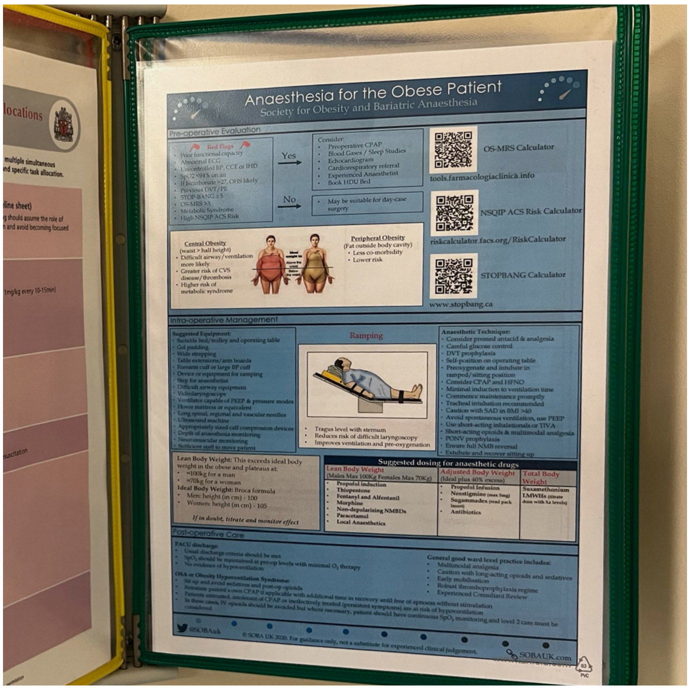
- sleep-disordered breathing, which can commonly be undiagnosed
- systemic hypertension
- ischaemic heart disease, often present at an earlier age
- heart failure
- cardiac conduction defects and arrhythmias
- diabetes mellitus
- metabolic syndrome.

Airway issues are also frequently seen in patients with obesity. NAP4 demonstrated an increased risk of adverse airway events in this group (Cook 2011) as have several other studies (see Chapter 21 Airway and respiratory).

Combining all the above factors and associated respiratory effects, increased metabolic rate and oxygen consumption, an increased risk of difficult airway, poor thoracic compliance and, adding general or other anaesthesia, it is easy to see why this group of patients are walking a thin line with little reserve should an adverse event arise. It is vital that appropriate assessment, optimisation and planning take place wherever possible in this group of patients before admission for surgery and anaesthesia (Cook 2011, Wynn-Hebden 2020).

Table 29.1 Classification of obesity

BMI (kg m^{-2})	Weight status
<18.5	Underweight
18.5-24.9	Healthy weight
25.0-29.9	Overweight
30.0-34.9	Obesity class I
35.0-39.9	Obesity class II
≥40.0	Obesity class III



Obesity in pregnancy is also increasingly encountered. In 2018, 21% of the antenatal population were obese and fewer than half had a BMI less than 25 kg m^{-2} (Denison 2018). The association of obesity and pregnancy increases the risk of operative delivery and associated anaesthesia risks due to comorbidity (Patel 2001, Khalifa 2021).

What we found

Activity Survey

In adult patients where BMI was reported, 431 (2%) were underweight (BMI < 18.5 kg m^{-2}); 7,635 (38%) were normal weight (BMI 18.5–24.9 kg m^{-2}); 5,673 (28%) were overweight (BMI 25.0–29.9 kg m^{-2}); 3,613 (18%) were obese class 1 (BMI 30.0–34.9 kg m^{-2}); 1,655 (8%) were obese class 2 (BMI 35.0–39.9 kg m^{-2}); and 1,019 (5%) were obese class 3 (BMI ≥ 40.0 kg m^{-2}). The proportion of patients in each category varied with a bimodal distribution; young and old patients had lower BMI scores than patients in middle age (Figure 29.1, Appendix Table 29A.1).

The estimated median BMI increased between NAP5 and NAP7 from 24.9 kg m^{-2} (IQR 21.5–29.5 kg m^{-2}) to 26.7 kg m^{-2} (IQR 22.3–31.7 kg m^{-2}), while the proportion of patients classified as at least overweight increased from 49% to 59% (Figure 29.2 and Appendix Table 29A.2). Within the obstetric population requiring anaesthetic intervention, the increase in obesity was more pronounced. The estimated median BMI increased from 24.8 kg m^{-2} (IQR 21.6–29.8 kg m^{-2}) to 27.1 kg m^{-2} (IQR 22.7–32.4) and the proportion classified as at least overweight increased from 46% to 62% (Figure 29.3 and Appendix Table 29.A2). The distributions of BMI in non-obstetric and obstetric patients were significantly different between NAP5 (Sury 2014), NAP6 (Kemp 2017) and NAP7 (non-obstetric, $p < 0.001$; obstetric, $p < 0.001$). The implications for pregnant patients are discussed in Chapter 34 Obstetrics.

Figure 29.1 BMI distribution by age in the NAP7 Activity Survey population (< 18.5 kg m⁻² ■, 18.5–24.9 kg m⁻² ■, 25.0–29.9 kg m⁻² ■, 30.0–34.9 kg m⁻² ■, 35.0–39.9 kg m⁻² ■, 40.0–49.9 kg m⁻² ■, 50.0–59.9 kg m⁻² ■, ≥ 60 kg m⁻² ■ where BMI was reported and patients ≥ 19 years; *n*=20,026). Values above the bars show the number of patients in each group.

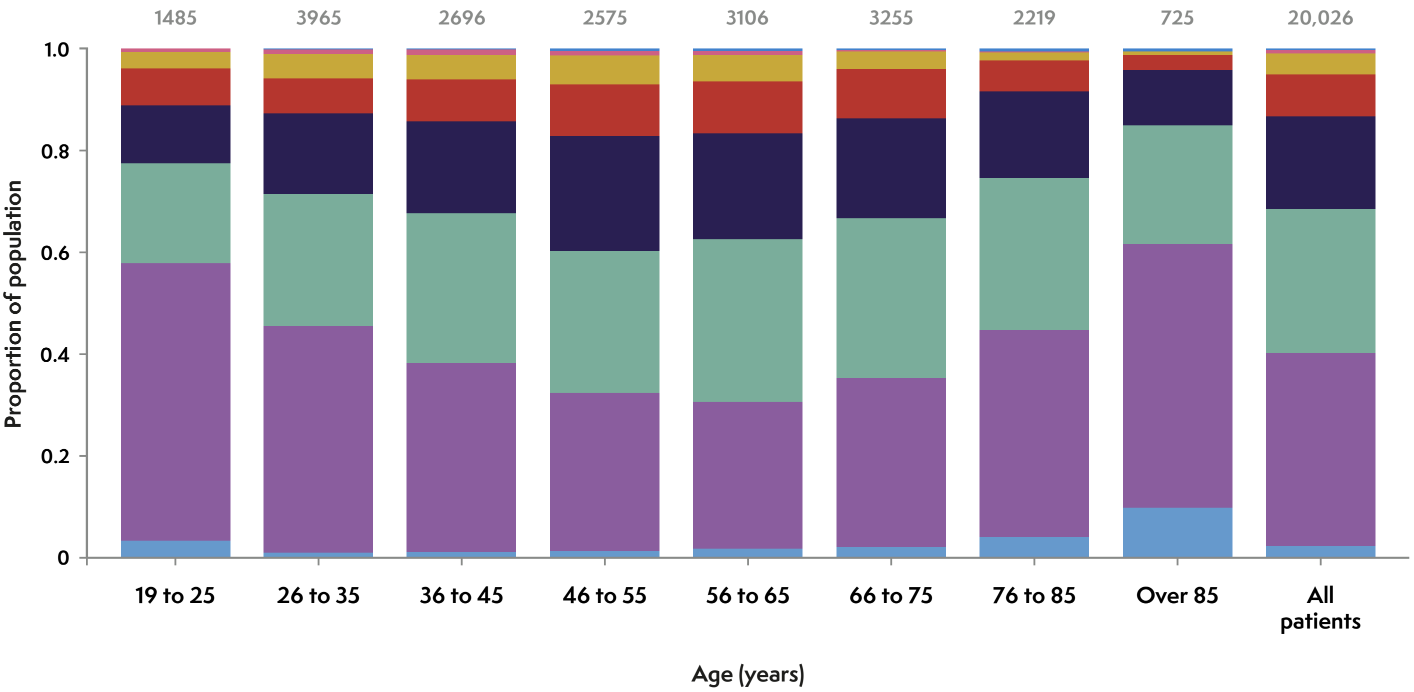


Figure 29.2 Trends in age and BMI over time. Data show the proportion of the Activity Survey population by BMI distribution in the non-obstetric population (NAP5 ■; NAP6 ■; NAP7 ■). Proportions show the relative change in the population proportion within the group between NAP5 and NAP7. ↑, increase; ↓, decrease; ↔, no change. Percentages may not total 100 due to rounding.

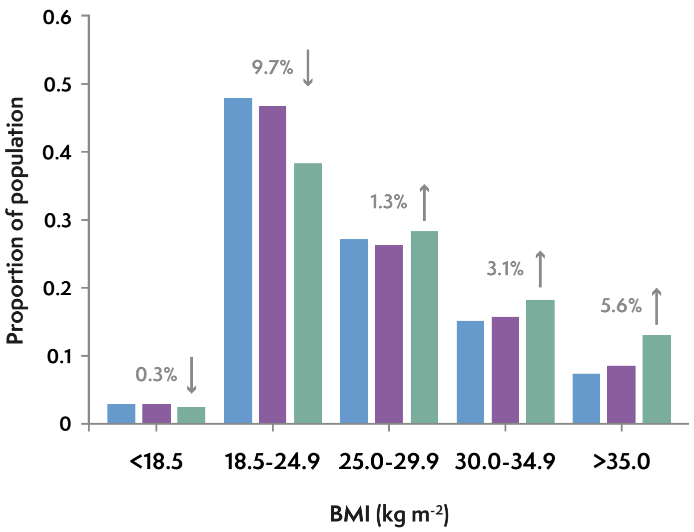
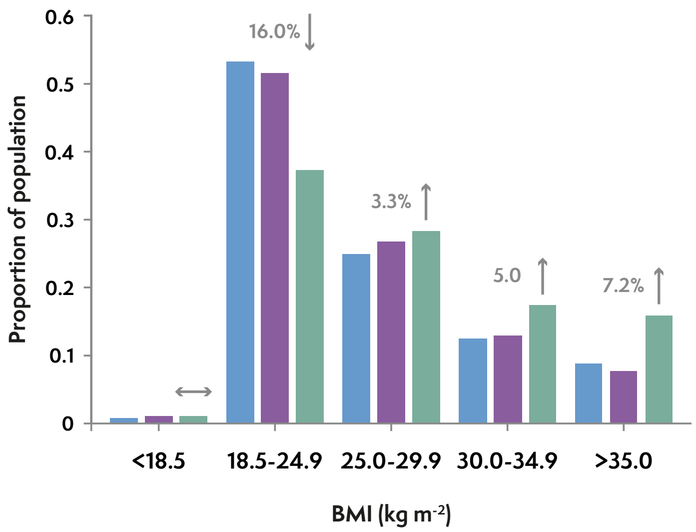


Figure 29.3 Trends in age and BMI over time. Data show the proportion of the Activity Survey population by BMI distribution in the obstetric population (NAP5 ■; NAP6 ■; NAP7 ■). Proportions show the relative change in the population proportion within the group between NAP5 and NAP7.



The effect of BMI on the chance of having one or more complications in a case did not reach statistical significance but showed some evidence of a bimodal distribution. The rates of complications increased by approximately 25% when BMI was below 18 kg m^{-2} or above 35 kg m^{-2} but with relatively low numbers of patients at BMI above 50 kg m^{-2} and above 60 kg m^{-2}, the confidence intervals are large (Figure 29.4, Appendix Table 29A.3). These overall increases in the frequency of complications were much less pronounced than for other patient factors such as ASA and frailty in those aged over 65 years or by surgical factors such as urgency, extent or duration (see Chapter 12 Activity Survey - complications). However, when complications are examined by system, some patterns do emerge (Figure 29.5).

Airway complications:

- rose from BMI 35 kg m^{-2}
- were two-fold higher than healthy BMI with BMI above 60 kg m^{-2}.

Breathing complications:

- rose from BMI 35 kg m^{-2}
- were approximately three- to six-fold higher than healthy BMI with all BMIs above 35 kg m^{-2}.

Circulation complications:

- rose from BMI 50 kg m^{-2}
- were approximately two-fold higher than healthy BMI with BMIs above 50 kg m^{-2}.

Metabolic complications:

- rose from BMI 50 kg m^{-2}
- were approximately two-fold higher than healthy BMI with BMIs above 50 kg m^{-2}.

In addition to the changes in airway management with increasing BMI (noted in Chapter 21 Airway and respiratory), the rates of neuraxial anaesthesia and regional anaesthesia were different across BMI classes ($\chi 2$, $p < 0.001$, $p = 0.008$, respectively).

Figure 29.4 Frequency of complications during anaesthesia by BMI in adult patients having general anaesthesia. Error bars represent 95% confidence interval.

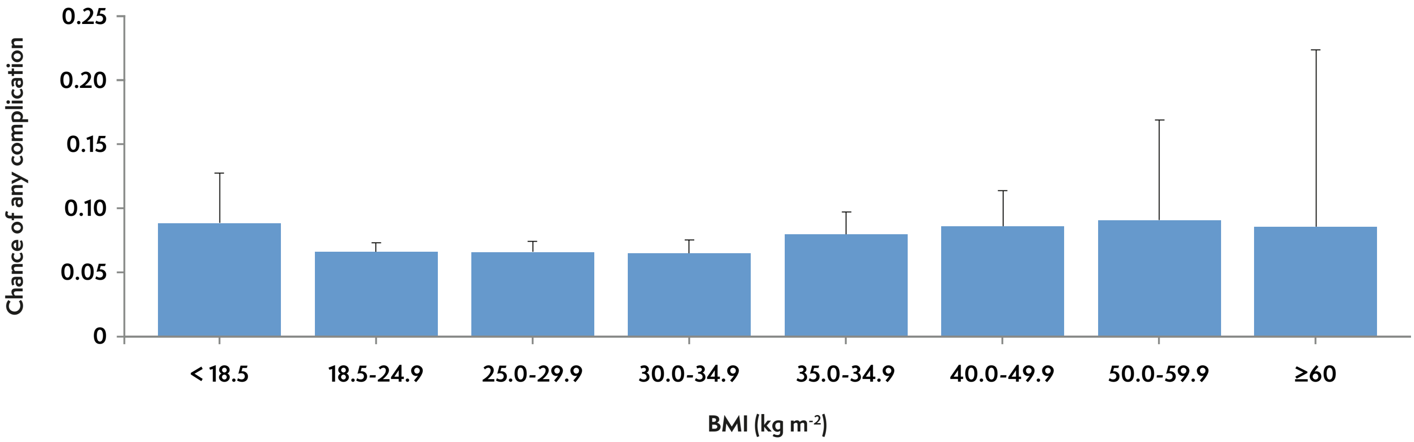
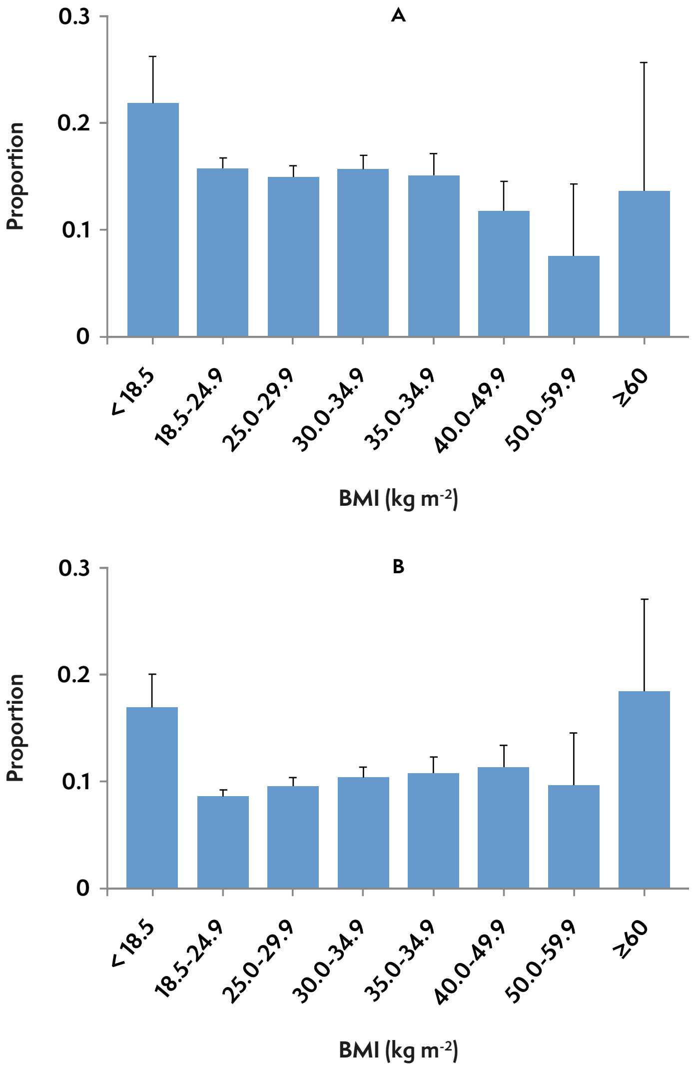


Figure 29.5 Frequency of complications by body system and by BMI. Blue bars represent the relative proportion of patients with complications in each cell. All patients 19 years and older.

BMI (kg m^{-2})	Airway	Breathing	Circulation	Neurological	Metabolic	Other	Patients in group
< 18.5	0.014	0.012	0.049	0.009	0.021	0.012	431
18.5–24.9	0.016	0.006	0.036	0.002	0.011	0.005	7635
25.0–29.9	0.018	0.010	0.030	0.002	0.012	0.004	5673
30.0–34.9	0.014	0.012	0.034	0.003	0.014	0.006	3613
35.0–39.9	0.019	0.019	0.046	0.001	0.012	0.006	1655
40.0–49.9	0.019	0.041	0.031	0.002	0.008	0.006	827
50.0–59.9	0.007	0.022	0.088	0.007	0.029	0.007	136
≥ 60	0.036	0.018	0.071	0.000	0.036	0.018	56
Unknown	0.007	0.006	0.039	0.001	0.009	0.004	691
All Patients	0.016	0.011	0.035	0.002	0.012	0.005	20717

The rates of regional anaesthesia were highest in patients with a BMI less than 18.5 kg m^{-2} (21%) and lowest in patients with a BMI between 50.0 and 59.9 kg m^{-2} (7%; Figure 29.6A, Appendix Table 29A.4). The rates of neuraxial anaesthesia were between 11% and 15% in all BMI classes, except less than 18.5 kg m^{-2} (23%) and above 60 kg m^{-2} (25%; Figure 29.6B, Appendix Table 29.A4).

Figure 29.6 Rates of (A) regional blocks and (B) neuraxial anaesthesia in the Activity Survey (age ≥ 19 years, non-obstetric patients). Values show the proportion of patients receiving each type of anaesthesia in each BMI class with 95% confidence interval error bar.



Cases

Patients with BMI 30–39.9 kg m^{-2}, 40-49 kg m^{-2}, 50-59.9 kg m^{-2} and > 60 kg m^{-2} accounted for 27%, 4.2%, 0.7% and 0.4% of the 635 NHS cardiac arrests in adults with known BMI and 26%, 3.8%, 0.6% and 0.3% of adult patients in the Activity Survey indicating no excess rate of cardiac arrests in this cohort.

Patients with BMI >30 kg m^{-2}

Patients with BMI >30 kg m^{-2} accounted for 226 (26%) of 881 cases reported to NAP7 and 32% of cardiac arrests in adults, compared to 34% of adult patients in the Activity Survey. Compared to the Activity Survey, patient characteristics did not differ dramatically.

Patients who had a perioperative cardiac arrest who had a BMI above 30 kg m^{-2} were, compared with patients with lower BMI who had a cardiac arrest and were more often female (52% vs 41%), slightly more likely to have a pre-existing functional disability (modified Rankin Scale [mRS] score ≥ 2, 33% vs 28%) and less likely to have frailty (Clinical Frailty Scale score ≥ 5, 17% vs 21%) but similar in terms of ASA, ethnicity, extent and urgency of surgery. Surgery was modestly more often elective (32% vs 26%). Surgical specialties did not differ notably, but patients with obesity were somewhat overrepresented in obstetrics (4.8% vs 3.3%) and underrepresented in cardiac surgery (5.8% vs 9.4%) and cardiology (6.2% vs 8.1%). The type of anaesthesia differed somewhat; patients with obesity having received general anaesthesia equally commonly, having received neuraxial anaesthesia more frequently (19% vs 13%) and regional anaesthesia less frequently (6.2% vs 8.4%). Cardiac arrests occurred at a similar time of day, phase of anaesthesia and location. The initial cardiac arrest rhythm was generally similar but with somewhat more asystole (21% vs 15%) and less bradycardia (7% vs 15%). Duration of resuscitation and early outcome (survival of the event, 74% vs 76%) differed little.

The panel-agreed most common causes of cardiac arrest were major haemorrhage (13%), septic shock (11%), bradycardia (10%) and hypoxaemia (10%), all broadly in keeping with the whole cohort of cardiac arrest cases, although haemorrhage was higher in the overall cohort (19%). Anaphylaxis as a cause accounted for 4.1% cases, pulmonary embolus 3.4% and aspiration of gastric contents, cannot intubate cannot oxygenate (CICO) and emergency front of neck airway (eFONA; all 1%), all similar to the overall cohort.

Key causal factors were judged to include the patient in 76%, anaesthesia in 44% and surgery in 34%, similar to all cases. Keywords included obstructive sleep apnoea, extubation, access, airway and obstetrics.

Reported outcomes were similar to all cases, and 87 (34%) of the 226 patients with BMI above 30 kg m^{-2} died. Of these deaths, the panel review judged that 21 (24%) were the result of an inexorable process, 15 (17%) partially, 18 (20%) uncertain, 32 (37%) were not, and one was not rated. Serious harm was experienced by 20 survivors and moderate harm by 113, with 6 not rated.

Quality of care was generally judged less good for patients with obesity than others: care before cardiac arrest was rated good in 42% (vs 48% overall) and poor in 16% (vs 11%), and overall care was rated good in 48% (vs 53%) and poor in 3.1% (vs 2.1%).

Debrief occurred or was planned in 57% of cases when the patient survived and 65% of deaths, compared with 49% and 61%, respectively, in all cases.

Patients with body mass index above 40 kg m^{-2}

Patients with BMI above 40 kg m^{-2} accounted for 41 (4.7%) of all 881 cases reported to NAP7 and 5.7% of cardiac arrests in adults, compared with 5.1% in the Activity Survey.

Patients with cardiac arrest who had BMI above 40 kg m^{-2} were, compared with cardiac arrest patients with BMI lower than 40 kg m^{-2}, more often of middle age (36–55 years, 35% vs 17%), female (63% vs 43%), ASA 4 (41% vs 28%), more likely to have pre-existing functional disability (mRS ≥ 2, 44% vs 28%), less likely to have frailty (Clinical Frailty Scale score ≥ 5, 36% vs 21%) but similar in terms of ethnicity, extent and urgency of surgery. Surgical specialties did not differ notably compared with those with a lower BMI.

NAP7 cases with a BMI above 40 kg m^{-2}, compared with cases with a lower BMI, received general anaesthesia less frequently (73% vs 83%), neuraxial anaesthesia more frequently (20% vs 14%), regional anaesthesia less frequently (4.9% vs 8%), and sedation as a solo technique more frequently (10% vs 2.3%).

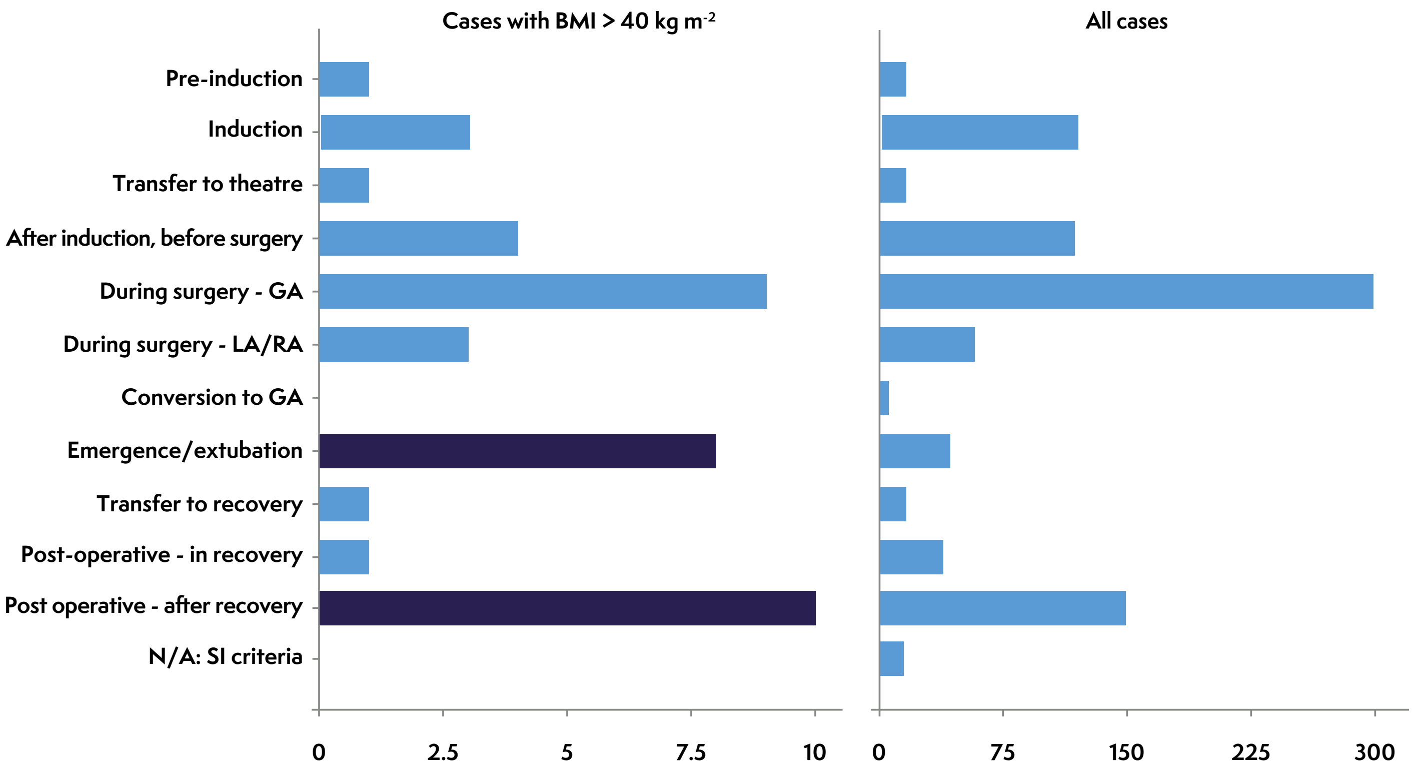
Cardiac arrests occurred at a similar time of day in each cohort. In the BMI above 40 kg m^{-2} cohort, cardiac arrest occurred after leaving recovery (30% vs 18%) and in critical care (22% vs 12%) rather more commonly (Figure 29.7). The duration of resuscitation was similar in both groups. The initial rhythm was generally similar in both cohorts.

Reported outcomes were poorer in this cohort than in those with a lower BMI; 63% of patients survived the initial event (vs 75% in those with a lower BMI). Among 41 patients with BMI above 40 kg m^{-2}, 19 (46%) died. At panel review, 10 (53%) of these deaths were judged part of an inexorable process, 1 (5%) partially, 4 (21%) uncertain and 4 (21%) not. Among 22 survivors, 1 was judged to have experienced severe harm and 20 moderate harm, with 1 uncertain.

The panel-agreed most common causes of cardiac arrest were severe hypoxaemia (27%) and bradycardia, major haemorrhage, pulmonary embolus and septic shock (all 9%). Severe hypoxaemia was more common as a cause than in all cases (27% vs 9%), as was pulmonary embolus (9% vs 2%).

There was no clear signal of an increase in causes related to anaphylaxis or pulmonary aspiration of gastric contents and there were no cases of CICO or eFONA.

Figure 29.7 Phase of anaesthesia and timing of cardiac arrest (a) patients with BMI above 40 kg m^{-2} (b) all patients. GA, general anaesthetic; LA, local anaesthetic; RA, regional anaesthetic; SI, special intervention.



An older patient with severe obesity, frailty and multiple longstanding comorbidities had a minor procedure in a remote location. Intraoperative care was unremarkable. As the patient was transferred from the operating table to their bed, they became bradycardic and then had a cardiac arrest. Prolonged resuscitation was required before ROSC was achieved. Echocardiography was undertaken during resuscitation. The patient required level 3 care in intensive care but had survived when reported to NAP7. All phases of care were judged good. The reporter and panel considered pulmonary embolus the most likely cause of the event.

Key contributory factors were judged to be patient in 87%, anaesthesia in 49% and surgery in 22%, with patient and anaesthetic factors increased compared to all cases (82% and 40%, respectively). Key words included extubation, airway and preoperative assessment.

A patient with severe obesity and due to have major surgery with general anaesthesia had a preoperative assessment by phone. The patient used non-invasive ventilation for sleep apnoea, but this appeared not to be known at the time of surgery. In the post-surgical period, the patient had a cardiac arrest likely related to medication-related reduced conscious level and airway obstruction. Cardiopulmonary resuscitation was required and, after admission to intensive care and delayed discharge, outcome was good.

A younger patient with severe obesity underwent general anaesthesia for an urgent minor procedure out of hours. After extubation, hypoxaemia, most likely due to agitation and airway obstruction, developed. Intubation and vascular access were difficult, and cardiac arrest occurred. Despite prolonged attempts at resuscitation, the patient died.

Quality of care was generally judged less good for patients with BMI above 40 kg m^{-2} than others: care before cardiac arrest good 34% (vs 48% overall) and poor 29% (vs 11%), care after cardiac arrest rated good in 74% (vs 80%) and poor in 7.7% (vs 1.2%) and overall care good in 37% (vs 53%) and poor in 7.3% (vs 2.1%). Debrief occurred or was planned in 50% of cases when the patient survived and 64% of deaths, very similar to 49% and 61%, respectively, in all cases.

Cases citing obesity in panel review

In 25 (2.8%) patients reported to NAP7, obesity was cited as a keyword or key lesson at panel review. These patients tended to be middle aged (25–55 years), mostly female, white, and 24% had BMI above 50 kg m^{-2}. They were not notably frail or undergoing a particular type of surgery. Regional anaesthesia was uncommon (4% vs 14% in the Activity Survey). Airway and respiratory complications were relatively common, including in the postoperative phase. In total, half of these cases occurred after surgery. In these cases, key contributory factors were judged as patient in 88%, anaesthesia in 64% and surgery in 24%. The cardiac arrest characteristics (timing, phase of anaesthesia, location, rhythm, resuscitation efforts) differed little between these cases and others in the NAP7 cohort, although prolonged resuscitation was infrequent. Outcomes were similar to cardiac arrests in the rest of the cohort both at the time of cardiac arrest and when reported to NAP7 except for delayed discharge (48% vs 27%). Seven (28%) patients died and two had severe harm. Of the seven deaths, one was judged the result of an inexorable process, one partially, three uncertain and two were not. The quality of care of these patients were generally rated relatively poorly: care before cardiac arrest rated good in 24% and poor in 28% and overall care good in 24% and poor in 4%. Debrief took place in 67% of cases.

A patient with severe obesity and comorbidity and with previous anaesthetic difficulties underwent major surgery in a remote location. Surgery was initially with spinal anaesthesia (noted to be difficult) and sedation. Appropriate equipment for drug delivery was not available which compromised drug dosing. Hypoxaemia developed during surgery with the cause uncertain and progressed to cardiac arrest. Prolonged resuscitation was required during which venous access was problematic. Resuscitation was successful and, following transfer to another hospital's intensive care unit (ICU), the patient made a full recovery after a prolonged period in ICU.

Clinical practice impacted by obesity: airway and breathing and obstetrics

Among specialty reviews, only airway and breathing and obstetrics were areas of practice in which obesity was a signal of notably high risk. The topics are discussed in full in those chapters (Chapter 21 Airway and respiratory, Chapter 34 Obstetrics) but are summarised here.

Airway and breathing

The Activity Survey showed a lower proportion of SGA use in NAP7 than NAP4 (Woodall 2011a). As BMI rose the proportion of patients who received anaesthesia with an SGA rather than a tracheal tube fell, notably as BMI exceeded 40 kg m^{-2}. However, as BMI rose, when an SGA was used, the proportion of first- to second-generation SGAs changed very little.

Patients with obesity (specifically BMI 35.0–49.9 kg m^{-2}) were overrepresented in airway and breathing reports. While 11.7% of patients in the Activity Survey had a BMI 35.0–49.9 kg m^{-2}, this population accounted for 20% of airway and respiratory-related cardiac arrests.

For patients with a BMI above 30 kg m^{-2}, 18% of cardiac arrests with airway or respiratory precipitants occurred at emergence or during transfer to recovery. This is a greater proportion than for lower BMI groups (5.7%), suggesting this as a higher risk phase for this patient group. Airway obstruction was a common aetiology, either following extubation or in the immediate postoperative period.

A patient with a high BMI having a minor general surgical procedure was cared for by an anaesthetist in training. General anaesthesia and tracheal intubation were chosen over spinal anaesthesia. Airway obstruction occurred at extubation. Hypoxia progressed to cardiac arrest. Resuscitation attempts were challenging due to body habitus and, despite reintubation, ROSC was never achieved and the patient died.

Gaps in monitoring were also seen in patients with obesity who had cardiac arrests secondary to airway or breathing complications.

A patient with obesity was extubated in theatre following urgent surgery. The patient was alert and tidal volumes were adequate. Monitoring was removed. During transfer to recovery, the patient had a respiratory arrest. Recognition of deterioration was delayed and there was progression to cardiac arrest. Monitoring was resumed in recovery and ROSC was achieved following airway management and correction of hypoxaemia.

Obstetrics

In the Activity Survey, 36.8% of patients were of healthy weight, 27.9% were overweight and 33% obese. The mean BMI of the obstetric population who received anaesthetic care increased between NAP5 and NAP7 from 24.8 kg m^{-2} to 27.1 kg m^{-2}. The proportion classified as overweight or higher increased from 46% of the population to 62%, with the steepest rise observed in patients with BMI over 35 kg m^{-2}, in the order of 7.2%.

Women who had a perioperative cardiac arrest were even more like to be overweight or obese: with, among 28 obstetric cardiac arrest patients, 10 (36%) being overweight and 11 (39%) obese. Thus, 75% of obstetric patients who arrested were overweight or obese compared with 62% in the general obstetric population.

Discussion

The key findings from NAP7 relating to obesity are five-fold:

- Rates of obesity in the population cared for by anaesthetists have increased markedly in the past decade.
- Perioperative complications increase in patients with obesity (and those who are underweight) by around 25%, but especially once BMI exceeds 50 kg m^{-2}.
- BMI appears not to be a major contributor to risk of cardiac arrest in those who are overweight or BMI 30–35 kg m^{-2} but may have an impact in higher BMIs.
- Airway problems, hypoxaemia and the complications in the post-surgery period are notable in this cohort.
- Outcomes of perioperative cardiac arrest are poorer for patients with obesity, but this is allied with suboptimal care more often, especially in those with BMI above 40 kg m^{-2}.

The NAP7 Activity Survey has shown that, over the past decade, the average BMI of the surgical population has increased significantly, such that the average BMI of patients cared for by anaesthetists is in the overweight category and 59% of patients are overweight or obese. Importantly, the highest proportional increase in weight is in the higher BMI categories, so that not only is the frequency of obesity in the surgical population increasing but also its extent. This is particularly important as the NAP7 data indicate that it is in higher levels of obesity that rates of complications increase and that outcomes are poorer. Obesity is a national issue, which requires national solutions but has daily implications for anaesthetists and our patients.

The NAP7 data provide evidence of increased risk for patients, especially when BMI exceeds 40 kg m^{-2} and especially 50 kg m^{-2}. These patients need thorough preoperative assessment (which was highlighted to be inadequate in several cases reported to NAP7), individualised risk assessment and communication of those risks. NAP7 provides data that should be useful in that regard. The logistics of patient care for patients with high levels of obesity are inevitably more complex; cases reported to NAP7 include issues secondary to obstructive sleep apnoea, obesity hypoventilation syndrome, opioid-related airway obstruction, difficult intravenous access and patient positioning. Care of these patients requires institutional preparation and individual case planning, including communication of risk at team briefs and appropriate time allocations for anaesthetic and surgical procedures, which may be more challenging in the obese patient. Crucially, the post-surgical period (extubation through to ward or ICU) appears to be a higher risk period for obese patients than those with a lower BMI. NAP7 highlights the need for caring for obese patients in an appropriate postoperative location that is appropriately staffed and with appropriate monitoring (Chapter 39 Postoperative care).

Patients with obesity had more complications than non-obese patients. Both increased BMI and decreased BMI led to increased rates of intraoperative complications, but these trends were less marked than for other patient factors such as ASA, frailty and surgical factors, including urgency, extent and duration of surgery. We have not yet undertaken a multivariate analysis, so it may be that obesity becomes even less contributory as co-variates are considered. However, there is a clear signal, as BMI rose above 40 kg m^{-2} and, particularly, above 50 kg m^{-2}, of a notably increased rate of airway, breathing, circulatory and metabolic complications. The risk of such complications being the start of a spiral of deterioration towards cardiac arrest is probably higher in these patients due to underlying comorbidities associated with obesity and the logistical and practical challenges of unexpected interventions in this group.

Obesity was not a major signal in cases of perioperative cardiac arrest reported to NAP7, but there are several caveats. First, as 34% of the population has a BMI above 30 kg m^{-2} it is no surprise that the cohort of patients with a BMI above 30 kg m^{-2} who had a cardiac arrest differs little from the overall population, as it forms a substantial part of it. Second, patients with a BMI above 40 kg m^{-2} accounted 5% of patients in the Activity Survey and 41 (4.6%) of 881 patients (1 in 22) who had a perioperative cardiac arrest. Patients with a BMI above 50–59.9 kg m^{-2} and 60 kg m^{-2} and above accounted for 5 (0.6%) and 3 (0.3%) of all cardiac arrests. These small numbers make identifying robust themes within cohorts of patients with severe obesity difficult to extract.

Notwithstanding this, some themes did emerge relating to obesity during subspecialty review and qualitative review of cases. Several cases described poor preoperative assessment in which the risk of severe obesity for the patient and the challenges for the anaesthetic and surgical teams seemed not to have been appreciated. The importance of face-to-face assessment of high-risk patients with obesity is emphasised, in part because of the risks that are inherently due to obesity itself but also the comorbidities that may accompany or be the result of obesity. Accompanying the post-surgical period as a period of increased risk for patients with obesity were regular references to airway or oxygenation difficulties and a notable increase in hypoxaemia as a cause of cardiac arrest. The importance of continuous monitoring when moving patients with obesity and the potential value of invasive blood pressure monitoring in patients with severe obesity was also highlighted in multiple panel reviews as were complications arising during patient transfer (eg from anaesthetic room to theatre) and when positioning.

Pulmonary embolus was also noted as a disproportionately common cause of cardiac arrest in patients with BMI above 40 kg m^{-2} – even though our period of data collection only included the intraoperative period and up to 24 hours after surgery.

Patients with obesity who had a cardiac arrest had different patterns of anaesthetic care compared with patients with lower BMI, despite surgical specialty not differing markedly. In the cases reported to NAP7, there was a tendency for more neuraxial anaesthesia, less regional anaesthesia and, in patients with BMI above 40 kg m^{-2}, more use of sedation as a solo technique. NAP7 cannot determine the reason for this but it is notable. In the NAP7 Activity Survey, the rates of regional anaesthesia and neuraxial anaesthesia varied with the patient's BMI class. Regional anaesthesia was used almost three times more often when the BMI was less than 18.5 kg m^{-2} than when BMI was 50–59.9 kg m^{-2}. Neuraxial techniques occurred more often at the extremes of BMI but were relatively constant between 18.5 and 59.9 kg m^{-2}. It is plausible that regional anaesthesia is being withheld from patients with obesity due to technical difficulty, and this may not be in their interests. This is an area fertile for future exploration. Of note, in previous NAPs (Woodall 2011b, Quinn 2011, Pearse 2011, Plaat 2014) and in NAP7, conversion of regional to general anaesthesia (see Chapter 34 Obstetrics) was a high-risk period for complications including airway problems, accidental awareness and cardiac arrest, so any increase in use of regional anaesthesia would need to be accompanied by robust plans for failure.

Only two clinical areas were notable for obesity being overrepresented: airway and breathing (see Chapter 21 Airway and respiratory) and obstetrics (Chapter 34 Obstetrics). Obesity impacted airway management little until BMI rose above 35 kg m^{-2}, at which point intubation rates increased. However, when an SGA was used, rate of use of a second-generation SGA did not increase notably with BMI, which is poor practice. Patients with obesity were approximately two-fold overrepresented in cardiac arrests with airway and breathing causes, many of which occurred in the post-surgery phase, highlighting this as a high-risk period for these patients. These findings are consistent with and add to the findings of previous studies (Cook 2011, Huitink 2020). Obesity increases the risk of failure of many airway procedures and the short safe apnoea time compounds difficulty (Huitink 2020). Further, when one airway technique fails, the likelihood of rescue techniques succeeding is also compromised: composite airway failure (Cook 2012). As described in NAP4, particularly for the patient with obesity there is a need for an airway management strategy (ie a series of plans each contingent on the failure of the previous technique and communicated within the airway team) rather than one plan (Cook 2011). There were instances in NAP7 where airway management could have been avoided if regional techniques had been employed; this was also noted in NAP4 (Cook 2011).

In obstetrics, the rise in BMI of patients was more severe than in other specialties and patients who had a perioperative cardiac arrest were disproportionately overweight or obese, accounting for 62% of the obstetric anaesthetic population and 75% of cardiac arrests. The obstetric patient with obesity is more likely to require anaesthetic interventions (Khalifa, 2021). Such care is often more technically difficult and complication rates higher (Patel, 2021), and obesity confers an increased risk of harm, including death through indirect (most notably cardiac) and direct (eg major obstetric haemorrhage, eclampsia and uterine rupture) causes (van den Akker, 2017).

Outcomes from perioperative cardiac arrest patients with a BMI 30–39.9 kg m^{-2} did not differ from patients with lower BMIs, but patients with a BMI above 40 kg m^{-2} had poorer outcomes, both at the time of cardiac arrest (ROSC 63% vs 75%) and survival at the time of reporting to NAP7 (54% vs 59%). Whether this was due to obesity itself, the comorbidities associated with obesity or other factors is unknown. However, the quality of care that patients with higher BMIs received was judged by the review panel to be good less often and poor more often than for other patients. This was especially notable for patients with BMI above 40 kg m^{-2}. This is an area that merits additional focus and (as described above) is likely due to a combination of institutional factors and individual case factors including preoperative assessment, risk scoring and communication, allocation of sufficient time for procedures, robust monitoring throughout the operative period and postoperative management in a safe, adequately staffed and appropriately monitored location.

Obesity rates continue to grow, generating a societal problem that can only be addressed by national initiatives. However, it has daily medical, logistical and operational consequences for healthcare. Such is the prevalence of obesity in the surgical population that managing the patient with significant or even severe obesity is now part of everyday medical care. The evidence from NAP7 is that perioperative teams manage patients up to a BMI of around 35 kg m^{-2} similarly, and with similar outcomes, as for patients with lower BMIs. Above this BMI, the risk of complications and their consequences increase. Anaesthetic practices likely differ. Multiple factors interact to mean that patients with a BMI above 35 kg m^{-2}, and certainly above 40 kg m^{-2}, have poorer outcomes than those with a BMI of 25–35 kg m^{-2}, and suboptimal care may contribute to this.

Recommendations

None.

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Appendix 29.1

Table 29A.1 The distribution of age and BMI in the NAP7 Activity Survey population in adult non-obstetric patients

BMI (kg m⁻²)	Age (years), *n* (%)								
	19–25	26–35	36–45	46–55	56–65	66–75	76–85	> 85	All patients
< 18.5	49 (3)	39 (1)	30 (1)	33 (1)	57 (2)	65 (2)	87 (4)	71 (10)	431 (2)
18.5–24.9	809 (54)	1767 (45)	1000 (37)	801 (31)	893 (29)	1083 (33)	906 (41)	376 (52)	7635 (38)
25.0–29.9	292 (20)	1029 (26)	791 (29)	718 (28)	992 (32)	1020 (31)	662 (30)	169 (23)	5673 (28)
30.0–34.9	171 (12)	624 (16)	491 (18)	580 (23)	649 (21)	641 (20)	379 (17)	78 (11)	3613 (18)
35.0–39.9	107 (7)	273 (7)	222 (8)	263 (10)	316 (10)	319 (10)	133 (6)	22 (3)	1655 (8)
40.0–49.9	48 (3)	192 (5)	131 (5)	145 (6)	163 (5)	109 (3)	34 (2)	5 (1)	827 (4)
50.0–59.9	9 (1)	34 (1)	27 (1)	25 (1)	22 (1)	12 (0)	7 (0)	0 (0)	136 (1)
≥ 60.0	0 (0)	7 (0)	4 (0)	10 (0)	14 (0)	6 (0)	11 (0)	4 (1)	56 (0)
Total	1485 (100)	3965 (100)	2696 (100)	2575 (100)	3106 (100)	3255 (100)	2219 (100)	725 (100)	20026 (100)

Table 29A.2 Distribution profiles of BMI in non-obstetric and obstetric patients in the NAP5, NAP6 and NAP7 Activity Surveys

BMI (kg m⁻²), *n* (%)	NAP5 (2013), *n* (%)	NAP6 (2016), *n* (%)	NAP7 (2021), *n* (%)
Non-obstetric:			
< 18.5	411 (3)	334 (3)	398 (2)
18.5–24.9	7301 (48)	5629 (47)	6494 (38)
25.0–29.9	4111 (27)	3162 (26)	4807 (28)
30.0–34.9	2282 (15)	1890 (16)	3081 (18
> 35.0	1106 (7)	1011 (8)	2186 (13)
Total	15211 (100)	12026 (100)	16966 (100)
Obstetric:			
< 18.5	12 (1)	14 (1)	33 (1)
18.5–24.9	915 (53)	650 (52)	1139 (37)
25.0–29.9	429 (25)	338 (27)	866 (28)
30.0–34.9	214 (12)	162 (13)	532 (17)
> 35.0	150 (9)	97 (8)	486 (16)
Total	1720 (100)	1261 (100)	3056 (100)

Table 29A.3 Rates of complications during anaesthesia by BMI

BMI (kg m⁻²)	No complication (*n*)	Complication (*n*)	Total (*n*)	Incidence (%)	Ratio compared with BMI 18.5–25 kg m⁻²
< 18.5	401	30	431	6.96	1.27
18.5–24.9	7215	420	7635	5.50	1.00
25.0–29.9	5353	320	5673	5.64	1.03
30.0–34.9	3412	202	3614	5.59	1.02
35.0–39.9	1545	110	1655	6.65	1.21
40.0–49.9	774	53	827	6.41	1.17
50.0–59.9	126	10	136	7.35	1.34
≥ 60	52	4	56	7.14	1.30

Table 29A.4 Reported use of regional and neuraxial techniques in patients by BMI in adult non-obstetric patients

BMI (kg m^{-2})	Regional block (*n*)	Neuraxial (*n*)	Patients in group (*n*)
< 18.5	84	90	398
18.5–24.9	990	736	6494
25.0–29.9	695	611	4807
30.0–34.9	466	422	3081
35.0–39.9	202	200	1382
40.0–49.9	73	97	642
50.0–59.9	8	14	109
≥ 60	7	13	53
Unknown	84	21	601
Total	2609	2204	17567