Severe Obesity in A Specialist Type 2 Diabetes Outpatient Clinic: An Australian Retrospective Cohort Study

Arunav Thakur
Western Sydney University

Dharmesh Sharma
Western Sydney University

Bhavya Gupta
Western Sydney University

Nikitha Kramadhari
Western Sydney University

Rohit Rajagopal
Macarthur Diabetes Service, Camden and Campbelltown Hospitals, New South Wales

David Simmons
Western Sydney University

Milan Piya (✉ m.piya@westernsydney.edu.au)
Western Sydney University

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Abstract

Background Obesity is a major risk factor for the development of type 2 diabetes and its complications. Signiﬁcant weight loss has been shown to improve glycaemia in people with type 2 diabetes (T2DM) and obesity. National and International guidelines recommend considering bariatric surgery for body mass index (BMI) \( \geq 35 \text{ kg/m}^2 \). We assessed the proportion of people with T2DM meeting criteria for surgery, how many had been offered a bariatric/obesity service referral, and compared the characteristics of people with BMI \( \geq 35 \text{ kg/m}^2 \) and BMI < 35 kg/m².

Methods Retrospective data were collected for all people with T2DM aged \( \geq 18 \) years, attending a hospital specialist diabetes outpatient service over three calendar years, 2017–2019.

Results Of 700 people seen in the service, 291 (42%) had BMI \( \geq 35 \text{ kg/m}^2 \) (the “BMI \( \geq 35 \) group”) and met criteria for bariatric surgery, but only 54 (19%) of them were offered referral to an obesity service. The BMI \( \geq 35 \) group was younger than those with a BMI < 35 kg/m² (56.1 ± 14.8 vs 61.4 ± 14.6 years, \( p < 0.001 \)) (mean ± SD), with similar diabetes duration (11.0 ± 9.0 vs 12.3 ± 8.9 years, \( p = 0.078 \)), and there was no significant difference in initial HbA1c (75 ± 27 vs 72 ± 26 mmol/mol, \( p = 0.118 \)) (9.0 ± 2.5 vs 8.7 ± 2.4%) or proportion treated with insulin (62% vs 58%). There was more GLP1 agonist use in the BMI \( \geq 35 \) group (13% vs 7%, \( p = 0.003 \)) but similar rates of SGLT2 inhibitor use (25% vs 21%, \( p = 0.202 \)). The BMI \( \geq 35 \) group received more new medication and/or dose adjustments (74% vs 66%, \( p = 0.016 \)). Only 29% in the BMI \( \geq 35\text{kg} \) group achieved HbA1c < 53 mmol/mol (7.0%).

Conclusions In spite of frequently meeting the criteria for bariatric surgery and not achieving glycaemic targets, people with T2DM in this specialist clinic received limited medical or surgical management of their obesity. Our data support the need to prioritise obesity management in the treatment of type 2 diabetes.

Background

Type 2 diabetes mellitus (T2DM) is a growing problem with a worldwide prevalence of approximately 7% in adults, and a similar prevalence across Australia [1][2]. Obesity is associated with an increase in mortality with increasing body mass index (BMI), and is a well-established risk factor for type 2 diabetes [3]. Obesity (BMI \( \geq 30 \text{ kg/m}^2 \)) prevalence worldwide is 13% [4], and 11% of adults in Australia are living with severe obesity (BMI \( \geq 35 \text{ kg/m}^2 \)) [5]. Beyond the major health challenge associated with diabetes and obesity, is a substantial economic burden [6]. The additional annual total health cost, in comparison to those with a normal weight without diabetes, is 26% for obesity alone and 46% for people with obesity and diabetes [6].

Glycaemic control is important in the context of T2DM, particularly in reducing the risk of microvascular complications [7]. In addition, the 10-year follow-up data from United Kingdom Prospective Diabetes Study showed a continued reduction in microvascular and macrovascular risk for participants who
underwent intensive glucose control, suggesting a benefit from early good control, the legacy effect [8]. However, in people with longstanding T2DM, particularly those with existing cardiovascular disease or risk factors, the benefits of pushing glycaemic targets lower to reduce cardiovascular disease and mortality are less clear [9].

Weight loss, if significant and sustained, can improve glycaemic control as shown in the DiRECT trial and Look AHEAD study [10][11]. However, sustained weight loss is difficult to achieve in clinical practice, whether it be with lifestyle or pharmacotherapy. Bariatric surgery is an established treatment option for severe obesity and T2DM, and can result in significant, sustained weight loss and improvement/remission of T2DM [12][13]. Bariatric surgery data and the DiRECT trial have both shown that intervening soon after the diagnosis of T2DM is necessary for diabetes remission with weight loss [10][14]. Hence, the European Association for the Study of Diabetes (EASD)-American Diabetes Association (ADA) consensus guidelines for T2DM management recommend treating obesity, alongside glycaemia, with weight-lowering medications and bariatric surgery [15].

The bulk of T2DM is managed in primary care with only a small proportion being seen in a specialist diabetes clinic, usually those with diabetes complications. These clinics are limited in numbers and waiting times are often more than several months, with various models of integrated care being proposed to improve patient care and reduce the burden on specialist clinics, including models where patients are seen or discussed with a specialist on several occasions before being discharged back to primary care [16]. In Australia, the National Health and Medical Research Council (NHMRC) Guidelines recommend considering bariatric surgery for people with T2DM and a BMI $\geq 35\text{kg/m}^2$ [17]. This is corroborated by multiple international guidelines including the UK National Institute for Health and Clinical Excellence (NICE) guidelines and Diabetes Surgery Summit [18][19]. Between July 2018 and June 2019, less than 10% of primary bariatric surgeries in Australia were publicly funded [20], and there are very few publicly funded specialised obesity services. As a result, many people with severe obesity and T2DM may not receive timely referrals to obesity services or have bariatric surgery discussed, as it is not readily available for them. Therefore, in people with T2DM attending a specialist diabetes outpatient clinic, our aims were:

1. To describe the proportion that met the recommended criteria for bariatric surgery using a cut-off of $\geq 35\text{kg/m}^2$.
2. To compare the characteristics and outcomes in people with a BMI $\geq 35\text{kg/m}^2$ to those with a BMI $< 35\text{kg/m}^2$.
3. To determine the proportion of people with BMI $\geq 35\text{kg/m}^2$ that were referred to the metabolic clinic or had bariatric surgery discussed with them as an option.
4. To compare metabolic outcomes between people who were new to the clinic, and people who had been attending the clinic in previous years.

**Participants And Methods**
Design

Retrospective data were collected for all non-pregnant adults with T2DM attending the specialist diabetes outpatient service in a public teaching hospital in Sydney.

The following inclusion criteria were applied:

- Type 2 diabetes
- Age $\geq 18$
- Had attended an appointment with an endocrinologist for type 2 diabetes between 01/01/17 and 31/12/19

A list of all people who saw an endocrinologist across the three calendar years was generated from the hospital’s electronic medical records. The database was then filtered to exclude type 1 diabetes, diabetes in pregnancy, or people with a general endocrine/thyroid condition alone. This database was then cross-checked with patient notes and correspondence letters to select all the people with T2DM. Those with no recorded height were excluded due to the inability to calculate their BMI. The data collection flow chart is shown in Fig. 1.

Patient electronic medical records (eMR) were used to obtain demographic data, pathology results, anthropometric data, use of insulin and other anti-diabetes medications, complications of diabetes, annual screening, patient education and referrals or discussions of bariatric surgery. This was corroborated by checking patient correspondence letters. The study was approved by the South West Sydney Local Health District (SWSLHD) Research Ethics Committee as a quality improvement project (Reference: CT20_2018).

We compared baseline data and follow up metabolic outcomes in people with a BMI $\geq 35\, \text{kg/m}^2$ to those with a BMI $< 35\, \text{kg/m}^2$. Some people only had one HbA1c reading available in a calendar year, and hence they had to be excluded when calculating HbA1c reduction and proportion reaching HbA1c $< 53\, \text{mmol/mol} (7.0\%)$. Amongst the BMI $\geq 35\, \text{kg/m}^2$ group, we also compared outcomes in people who were new referrals to the clinic to existing patients who had been attending the clinic in previous years.

Data were analysed using SPSS software, version 26 (SPSS Inc., Chicago, Ill, USA). Distribution of continuous variables was tested for normality using the Kolmogorov–Smirnov test. Means and standard deviations were computed for continuous variables and frequencies and percentages for categorical variables. T-tests were performed for continuous variables and chi-square tests for categorical variables. P-value of $< 0.05$ was considered statistically significant. All tests were 2 tailed.

Results
Of the 700 eligible people, 42% had a BMI $\geq 35$ kg/m$^2$. Almost a quarter of people (23%) had a BMI $\geq 40$ kg/m$^2$. The BMI $\geq 35$ kg/m$^2$ group was younger, with a similar diabetes duration, and a higher proportion of women (Table 1). Among the BMI $\geq 35$ kg/m$^2$ people, only 19% (n = 54) were either offered referral to an obesity clinic, or had bariatric surgery discussed with them. The BMI $\geq 35$ kg/m$^2$ group attended a higher number of dietitian appointments on average (0.3 ± 0.7 vs 0.2 ± 0.5, p = 0.019) but there was no difference between both groups for endocrinologist (1.8 ± 1.6 vs 1.9 ± 1.8) and diabetes educator (specialist nurse) appointments (0.7 ± 1.3 vs 0.7 ± 1.3) (Table 2). There was no statistical difference in starting Hba1c (75 ± 27 vs 72 ± 26 mmol/mol, p = 0.118) (9.0 ± 2.5 vs 8.7 ± 2.4%) and the two groups had a similar reduction in Hba1c between their first and last readings (15 ± 28 vs 14 ± 28 mmol/mol) (-1.4 ± 2.6 vs -1.2 ± 2.5%) (Table 2).

A similar proportion of people were treated with insulin (62% vs 58%) and oral anti-diabetes agents including SGLT2 inhibitors, with fewer patients in the BMI $\geq 35$ kg/m$^2$ group on sulphonylureas (31% vs 39%) (Fig. 2). In the BMI $\geq 35$ kg/m$^2$ group, there was more GLP1 receptor agonist use (13% vs 6.6%, p = 0.003) but less DPP4i use (23% vs 32%, p = 0.015) (Fig. 2). The BMI $\geq 35$ kg/m$^2$ group had a higher total daily insulin dose (59.9 ± 49.3 vs 37.2 ± 26.0, p = 0.004) (Table 1) and a higher rate of lipohypertrophy (5.3% vs 2.0%, p = 0.019), but suffered from less documented hypoglycaemia (21% vs 30%, p = 0.007) (Table 2). There was also less cholesterol-lowering medication use in the BMI $\geq 35$ kg/m$^2$ group (53% vs 61%, p = 0.047) (Table 1). Obstructive sleep apnoea (25% vs 5.9%, p < 0.001), foot ulcers (8.6% vs 3.9%, p = 0.009) and depression (16% vs 11%, p = 0.049) were more prevalent in the BMI $\geq 35$ kg/m$^2$ group, with no difference in other co-morbidities including hypertension, dyslipidaemia, ischaemic heart disease, stroke, chronic kidney disease, peripheral vascular disease, peripheral neuropathy, autonomic neuropathy and diabetic retinopathy (Table 1). People with a BMI $\geq 35$ kg/m$^2$ were more likely to have additional medications/dose increases to diabetes medications during their consultation (74% vs 66%, p = 0.016), but there were no differences in annual screening, or patient education regarding hypoglycaemia, driving, and target Hba1c.

Table 3 compares new patients to the clinic and existing clinic patients with BMI $\geq 35$ kg/m$^2$. New patients had a higher Hba1c, shorter diabetes duration, greater metformin therapy, educator and dietitian attendance, and had a greater Hba1c reduction in clinic than existing clinic patients. Existing patients were more likely to be treated with insulin and/or sulphonylureas, but there was no significant difference in new diabetes agent use (SGLT2 inhibitors and GLP-1 receptor agonists). In the BMI $\geq 35$ kg/m$^2$ group, Hba1c dropped significantly for people in their first year of attendance, but not for those who had attended the clinic in previous years (-18 ± 31 vs -3 ± 16 mmol/mol, p < 0.001) (-1.6 ± 2.8 vs -0.3 ± 1.4%) (Table 3). However, there was no difference in the proportion reaching Hba1c < 53 mmol/mol (7%) in the first year of clinic attended between those with BMI $\geq 35$ kg/m$^2$ and BMI < 35 kg/m$^2$ groups (31% vs 38%, p = 0.261).
## Table 1  
- Baseline Data

| Measure                              | BMI ≥35 kg/m² (n = 291) | BMI < 35 kg/m² (n = 409) | P value |
|--------------------------------------|--------------------------|---------------------------|---------|
| **Age**                              | 56.1 ± 14.8              | 61.4 ± 14.6               | < 0.001|
| **%Women**                           | 53.3% (n = 155)          | 42.3% (n = 173)           | 0.004  |
| **Weight (kg)**                      | 119.6 ± 24.3             | 81.9 ± 16.2               | < 0.001|
| **BMI (kg/m²)**                      | 42.5 ± 7.0               | 28.8 ± 3.8                | < 0.001|
| **Duration of Diabetes (years)**     | 11.0 ± 9.0               | 12.3 ± 8.9                | 0.078  |
| **%Smoker/Ex-Smoker**                | 31% (n = 90)             | 28% (n = 115)             | 0.421  |
| **Hypertension**                     | 70% (n = 202)            | 66% (n = 268)             | 0.270  |
| **Systolic BP**                      | 131 ± 18                 | 130 ± 18                  | 0.265  |
| **Diastolic BP**                     | 76 ± 11                  | 75 ± 11                   | 0.418  |
| **Dyslipidaemia**                    | 59% (n = 171)            | 59% (n = 241)             | 0.939  |
| **Cholesterol Medication**           | 53% (n = 154)            | 61% (n = 247)             | 0.047  |
| **Total cholesterol**                | 4.5 ± 1.3                | 4.2 ± 1.4                 | 0.138  |
| **LDL**                              | 2.3 ± 1.0                | 2.2 ± 0.9                 | 0.223  |
| **HDL**                              | 1.1 ± 0.3                | 1.2 ± 0.9                 | 0.504  |
| **Triglycerides**                    | 2.8 ± 1.8                | 2.7 ± 3.4                 | 0.786  |
| **Obstructive Sleep Apnoea**         | 25% (n = 73)             | 6% (n = 24)               | < 0.001|
| **Ischaemic Heart Disease**          | 25% (n = 71)             | 26% (n = 104)             | 0.734  |
| **Stroke**                           | 9.7% (n = 28)            | 7.9% (n = 32)             | 0.411  |
| **Chronic Kidney Disease Stage 3 or below** | 19% (n = 55)            | 22% (n = 91)             | 0.261  |
| **eGFR**                             | 70.2 ± 22.8              | 67.7 ± 23.9               | 0.217  |
| **Abnormal Urine ACR**               | 51% (n = 107)            | 47% (n = 116)             | 0.838  |

eGFR = estimated glomerular filtration rate, ACR = albumin/creatinine ratio,  
LDL = low density lipoprotein, HDL = high density lipoprotein, BP = blood pressure
| Measure                                      | BMI ≥35 kg/m² (n = 291) | BMI < 35 kg/m² (n = 409) | P value |
|----------------------------------------------|--------------------------|---------------------------|---------|
| Peripheral Vascular Disease                  | 42% (n = 18)             | 5.4% (n = 22)             | 0.660   |
| Peripheral Neuropathy                        | 18% (n = 52)             | 18% (n = 73)              | 0.987   |
| Current/Previous Foot ulcer                  | 8.6% (n = 25)            | 3.9% (n = 16)             | 0.009   |
| Previous lower limb amputations              | 4.1% (n = 12)            | 2.4% (n = 10)             | 0.210   |
| Laser treatment for Diabetic Retinopathy     | 4.3% (n = 12)            | 6.4% (n = 26)             | 0.257   |
| Depression                                   | 16% (n = 46)             | 11% (n = 44)              | 0.049   |
| Starting HbA1c                               | 75 ± 27 mmol/mol (9.0 ± 2.5%) | 72 ± 26 mmol/mol (8.7 ± 2.4%) | 0.118   |
| % on Insulin                                 | 62% (n = 180)            | 58% (n = 235)             | 0.252   |
| Total daily dose of insulin (units)          | 59.9 ± 49.3              | 37.2 ± 26.0               | 0.004   |

eGFR = estimated glomerular filtration rate, ACR = albumin/creatinine ratio,

LDL = low density lipoprotein, HDL = high density lipoprotein, BP = blood pressure
Table 2  
– Glycaemia

| Measure                                    | BMI ≥35 kg/m² (n = 291) | BMI < 35 kg/m² (n = 409) | P value |
|--------------------------------------------|-------------------------|--------------------------|---------|
| Final HbA1c *                              | 66 ± 20 mmol/mol (8.2 ± 1.8%) | 62 ± 19 mmol/mol (7.8 ± 1.7%) | 0.073   |
| HbA1c reduction % *                        | 15 ± 28 mmol/mol (1.4 ± 2.6%) | 14 ± 28 mmol/mol (1.2 ± 2.5%) | 0.661   |
| % achieving HbA1c < 53 mmol/mol (7.0%) *   | 29%                     | 39%                      | 0.092   |
| % with HbA1c > 75 mmol/mol (9.0%) *        | 29%                     | 19%                      | 0.066   |
| Documented hypoglycaemia                   | 21% (n = 59)            | 30% (n = 121)            | 0.007   |
| Frequent hypoglycaemic episodes            | 9.5% (n = 27)           | 14% (n = 56)             | 0.084   |
| Documented severe hypoglycaemia            | 1.4% (n = 4)            | 2.3% (n = 9)             | 0.418   |
| Lipohypertrophy                            | 5.3% (n = 15)           | 2.0% (n = 8)             | 0.019   |
| Endocrinologist Appointments Attended/patient | 1.8 ± 1.6              | 1.9 ± 1.8                | 0.788   |
| Total Diabetes Specialist Nurse (Educator) Appointments Attended/patient | 0.7 ± 1.3              | 0.7 ± 1.3                | 0.998   |
| Total Dietician Appointments Attended/patient | 0.3 ± 0.7              | 0.2 ± 0.5                | 0.019   |

* n = 153 (BMI ≥ 35) and n = 119 (BMI < 35) had 2 HbA1c readings available
Table 3
– New People (first year in clinic) vs Existing People (from previous years) (BMI ≥ 35kg/m²)

| Measure                        | New (n = 208) | Existing (n = 207) | P value |
|--------------------------------|--------------|--------------------|---------|
| **Age**                        | 54.2 ± 14.9  | 61.0 ± 12.4        | < 0.001 |
| %Women                         | 51% (n = 107)| 56% (n = 116)      | 0.348   |
| Weight (kg)                    | 120.6 ± 24.8 | 118.4 ± 21.4       | 0.334   |
| BMI (kg/m²)                    | 42.4 ± 7.2   | 42.8 ± 6.5         | 0.570   |
| Duration of Diabetes (years)   | 10.0 ± 9.0   | 13.5 ± 8.6         | < 0.001 |
| Starting HbA1c *               | 78 ± 27 mmol/mol (9.3 ± 2.5%) | 66 ± 21 mmol/mol (8.2 ± 1.9%) | < 0.001 |
| HbA1c reduction (%) *          | 18 ± 31 mmol/mol (1.6 ± 2.8%) | 3 ± 16 mmol/mol (0.3 ± 1.4%) | < 0.001 |
| % achieving HbA1c < 53 mmol/mol (7.0%) * | 31%          | 23%                | 0.205   |
| % with HbA1c > 75 mmol/mol (9.0%) * | 33%          | 22%                | 0.116   |
| % on Insulin                   | 59% (n = 123)| 70% (n = 144)      | 0.027   |
| Metformin                      | 83% (n = 173)| 75% (n = 156)      | 0.041   |
| Sulphonylurea                  | 27% (n = 56) | 41% (n = 85)       | 0.003   |
| DPP4i                          | 25% (n = 51) | 24% (n = 49)       | 0.842   |
| GLP1 agonist                   | 18% (n = 37) | 20% (n = 41)       | 0.684   |
| SGLT2i                         | 23% (n = 48) | 32% (n = 65)       | 0.057   |
| Endocrinologist Appointments Attended/patient | 1.8 ± 1.8 | 1.8 ± 0.9 | 0.878 |
| Total Diabetes Specialist Nurse (Educator) Appointments Attended/patient | 0.8 ± 1.5 | 0.4 ± 0.9 | < 0.001 |
| Total Dietician Appointments Attended/patient | 0.4 ± 0.7 | 0.2 ± 0.5 | < 0.001 |

DPP4i = dipeptidyl peptidase-4 inhibitor, GLP1 agonist = glucagon-like peptide-1 receptor agonist, SGLT2i = sodium-glucose transport protein 2 inhibitor

*n = 94 (new) and n = 82 (existing) had 2 HbA1c readings available
Discussion

This study showed that almost half of the people attending the specialist T2DM clinic have a BMI \( \geq 35 \text{ kg/m}^2 \) and meet the criteria for bariatric surgery, and less than a quarter achieve an HbA1c < 53 mmol/mol (7%). However, only 1 in 5 of the people that met the criteria were offered a referral to an obesity/metabolic clinic or for bariatric surgery. This audit also showed that the BMI \( \geq 35 \text{ kg/m}^2 \) group were younger but already had diabetes for an average of 11 years, had higher insulin requirements and were more likely to have additional medications or doses added to their regimen during consultation. They had a similar diabetes duration to the BMI < 35 kg/m\(^2\) group, with no difference in initial HbA1c.

The high proportion of people with BMI \( \geq 35 \text{ kg/m}^2 \) in our clinic aligns with an audit of a specialist diabetes clinic in the UK, which revealed that 52% of participants with T2DM had obesity (BMI \( \geq 30 \text{ kg/m}^2 \)) and a further 8.1% had a BMI \( \geq 40 \text{ kg/m}^2 \) [21]. The people with obesity were younger, had worse glycaemic control, higher blood pressures, and were more likely to be on an antihypertensive or lipid lowering medication compared to the people with a BMI < 30 kg/m\(^2\) [21]. Although there is a paucity of studies which have assessed obesity in T2DM clinics, our results and those of the study from the UK show that in people with T2DM, obesity is extremely common and associated with worse outcomes. The low proportion of referrals for surgery or obesity/metabolic clinics in our study can be attributed to a combination of lack of publicly funded obesity services and availability of bariatric surgery [20][22]. Barriers to accessing obesity/metabolic clinics in Australia have been detailed previously by Atlantis et al. and include factors such as strict entry criteria (eg. BMI \( \geq 40 \text{ kg/m}^2 \)), prolonged wait times, and out-of-pocket costs [22]. Furthermore, the sixth annual report from the Bariatric Service Registry of Australia stated that in 2019, only 6.1% of primary bariatric surgeries were publicly funded, the rest being privately funded [19]. Previous studies have shown that there is also a reluctance in both patients and health care professionals to opt for bariatric surgery due to bias, negative media and attitudes towards weight-loss surgery [23][24].

Data from the UK's National Diabetes Audit (NDA) showed little association between BMI and adverse outcomes, apart from an inverse gradient for stroke and MI. Similarly, in our study, the BMI \( \geq 35 \text{ kg/m}^2 \) did not have a higher rate of microvascular or macrovascular complications compared to the BMI < 35 kg/m\(^2\) group [25], although the BMI \( \geq 35 \text{ kg/m}^2 \) group was younger. As expected, the prevalence of OSA was much higher in the BMI \( \geq 35 \text{ kg/m}^2 \) group (26% vs 6.5%, \( p < 0.001 \)) [26]. It is possible that many people in this diabetes clinic have undiagnosed OSA, given that previous studies have demonstrated much higher prevalence of OSA in a specialist diabetes outpatient population [26]. The BMI \( \geq 35 \text{ kg/m}^2 \) group also had a higher prevalence of foot ulcers, thus aligning with a previous study which showed a positive correlation between obesity and diabetic foot ulcers [27].

A retrospective cohort study from Australia, consisting of people with T2DM and BMI \( \geq 30 \text{ kg/m}^2 \), compared glycaemic control in participants attending a multidisciplinary weight management clinic to participants receiving “best practice” care in a specialist diabetes clinic [28]. At 30 months, the people
attending the weight management clinic achieved a greater HbA1c reduction than those attending the diabetes clinic [28]. This suggests that our BMI≥35kg/m² population, who had similar baseline characteristics to the participants in the cohort study, are more likely to achieve better glycaemic control by attending a weight management clinic. This may be because of the multidisciplinary nature of weight management programs that have greater dietitian and psychologist support, and the data here showing very few patients in the clinic were seen by a dietitian. Another study of a publicly funded metabolic clinic in Australia revealed that people with T2DM and a BMI≥40kg/m² benefitted from improved glycaemic control and reduced diabetic medication load after 6 months of attending the clinic [29], significantly more so than the BMI≥35kg/m² population in this study. Therefore, the BMI≥35kg/m² group may have been better served in the multidisciplinary obesity service, leaving more capacity for the specialist diabetes clinic to see more patients with T2DM and its complications. This is further supported by the fact that new patients to the clinic saw an improvement in HbA1c in the first year, but there was no ongoing further improvement in glycaemia, although the initial benefit seemed to be maintained. Hence, there is also potential for these patients to be discharged back to primary care since they do not require long-term specialist follow-up. As a result, this would increase capacity in the already strained public T2DM clinic.

In the Look AHEAD trial, people with type 2 diabetes and overweight/obesity who received intensive lifestyle intervention for weight loss had a lower HbA1c, reduced sleep apnoea, reduced diabetes medication requirements, improved mobility and quality of life, fewer hospitalisations, and reduced healthcare costs [9]. With regards to bariatric surgery, a study of 5-year outcomes comparing bariatric surgery to medical therapy revealed that participants with type 2 diabetes who underwent surgery alongside medical therapy were far more likely to achieve the HbA1c < 6% target than those receiving medical therapy alone [30]. In addition, a post-hoc analysis of participants from the Swedish Obese Subjects Study revealed that bariatric surgery was associated with a reduced risk of microvascular complications in patients with diabetes [31]. Bariatric surgery data have also shown that diabetes duration is important in predicting who is likely to achieve diabetes remission [14]. The DiRECT trial also highlighted the importance of intervening soon after the diagnosis of T2DM for diabetes remission with weight loss. Thus, these studies suggest that the presence of obesity should be recognised early on in type 2 diabetes and managed alongside glycaemia, with timely referrals to obesity clinics or for bariatric surgery if appropriate, as significant sustained weight loss can improve glycaemic control, overall health, and lead to remission of diabetes.

The American Diabetes Association (ADA) guidelines recommend the use of weight lowering anti-diabetes medications in people with T2DM and obesity [32]. Weight loss in the setting of T2DM is imperative, with the DiRECT trial demonstrating, in a UK primary care setting, that significant sustained weight loss in participants with recently diagnosed diabetes resulted in almost half of the participants achieving diabetes remission at 12 months [10]. In our BMI≥35kg/m² group, use of weight-lowering medications was limited with less than 1 in 5 participants on a GLP1 agonist and only a quarter on an SGLT2 inhibitor. Data from the Australian National Diabetes Audit (ANDA) showed that in 2019, 27% of
people with T2DM were on an SGLT2 inhibitor and 12% were on a GLP1 receptor agonist [33]. Although our use of weight lowering medications in the BMI $\geq 35$ kg/m$^2$ group was comparable to that of the ANDA, the figures in our specialist clinic should have been higher as the mean BMI of the ANDA population was only 33.5 kg/m$^2$ [33]. However, some of these agents like GLP1 agonists and SGLT2 inhibitors are relatively new and are more expensive than the traditional therapies including sulphonylureas and insulin, which treating clinicians may be more familiar with. Unlike the weight-lowering agents, sulphonylureas are associated with weight gain [31]. In our BMI $\geq 35$ kg/m$^2$ group, sulphonylurea use was appropriately lower than in the BMI < 35 kg/m$^2$ group.

This study has some limitations. This is a single centre study of a publicly funded specialist diabetes clinic. However, there are several endocrinologists practising within this clinic. A proportion of people were excluded from the study as their records did not contain a height or weight. There was also a lack of serial weight measurements for the majority of patients which may indicate that staff in the specialist clinic were more focussed on glycaemic control rather than obesity management. Furthermore, some people only attended the clinic once, which made it difficult to assess their progress in regards to weight loss and glycaemic control. The retrospective study design does not account for discussions regarding bariatric surgery or referral to a metabolic clinic which were not documented. A major strength of this study is that all eligible people who attended the clinic were included in the study.

**Conclusions**

The results from this study provide a basis for future policy and clinical practice. Many people who attended the public T2DM clinic met the NHMRC criteria for bariatric surgery, but were often not offered a referral to an obesity service or had bariatric surgery discussed as a therapeutic option. Most of the improvement in glycaemic control seemed to happen in the first year, and the following years were spent maintaining that improvement but did not see further improvement in glycaemia. This improvement may possibly be maintained in primary care, or an integrated care model. Perhaps these people with severe obesity and T2DM are best managed by being given the option of being referred for obesity management or bariatric surgery, especially with the increasing availability of publicly funded bariatric surgery. This would also free up resources in the specialist T2DM clinic, where waiting times in most public hospitals in Australia are several months long. Therefore, the results of this study support the need to systematically consider obesity management in the overall structured management of T2DM.

**List Of Abbreviations**

T2DM – Type 2 Diabetes Mellitus

BMI – Body Mass Index

GLP1 – Glucagon-like Peptide 1
Declarations

Ethics approval and consent to participate

The study was approved as a Quality Improvement Project by the South West Sydney Local Health District (SWSLHD) Human Research Ethics Committee (HREC) (Reference: CT20_2018). As part of this approval, a waiver of individual patient consent was approved by the SWSLHD HREC, and this study was conducted in accordance with the Declaration of Helsinki.

Conflict of interest disclosures:

The authors have no conflict of interest to declare.

Consent for Publication

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are hospital patient data that would not be freely available. For further details of the type of data used and any specific questions, please contact the corresponding author.
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**Authors’ contributions**

AT carried out data collection, data analysis, and writing of the original draft. DSh performed data collection and statistical analysis. BG and NK were involved in data curation and review of the original draft. RR and DS participated in the design of the study and were involved in editing the manuscript. MKP conceived of the study, participated in its design and supervision, and helped to draft the manuscript. All authors read and approved the final manuscript.

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Figures
Figure 1

Data Collection Flowchart