

Type 2 diabetes is an independent predictor of weight loss in Tier 3 Weight Assessment and Management Services

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Abstract

Introduction: A specialist weight management service provides an effective treatment option for severe obesity; however, there are limited data exploring the baseline predictors of response and effect on HbA_{1c} following engagement with the service.

Methods: We used prospective data from the regional weight management services within the Hull University Teaching Hospitals NHS Trust Tier 3 Obesity Programme. Data were available for 249 patients referred to the service. T-tests were used for univariate baseline characteristics of those with and without 5% weight loss after engagement with the service. Logistic regression analysis was used to identify independent predictors of weight loss at 12 months.

Results: A total of 309 patients were referred to the Tier 3 adult weight management service, of which 249 (80.6%) participated in the programme and had at least one follow-up. The median age of the study population was 46 years (range 36–55) and consisted of 66% females with a median baseline body mass index of 44 kg/m² (range 42–45). The prevalence of type 2 diabetes was 31%, hypertension was 35%, gastro-oesophageal reflux disease was 34% and osteoarthritis was 29%. The median baseline weight on enrolment in the programme was 126 kg (range 115–138). During the follow-up period of 1 year, the median weight fell to 120.5 kg at 3 months, 119.6 kg at 6 months, 117.7 kg at 9 months and 117.5 kg at 12 months. The median HbA_{1c} fell from a baseline of 60.25 mmol/mol to 54.4 mmol/mol during the follow-up period. Sixty-four patients had a baseline HbA_{1c} of >53 mmol/mol (7% HbA_{1c}), which fell to <53 mmol/mol in 21% of patients during the follow-up period. In the logistic regression model, higher age (OR 1.05, p=0.0001), type 2

diabetes (OR 2.54, p=0.002) and dyslipidaemia (OR 2.21, p=0.03) were independently associated with more than 5% weight loss at 12 months follow-up.

Conclusion: Engagement with Tier 3 adult weight management is associated with significant weight loss and improvement in glycaemic control in a large proportion of patients at one year. Higher age, diabetes and dyslipidaemia at baseline are independent predictors of weight loss on the Tier 3 weight management service.

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Key words: Tier 3 weight management, weightwise, BMI, obesity, diabetes, HbA_{1c}, predictors of weight loss

Introduction

Obesity has become an increasing global problem, and its prevalence is reaching pandemic proportions. It is classified as a body mass index (BMI) of ≥ 30 kg/m², with morbidly obese defined as a BMI of ≥ 40 kg/m². In the UK, 29% of the adult population is obese and 4% are morbidly obese, with the proportion of obesity increasing with age among both sexes.¹

Oxidative stress due to obesity is associated with metabolic syndrome, hypertension, diabetes, dyslipidaemia, atherosclerosis and cancer.^{2–5} It is also related to fatty liver disease, gallstones, gastro-oesophageal reflux disease (GORD), obstructive sleep apnoea and psychiatric disease.² During the ongoing COVID-19 pandemic, obesity has emerged as one of the most critical risk factors for increased morbidity and mortality.^{5,6} Many of these conditions associated with obesity can be reversed with weight loss.^{7–12} For instance, a recent study in patients with type 2 diabetes (Diabetes Remission Clinical Trial (DiRECT)) determined that a weight loss of more than 10% can cause remission of diabetes in two-thirds of patients.^{13,14} Weight loss has also been shown to have a beneficial effect on blood pressure, renal function and to reduce the risk of various cancers.³

The UK National Health Service (NHS) manages obesity using a tier-based system. Tiers 1 and 2 are aimed at individuals who are overweight, and services are provided by community-based encouragement of a healthier lifestyle through diet and exercise. Tier 1 focuses on brief health advice, which includes public health and national campaigns. Tier 2 involves health and weight

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management services, which patients can self-refer to or be referred via their GP. The Tier 3 Weight Assessment and Management Service (T3WAMS)^{11,12} is aimed at individuals who are obese, have other complex medical needs and have not responded to previous tier interventions. It involves specialist assessment and multidisciplinary management with at least a bariatric physician or endocrinologist, a dietician, a specialist nurse, a clinical psychologist and access to physical therapy. Tier 4 management¹³ involves multidisciplinary team (MDT) support and bariatric surgery, and is offered to adults who have a BMI of ≥ 40 kg/m², or ≥ 35 kg/m² with comorbidities who have gone through or will go through the Tier 3 management, or those with a BMI of ≥ 50 kg/m².^{5,9,11,12}

The evidence of effectiveness behind T3WAMS is growing, and with it is the need for more descriptive data regarding its impact on different patient populations for a more individualised patient-focused service.^{11,14} One observational study¹² reported patient characteristics that were associated with higher patient engagement, which included older age, diagnosis with obstructive sleep apnoea and higher BMI at the time of referral. This study also established a significant association between the completion rate of T3WAMS and weight loss. Although completion rates have repeatedly been associated with higher weight loss and health risk reduction, the evidence describing the independent relationship between baseline clinical characteristics and weight reduction is scarce. Given the ever increasing demand for T3WAMS and significant pressures on the service, it is crucial to identify the patients who are most likely to benefit from the T3WAMS. The objective of the study is therefore to examine the effect of the T3WAMS on weight loss and identify the baseline clinical characteristics associated with weight loss in our specialised weight management programme.

Methods

This prospective study was performed using longitudinal data from the regional weight management Tier 3 services within the Hull University Teaching Hospitals NHS Trust. Follow-up on the change in longitudinal weight was done over one year. The area encompassed by our Tier 3 service has been deemed the fourth local authority district with the most substantial proportion of high deprived neighbourhoods in England. Kingston upon Hull ranked in the top 10 in every measure of deprivation according to the 2019 report of the English Indices of Deprivation. The service's catchment area also includes North and North East Lincolnshire, which also has high levels of deprivation.

The T3WAMS began to receive referrals in May 2015 from both North Lincolnshire CCG and North East Lincolnshire CCG. The bariatric specialist nurse received referrals via post or internal email and triaged the referrals to decide if patients were acceptable to be appointed to the T3WAMS according to the previously mentioned criteria. If a patient met the criteria, they would be sent a contract from the service, offering them a place in the weight management programme. Once the patient has accepted a place, the Tier 3 MDT coordinator books an initial multidisciplinary clinic appointment which includes an endocrinologist/bariatric

physician, bariatric specialist nurse, psychological therapist, highly specialist dietician (bariatric) and the Tier 3 MDT coordinator. An individual plan is generated for each patient. The patients can go through a dietetic pathway which includes one-to-one sessions with specialist dieticians with an appointment at 3, 6, 9 and 12 months. The patients get bariatric blood screening, onward referrals for sleep studies, exercise on referral, etc. These patients also get multiple follow-up sessions if counselling/treatment, cognitive behavioural therapy, etc is required at 3- and 6-month intervals.

Initially, 309 patients were referred to the T3WAMS, of which data were available for 249 who participated in the programme and had at least one follow-up. The population included adult patients (≥ 18 years old) with a BMI of ≥ 40 kg/m², or ≥ 35 kg/m² with comorbidities. Data on baseline characteristics such as age, sex, baseline weight and BMI were collected, as well as other obesity-related health conditions such as hypertension, type 2 diabetes, GORD, osteoarthritis and depression/anxiety.

Statistical analysis

The baseline demographic and clinical characteristics were reported as median and interquartile ranges and percentages as appropriate. T-tests were used for univariate baseline characteristics of those with and without 5% weight loss after engagement with the service. Logistic regression analysis was used to identify independent predictors of 5% weight loss at 12 months. A cut-off of 5% weight loss was used as it confers significant improvements in cardiometabolic risk.¹⁵

Results

Of the 309 patients initially enrolled, 249 (80.6%) completed the programme with at least one follow-up. Their baseline health characteristics are shown in Table 1. The median age of the study population was 46 years (IQR 36–55). The participants comprised 66% females (n=204) and had a median baseline BMI of 44 kg/m² (IQR 42–45). Type 2 diabetes was prevalent in 31% (n=96), hypertension in 35% (n=108), GORD in 34% (n=106) and osteoarthritis in 29% (n=90).

The median baseline weight of all 309 participants on enrolment was 126 kg (IQR 115–138). Throughout the follow-up period of 1 year, the median weight fell to 120.5 kg at 3 months, 119.6 kg at 6 months, 117.7 kg at 9 months and 117.5 kg at 12 months (Figure 1). The median HbA_{1c} fell from a baseline of 60.25 mmol/mol to 54.4 mmol/mol during the follow-up period, as shown in Figure 2. Sixty-four patients had baseline HbA_{1c} of >53 mmol/mol (7% HbA_{1c}), which fell to <53 mmol/mol during the follow-up period in 21%.

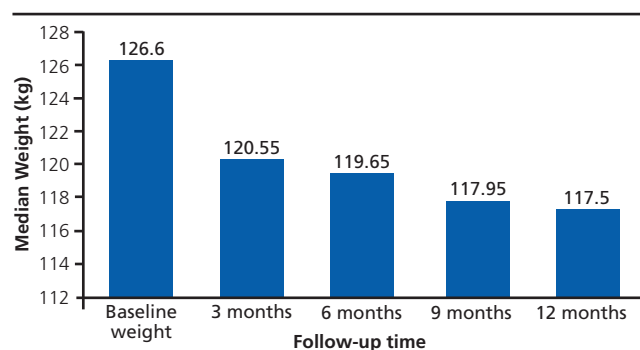
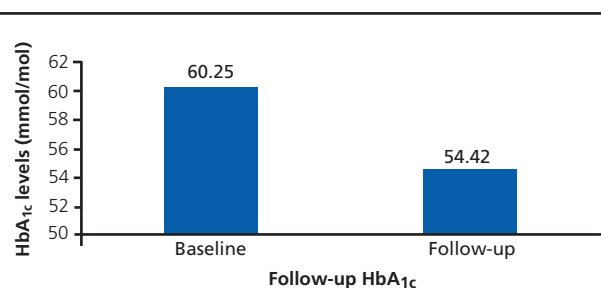
Table 2 shows the comparative baseline characteristics of those with and without $\geq 5\%$ weight loss at the 3-month follow-up. 33% of the study population achieved 5% weight loss at the end of the 3-month follow-up period. At the end of the initial 3-month follow-up period, older patients ($p=0.0001$) and those with type 2 diabetes ($p=0.002$) and dyslipidaemia ($p=0.03$) were more likely to lose $\geq 5\%$ weight.

The logistic regression model showed that higher age (OR

Table 1 Demographic characteristics of 309 severely obese patients enrolled in the Tier 3 weight management service

	Percentage (n=309)
Age, median (IQR)	46 (36–55)
BMI, baseline median (IQR)	44 (42–45)
Weight (kg), baseline median (IQR)	126 (115–138)
Female	204 (66%)
Type 2 diabetes	96 (31%)
Hypertension	108 (35%)
GORD	106 (34%)
Osteoarthritis	90 (29%)
Depression/anxiety	84 (27%)
Dyslipidaemia	47 (15%)
Asthma	36 (11%)
Stress incontinence	31 (10%)
OSA	27 (8%)
PCOS	21 (6%)
Cardiovascular disease	14 (5%)
Pre-diabetes	13 (4%)
NAFLD	1 (0.3%)

BMI, body mass index; GORD, gastro-oesophageal reflux disease; NAFLD, non-alcoholic fatty liver disease; OSA, obstructive sleep apnoea; PCOS, polycystic ovary syndrome.

Figure 1. Effect of Tier 3 weight management services on follow-up weight at 3, 6, 9 and 12 months**Figure 2.** Effect of Tier 3 weight management services on HbA_{1c} in patients with type 2 diabetes during the last follow-up**Table 2** Comparative base characteristics of patients with >5% weight loss and those with <5% weight loss in Tier 3 weight management services

	≥5% weight loss (n=84)	<5% or no weight loss (n=255)	P value
Age, mean	51 (10)	43.5 (12)	0.0101
Baseline BMI	44.5 (4.5)	45.4 (5.1)	0.15
Sex (F)	71 (84%)	154 (68%)	0.18
Baseline weight	124 (17.8)	130 (21.8)	0.01
Type 2 diabetes	54 (64%)	42 (18%)	<0.0001
Hypertension	37 (44%)	71 (31%)	0.05
GORD	30 (35%)	76 (33%)	0.85
Osteoarthritis	28 (33%)	62 (27%)	0.39
Depression/anxiety	23 (27%)	61 (11%)	1
Dyslipidaemia	22 (26%)	25 (11%)	<0.0001
Asthma	11 (13%)	25 (11%)	0.77
Stress incontinence	10 (11%)	21 (9%)	0.8
OSA	21 (25%)	6 (2%)	0.7
PCOS	1 (1%)	20 (8%)	NA
Cardiovascular disease	6 (7%)	8 (3%)	NA

BMI, body mass index; GORD, gastro-oesophageal reflux disease; NAFLD, non-alcoholic fatty liver disease; OSA, obstructive sleep apnoea; PCOS, polycystic ovary syndrome.

Table 3 Predictors of weight loss in Tier 3 weight management services

	Odds ratio	95% CI	P value
Age	1.05	1.02 to 1.08	0.0001
Type 2 diabetes	2.54	1.38 to 4.6	0.002
Dyslipidaemia	2.21	1.04 to 4.7	0.03

1.05, $p < 0.05$), type 2 diabetes (OR 2.54, $p < 0.05$) and dyslipidaemia (OR 2.21, $p < 0.05$) were independently associated with more than 5% weight loss at the 3-month follow-up (Table 3).

Discussion

In this study we report the efficacy of Tier 3 weight management services provided by T3WAMS Hull University Teaching Hospitals NHS Trust and identify baseline characteristics associated with weight loss. We have shown that baseline age, diabetes status and presence of dyslipidaemia are independent predictors of weight loss in the Tier 3 programme.

In the present study, 33% of the participants achieved ≥5% weight loss as recommended by the NICE guidelines, similar to previous studies on T3WAMS.^{16–20} More importantly, maximal weight loss was achieved at 3 months, and most of those with ≥5% weight loss continued to lose weight or maintain the ≥5% weight loss at the end of the 12 months.

This is, to the best of our knowledge, the first study examining the independent predictors of weight loss in T3WAMS. Patients of higher age, those with diabetes and those with dys-

lipidaemia were more likely to achieve $\geq 5\%$ weight loss. There are several studies in a non-T3WMS setting which show the beneficial effects of age and diabetes status on weight loss. A study by Crowe *et al*⁸ which looked at an 8-week structured weight loss programme showed higher rates of completion in older patients, men and those diagnosed with diabetes. They also showed that men and patients with diabetes had an overall greater reduction in waist circumference than non-diabetics and women. Another study in the population from the USA and the UK found a high proportion of obese older adults experienced clinically significant weight loss.²¹

Our study has also shown improvements in glycaemic control following weight loss with T3WAMS. This is consistent with previous studies showing the beneficial effects of weight loss in non-T3WAMS settings.^{22,23} T3WAMS can thus be valuable to patients with diabetes, and prompt referral to T3WAMS in those with diabetes and obesity is essential.

Given the cross-sectional nature of the study, we can only speculate why these three factors are likely to be associated with weight loss. It is possible that those with higher age, presence of diabetes and dyslipidaemia were more motivated to lose weight and more likely to engage with the T3WAMS programme. It is also expected that T3WAMS is associated with better control of type 2 diabetes as the patients were promptly initiated on newer oral diabetes medications such as sodium-glucose transport protein 2 inhibitors and glucagon-like peptide-1 analogues, which help with weight loss. Similarly, those with dyslipidaemia and other metabolic complications are more likely to be initiated on metformin and weight loss medications such as orlistat, which could not be done in primary care. Since we do not have data on medication prescriptions, we are unable to adjust for these in the regression analysis.

This was a non-randomised longitudinal observation study that represented an active service in clinical practice. Thus, a control was not feasible. Socioeconomic characteristics were not measured, hence the effect of competing priorities such as employment and family circumstances could not be evaluated. Previous observational studies have suggested the impact of patients' socioeconomic status and deprivation scores in their engagement with the Tier 3 service.²⁴ Engagement above one follow-up was not assessed, therefore it is not known if higher interaction with the service could be a confounding factor to successful weight loss. Furthermore, the 60 patients who were lost to follow-up or could not complete the study were not further interviewed to discuss the reasons behind the decision. Patients with poor motivation may therefore have been under-represented. Long-term weight loss beyond one year is unknown, so we could not assess if weight loss was maintained or if low weight loss groups achieved further weight loss after one year. Furthermore, data were collected from patients at various stages of follow-up, so we are not able to make a clear correlation between the number of sessions and outcomes. Finally, our analysis was not adjusted for socioeconomic status deprivation and psychological factors. Further studies are needed to investigate the effect of these factors on the efficacy of T3WMS. Our



Key messages

- Baseline age, diabetes status and presence of dyslipidaemia are independent predictors of weight loss in the Tier 3 weight management programme
- The Tier 3 weight management programme can lead to significant improvement in glycaemic control in patients with type 2 diabetes

findings were specific to the region covered by the Hull University Teaching Hospitals Trust, an area with a high English Deprivation Index. This may limit the generalisability of the study outcomes to affluent regions in the UK. Larger scale studies are needed to determine whether the results achieved in this paper are generalisable to a broader population.

This study is one of the first to evaluate direct predictors of weight loss in a Tier 3 weight management service. These findings can inform further improvements of this service in deprived regions of the UK where obesity is more prevalent. Additionally, it can provide data on the impact of weight loss on diabetes control, demonstrated by significant decreases in HbA_{1c}, which is a current priority across the country. The selection criteria of this study excluded those patients who did not attend follow-ups, minimising the impact of patient motivation on weight loss. The study was conducted in an active clinical setting where the measurement of engagement is not routinely taken; therefore, the results reflect day-to-day challenges faced by this service. Finally, the findings of this study can aid doctors in determining how much weight patients will be expected to lose during their contact with services, improving engagement through realistic and achievable goals.

Conclusion

This study showed a consistent decrease in weight loss over one year, which also correlated with a reduction in HbA_{1c} in type 2 diabetics. Predictors of weight loss were type 2 diabetes, dyslipidaemia and increasing age. It provides valuable evidence to inform and improve the Tier 3 weight loss services provided by the NHS.

Conflict of interest NS, KL, HD, GIL, ASP, SB have nothing to disclose. KM reports other from Novo Nordisk, other from Lilly, other from NAPP, outside the submitted work. TS reports grants from Novo Nordisk, grants from Abbott, outside the submitted work.

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ERRATUM

The effect of dapagliflozin on alanine aminotransferase as a marker of liver inflammation: updated results from the ABCD dapagliflozin audit

THOMAS SJ CRABTREE, MAHENDER YADAGIRI, IAN GALLEN, SUZANNE PHILLIPS, ALISON EVANS, ANURITA ROHILLA, DEVESH SENNIK, ALEX BICKERTON, SUSANNAH ROWLES, ISKANDAR IDRIS, ROBERT E J RYDER, ON BEHALF OF THE ABCD DAPAGLIFLOZIN AUDIT CONTRIBUTORS

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In the article listed above, one of the co-authors' names had been omitted. Dr Devesh Sennik is now included in the author list and his address details, Consultant & Clinical Lead Diabetes & Endocrinology, Princess Alexandra Hospital, Harlow, UK, are included in the author box. The correct version of this can be found online www.bjd-abcd.com/index.php/bjd/article/view/515/747