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ORIGINAL CONTRIBUTIONS

Improvement in Erectile Dysfunction Among Male Obese Patient, Following Bariatric Surgery in Hospital Canselor Tuanku Muhriz (HUKM)

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Abstract

Purpose Obesity is associated with multiple health-related complications and affects various aspects of life, including erectile dysfunction (ED). The aim of this study is to postulate that erectile dysfunction in male obese patients can be reversed following bariatric surgery.

Materials and Methods We conducted a non-randomized quasi-experimental study (prospective) between 2 groups, those who underwent surgery with the control group. In this study, the resolution of erectile dysfunction following bariatric surgery comparing with the control group was evaluated in terms of International Index of Erectile Function (IIEF) score. IIEF score is taken by delivering validated questionnaire to participants that enrolled in this study, both the control and intervention group.

Results A total of 25 patients were included in this study, 13 from the intervention group and 12 from the control group. From our study, we evaluated the resolution of IIEF score in both groups. We found that the resolution of erectile function is statistically significant in the intervention group compared to control group. Spearman rank correlation (r_s) test was performed to identify the correlation between age and IIEF score.

Conclusion Statistically significant improvements in erectile function were found following bariatric surgery. This is evidenced by the improvements in the IIEF score post-surgery compared to control group.

Keywords Erectile dysfunction (ED) · Body mass index (BMI) · Obesity

Key Points
- Obesity is a burgeoning problem in nations worldwide.
- Male sexual dysfunction encompasses a spectrum of health problems, including lack of sexual desire (libido), erectile dysfunction (ED) or ejaculatory dysfunction.
- Resolution of erectile function is more pronounced once the metabolic risk factor is reduced.
- This study aims to be an eye-opener to patients with underlying multiple health issues, particularly those with impaired or reduced sexual function, and its involves integrated hormonal, metabolic, psychological and social factors affecting erectile function.

Introduction

Obesity is a burgeoning problem in developing and developed nations worldwide, including Malaysia. In fact, in the year 2019, according to the World Health Organization (WHO), Malaysia was listed first among the Asian countries, with approximately 64% of the male population and 65% of the female population being either overweight or obese [1]. On the other hand, the National Health and Morbidity Survey (NHMS) 2015 reported that the national prevalence of

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obesity in adults above 18 years of age was more than 17.7% (3.3 million), whereas the prevalence of patients who were overweight was 30.0 (5.6 million) [2].

Medical conditions such as hypertension, dyslipidaemia, coronary heart disease, type 2 diabetes mellitus (T2DM), coronary artery disease (CAD), vascular insufficiencies, musculoskeletal disease, obstructive sleep apnoea (OSA), chronic back pain and osteoarthritis (OA) are strongly associated with obesity and have a significant effect on the global disease burden [3]. Furthermore, obesity is also linked to a variety of urological disorders, namely urinary incontinence and various aspects of sexual dysfunction [4].

Currently, bariatric surgery remains the only favourable option for sustainable weight loss in obese patients, and over the past 5 to 10 years, there has actually been an increase in the number of patients who underwent bariatric surgery and benefited from it in many ways. For example, bariatric surgery has markedly improved the metabolism of patients, resulting in well-controlled blood pressure, sugar, cholesterol and improvements in sexual and urinary function [5].

Male sexual dysfunction encompasses a spectrum of health problems, namely lack of sexual desire (libido), erectile dysfunction (ED) or ejaculatory dysfunction [6]. Among all this, erectile dysfunction (ED) is the most common complication related to obesity in male patients [7]. On the contrary, hypertension, dyslipidaemia and diabetes mellitus, being part of the metabolic syndrome, are reversible risk factors for erectile dysfunction (ED). Resolution of erectile function is more pronounced once the metabolic risk factor is reduced following bariatric surgery through a complex mechanism. However, the causes of ED are multifactorial, and a multidisciplinary approach is warranted in addressing this issue [8].

A study conducted by Michal R. Janik et al. (2016) involving male obese patients showed that erectile dysfunction was common before bariatric surgery. It was shown to have significant improvement post-surgery after bariatric surgery. This proves that morbidly obese patients can reverse erectile dysfunction with a resultant increase in the quality of life [9]. The main difference between this study and ours is that we categorize patients into two groups, one with surgical intervention and the other with medical intervention, whereas the author uses the same patient for the control and intervention groups. The author also uses the IIEF and Sexual Quality of Life-Male (SQoL-M) questionnaires in their study to examine erectile dysfunction and quality of life at the same time. On the other hand, we used the IIEF questionnaire to compare the resolution of erectile function over time in both groups.

In another study published by L.O. Reis et al. (2009) in the International Journal of Andrology, the author concluded that bariatric surgery improves erectile function and hormonal levels in morbidly obese men compared with non-surgical weight loss. Thereby, erectile dysfunction (ED) should be regarded as one of the numerous potentially reversible complications of obesity [10].

Similarly, in another study by Li Kun et al. (2014) in China, the author studied Chinese obese male patients with erectile dysfunction. From the retrospective cohort study, the author concluded significant improvements were achieved in IIEF score, cavernosal morphological vasculopathy and carotid wall alteration post-bariatric surgery. This is due to significant improvements in endothelial function and the resultant increase in cavernosal blood supply following bariatric surgery [11].

A systematic review and meta-analysis were performed by Felipe Placco et al. (2017) on the impact of bariatric surgery on erectile function. In this meta-analysis, the author concluded that bariatric surgery leads to improvements in erectile function in terms of IIEF score. The author also believes that the resolution in erectile function is achieved by weight loss in obese men, which directly contributes to decreasing erectile dysfunction [12].

Malaysia is a multiracial country with various religious, cultural and social backgrounds living in harmony with each other. However, matters pertaining to sexual health and urinary problems still remain taboo in some communities and even among educated professionals. Inadequate local data is available for research purposes.

This study also aims to educate morbidly obese male patients with underlying multiple health issues, particularly those with impaired or reduced sexual function. Erectile dysfunction (ED) is reversible with bariatric surgery; hence, quality of life can be tremendously improved, leading to a healthier and happier lifestyle. It is also imperative to break the taboo within our community so that patients can discuss this matter openly with their medical practitioner.

Methodology

Study Design and Setting

This was a non-randomized, quasi-experimental (prospective) study that was carried out entirely in single centre. This study had approval from our institutional ethical committee. The intervention group consisted of male obese patients (BMI > 30) undergoing bariatric surgery during the period of 15 May 2019 until 15 November 2019. The control group, on the other hand, consists of male obese patients who undergo lifestyle modifications instead of surgical intervention. In the control group, patients will be co-managed by a dietitian (who will counsel patients on appropriate foods to consume and watch their calorie intake), a physiotherapist (who will advise patients on how to perform work outs to achieve maximum weight loss) and an endocrinologist (who will manage the metabolic syndrome, which includes

dyslipidaemia, hypertension and diabetes mellitus) and will be started on the pharmacologic agent phentermine (Adipex, also known as appetite suppressant). All of this constitutes lifestyle modifications in the control group (non-surgical intervention). The intervention group was seen at the surgical clinic at 1, 3 and 6 months following bariatric surgery, whereas the control group was seen at the medical clinic at a similar interval. During the clinic review, a validated IIEF questionnaire is given to assess the score and stratify the level of erectile dysfunction among respondents.

Inclusion criteria include morbidly obese male patients with a body mass index (BMI) of more than 30 with obstructive sleep apnoea (OSA) and hypertension (HPT). Both groups will then be matched together based on OSA and HPT. The exclusion criteria include patients with a previous history or treatments related to erectile dysfunction; a history of previous bariatric surgery; a history of antidepressants or psychotropic drugs, a beta blocker, a 5-alpha reductase inhibitor or spironolactone usage; or a history of pituitary or testicular disorders.

The primary objective was to study the prevalence of erectile dysfunction (ED) among male obese patients with BMI equivalent or more than 30 and the effect of bariatric surgery on sexual function, particularly erectile dysfunction, which was assessed using the IIEF score in both groups. The score is then taken in both groups at the start of the study, as well as at 1, 3 and 6 months, and compared. The secondary objectives were to compare the resolution of erectile dysfunction among obese male patients in both the intervention and control groups. The improvements in the BMI, different ethnicity and varying age with regard to the IIEF score among the respondents from both groups are also evaluated.

Respondents from both groups were initially seen in their respective medical and surgical clinics, where the study design was explained in detail. The decision for bariatric surgery and the decision for lifestyle modifications depend solely on the patient's wishes. Hence, the patients seen in the surgical clinic are those that are keen for surgical intervention, while those seen in the medical clinic are keen for lifestyle modifications instead of bariatric surgery. Patients who have given their consent will be enrolled in this study. A validated questionnaire will then be distributed to respondents on subsequent follow-up, and the corresponding IIEF score will be taken. The final dataset is compiled and tabulated. In both groups, respondents were matched together based on their underlying co-morbidities, which were obstructive sleep apnoea (OSA) and hypertension (HPT) prior to statistical analysis.

Participants for this study were interviewed using the International Index of Erectile Function (IIEF-5) questionnaire to determine the presence and severity of ED. The questionnaire has been validated in both Malay and English, and it is sufficient to diagnose ED [13, 14]. These questionnaires were distributed to the respective respondents based on their language preference during the subsequent follow-up in clinic.

Table 1 Erectile dysfunction and respective score

Erectile dysfunction (ED)	Score
No ED	22–25
Mild ED	17–21
Mild to moderate ED	12–16
Moderate ED	8–11
Severe ED	1–7

Table 2 Class of obesity according to the body mass index (BMI)

BMI	Class of obesity
≥ 18 and < 25	Normal
≥ 25 and < 30	Pre-obesity
≥ 30 and < 35	Class 1 obesity
≥ 35 and < 40	Class 2 obesity
≥ 40	Class 3 obesity

Data Assessment

Improvement in erectile function is assessed by giving our respondents a validated questionnaire (the IIEF) and comparing the IIEF score before and after bariatric surgery (at 1 month, 3 months and 6 months) for male obese patients with a BMI of 30 or more. The validated questionnaire (IIEF) was also used to compare the score in the control group. Patients from both groups were then further classified according to their respective scores based on the questionnaire. The scoring system is depicted in Table 1 [15].

Body mass index (BMI) is calculated by dividing the weight of patients (in kilograms) by the square roots of their height (in meters^2). Table 2 shows the different classes of obesity [16]. The study includes those with a BMI greater than 30. Both groups were subsequently matched together based on their underlying co-morbidities (OSA and HPT).

Statistical Analysis

IBM SPSS Statistical Package for the Social Sciences (SPSS) for Windows version 22.0 (SPSS Inc., Chicago, II, USA) was used for statistical analysis. The normality of continuous variables was assessed for each group using the Shapiro–Wilk test, which revealed that the distribution of IIEF score and BMI was not normal. Hence, a Mann–Whitney analysis was done to compare the median IIEF score between the study groups. Besides this, we used the non-parametric Friedman test to test for differences between groups when the dependent variable being measured was ordinal.

Subsequently, we used the Dunn-Bonferroni post hoc analysis (multiple comparison test) to compare between months 0 with 1, 0 with 3, 0 with 6, 1 vs 3, 1 vs 6 and 3 vs 6 months. This is a non-parametric test that allows us to do multiple comparisons between two independent datasets. The same test was also performed to compare both the BMI and IIEF of respondents among various major ethnic groups. We also performed a statistical analysis to find the correlation between age and IIEF score. Analysis showed skewed data; hence, Spearman rank correlation (r_s) was used for analysis.

Final Results

Table 3 shows the comparison of the IIEF score between the intervention and control groups at 0, 1, 3 and 6 months. At the beginning of the study, there was no statistically significant difference found in the median IIEF score between both groups ($p = 0.340$). However, a significant difference was observed at month 1, when the intervention group's median IIEF score (10, IQR = 10–11.5) was higher than the control group's (8, IQR = 7.3–8.4) ($p < 0.001$). Similar significant differences were also noted at the 3rd and 6th months, respectively, where the median IIEF score of the intervention group (14, IQR = 13.2–15) was higher than the control group (8.5, IQR = 8.1–9.4) ($p < 0.001$) for the 3rd month, and the median IIEF score of the intervention group (17, IQR = 16–18.3) was also higher than the control group (9, IQR = 8.0–9.9) ($p < 0.001$) for the 6th month.

Table 3 Comparison of IIEF score between intervention and control groups at 0, 1, 3 and 6 months ($n = 25$)

Month	Study group		*P*
	Intervention ($n = 13$)	Control ($n = 12$)	
0	8 (6.9–8.2)	7 (6.8–7.6)	0.340
1	10 (10–11.5)	8 (7.3–8.4)	< 0.001**
3	14 (13.2–15)	8.5 (8.1–9.4)	< 0.001**
6	17 (16–18.3)	9 (8.0–9.9)	< 0.001**

Data presented as median (IQR–IIEF score). Mann–Whitney *U* test was performed.

**Significant at $p < 0.001$.

Figure 1 depicts the distribution of the median IIEF score in the control group based on BMI categories. The *x* axis (BMI) represents classes of obesity from pre-obesity to obesity classes 1, 2 and 3, respectively, whereas the *y* axis (IIEF) represents the IIEF score at one point in time. For the pre-obesity group, the minimum median IIEF score was recorded at the 6th month, and the maximum median IIEF score was recorded at the 3rd month. As for class 1 obesity, the minimum median IIEF score recorded at the beginning of the study was 7 and increased slowly to 9.5 at the end of the study. Moving on to class 2 obesity, the minimum and maximum median IIEF scores recorded were 7 and 8.5, respectively. Lastly, for class 3 obesity, the minimum score recorded at the beginning of the study was 7 and increased to only 8.5 at the end of the study. In summary, the improvements in the IIEF score are not markedly noticeable in the control group.

Figure 2 depicts the distribution of the median IIEF score in the control group based on BMI categories. The *x*

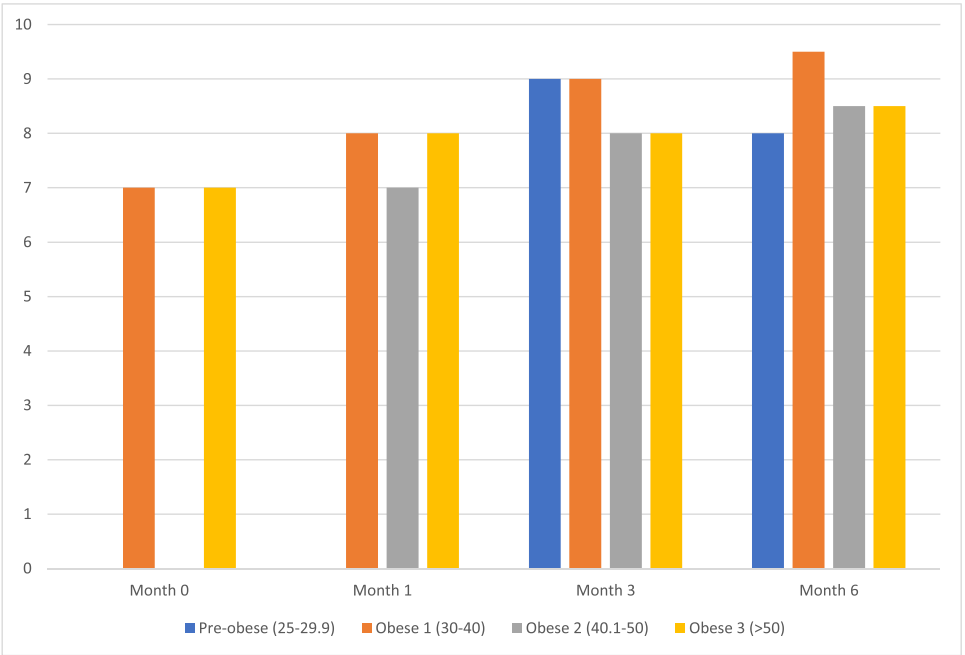


Fig. 1 Distribution of median IIEF score in control group based on BMI categories

axis (BMI) represents classes of obesity from pre-obesity to obesity classes 1, 2 and 3, respectively, whereby the *y* axis (IIEF) represents the IIEF score at one point in time. For the pre-obesity group, the minimum median IIEF score was 12 and the maximum score was 16. As for the class 1 obesity, the minimum median IIEF score was recorded at the beginning of the study at 8 and progressively increased to 16 at the end of the study in the 6th month. Moving on to class 2 obesity, the minimum and maximum median IIEF scores recorded were 7 and 17, respectively, at the end of the study. Lastly, for class 3 obesity, the minimum median score recorded at the beginning of the study was 8 and increased to 20 at the end of the study. In summary, the improvements in the IIEF score are marked and progressively noticeable in the intervention group.

Table 4 shows the demographic data or subgroup analysis according to the ethnicity within the control group. Friedman analysis showed statistically significant results in the Malay and Indian subgroups, with *p* values for overall changes of 0.001 and 0.033, respectively, in the control group, which is statistically significant. Dunn-Bonferroni post hoc analysis for pairwise comparisons, on the other hand, revealed statistically significant results in Malay ethnicity with a *p* value of <0.008 at month 0 vs 6. Similarly, in the Indian ethnicity, statistically significant results were observed at months 0 vs 3 and month 0 vs 6, with a *p* value of 0.027, respectively. No significant findings were noted among Chinese patients within the control group.

Table 5 shows the demographic data or subgroup analysis according to the ethnicity within the intervention group. Friedman analysis showed statistically significant results in the Malay and Chinese subgroups, with *p* values for overall changes of 0.001 and 0.029, respectively, in the intervention group. Dunn-Bonferroni post hoc analysis for pairwise comparisons, on the other hand, revealed statistically significant results in Malay ethnicity, with a *p* value of 0.001 at month 0 vs 6 and a *p* value of 0.012 at month 1 vs 6. Similarly, in the Chinese ethnicity, statistically significant results were observed at month 0 vs 6 with a *p* value of 0.027. No significant findings were noted among Indian patients within the intervention group.

Table 6, on the other hand, shows the comparison between the median IIEF scores between the intervention and control groups. If any difference in the overall median scores was noted, pairwise comparisons were then reported. The Friedman test was performed and showed a significant difference in overall changes in the IIEF score within the intervention group. Subsequent Dunn-Bonferroni post hoc analysis showed a significant difference in the median IIEF score between months 0 and 3 ($p<0.001$), months 0 and 6 ($p<0.001$) and months 1 and 6 ($p<0.001$) in the intervention group. On the other hand, Dunn-Bonferroni post hoc analysis only showed a significant difference in the median IIEF score between months 0 and 6 ($p<0.001$).

Table 7 compares the median BMI between the intervention and control groups. The Friedman test was performed and showed a significant difference in overall changes in BMI within

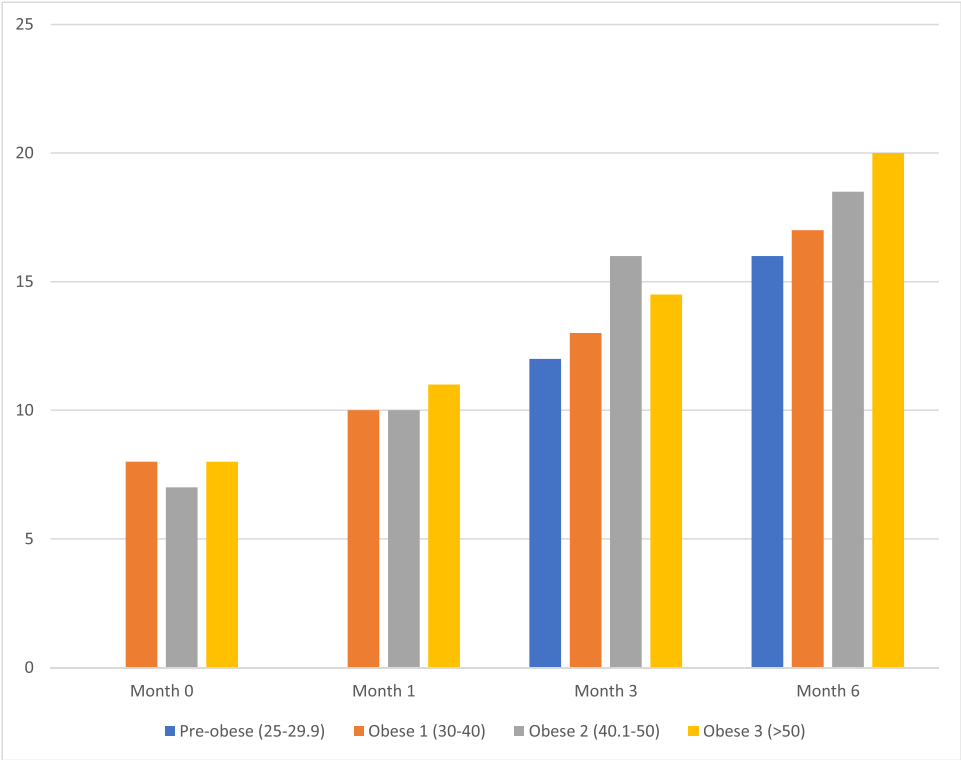


Fig. 2 Distribution of median IIEF score in intervention group based on BMI categories

Table 4 Demographic subgroup analysis according to ethnicity within control group

Group	Month	IIEF score	*p* for overall changes[a]	Pairwise comparison	*p* for pairwise comparison[b]
Malay ($n=7$)	0	7 (6.5–7.5)	0.001*	Month 0 vs 1	1.000
	1	8 (7.5–8.5)		Month 0 vs 3	0.058
	3	9 (8–10)		Month 0 vs 6	0.008*
	6	9 (8–10)		Month 1 vs 3	0.471
				Month 1 vs 6	0.104
				Month 3 vs 6	1.000
Chinese ($n=2$)	0	7 (0)	0.392	N/A	
	1	7.5 (0)			
	3	8 (0)			
	6	8 (0)			
Indian ($n=3$)	0	7 (0)	0.033*	Month 0 vs 1	0.527
	1	8 (0)		Month 0 vs 3	0.027*
	3	9 (0)		Month 0 vs 6	0.027*
	6	9 (0)		Month 1 vs 3	0.114
				Month 1 vs 6	0.114
				Month 3 vs 6	1.000

Table 5 Demographic subgroup analysis according to ethnicity within intervention group

Group	Month	IIEF score	*p* for overall changes[a]	Pairwise comparison	*p* for pairwise comparison[b]
Malay ($n=8$)	0	7.5 (7–8)	<0.001**	Month 0 vs 1	0.728
	1	10 (9.5–10.5)		Month 0 vs 3	0.012
	3	13 (12–14)		Month 0 vs 6	<0.001*
	6	17 (16–18)		Month 1 vs 3	0.728
				Month 1 vs 6	0.012*
				Month 3 vs 6	0.728
Chinese ($n=3$)	0	9 (0)	0.029*	Month 0 vs 1	1.000
	1	12 (0)		Month 0 vs 3	0.347
	3	16 (0)		Month 0 vs 6	0.027*
	6	19 (0)		Month 1 vs 3	1.000
				Month 1 vs 6	0.347
				Month 3 vs 6	1.000
Indian ($n=2$)	0	7 (0)	0.112	N/A	

the intervention group. Subsequent Dunn-Bonferroni post hoc analysis showed a significant difference in median BMI between months 0 and 3 ($p=0.001$), months 0 and 6 ($p<0.001$) and months 1 and 6 ($p<0.001$) in the intervention group. On the contrary, in the Dunn-Bonferroni test on the control group at the post hoc stage, no significant differences were noted.

Table 8 shows the correlation between age and IIEF score at each point in time. This analysis is performed to find out whether IIEF score and age are dependent variables on each other. This is the correlation between age and the IIEF score at each time point. From the initial analysis, we noted the data were skewed, thereby using Spearman rank correlation (r_s). Results show no correlation between age and an IIEF score at any time point, and no statistical significance was noted. Age is a risk factor that contributes to erectile dysfunction in the general population. In our study, the general age group of respondents was around 30 to 45 years old. Thus, it can be concluded that age is an independent variable and did not influence the IIEF score in this study.

Discussion

Bariatric surgery has significantly reduced the number of ED visits among bariatric patients. On the other hand, medical disorders such as hypertension, diabetes and

Table 6 Changes in IIEF score within each group

Group	Month	IIEF score	*p* for overall changes[a]	Pairwise comparison	*p* for pairwise comparison[b]
Intervention ($n=13$)	0	8 (6.9–8.2)	< 0.001**	Month 0 vs 1	0.290
	1	10 (10–11.5)		Month 0 vs 3	< 0.001**
	3	14 (13.2–15)		Month 0 vs 6	< 0.001**
	6	17 (16–18.3)		Month 1 vs 3	0.290
				Month 1 vs 6	< 0.001**
				Month 3 vs 6	0.290
Control ($n=12$)	0	7 (6.8–7.6)	< 0.001**	Month 0 vs 1	1.000
	1	8 (7.3–8.4)		Month 0 vs 3	0.002*
	3	8.5 (8.1–9.4)		Month 0 vs 6	< 0.001**
	6	9 (8.0–9.9)		Month 1 vs 3	0.086
				Month 1 vs 6	0.027*
				Month 3 vs 6	1.000

Table 7 Changes in BMI within each group

Group	Month	BMI	*p* for overall changes[a]	Pairwise comparison	*p* for pairwise comparison[b]
Intervention ($n=13$)	0	44.1 (41–56)	< 0.001**	Month 0 vs 1	0.568
	1	39.6 (37–50)		Month 0 vs 3	0.001*
	3	37.5 (34–47)		Month 0 vs 6	< 0.001**
	6	33.6 (31–40)		Month 1 vs 3	0.201
				Month 1 vs 6	< 0.001**
				Month 3 vs 6	0.290
Control ($n=12$)	0	44.05 (36–51)	0.046*	Month 0 vs 1	1.000
	1	42.6 (37–51)		Month 0 vs 3	0.197
	3	41.7 (36–50)		Month 0 vs 6	0.055
	6	41.7 (35–50)		Month 1 vs 3	1.000
				Month 1 vs 6	1.000
				Month 3 vs 6	1.000

Table 8 Correlation between age and IIEF score

Group	Month	Age	
		r_s	*p* value
Medical	0	−0.440	0.152
	1	−0.546	0.66
	3	−0.268	0.397
	6	−0.319	0.312
Surgical	0	−0.504	0.079
	1	0.035	0.910
	3	0.075	0.809
	6	0.083	0.788

dyslipidaemia also contribute to the development of ED. Since bariatric surgery leads to resolution of these medical conditions, it indirectly improves insulin resistance and normalizes hormone levels, particularly testosterone, subsequently resulting in improvements in erectile function among obese male patients [17]. In our study, we noted the prevalence of ED was high between both groups, with the median IIEF score ranging from seven to eight (indicating moderate to severe ED), with a *p* value of 0.340 at the beginning of the study. Subsequently, in the intervention group, there are progressive improvements in the IIEF score and resolution of erectile function from severe ED to mild ED in just 6 months, with a *p* value of < 0.001. On the contrary, the control group remained static in terms of IIEF score and only showed improvements from severe ED to only moderate ED in 6 months with a *p* value of < 0.001.

A study by L. De Angelis et al. (2001) showed that erectile dysfunction in men with diabetes correlates with the level of glucose control, neuropathy and endothelial functions. Endothelial dysfunction seen in type 2 diabetes mellitus patients has been linked to defective and reduced nitric

oxide availability in this study [18]. In another interesting study by H. Solomon et al. (2012), the author concluded that at least 15% of patients being treated for hypertension and 39% of patients being treated for cardiac disease have ED. The likelihood of having an ED rises to 20% in hypertension patients and 56% in cardiac patients who smoke cigarettes. Diabetic patients stand approximately a 50% chance of developing ED, and patients with hypercholesterolemia have at least a 60% chance of developing ED. The mechanisms involved complex pathophysiology and were interrelated [19].

The advantages of bariatric surgery were very well established in female patients; however, in male patients, this issue has not been sufficiently investigated, particularly regarding erectile dysfunction (ED) [20]. This was one of the reasons why we embarked on this study. Many men find it difficult to admit that they suffer from erectile dysfunction [21]. The stigma prevents them from asking for help, and many of them have low self-esteem and live in fear of embarrassment, making them unable to discuss this issue with their medical practitioner. Hence, health promotion and continuous medical education are pivotal in breaking the stigma and offering these patients the necessary assistance.

Erectile Dysfunction and IIEF

Efthymiou et al. (2014) previously assessed the sexual function of 30 male obese patients in a study. These respondents were then evaluated using the IIEF questionnaire, and the respondents were then interviewed before bariatric surgery and at 1 month, 6 months and 1 year post-bariatric surgery. From this study, the author concluded that significant improvements in erectile function were noted at the end of 1 year post-bariatric surgery [22].

In another study, Rosenblatt et al. (2012) performed a comparative study among 24 patients, of whom 12 were obese patients undergoing bariatric surgery and another 12 were lean control patients. The authors concluded that there were no significant improvements in the IIEF score, but the overall degree of erectile function and satisfaction was higher in the obese group compared to the lean group after bariatric surgery [23]. Erectile dysfunction can be reversed via surgical intervention, as evaluated using IIEF questionnaires (Fig. 3), most likely through modifications in sex hormone levels, particularly increasing total free testosterone through a complex physiological system [10].

In a more recent prospective cohort study, Groutz et al. (2016) investigated the effects of bariatric surgery on the lower urinary tract system and sexual function. The author enrolled 53 obese men who underwent bariatric surgery and reviewed the IIEF score and International Prostate Symptoms Score before and 3 months after surgery. Within 3 months of surgery, this study found significant and rapid improvements in erectile function, as evidenced by a decrease in BMI and an increase in IIEF score [24].

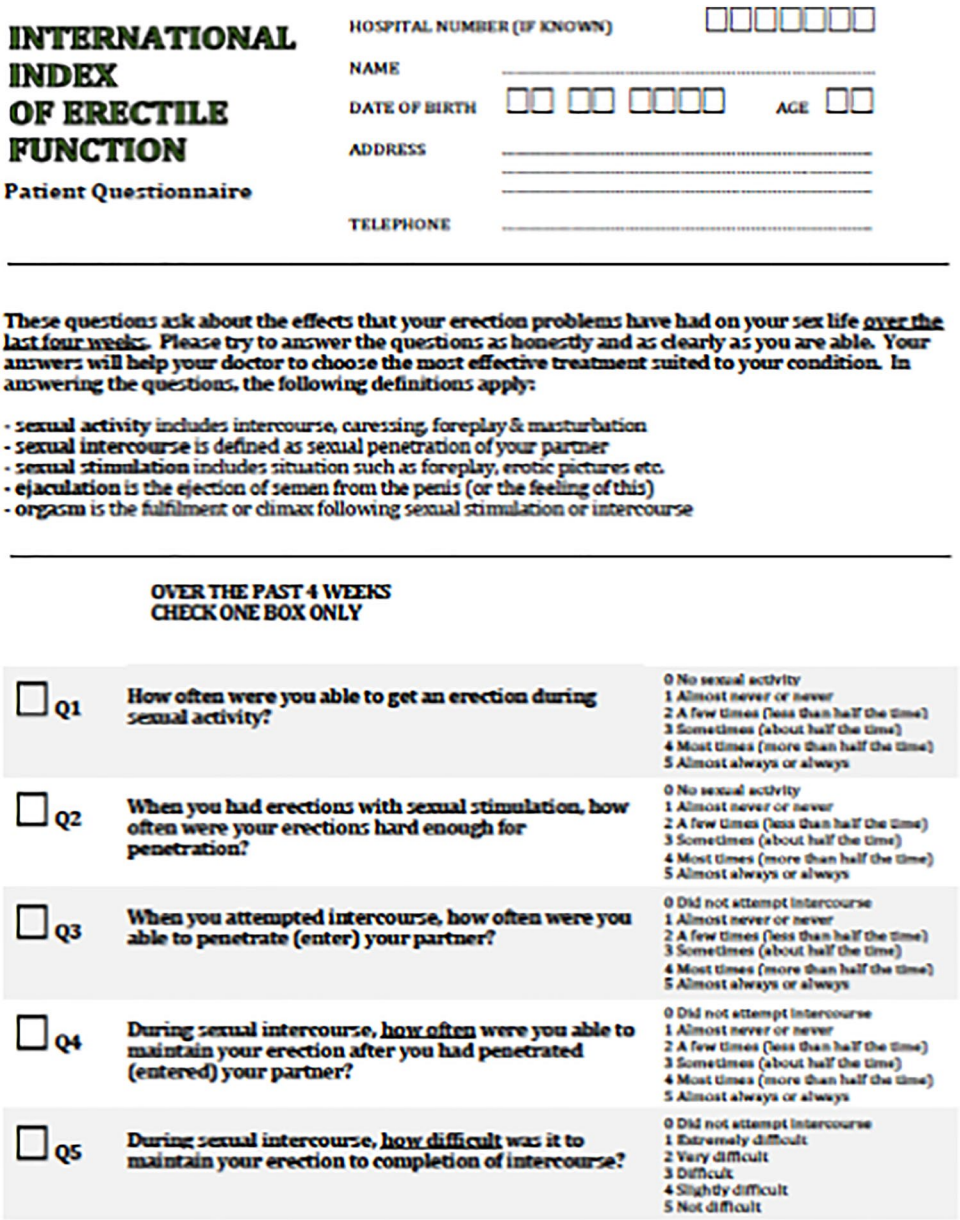
In our study, we noticed that in the intervention group, the IIEF score increased progressively from 8 (median IQR 6.9–8.2) at the beginning of the study to 17 (median IQR 16.3–18.3) at the end of the study, $p < 0.001$. The control group, on the other hand, showed very small improvements in IIEF, from 7 (median IQR 6.8–7.6) at the beginning of the study to 9 (median IQR 8.0–9.9), $p < 0.001$. Subsequent pairwise comparisons were performed in the intervention group and showed statistical significance with $p < 0.001$ in the following months (month 0 vs 3, month 0 vs 6 and month 1 vs 6). The control group, on the other hand, only showed statistical significance with a $p < 0.001$ in the month 0 vs 6 and a $p < 0.05$ in the month 0 vs 3. Hence, it can be concluded from our study that bariatric surgery increases the IIEF score, subsequently leading to the resolution of erectile dysfunction.

Age and Erectile Dysfunction

Erectile dysfunction (ED) is defined as the inability to achieve and maintain an erection to permit satisfactory sexual intercourse [25]. The causes of erectile dysfunction are complex and multifactorial, comprising both organic and psychological aspects. It necessitates a multidisciplinary approach to ED investigations and management. Regardless of the pathophysiology of ED, the primary causes of ED are cardiovascular disease (CVD), hypertension and diabetes. Advancing age is also seen as a risk factor for developing erectile dysfunction [26]. The Massachusetts Male Aging Study (MMAS), a community-based, large, randomized study by Feldman et al. (1994), confirmed the correlation between ED and vascular diseases such as hypertension, heart disease and diabetes. The author also concluded that the prevalence of ED is between 40 and 70 years old. Other factors, such as cigarette smoking and vascular problems, showed a predominance over and above the age trend [21].

In our study, we performed statistical analysis to find the correlation between age and IIEF score. Analysis showed skewed data; hence, Spearman rank correlation (r_s) was used. Results showed that age is independent of the IIEF score at any given point in time and is not statistically significant. Our respondents' ages range from 30 to 45 years old. As a result, there is no correlation between age and IIEF in this study, however, given that the causes of ED are multifactorial and that ageing is an irreversible risk factor for developing ED.

Fig. 3 IIEF questionnaire



INTERNATIONAL INDEX OF ERECTILE FUNCTION

Patient Questionnaire

HOSPITAL NUMBER (IF KNOWN) ☐☐☐☐☐☐

NAME .....

DATE OF BIRTH ☐☐ ☐☐ ☐☐☐☐ AGE ☐☐

ADDRESS .....

TELEPHONE .....

These questions ask about the effects that your erection problems have had on your sex life over the last four weeks. Please try to answer the questions as honestly and as clearly as you are able. Your answers will help your doctor to choose the most effective treatment suited to your condition. In answering the questions, the following definitions apply:

- **sexual activity** includes intercourse, caressing, foreplay & masturbation
- **sexual intercourse** is defined as sexual penetration of your partner
- **sexual stimulation** includes situation such as foreplay, erotic pictures etc.
- **ejaculation** is the ejection of semen from the penis (or the feeling of this)
- **orgasm** is the fulfilment or climax following sexual stimulation or intercourse

OVER THE PAST 4 WEEKS
CHECK ONE BOX ONLY

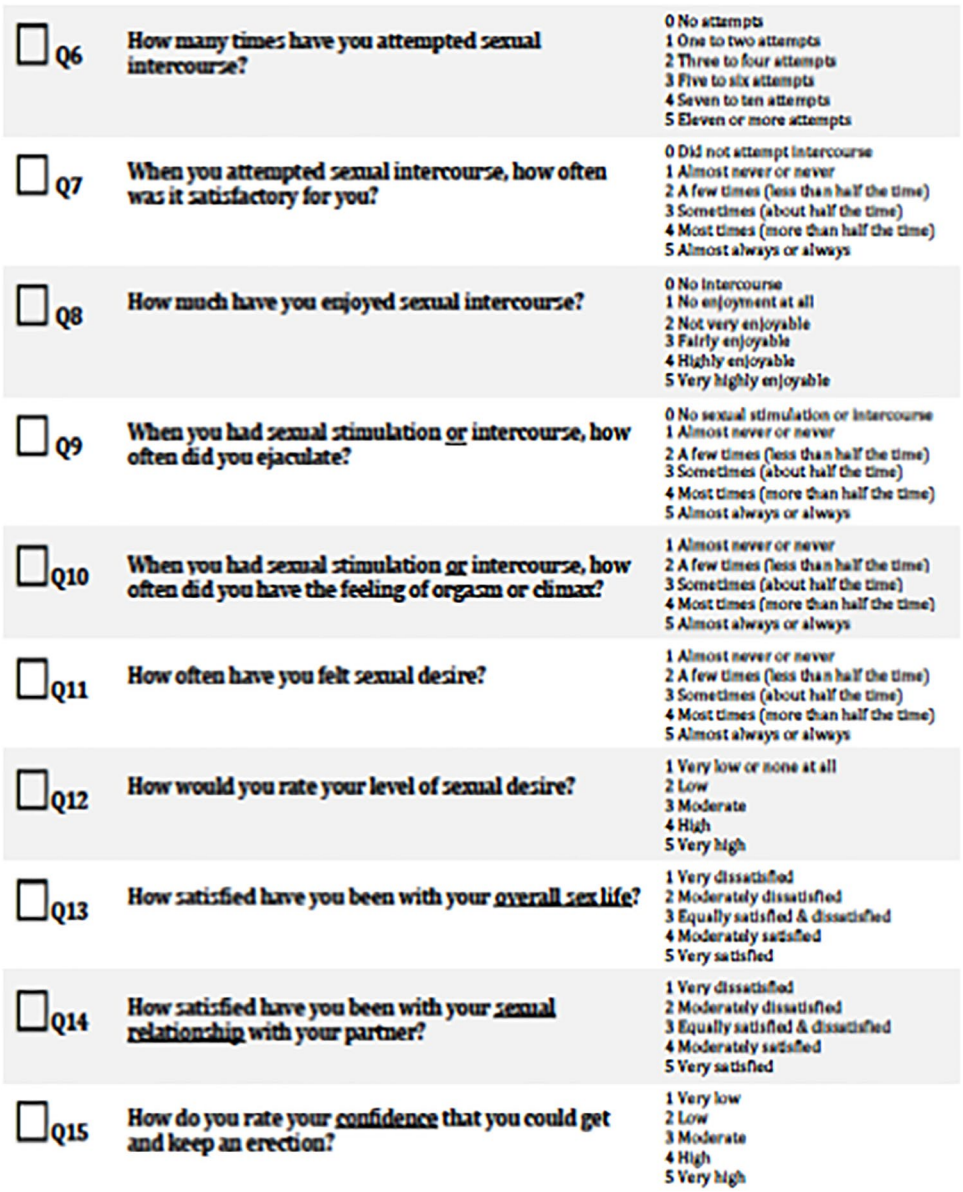
☐ Q1	How often were you able to get an erection during sexual activity?	0 No sexual activity 1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q2	When you had erections with sexual stimulation, how often were your erections hard enough for penetration?	0 No sexual activity 1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q3	When you attempted intercourse, how often were you able to penetrate (enter) your partner?	0 Did not attempt intercourse 1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q4	During sexual intercourse, how often were you able to maintain your erection after you had penetrated (entered) your partner?	0 Did not attempt intercourse 1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q5	During sexual intercourse, how difficult was it to maintain your erection to completion of intercourse?	0 Did not attempt intercourse 1 Extremely difficult 2 Very difficult 3 Difficult 4 Slightly difficult 5 Not difficult

Erectile Dysfunction and BMI

In a prospective case-series study by Mora et al. (2013), the author concluded, using a multivariate regression analysis, that variations in BMI were independent predictors of IIEF score improvements at 1 year following bariatric surgery and not merely confined to metabolic or hormonal factors [27]. In another interesting study by K. Esposito et al., the author deduced that obesity is an important risk factor for the development of type 2 diabetes, which is again one of the main causes of ED. Men with a BMI higher than 28.7 are likely to carry approximately 30% higher risk for ED compared to those with a normal BMI [28].

We also studied the changes in BMI within each group. In the intervention group, the BMI decreased progressively from 44.1 (median IQR 41–56) at the beginning of the study to 33.6 (median IQR 31–40) at the end of the study, $p < 0.001$. The BMI in the control group, on the other hand, showed little reduction from 44.05 (median IQR 36–51) at the beginning of the study to 41.7 (median IQR 35–50) at the end of the study, $p < 0.05$. Subsequent pairwise comparisons were performed in the intervention group and showed statistical significance with $p < 0.001$ in the following months (month 0 vs 3, month 0 vs 6 and month 1 vs 6). The control group, on the other hand, did not show any statistical significance with regard to BMI. Hence, improvements in BMI can significantly improve erectile function, and

Fig. 3 (continued)



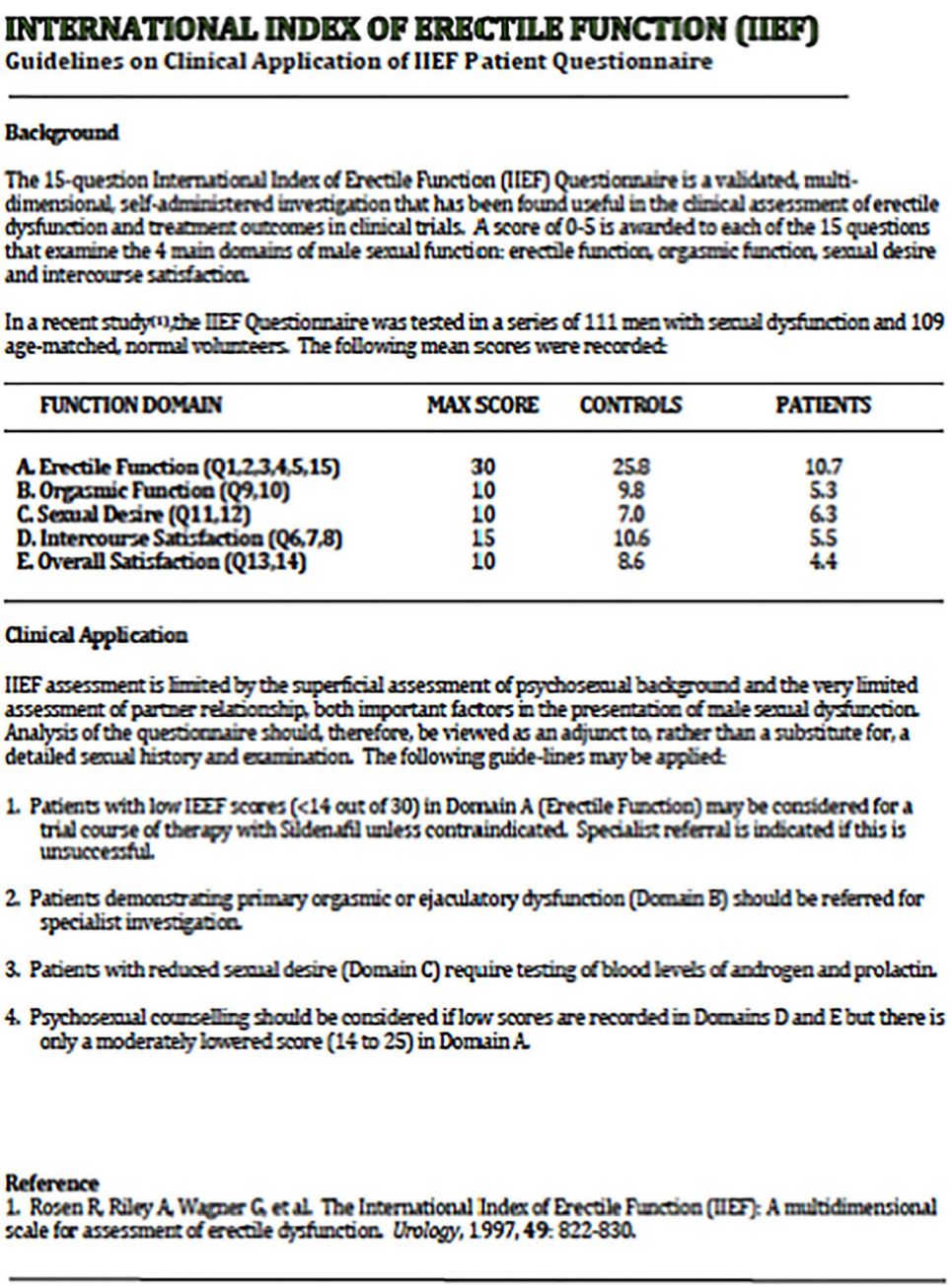
☐ Q6	How many times have you attempted sexual intercourse?	0 No attempts 1 One to two attempts 2 Three to four attempts 3 Five to six attempts 4 Seven to ten attempts 5 Eleven or more attempts
☐ Q7	When you attempted sexual intercourse, how often was it satisfactory for you?	0 Did not attempt intercourse 1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q8	How much have you enjoyed sexual intercourse?	0 No intercourse 1 No enjoyment at all 2 Not very enjoyable 3 Fairly enjoyable 4 Highly enjoyable 5 Very highly enjoyable
☐ Q9	When you had sexual stimulation or intercourse, how often did you ejaculate?	0 No sexual stimulation or intercourse 1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q10	When you had sexual stimulation or intercourse, how often did you have the feeling of orgasm or climax?	1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q11	How often have you felt sexual desire?	1 Almost never or never 2 A few times (less than half the time) 3 Sometimes (about half the time) 4 Most times (more than half the time) 5 Almost always or always
☐ Q12	How would you rate your level of sexual desire?	1 Very low or none at all 2 Low 3 Moderate 4 High 5 Very high
☐ Q13	How satisfied have you been with your overall sex life?	1 Very dissatisfied 2 Moderately dissatisfied 3 Equally satisfied & dissatisfied 4 Moderately satisfied 5 Very satisfied
☐ Q14	How satisfied have you been with your sexual relationship with your partner?	1 Very dissatisfied 2 Moderately dissatisfied 3 Equally satisfied & dissatisfied 4 Moderately satisfied 5 Very satisfied
☐ Q15	How do you rate your confidence that you could get and keep an erection?	1 Very low 2 Low 3 Moderate 4 High 5 Very high

surgical intervention seems to have a significant advantage over the control group.

Limitations

Our study had some limitations. This is a non-randomized study, and the decision for surgical or medical intervention is solely based on the patient's wish; hence, the study is vulnerable to selection bias. The confounders and bias were controlled by matching both groups with known co-morbidities, such as obstructive sleep apnoea (OSA) and hypertension (HPT). Both groups were also not comparable on smoking status, and some might have more than two co-morbidities (besides OSA and HPT), which may worsen the pre-existing ED [29]. Metabolic syndrome is a known reversible risk factor for developing erectile dysfunction. Only a 6-month follow-up was performed; likely, a longer follow-up can be performed to see the long-term effects of surgical intervention in the resolution of erectile dysfunction. This study can be improved by adding a hormonal study, and hormonal levels can be taken at particular points in time to see if there is an association within the intervention and control groups. More respondents should be recruited in the future studies to enable us to find the correlation between ethnicity and ED. To date, only a few studies have been published on this in Europe and China. Besides this, the Sexual Quality of Life-Male (SQoL-M) questionnaire can be given together with the IIEF questionnaire to determine both the degree of erectile dysfunction and the sexual quality of life at the same time. In the intervention group, further subgrouping can be done by further

Fig. 3 (continued)



INTERNATIONAL INDEX OF ERECTILE FUNCTION (IIEF)

Guidelines on Clinical Application of IIEF Patient Questionnaire

Background

The 15-question International Index of Erectile Function (IIEF) Questionnaire is a validated, multi-dimensional, self-administered investigation that has been found useful in the clinical assessment of erectile dysfunction and treatment outcomes in clinical trials. A score of 0-5 is awarded to each of the 15 questions that examine the 4 main domains of male sexual function: erectile function, orgasmic function, sexual desire and intercourse satisfaction.

In a recent study[1],the IIEF Questionnaire was tested in a series of 111 men with sexual dysfunction and 109 age-matched, normal volunteers. The following mean scores were recorded:

FUNCTION DOMAIN	MAX SCORE	CONTROLS	PATIENTS
A. Erectile Function (Q1,2,3,4,5,15)	30	25.8	10.7
B. Orgasmic Function (Q9,10)	10	9.8	5.3
C. Sexual Desire (Q11,12)	10	7.0	6.3
D. Intercourse Satisfaction (Q6,7,8)	15	10.6	5.5
E. Overall Satisfaction (Q13,14)	10	8.6	4.4

Clinical Application

IIEF assessment is limited by the superficial assessment of psychosexual background and the very limited assessment of partner relationship, both important factors in the presentation of male sexual dysfunction. Analysis of the questionnaire should, therefore, be viewed as an adjunct to, rather than a substitute for, a detailed sexual history and examination. The following guide-lines may be applied:

1. Patients with low IEEF scores (<14 out of 30) in Domain A (Erectile Function) may be considered for a trial course of therapy with Sildenafil unless contraindicated. Specialist referral is indicated if this is unsuccessful.
2. Patients demonstrating primary orgasmic or ejaculatory dysfunction (Domain B) should be referred for specialist investigation.
3. Patients with reduced sexual desire (Domain C) require testing of blood levels of androgen and prolactin.
4. Psychosexual counselling should be considered if low scores are recorded in Domains D and E but there is only a moderately lowered score (14 to 25) in Domain A.

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classifying bariatric surgery into mini-gastric bypass, laparoscopic gastric bypass surgery or laparoscopic sleeve gastrectomy and finding the correlation with erectile dysfunction. In my opinion, these are some of the areas where the study can be improved in the future.

Conclusion

In our present study, we noted a high prevalence of ED among obese male patients in the intervention and control groups. At the start of the study, the median IIEF score in both groups ranged from moderate to severe ED. This shows that all respondents are suffering from erectile dysfunction at the beginning, based on the IIEF score. Subsequently, in the intervention group, significant improvements in IIEF score and resolution of erectile function were seen from severe ED to mild ED at the end of the study. In the control group, no significant improvements are seen in the IIEF score. Similarly, marked improvements are also seen in the BMI of patients in the intervention group, while only slight improvements in BMI are seen in the control group. Demographic data showed statistical significance with regard to the IIEF score for Malay and Chinese ethnicity in the intervention

group. Malay and Indian ethnicities, on the other hand, showed statistical significance in the control group. Subsequent analysis showed that age is independent of the IIEF score at any given point in time and is not statistically significant; hence, age is an independent variable and did not influence the IIEF score in our study.

Men and obesity appear to be experiencing a complex pathophysiology. Erectile function resolutions are not limited to simply losing weight; there appear to be integrated hormonal, metabolic, psychological and social factors that affect erectile function in males, particularly obese patients. Although bariatric surgery has some limitations in comparison to non-surgical weight loss, it is still the best treatment for erectile dysfunction, especially in obese patients.

Declarations

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Statement of Human and Animal Rights No human or animals were harmed during this study.

Conflict of Interest The authors declare no competing interests.

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