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ORIGINAL ARTICLE

Weight trends in living kidney donors suggest predonation counselling alone lacks a sustainable effect on weight loss: a single centre cohort study

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SUMMARY

Living kidney donors are at risk of long-term end-stage renal disease, and obesity is an independent risk factor. In our centre, predonation counselling of obese donors concentrates on lifestyle modifications, particularly weight loss and exercise. Whether these recommendations have a sustainable effect after donation remains unknown. We conducted a retrospective analysis of all donors who proceeded to donation between 2012 and 2016. Donors' body mass index (BMI) was compared between predefined time points using matched pair analysis. Among 303 donors included, 15% were obese at initial assessment. Obese donors were observed to lose weight by the time of donation (mean BMI difference 1.32 kg/m^2, $P < 0.001$), but bounced back to their initial weight at one-year postdonation (mean BMI difference + 1.47 kg/m^2, $P < 0.001$), which was maintained at two-year postdonation. While 71% of obese donors lost weight by the time of donation, 56% of them gained that weight back at one year. Our findings underline the success of predonation counselling on lifestyle modification in highly motivated obese donors, although additional strategies are required to sustain weight loss. The impact of weight gain on long-term risk needs further evaluation. Living donor programmes should provide continued support with lifestyle modifications after donation.

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Introduction

Living donor kidney transplantation is widely accepted to be the treatment of choice for most patients with end-stage renal disease (ESRD), and great efforts are undertaken to expand living donor kidney transplantation programmes. However, evidence has emerged in recent years that led to an increased awareness of the potential long-term risks for kidney donors, who are now widely counselled on the risk of ESRD [1,2].

Among several risk factors that contribute to the long-term risk of end-stage renal disease (ESRD) for kidney donor candidates, obesity and smoking are the only two modifiable risk factors [3]. Obesity is a significant risk factor for new-onset ESRD, associated either directly with glomerulopathy caused by hyperfiltration, or indirectly with diabetes and hypertension, which are known independent risk factors of ESRD [4]. Obese living kidney donors are at increased risk of long-term ESRD compared to nonobese donors [5].

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It is also known that obesity-associated glomerulopathy is often reversible with weight loss [6]. In line with changes in the general population, an significant proportion of living donor candidates are now obese [7], and its prevalence is expected to increase further in the future [8].

The UK national guidelines suggest that healthy overweight donors may safely proceed to donation, while healthy class I obese donors must be carefully evaluated for cardiovascular and kidney disease risk factors that may preclude donation. The latter are also counselled for the long-term risk of ESRD and are generally advised to make lifestyle modifications aiming primarily at weight loss before donation. The importance of maintaining healthy habits to sustain the ideal body weight is also emphasized [9].

Our living donor programme concentrates much effort on individualized risk assessment for living kidney donor candidates, with lifestyle modifications addressing important risk factors, including weight loss, smoking cessation and exercise. High body mass index (BMI) donors, in particular, are encouraged to reduce their body weight before proceeding to donation. The aim of this study was to investigate the postdonation BMI trends and whether predonation counselling had a sustainable effect in obese living kidney donors.

Methods

We conducted a retrospective cohort study of all living kidney donors between 01.01.2012 and 31.12.2016, at our centre. Our living donor pathway includes an initial assessment, followed by a preoperative assessment (within two weeks from the planned date of surgery) and annual follow-up visits after donation. Donors are offered the option to be followed up at the outpatient clinic of our institution or their local centres. Our study only included donors who were followed up at our institution, to ensure accuracy of follow-up data. The follow-up period for this cohort was limited to two-year postdonation.

All prospective donors are consented on the lifelong risk of ESRD utilizing a widely accepted online calculator ('ESRD Risk Tool for Kidney Donor Candidates'; transplantmodels.com/esrdrisk), developed on US data [3]. We routinely measure BMI at different time points, as it is a reliable and convenient measure to assess obesity and glomerulomegaly associated with obesity, compared to computed tomography and waist circumference measurement [10]. We also routinely counsel obese donors to lose weight before donation, both to minimize perioperative risks and reduce the long-term risk of postdonation ESRD.

In our centre, donor counselling is provided by a team comprising of specialist living donor nurse, nephrologist and a surgeon, individually at different time points of the donors' work up. Living donor nurses advise donors on general lifestyle modifications and smoking cessation. Nephrologists screen donors for diabetes, hypertension and family history of renal disease; they also discuss about the long-term risk of ESRD and its modifiable risk factors such as body weight and smoking. Surgeons reiterate the previous discussions, discuss about the short-term complications of donation and sign patients off for donation. The discussion of counselling and patient's understanding is clearly documented by respective teams on patient's records. We counsel all our donors against smoking and inform them of the short-term and long-term risks of smoking. We offer them psychology advice if they have difficulty quitting smoking. We counsel all obese donors (BMI $\geq$ 30 kg/m^2) about the long-term risks of ESRD and advise them to make lifestyle modifications aiming primarily at weight loss before donation, targeting a BMI under 30 kg/m^2. Interventions offered to patients include enrolment in the National Medical Weight Loss Programme; [11] advising general practitioners to refer to local weight loss groups such as Weight Watchers; [12] joining 'the Fast 800' by Dr Michael Mosley; [13] or joining 'NHS Couch to 5K' [14]. Although our unit has a dedicated Weight Loss Clinic for patients with reduced kidney function, run by dietitians and physiotherapists, most prospective donors are encouraged to access services locally. Prospective donors are offered regular follow-up with the Living Donor team, to assess progress and to provide ongoing support and motivation.

We usually proceed with donation if obese donors lose weight prior to donation. It may be possible for obese donors who do not lose weight still to donate, particularly if they are the only compatible donor available for a recipient, or if they have a better HLA mismatch with their recipient compared to other available donors. These issues are always discussed in a multidisciplinary meeting. Donors with a BMI < 30 kg/m^2 are advised about the risk of weight gain and of the importance of maintaining a healthy lifestyle after donation. Those with central obesity but a BMI < 30 kg/m^2 are also advised to lose weight before surgery, to minimize the risk of short-term operative complications. We monitor weight trends postdonation, and similar advice and counselling are offered if they put on weight postdonation.

As part of our unit's protocol, a family history of type 2 diabetes is not a contra-indication to donation,

but forms part of a detailed assessment of potential postdonation risks. Any potential donor with a family history of type 2 diabetes in a first degree relative undergoes an oral glucose tolerance test (OGTT) and has a lifetime risk of developing type 2 diabetes estimated using the QDiabetes-2018 risk calculator. If the OGTT is abnormal, potential donors are counselled about lifestyle modifications and encouraged to aim to normalize the OGTT before donation. A careful risk assessment will then be undertaken in a multidisciplinary meeting, where the presence or absence of other risk factors for long-term kidney disease will determine if such donors can eventually proceed with donation. Individuals with persistently abnormal OGTT results do not proceed to donation. Our practice is in line with the national guidance on living kidney donation set out by the British Transplantation Society (BTS) and the KDIGO clinical practice guidelines on the evaluation and care of living kidney donors.

Clinical and laboratory parameters, BMI, blood pressure, urinalysis, renal function, and use of medications for hypertension and diabetes were recorded at each visit. All study subjects were grouped into BMI groups, according to World Health Organization (WHO) classification: underweight (BMI < 18.5 kg/m^2), normal (BMI 18.5–24.9 kg/m^2), overweight (BMI 25.0–29.9 kg/m^2), class I obese (BMI 30.0–34.9 kg/m^2), class II obese (BMI 35.0–39.9 kg/m^2) and class III obese (BMI ≥ 40 kg/m^2) [15,16]. Comparisons for continuous variables were performed with parametric (Student's *t*-test, ANOVA) and nonparametric tests (Wilcoxon/Kruskal–Wallis rank sums test), depending on type of distribution. Categorical variables were compared with chi-squared test. Matched pair analysis was performed to compare donors' BMI at defined time points: at initial assessment, at donation, at one-year and two-year postdonation. This type of analysis is more powerful than commonly utilized unpaired or independent tests; in that it eliminates variation between samples that could be attributed to extraneous factors. Differences in BMI at specific time points were calculated and compared for each donor individually rather than all donors as a group. We consider this methodology important as it gives a better insight in postdonation weight gain beyond the confines of study groups. Cases with missing data were pairwise excluded. Multivariate logistic regression was performed to relate donors' characteristics associated with difference in BMI at different time points. Variables were selected based on potential clinical correlation with changes in weight over time. Weight gain was defined as a positive change in BMI between a later and an earlier time point ($BMI_{(later)}$ - $BMI_{(earlier)} > 0$), and weight loss was defined as a negative change in BMI between a later and an earlier time point ($BMI_{(later)} - BMI_{(earlier)} < 0$). Statistical analyses were performed with JMP (version 14.0).

Results

During the study period, a total of 567 living donor nephrectomies were performed at our centre. Of those, 303 donors were followed up in our institution postdonation, while 262 donors were followed up at their local centres, and thus were excluded from the analysis. Figure 1 shows the number of donor cases included for comparisons at defined time points.

In this study cohort, 82.3% of donors were of white ethnicity and the mean age at the time of donation was 44.10 years (SD $\pm$ 12.30). Due to the small number of donors in the underweight ($n = 2$), class II obese ($n = 2$) and class III obese ($n = 1$) groups, we simplified BMI groups to normal weight (BMI < 25 kg/m^2), overweight (BMI 25–30 kg/m^2) and obese (BMI ≥ 30 kg/m^2). The distribution of donors in these groups was 40.6%, 44.6% and 14.9%, respectively. Donor age and ethnicity were similar across all groups. Male donors ($n = 163$, 53.8%) were predominantly overweight or obese (69.3%) at initial assessment, compared to female donors (47.9%) ($P < 0.001$). The median time lag from initial assessment to kidney donation was significantly longer by 2 months for obese donors ($P = 0.033$). MDRD GFR significantly underestimated actual GFR by 6.26 ml/min ($P < 0.001$). Across BMI groups, there were no significant differences in EDTA GFR or preoperative MDRD GFR ($P = 0.118$ and $P = 0.180$, respectively). 10% of donors were receiving treatment for hypertension and none were diagnosed with diabetes at the time of donation (Table 1).

Changes in donor BMI between specific time points were analysed for the whole study cohort (Fig. 2) and also for different BMI groups (Fig. 3). Matched pair analysis revealed that donors, irrespective of their BMI at donation, put on weight at two-year follow-up (mean difference 0.63, 95% CI 0.31 to 0.94, $P < 0.001$ in normal weight; mean difference 0.55, 95% CI 0.20 to 0.90, $P = 0.002$ in overweight groups), with obese donors showing the highest BMI increase (mean difference 1.73 kg/m^2; 95% CI 1.07 to 2.39, $P < 0.001$) (Table 2).

Normal weight donors consistently increased their body weight from initial assessment to donation (mean BMI difference 0.42 kg/m^2, $P < 0.001$). This was not considered clinically important for the majority of

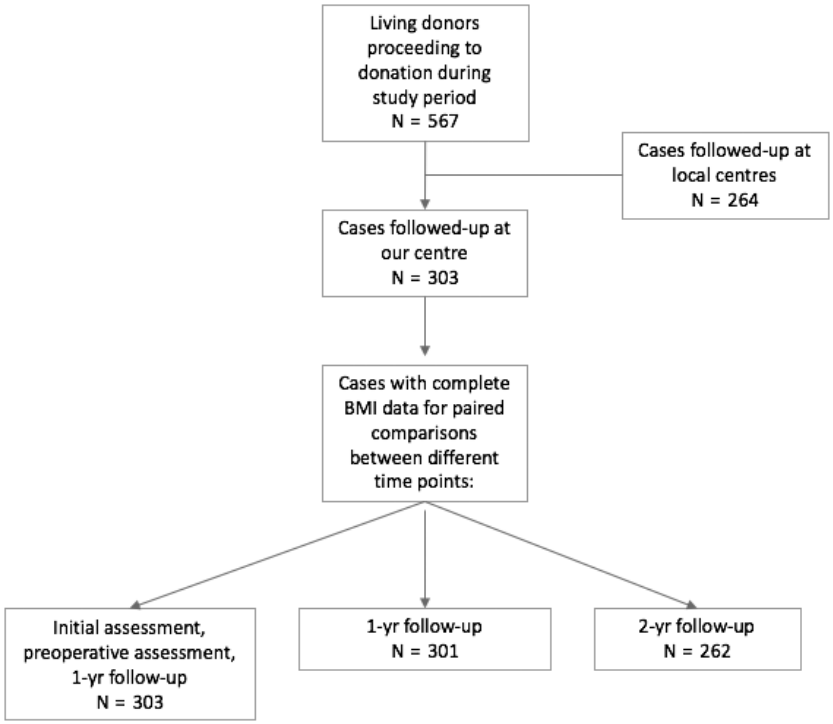

Figure 1 Flowchart representing number of donor cases included for comparisons at defined time points with inclusions and exclusions.

Table 1. Baseline characteristics of kidney donors.

At initial assessment	Total (n = 303)	Normal weight (n = 123)	Overweight (n = 135)	Obese (n = 45)	P value
Gender, n (%)					
Male	163 (53.8)	50 (40.65)	86 (63.70)	27 (60)	0.001
Female	140 (46.2)	73 (59.35)	49 (36.30)	18 (40)	
Donor ethnicity, n (%)					
White	246 (82.3)	98 (83.8)	113 (80.1)	35 (85.4)	0.850
Black	18 (6)	7 (6)	10 (7.1)	1 (2.4)	
Other	35 (11.7)	12 (10.3)	18 (12.8)	5 (12.2)	
Age, years	43.11 (12.19)	42.70 (13.69)	44.34 (11.01)	40.55 (10.95)	0.125
BMI, kg/m^2	26.05 (3.84)	22.35 (1.67)	27.34 (1.51)	32.26 (1.93)	<0.001
EDTA GFR ml/kg/1.73m^2	94.33 (13.12)	95.60 (13.13)	92.64 (12.61)	95.93 (14.24)	0.118
Donors treated for HTN, n (%)	31 (10.23)	8 (6.50)	15 (11.11)	8 (17.78)	0.09*
Donors on multiple agents for HTN, n (%)	5 (1.65)	0 (0)	3 (2.22)	2 (4.44)	0.015
At donation					
Age, years	44.10 (12.30)	43.69 (13.79)	45.25 (11.17)	41.79 (11.02)	0.174
Lag to donation in months, median (IQR)	8.9 (8.8)	8.5 (9.6)	8.5 (8.3)	10.5 (13)	0.046
BMI, kg/m^2	26.08 (3.54)	22.77 (1.96)	27.47 (1.92)	30.94 (1.91)	<0.001
Preoperative MDRD GFR ml/min/1.73m^2	88.07 (15.07)	90.24 (16.55)	86.15 (14.10)	87.89 (12.97)	0.180

Values expressed as mean (SD), unless otherwise stated. Abbreviations: BMI, body mass index; IQR, inter quartile range; EDTA GFR, ^{51}Cr- ethylene diamine tetraacetic acid glomerular filtration rate; MDRD GFR, MDRD 4-variable glomerular filtration rate; HTN, hypertension; DM, diabetes mellitus. *p value for overall group comparison; P = 0.03 for comparison between obese and normal weight donors only.

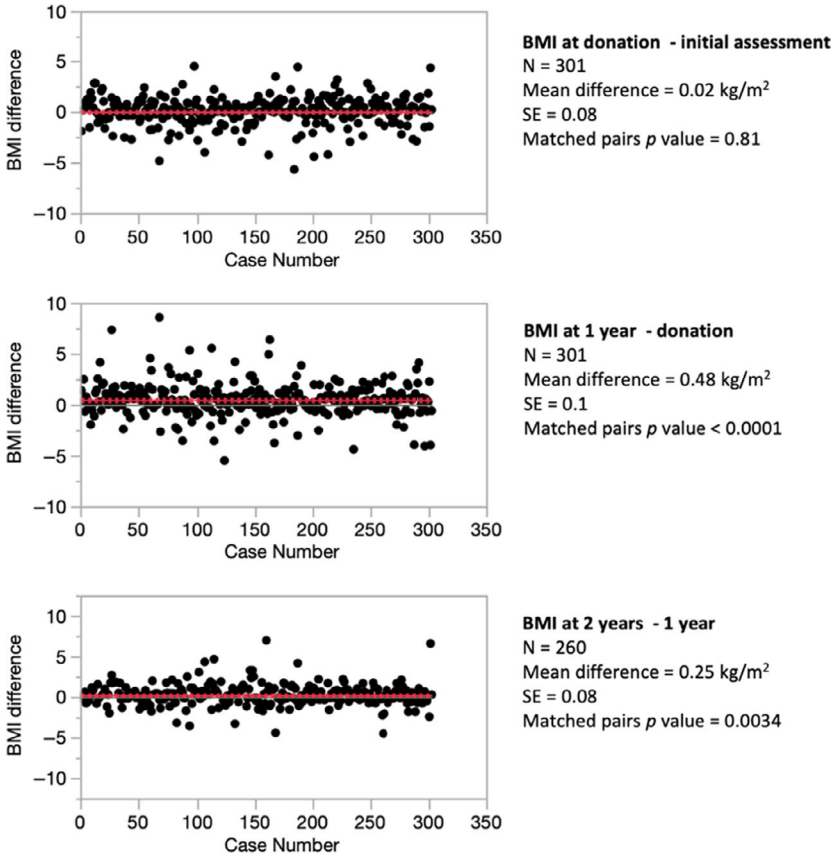

Figure 2 Differences in donor BMI between consecutive time points across the whole study cohort. Mean BMI difference is presented by the red line, while black dots correspond to individual case BMI changes.

donors in this group, who continued to have normal weight. Subgroup analysis, however, identified 17 normal weight donors (13.8%) who became overweight at donation (mean BMI increase 1.79 kg/m^2, $P < 0.001$). At 1- and 2-year postdonation, 11 (8.9%) and 7 (5.7%) donors remained overweight with a mean BMI of 26.36 (SD ± 0.82) and 27.06 (SD ± 0.80), respectively (Fig. 4a). Overweight donors maintained their body weight from initial assessment to donation. A subgroup of 10 donors (7.4%) switched from overweight to obese at the time of donation (mean BMI increase 2.13 kg/m^2, $P < 0.001$). At 1- and 2-year postdonation, 7 (5.2%) and 6 (4.4%) donors remained obese with a mean BMI of 31.28 (SD ± 1.08) and 32.35 (SD ± 2.38), respectively (Fig. 4b).

In contrast to the other groups, obese individuals were observed to lose weight between initial assessment and donation, with a mean BMI difference of −1.32 kg/m^2 (95% CI: −1.81 to −0.82, $P = <0.001$). However, mean BMI at 2-year postdonation returned to the value recorded at initial assessment (Table 2) (Fig. 3). On multivariate logistic regression, when adjusted for donors' age, gender, BMI group at initial assessment and lag to donation, female gender (OR 2.11; 95% CI 1.26 to 3.51, p = 0.004) and obesity at initial assessment (OR 7.25; 95% CI 3.27 to 16.06, p < 0.001) were associated with weight loss between initial assessment and donation; whereas male gender (OR 2.18; 95% CI 1.31 to 3.61, $P = 0.003$) and normal weight at initial assessment (OR 7.73; 95% CI 3.39 to 17.62, $P < 0.001$) were associated with weight gain between initial assessment and donation. However, no individual factors were associated with weight gain or loss between donation and one-year postdonation. Weight loss and weight gain event rates, with the corresponding multivariate models are presented in the Tables S1 and S2.

Normal weight donors had higher mean MDRD GFR at 1-year follow-up compared to overweight and obese donors (mean difference 5.3 ml/min, $P = 0.037$; and 2.1 ml/min, $P = 0.077$, respectively). No differences in renal function were observed among donor groups at 2-year postdonation ($P = 0.91$). The incidence of hypertension was similar to predonation rates within BMI groups throughout the study period. Obese donors were

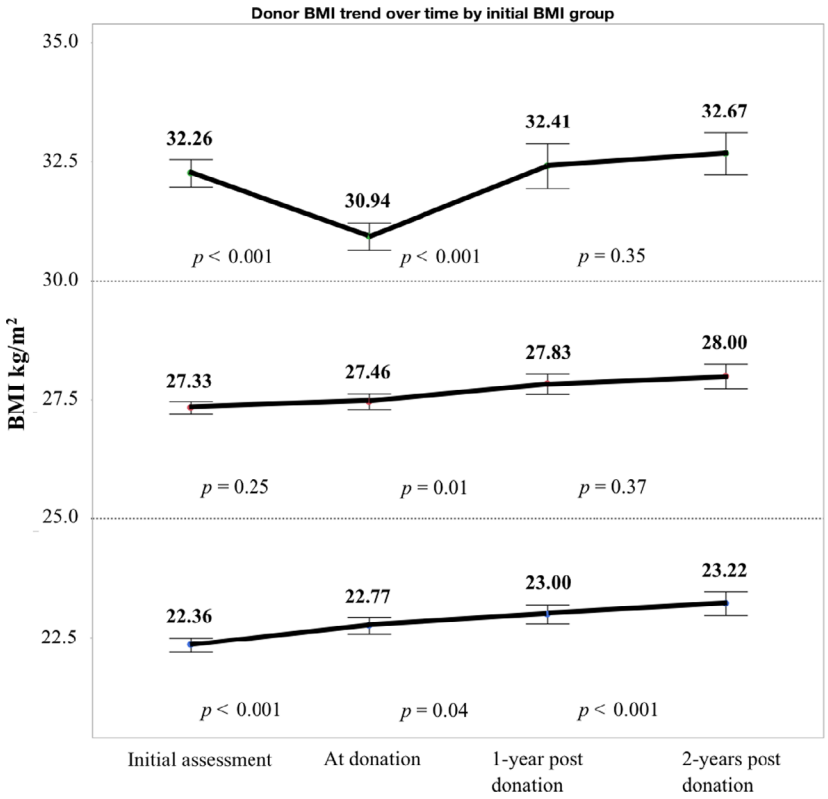

Figure 3 BMI trends in donors according to BMI groups at initial assessment. Obese donors show different trend compared to overweight and normal weight donors, with significant weight loss from initial assessment to donation. Values are shown as mean BMI with standard error. Comparisons between consecutive time points are shown by *P* values.

more likely to be hypertensive compared to normal weight but not overweight donors, at baseline and during follow-up. They also had higher requirements on anti-hypertensive agents compared to overweight donors at baseline and 1-year postdonation. No cases with diabetes were observed during follow-up (Tables 1 and 3).

Discussion

In this study, we observed that most obese donors (32 out of 45; 71.1%) seem to comply with the predonation counselling with regard to weight loss and indeed lose weight from initial assessment to donation. This implies that motivation to donate and appropriate predonation counselling can be effective in this group of donors, at least in the short-term. Despite the initial weight loss with successful counselling, weight loss was not sustained at 1 and 2-year follow-up, even with similar counselling methods as before. Instead, the weight gain was such that 1-year BMI matched or exceeded the BMI at initial assessment and remained at a similar level at 2-year postdonation. New strategies are required to motivate and enable obese living kidney donors to lose weight and sustain this weight loss postdonation. Living donor programmes should provide continued support with lifestyle modifications after donation.

Our study describes the temporal trends in living kidney donor BMI from initial assessment to two-year postdonation. Although weight gain in the living kidney donor population as a whole has been previously reported by Issa et al. [17] and Bugeja et al. [18], the main strength of our study is that it clearly demonstrated an initial weight loss from predonation counselling to donation, suggesting that most obese donors are appropriately motivated to lose weight in order to proceed with donation. Although Issa et al. [17] report that 12% of obese donors switch to overweight group prior to donation, they do not explain why these trends are observed. We observed that 29% of obese donors switch to overweight group with appropriate counselling. Weight gain at follow-up time points, despite similar counselling methods, implies that different strategies are required to achieve maintenance of initial weight loss, with the potential of a long-standing health benefit after donation. We utilized a single centre robust dataset with prospectively collected data at the point of

Table 2. BMI trends from initial assessment to 2-year postdonation, for different BMI groups.

BMI groups	Initial assessment to donation	At donation to 1-year postdonation	At donation to 2-year postdonation	1-year postdonation to 2-year postdonation
Normal weight				
Mean BMI	22.35 22.77	22.77 23.00	22.60 23.23	22.82 23.23
Mean difference (95% CI)	0.42 (0.22 to 0.61)	0.24 (0.01 to 0.46)	0.63 (0.31 to 0.94)	0.41 (0.17 to 0.64)
Number of donors	123	123	105	105
P value	<0.001	0.042	0.0001	<0.001
Overweight				
Mean BMI	27.34 27.47	27.46 27.84	27.45 28.00	27.87 28.00
Mean difference (95% CI)	0.13 (−0.09 to 0.35)	0.38 (0.09 to 0.66)	0.55 (0.20 to 0.90)	0.12 (−0.15 to 0.40)
Number of donors	135	133	114	112
P value	0.25	0.01	0.002	0.375
Obese				
Mean BMI	32.26 30.94	30.94 32.41	30.95 32.67	32.49 32.67
Mean difference (95% CI)	−1.32 (−1.81 to −0.82)	1.47 (0.79 to 2.15)	1.73 (1.07 to 2.39)	0.18 (−0.22 to 0.59)
Number of donors	45	45	43	43
P value	<0.001	<0.001	<0.001	0.357

BMI, body mass index; 95% CI, 95% confidence interval

care, which has significant advantages compared to retrospective registry data.

Mustian et al. have reported that the vast majority of obese donors are willing to lose weight in order to become eligible for kidney donation, with high levels of engagement to dietary and exercise interventions among individuals who donate to close relatives [19]. Despite obese donors' initial positive response to predonation counselling, weight loss was not sustained at 1-year follow-up. Instead, in 56.3% (18 out of 32 who lost weight before donation) the weight gain was such that 1-year BMI matched or exceeded the BMI at initial assessment and remained at a similar level at 2-year postdonation. Effectively, only approximately one third (14/45; 31.1%, data not shown) of all obese donors managed to maintain a body weight lower than their predonation baseline. This observation also raises significant concerns with regard to the long-term risk of ESRD. Although the adjusted risk of obesity-associated ESRD in healthy nondonors is relatively small (1.16 per 5-point increase; 95% CI 1.04–1.29) [3], it becomes substantially higher in obese donors (1.61 per 5-point increase; 95% CI 1.29–2.00) [20]. Additionally, obese donors were recently shown to have a 1.9-fold increased risk of ESRD within twenty years from donation [21]. Hence, we consider predonation counselling ineffective in this respect. We suggest that the follow-up schedule for obese donors be more intensive with additional clinic reviews to prevent weight gain and maintain the 'new' weight baseline. Serial BMI measurements, re-evaluation of ESRD risk, continued counselling, prompt referral to weight loss clinics and access to psychology services should ideally form integral parts of an individualized care package. From an entirely different perspective, excluding or delaying potential living donors from donating on the basis of high BMI alone may not be justified, based on the above observation. If obese donors are expected to gain back all the weight at 1 year after donation, then the net benefit of the initial weight loss will only have been a reduction in perioperative risk and surgical complications [22].

All donors tend to progressively increase their body weight for up to two years after donation, irrespective of their initial weight. Although most donors will remain in their initial BMI group, we identified one subgroup that warrant further attention: 7.4% of overweight donors who become obese. When considering BMI as a continuum with a linear effect, rather than nominal groups, some of these individuals will be at higher risk for long-term ESRD compared to their baseline estimate. Above a BMI threshold of 27 kg/m^2, even a modest increase of BMI by 1kg/m^2 has been associated with a 7% increase in long-term risk of ESRD [21]. In our series, donors

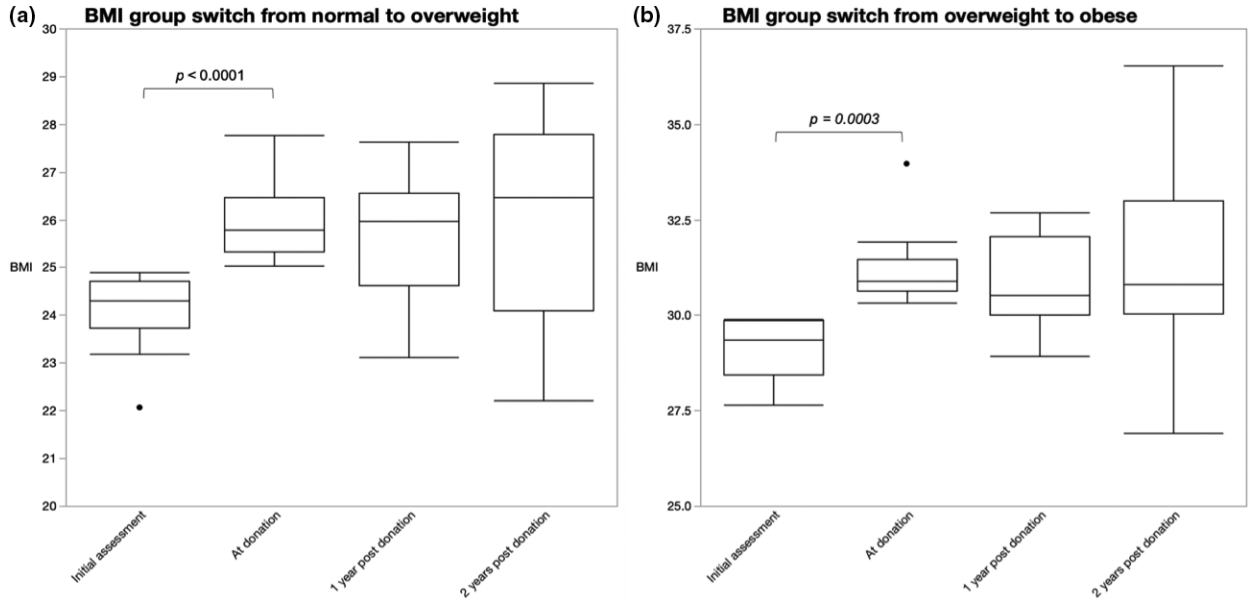

Figure 4 Mean BMI among subgroup of donors who gain weight and switch to higher BMI groups from initial assessment to donation. (a) Mean BMI of normal weight donors who become overweight at donation (*n*/*N* = 17/123; 13.8%). (b) Mean BMI of overweight donors who become obese at donation (n/N = 10/135; 7.4%). Bars represent mean values with standard deviation, and lines represent range. Black dots correspond to outliers.

Table 3. Donor characteristics at one- and two-year postdonation according to BMI groups.

At 1-year postdonation	Total (*n* = 301)	Normal weight (*n* = 123)	Overweight (*n* = 133)	Obese (*n* = 45)	*P* value
Creatinine, μmol/L	110.9 (23.44)	104.4 (22.72)	116.5 (22.07)	113 (24.96)	0.001
MDRD GFR ml/min/1.73 m^2	58.10 (12.54)	60.06 (13.75)	54.78 (9.90)	57.96 (12.49)	0.023
Patients treated for HTN, *n* (%)	28 (9.3)	8 (6.5)	11 (9)	10 (16)	0.104*
Patients on multiple anti-hypertensive agents, *n* (%)	6 (2.0)	0 (0.0)	3 (2.3)	3 (6.7)	0.018
Patients treated for DM, *n* (%)	0				
Patients with proteinuria 2 + or more on urinalysis, *n* (%)	1 (0.3%)	0	1 (0.3%)	0	

At 2 year postdonation	Total (*n* = 262)	Normal weight (*n* = 105)	Overweight (*n* = 114)	Obese (*n* = 43)	*P* value
Creatinine, μmol/l	109 (23)	104.25 (20.53)	111.65 (22.21)	110.60 (27)	0.06
MDRD GFR ml/min/1.73 m^2	58.15 (12.20)	58.5 (11.71)	57.8 (11.1)	58.5 (14.77)	0.91
Patients treated for HTN, *n* (%)	25 (9.5%)	5 (5.4%)	11 (10%)	9 (15%)	0.150**
Patients on multiple anti-hypertensive agents, *n* (%)	7 (2.7%)	1 (0.9%)	3 (2.6%)	3 (7.0%)	0.117
Patients treated for DM, *n* (%)	0				
Patients with proteinuria 2 + or more on urinalysis, *n* (%)	2 (0.8%)	0	2 (0.8%)	0	

Values expressed as mean (SD), unless otherwise stated. Abbreviations: BMI, body mass index; SD, standard deviation; HTN, hypertension; DM, diabetes mellitus; MDRD GFR, MDRD 4-variable glomerular filtration rate. **P* value for overall group comparison; *P* = 0.03 for comparison between obese and normal weight donors only. ***P* value for overall group comparison; *P* = 0.04 for comparison between obese and normal weight donors only.

with BMI higher than 27 kg/m^2 at donation did indeed put on weight at 2-year postdonation (mean BMI difference 1.1 kg/m^2; 95% CI 0.7–1.5; $P < 0.001$). This donor subgroup, however, would not normally be consented for the above risk, according to current practice guidelines. Identifying donor subgroups whose BMI-associated health risk profile may change over time seems challenging at the moment. Thus, we suggest that all donors are counselled about the need to maintain an optimal body weight, in the long-term after donation.

Weight gain in donors, just in line with the general population, is associated with new-onset diagnosis of hypertension and diabetes [17,23]. In our donor population, the low incidence of diabetes, proteinuria or increased need for anti-hypertensive medications could be attributed to donor selection bias, where class II and III obese individuals would not be considered for donation and alternative donors would be sought, with very few exceptions. This may not be true for other centres though, due to wide disparity in donor selection on the basis of BMI across transplant units [24].

The main limitation of our study is the relatively small sample size of obese donors, although their proportion to the total number of donors (14.9%, in our series) is very similar to that reported in large registry studies (17.2%) [21]. Moreover, the strength of statistical significance observed in the obese subgroup comparisons implies that an increase in sample size would probably not have a significant effect in our results. The follow-up period was limited to 2 years, mainly because after this period of time most donors return to their local hospital or GP surgeries for their long-term follow-up. Unfortunately, due to lack of a robust regional network, accurate data capturing is not possible. For this reason, we chose not to include incomplete or inaccurate data, which would dilute the robustness of our local dataset. Nevertheless, for the purpose of our study, the 2-year follow-up period was sufficient to clearly demonstrate the BMI trends in our donor population, especially for the obese subgroup where the 'compensation' of the initial weight loss becomes evident at 1 year after donation. The purpose of this study was not to derive any definitive conclusions about the impact of weight gain on risk of hypertension and diabetes. Finally, we acknowledge that our study could not capture reliable information on the number of donors who came forward but were turned down at the screening phase due to high BMI, and thus did not proceed to donation.

A systematic review and meta-analysis by Hartmann-Boyce et al, comparing different strategies for weight loss suggest that commercial weight management programmes achieved a more substantial and sustained weight loss at 1 and 2 years, compared to their controls who just received dietary advice and recommendations on physical activity by healthcare professionals [25]. According to NICE guidelines, obesity management should include behaviour change strategies along with diet and physical activity [26]. Behaviour change strategies, where an individual maintains healthy behaviours, autonomously, than by an external force have been effective in controlling diet and increasing physical activity, thereby losing bodyweight [27]. Although behaviour change strategies are successful in losing weight, only a proportion of these individuals maintain this weight loss. A model created by Greaves C et.al, proposes that continuation of behavioural interventions can be effective in weight loss maintenance. This can be achieved by self-motivation, reflecting on previous experiences with weight management, setting a target weight and developing strategies to overcome the impulse to overeat, especially when stressed or in low mood [28]. Although initial studies explain patterns that lead to maintenance of these behaviour changes, further research is warranted in developing effective tools [29].

In conclusion, living kidney donors are highly motivated individuals. When appropriately counselled, they are able to make appropriate lifestyle modifications in order to proceed with donation to their loved ones. Our findings highlight the need to introduce new strategies aiming at maintaining a healthy body weight after donation, particularly for obese donors. While all donors should be offered advice on healthy diet and exercise, obese individuals should be counselled about weight loss before donation, if possible. More importantly, the latter should be assessed more frequently after donation and be offered access to suitable interventions in order to maintain a lower, if not ideal, body weight.

Authorship

SRP: Involved in collection of data and preparation of manuscript. QA: involved in collection of data. LS: involved in patient care and collection of data. RG: involved in patient care and suggestions to write manuscript. NK: involved in patient care, designed study, analysed data and preparation of manuscript.

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Conflict of interest

The author(s) of this study have no involvements that might raise the question of bias in the work reported or in the conclusions, implications, or opinions stated. The results presented in this paper have not been published previously in whole or part, except in abstract format.

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Data availability statement

The data underlying this article will be shared on reasonable request to the corresponding author.

SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Donor weight loss and weight gain event rates between selected time points.

Table S2. Multivariate regression models for donor weight loss and weight gain between selected time points.

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