

Improvement in Health-Related Quality of Life and Symptoms Following Lipedema Liposuction

A Longitudinal Study

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Background: Lipedema is a chronic fat disorder characterized by disproportionate fat deposition in the lower limbs, leading to pain, mobility issues and reduced health related quality of life (HRQoL).

There is growing evidence that liposuction of the excess fat not only reduces soft tissue pain but also improves HRQoL. The published data, however, remain limited, and there are no studies of liposuction in the UK lipedema population. This study aimed to evaluate the effectiveness of liposuction on HRQoL and symptoms in UK lipedema patients using 2 HRQoL instruments and a Lipedema Symptom Scale.

Patient and Methods: Lipedema patients undergoing liposuction between January 2016 and December 2021 completed Short-Form Health Survey (SF-36), World Health Organization Quality-of-Life Assessment (WHOQOL-BREF), and 17-question Lipedema Symptom Scale preoperatively and postoperatively. Paired *t* test was used to compare the preoperative and postoperative mean scores of the different domains of the SF-36 and WHOQOL-BREF and preoperative and postoperative mean scores for the lipedema symptom scale. Paired *t* test was also used to compare preoperative and postoperative SF-36 scores to age-matched normative data for the English population to assess the extent of HRQoL improvement relative to the general population.

Results: Seventy-six women were included in the study with a mean age of 46.4 ± 12 years. Mean follow-up (interval between first liposuction surgery and postoperative completion of the instruments) was 25.3 ± 23.2 months. There was significant improvement in all SF-36 and WHOQOL-BREF domains postoperatively ($P < 0.001$). Compared with age-matched normative data, postoperative SF-36 scores remained lower in physical functioning, social functioning, and general health. Postoperative results also showed a highly significant improvement ($P < 0.001$) across all 17 items of the Lipedema Symptom Scale.

Conclusion: This longitudinal study indicates liposuction is an effective treatment for improving HRQoL and symptoms in lipedema patients, although it may not completely restore HRQoL to normative levels. Limitations include potential selection bias, sampling bias, and the need for longer follow-up. The findings support liposuction as a first-line treatment for lipedema and could inform decision-making for both patients and policymakers.

Key Words: health-related quality of life, lipedema, lipedema liposuction, lipedema symptoms; lipodema, SF-36, WHOQOL-BREF

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Lipedema is a chronic, debilitating fat disorder almost exclusively affecting women, with an estimated prevalence of 5%–15%.^{1,2} First described in the 1940s, the condition remains understudied, with limited data on its epidemiology, natural history, pathophysiology, and effective treatments.³

Patients present with disproportionately large lower limbs and a slim upper body.⁴ The fat deposition in the lower limbs is typically symmetrical and circumferential, giving the lower limbs a column-like appearance. The upper limbs are also affected in 30%–80% of patients.^{5,6} Importantly, lipedema is recognized as a metabolic disorder affecting fat distribution and not merely a cosmetic concern. In contrast to obesity, lipedema fat is resistant to diet or exercise.

Patients report various symptoms, including soft-tissue pain, pressure hypersensitivity, and easy bruising.^{1,7,8} The disease severely impacts health-related quality of life (HRQoL), with patients experiencing low self-esteem, depression, and thoughts of self-harm and suicide.^{9–12}

In a survey of UK lipedema patients, 85% reported lipedema affected their mental health, ability to cope with life, and sexual activity.¹³ The presence of comorbidity such as obesity, varicose veins, and secondary lymphedema may further impair HRQoL.

Traditional management (manual lymphatic drainage, compression therapy, exercise, weight management, and psychosocial support) alleviates symptoms but minimally reduces limb volume.

Lipedema liposuction is increasingly recognized as an effective treatment, reducing limb volume and slowing disease progression.^{14–17} Studies show it improves pain, gait, mobility, and HRQoL.^{18–24} However, in March 2022, the UK National Institute for Health and Care Excellence concluded that evidence on efficacy was inadequate, recommending further research on patient-reported outcomes, including HRQoL.²⁵

No studies have examined the impact of liposuction on the HRQoL of UK patients with lipedema. Therefore, this study aims to assess HRQoL before and after lipedema liposuction using the Short-Form Health Survey (SF-36) and World Health Organization Quality-of-Life Assessment (WHOQOL-BREF) quality-of-life instruments and evaluate treatment effects on symptomatology using a Lipedema Symptom Scale.

PATIENTS AND METHODS

Patient Selection

Patients diagnosed with lipedema and scheduled to undergo liposuction by the author from January 1, 2016, to December 31, 2021, were invited to participate in the study. Recruitment was postponed during March to July 2020, due to the COVID-19 pandemic.

Patients were diagnosed with lipedema by the author using the modified diagnostic criteria of Buck and Herbst (Table 1).²⁶ Patients were then classified into type and stage categories based on the Schmeller classification (Tables 2 and 3 respectively).²⁷ The Schmeller classification subdivides lipedema into 5 types and 3 stages, depending on the distribution and severity of the excess fat.

Patients were excluded from the study if they declined to participate, had previously undergone lipedema liposuction at another facility, underwent simultaneous body contouring (eg, arm lift, thigh lift, etc), were diagnosed with lipolymphedema, or failed to complete the HRQoL instruments in their entirety. Body mass index was not used as a criterion for exclusion.

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TABLE 1. Lipedema Diagnostic Criteria

Almost exclusive occurrence in women
Bilateral and symmetrical manifestation with minimal involvement of the feet
Ankle pantaloony deformity or cuff at the wrist*
Minimal pitting edema
Negative Kaposi-Stemmer sign
Pain, tenderness on pressure
Easy bruising
Persistent enlargement after elevation of the extremities or weight loss
Arms are affected 30% of the time
Hypothermia of the skin
Swelling worsens with orthostasis in summer
Unaffected by caloric restriction
Telangiectasias over the pretibial fat pads and/or fat lobules*
*Added/modified by the author.

This study was granted ethical approval, patients provided their informed consent to participate, and all data were anonymized.

Surgical Technique

Lipedema liposuction was performed using either water-jet assisted liposuction (WAL) or tumescent power-assisted liposuction (PAL). The author routinely uses WAL as the standard procedure and uses PAL when the fat has a firm or fibrotic consistency.

All patients underwent lipedema liposuction with either intravenous sedation or general anesthesia. Patients with stage 1 and 2 lipedema were treated in a clinic facility on a day-case basis. Those with stage 3 lipedema were treated in a hospital facility and remained overnight for routine observation.

Patients diagnosed with varicose veins, especially those with stage 3 lipedema, were required to have them treated prior to liposuction.

All patients received a prophylactic single dose of antibiotic and tranexamic acid (1g) intravenously on anesthetic induction.

Every patient underwent liposuction of both lower limbs, with additional liposuction of the posterior arms (type IV) performed concurrently in selected cases. Patients with stage 2 and stage 3 lipedema underwent multiple surgeries, with the first surgery always including liposuction of the anterior lower limb, from ankle to mid thigh. In selected cases, liposuction of the calves was also performed. The author found this approach to be the most effective in addressing the most symptomatic areas first, while also providing optimal shaping. A 6-week interval was observed between each operation.

Liposuction of the upper limb typically involved the posterior arm. The forearm was also liposuctioned if there was a wrist cuff present, was significantly enlarged, or had multiple lipomas present.

TABLE 2. Lipedema Types

Type	Description
I	Pelvis, buttocks, and hips (“saddlebags”).
II	Buttocks to knees. There may be tender deposits of fat around the inner side of and below the knee.
III	Buttocks to ankles, where a prominent “cuff” or “ankle pantaloony” deformity develops.
IV	Upper limbs
V	Lower legs

All incisions were left open to facilitate fluid drainage and healed by secondary intention.

After surgery, all patients were managed in accordance with a standard protocol, that included the following:

1. Application of circular or flat-knit class 2 (32–40 mm Hg) compression tights and class 2 arm compression sleeves, when indicated. Patients obtained their own compression garments and were advised to purchase a size that fitted them prior to surgery and replace them for a smaller size once they felt loose. Compression garments were worn 24 hours a day for a minimum 6 weeks, or longer if the postoperative swelling persisted.
2. One-week course of oral antibiotics.
3. Full mobilization.
4. Five-day course of low-molecular-weight heparin for stage 3 patients.

Some patients chose to have manual lymphatic drainage or deep oscillation therapy to help ease the postoperative swelling, but it was not a mandatory requirement. Patients were instructed to wait at least 1 week before starting these therapies.

Although lipedema liposuction is generally considered a clean procedure with a low infection risk, postoperative antibiotics were given due to the large volume of fat removed and the potential morbidity and costs associated with even infrequent infections.

Questionnaire

Each patient completed a questionnaire prior to their first surgery, typically during their preoperative consultation. The questionnaire comprised 4 parts:

1. General information such as age, living arrangements, duration of disease and comorbidity
2. Short-Form Health Survey
3. World Health Organization Quality-of-Life Assessment
4. Lipedema Symptom Scale

Patients were seen for follow-up at 6 weeks, 6 months, 1 year, or beyond 1 year (at their request) and requested to complete the questionnaire at each time point, either in clinic or at home after their follow-up visit, ensuring flexibility and high response rates.

To account for follow-up variability, the exact time interval between surgery and the completion of the last follow-up questionnaire for each patient was recorded.

Short-Form Health Survey

SF-36 is a concise HRQoL instrument that is widely used in HRQoL research and evaluates functional status and overall well-being.^{28,29} SF-36 is superior to other HRQoL instruments as it covers all aspects of health and is not disease-specific.

The scale consists of 36 items covering 8 domains of health-related HRQoL: physical functioning (PF), role limitations caused by physical health problems (RP), role limitations caused by emotional problems (RE), energy levels (VT), mental health (MH), social functioning (SF), bodily pain (BP), and general health (GH).

When answering the various questions, patients are asked to reflect on their life during the preceding 4 weeks. A score is calculated for

TABLE 3. Lipedema Stages

Stage	Description
1	Smooth skin with thickened subcutaneous fat tissue
2	Uneven skin with indentations in the fat tissue and larger mounds of fat tissue (lipomas) able to be seen and felt
3	Uneven skin with thickened, fibrotic subcutaneous fat. Larger mounds of fat (lobules) causing deformation, especially on the thighs and around the knees

TABLE 4. Lipedema Symptom Scale

1	How do you rate your pain intensity?	None	Minor	Medium	Strong	Very strong
2	How often are the affected areas painful?	Never	Seldom	Sometimes	Often	Almost always
3	Spontaneous bruising	Never	Seldom	Sometimes	Often	Almost always
4	Legs feel heavy	Never	Seldom	Sometimes	Often	Almost always
5	The affected areas on my legs feel cold	Never	Seldom	Sometimes	Often	Almost always
6	The affected areas on my arms feel cold	Never	Seldom	Sometimes	Often	Almost always
7	Ankle swelling	Never	Seldom	Sometimes	Often	Almost always
8	Lower back pain	Never	Seldom	Sometimes	Often	Almost always
9	Difficulty climbing stairs	Never	Seldom	Sometimes	Often	Almost always
10	Difficulty kneeling down	Never	Seldom	Sometimes	Often	Almost always
11	The affected areas are sensitive to touch or pressure	Never	Seldom	Sometimes	Often	Almost always
12	Knee pain	Never	Seldom	Sometimes	Often	Almost always
13	Difficulty walking	Never	Seldom	Sometimes	Often	Almost always
14	I am unhappy with the appearance of my legs	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
15	I find it difficult to get clothes that fit	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
16	I find it difficult to get shoes/boots that fit	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
17	I am self-conscious of showing my legs in public	Strongly disagree	Disagree	Undecided	Agree	Strongly agree

each domain ranging from 1 to 100, with a higher score reflecting better health. A total score is also calculated. Normative data for SF-36 of English women aged 45–54 years were used for comparison.³⁰

World Health Organization Quality-of-Life Assessment

WHOQOL-BREF is another HRQoL instrument based on the WHO Quality-of-Life Assessment instrument (WHOQOL-100). It consists of 26 items, of which 24 items relate to 4 domains, namely, physical health (7 items), psychological health (6 items), social relationships (3 items), and environment (8 items).³¹ The remaining 2 items relate to overall quality of life and satisfaction with health.

TABLE 5. Patient Characteristics (n = 76)

Characteristics	n	%
Living arrangements		
Lives with partner/family	51	67.1
Lives alone	5	6.6
Unanswered	20	26.3
Duration of disease		
<1 y	3	3.9
1–5 y	6	7.9
6–10 y	12	15.8
>10 y	52	68.4
Unanswered	3	3.9
Comorbidity*		
Cancer	1	1.3
Poor circulation	2	2.6
Lung disease (COPD, OSA)	6	7.9
Depression	14	18.4
Osteoarthritis	15	19.7
Hypertension	11	14.5
Diabetes	2	2.6
Renal disease	1	1.3
Unanswered	36	47.4

*Categories are not mutually exclusive.
COPD, chronic obstructive pulmonary disease; OSA, obstructive sleep apnea.

Each item is rated on a 5-point Likert scale and scored from 1 to 5, with 1 being the least happy or satisfied and 5 being the most happy or satisfied.

The mean score of the items in each domain is used to calculate the domain scores, which are then transformed linearly on a 1- to 100-point scale,³² with a mean score of <40 indicating poor quality of life, 41–60 indicating moderate quality of life, and >60 indicating good quality of life.

Lipedema Symptom Scale

To assess the effect of liposuction on lipedema symptoms, patients completed a 17-item questionnaire with apparent validity. Each item represents a known symptom of lipedema, drawn from established literature and clinical observation by the author. Patients rated each item on a 5-point Likert scale, ranging from 1 (“none,” “never,” “strongly disagree”) to 5 (“very strong,” “almost always,” “strongly agree”) (Table 4). A higher cumulative score indicates greater severity of symptoms.

Statistical Analysis

Statistical analysis was performed using IBM SPSS Statistics for Windows, version 23.0 (IBM Corp). Descriptive analyses included percentages and mean ± SD.

Paired *t* test was used to compare the preoperative and postoperative mean scores of the different domains of the SF-36 and WHOQOL-BREF, and preoperative and postoperative mean scores for the Lipoedema Symptom Scale.

To evaluate internal consistency of the SF-36 questionnaire, 2 techniques were used: item-total correlation and Cronbach α .

TABLE 6. Patient Distribution According to Type and Stage (n = 76)

Type	Stage 1 (%)	Stage 2 (%)	Stage 3 (%)	Total (%)
I and II			1	1 (1.3)
I, III, and IV			1	1 (1.3)
II		3		3 (3.9)
II and IV		1	1	2 (2.6)
III	15	15	11	41 (53.9)
III and IV	6	10	11	27 (35.5)
V		1		1 (1.3)
Total (%)	21 (27.6)	30 (39.5)	25 (32.9)	76

TABLE 7. Liposuction Surgery Details

	Stage 1	Stage 2	Stage 3
	Mean ± SD	Mean ± SD	Mean ± SD
Number of liposuction surgeries	1.2 ± 0.51	2.00 ± 0.77	2.16 ± 1.00
Total volume of fat removed per patient, L	3.68 ± 2.12	9.53 ± 3.50	12.99 ± 6.01
Volume of fat removed per surgery, L	3.08 ± 1.20	5.00 ± 1.40	6.17 ± 1.03

Item-total correlation estimates the correlation between an individual item and the sum of the other items within the same domain. A value greater than 0.4 is considered acceptable.³³

Cronbach α determines how closely related a set of items is as a group. A higher Cronbach α value, typically above 0.7, indicates good internal consistency, meaning the items measure the same underlying concept.³⁴ Both item-total correlation and Cronbach α were analyzed preoperatively and postoperatively.

To evaluate internal consistency of the 17-item Lipedema Symptom Scale, item-total correlation and Cronbach α were calculated.

Observed differences between preoperative and postoperative scores were described using 95% confidence intervals. A 2-tailed $P < 0.05$ was considered statistically significant.

RESULTS

Patient Characteristics

Of the 151 patients eligible for inclusion, a total of 76 (women 50.3%) were included. The characteristics of the study population are

presented in Table 5. The mean age of the study population was 46.4 ± 12 years. The majority of patients lived with a partner or family (67.1%), and the majority reported having lipedema for more than 10 years (68.4%). Mean follow-up (time between first surgery and completion of the postoperative questionnaire) was 25.3 months (range, 1.5–88.9 months).

The distribution of patients according to disease type and stage is shown in Table 6, with the largest groups comprising type III and types III and IV, 41 (53.9%) and 27 (35.5%), respectively. Regarding stage, the largest group was stage 2 (39.5%).

Patients with stage 1 disease underwent a mean 1.2 operations with a mean total of 3.68 L of fat aspirated (Table 7).

Four patients reported complications secondary to lipedema liposuction, and these included cellulitis (1, 1.3%) that did not require hospitalization and minor asymmetry (3, 3.9%). Those with minor asymmetry underwent revision liposuction during their second surgery. The vast majority of patients (72, 94.7%) did not have any complication.

Figures 1-3 demonstrate the transformative effects of lipedema liposuction on lower limb morphology.

Short-Form Health Survey

The preoperative and postoperative mean scores for the 8 domains are presented in Table 8. There was a highly significant improvement in all domains following lipedema liposuction ($P < 0.001$).

Internal Consistency

All the domains preoperatively and postoperatively have a Cronbach $\alpha > 0.9$, indicating excellent internal consistency reliability. This suggests the items within each domain are closely related and measure the same underlying construct.

Item-total correlation coefficients ranged from 0.68 to 0.92, suggesting the individual items have a moderately strong to strongly positive correlation with the total scale score. These values suggest that the



FIGURE 1. Lipedema type III, stage 1. Age 43 years. Result after single liposuction of the lower limbs from ankle to mid-thigh (anterior aspect), 3.6 L removed.



FIGURE 2. Lipedema type III & type IV, stage 3. Age 54. Result after single liposuction of the lower limbs from ankle to mid-thigh (anterior aspect), 6.6L removed.

items are performing well and contributing meaningfully to the measurement of the intended construct.

When comparing preoperative and postoperative SF-36 scores with English normative data (Table 9), the following can be observed:

For all domains, the preoperative mean scores were significantly lower than the English norms ($P < 0.001$), indicating our lipedema patients had poor quality of life before surgery (Table 9).

For 5 domains, RP, RE, VT, MH, and BP, the postoperative scores increased and were not significantly different from the English norms. This indicated patients' quality of life improved in these areas and was comparable to the age-matched general population after the surgery.

However, for the remaining domains of PF, SF, and GH, the postoperative scores remained significantly lower than the English norms ($P < 0.001$, $P < 0.05$, $P < 0.05$, respectively). This suggests the patients continued to experience deficits in physical abilities, social functioning, and overall health perceptions compared with their peers, even after the surgery.

World Health Organization Quality-of-Life Assessment

The preoperative and postoperative mean scores of the 4 domains and 2 items: overall quality of life and satisfaction with health, are presented in Table 10.

Preoperatively, the mean value of the 4 domains was 60.3 ± 20.4 , and the domain with the lowest score was psychological health (mean, 48.7 ± 19.0).

Postoperatively, the mean value of the 4 domains was 73.3 ± 19.6 , and the domain with the highest score was environmental health (mean, 78.5 ± 16.9).

When comparing preoperative and postoperative mean scores, there was highly significant improvement across the 4 domains ($P < 0.001$) and the 2 items ($P < 0.001$).

Internal Consistency

The Cronbach α for each domain preoperatively and postoperatively was 0.9 or above, indicating excellent internal consistency i.e each item was closely related to the overall construct being measured by the instrument.

The item-total correlations ranged from 0.86 to 0.96, indicating that each item contributed to the overall measurement of the construct; i.e each item in the scale had a strong positive correlation with the total score.

Lipedema Symptom Scale

Preoperatively, patients scored highest (4.85 ± 0.58) on the items 'I am unhappy with the appearance of my legs' and 'I am self-conscious about showing my legs in public,' highlighting significant concerns regarding leg appearance.(Table 11). The lowest score (2.97 ± 1.5) was for the statement, 'The affected areas on my arms feel cold,' indicating that cold sensation in the arms was less of a concern prior to surgery.

A comparison of preoperative and postoperative mean scores revealed highly significant improvements in all items ($P < 0.001$), with 'The affected areas on my arms feel cold' showing a significant improvement at $P < 0.05$.

Internal Consistency

Analysis yielded a Cronbach α of 0.93–0.94, indicating excellent internal consistency among the items. This high level of internal consistency supports the reliability of the questionnaire in assessing the symptoms of lipedema.

The item-total correlations were high and ranged from 0.65 to 0.86, indicating that each question contributed meaningfully to the



FIGURE 3. Lipedema type III and type IV, stage 3. Age 54 years. Result after single liposuction of the lower limbs from ankle to groin (anterior aspect) and calves, 7.3 L removed.

overall measurement of symptom burden i.e each question in the scale had a strong positive correlation with the total score. Some questions, such as ‘How do you rate your pain intensity?’, ‘Spontaneous bruising,’ ‘Ankle swelling,’ ‘Lower back pain,’ and ‘I find it difficult to get shoes/boots that fit,’ show a moderate correlation (0.6 to 0.7) with the total scores. The question ‘Difficulty walking’ has the highest correlation (0.86) with the total scores, indicating it is the most representative of the overall construct being measured.

Concurrent Validity

Concurrent validity was investigated by correlating postoperative SF-36 domain scores with postoperative 17-item Lipedema Symptom Scale scores (Table 12). The results demonstrate strong negative correlations between the majority of the SF-36 domains and the Lipedema Symptom Scale

items, indicating that higher scores on the Lipedema Symptom Scale are associated with lower quality of life as measured by the SF-36. Pearson correlation between the SF-36 domains and the Lipedema Symptom Scale items ranged from –0.18 to –0.80, suggesting there is good level of concurrent validity between the 2 scales. Less severe symptoms as reported on the Lipedema Symptom Scale were associated with higher scores on the SF-36 dimensions. Bodily pain had strong negative correlation with most lipedema symptoms, especially “How do you rate your pain intensity?” (–0.80), “Difficulty walking” (–0.76), and “Difficulty climbing stairs” (–0.74). Role limitations due to emotional problems had the weakest negative correlation with lipedema items, but still showed moderate negative correlation with most items. These negative correlations indicate SF-36 and the Lipedema Symptom Scale measure related constructs, with better HRQoL (as measured by the SF-36) being associated with less severe lipedema

TABLE 8. SF-36: Preoperative and Postoperative Scores of the 8 Domains

Domain	Preoperative			Postoperative			
	Score, Mean ± SD	Item-Total Correlation Coefficients	Cronbach α	Score, Mean ± SD	Item-Total Correlation Coefficients	Cronbach α	P*
PF	51.5 ± 31.3	0.84	0.96	76.4 ± 27.1	0.90	0.96	<0.001
RP	43.4 ± 42.5	0.81	0.95	81.3 ± 34.7	0.83	0.94	<0.001
RE	60.8 ± 42.7	0.69	0.90	85.3 ± 29.0	0.68	0.98	<0.001
VT	38.5 ± 23.3	0.86	0.96	59.0 ± 24.5	0.92	0.96	<0.001
MH	59.6 ± 20.9	0.84	0.96	76.5 ± 13.4	0.90	0.97	<0.001
SF	59.3 ± 25.9	0.75	0.93	81.5 ± 19.2	0.80	0.95	<0.001
BP	48.8 ± 26.5	0.81	0.95	72.8 ± 23.1	0.85	0.96	<0.001
GH	49.4 ± 24.5	0.84	0.96	65.4 ± 23.9	0.89	0.97	<0.001

*Paired t test was used for comparison, P < 0.001 indicating a statistically highly significant difference.

TABLE 9. SF-36: Comparison of English Normative Data With Preoperative and Postoperative Domain Scores

Domain	English Normative Data*		Preoperative			Postoperative		
	n	Score, Mean ± SD	n	Score, Mean ± SD	P†	n	Score, Mean ± SD	P†
PF	917	84.8 ± 18.3	76	51.5 ± 31.3	<0.001	76	76.4 ± 27.1	<0.001
RP	960	82.4 ± 32.0	76	43.4 ± 42.5	<0.001	76	81.3 ± 34.7	ns
RE	965	80.8 ± 33.6	76	60.8 ± 42.7	<0.001	76	85.3 ± 29.0	ns
VT	957	59.4 ± 20.3	76	38.5 ± 23.3	<0.001	76	59.0 ± 24.5	ns
MH	950	73.2 ± 18.2	76	59.6 ± 20.9	<0.001	76	76.5 ± 13.4	ns
SF	973	87.0 ± 20.8	76	59.3 ± 25.9	<0.001	76	81.5 ± 19.2	<0.05
BP	965	77.4 ± 22.3	76	48.8 ± 26.5	<0.001	76	72.8 ± 23.1	ns
GH	950	73.1 ± 19.9	76	49.4 ± 24.5	<0.001	76	65.4 ± 23.9	<0.05

*Normative data for English women aged 45–54 years.
†Paired *t* test was used for comparison, *P* < 0.05 indicating a statistically significant difference and *P* < 0.001 indicating a highly significant difference.
ns, not significant.

symptoms. This provides evidence for the concurrent validity of the measures.

DISCUSSION

Patients expect healthcare to enhance their quality of life, making it crucial to measure how treatments impact this aspect. By using generic quality-of-life instruments, such as the SF-36 and WHOQOL-BREF, to evaluate liposuction for lipedema, we provide relevant information that can help both policymakers and patients make informed decisions.

To our knowledge, this is the first study to assess lipedema liposuction using both SF-36 and WHOQOL-BREF in conjunction with a Lipedema Symptom Scale. Furthermore, it represents the single largest series of lipedema liposuction on UK patients.

The majority of patients in our study presented with type III, and types III and IV lipedema, 41 (53.9%) and 27 (35.5%), respectively. This is similar to the findings of Falck et al, who reported the most common lipedema type was a combination of type III and type IV.³⁵ In this study, stage 2 represented the largest subgroup of 30 patients (39.5%).

Type I lipedema (steatopygia) comprised a very small proportion of 2 patients (2.6%) and presented in combination with type II and types III and IV. Both patients were at stage 3. In the author's experience, presentation of type I in isolation is rare, and type 1 patients typically present late, only when the buttocks have become so large as to cause functional impairment, such as difficulty with walking, toileting and sitting.

In this study, 14 patients (18.4%) were being treated for depression, which is higher than the 16% rate of moderate to severe depressive symptoms reported among women aged 30–49 in the United Kingdom.

However, caution is needed when comparing these groups, as our lipedema patients were actively receiving treatment for their depression, whereas it is unclear if the same applies to the surveyed UK population.³⁶

The higher rate of depression in our lipedema population is consistent with the findings of other studies.^{2,37} It is important to note that the high rate of depression in our lipedema patients may have influenced the HRQoL results. Furthermore, depression may impede postoperative behavioral change, such as the need to exercise and improve diet.

As anticipated, there was a correlation between the number of liposuction surgeries patients underwent and stage of disease. Typically, 1 or 2 liposuction surgeries are adequate for debulking the lower limbs and achieving aesthetic goals in most stage 1 and stage 2 patients. Stage 3 patients, however, often require multiple surgeries. As the vast majority of UK lipedema patients have to self-fund their surgery, stage 3 patients are often limited in the number of surgeries they can afford (mean of 2.16 surgeries in this study). Thus, a mean of 2.16 surgeries for stage 3 patients may not reflect the actual number of surgeries needed for complete debulking, as the number is influenced by financial constraints rather than medical necessity.

Our results indicated a significant delay in the diagnosis of lipedema, with 52 patients (68.4%) reported having lipedema for over 10 years before diagnosis. This finding aligns with another study that reported more than 80% of lipedema patients had the disease for more than 10 years before diagnosis.¹¹

The prolonged time to diagnosis is largely due to poor recognition of the disease, frequent misdiagnosis by health professionals, and

TABLE 10. WHOQOL-BREF: Preoperative and Postoperative Scores of the 4 Domains and 2 Items: Overall Quality of Life and Satisfaction With Health

	Preoperative			Postoperative			<i>P</i>
	Score, Mean ± SD	Item-Total Correlation Coefficients	Cronbach α	Score, Mean ± SD	Item-Total Correlation Coefficients	Cronbach α	
Item 1. Overall quality of life	55.2 ± 27.5	0.88	0.93	78.7 ± 21.3	0.86	0.93	<0.001
Item 2. Satisfaction with health	35.7 ± 28.8	0.88	0.93	64.7 ± 28.7	0.86	0.93	<0.001
Domain 1. Physical health	52.8 ± 23.8	0.92	0.96	72.9 ± 22.7	0.94	0.97	<0.001
Domain 2. Psychological health	48.7 ± 19.0	0.92	0.95	68.6 ± 18.7	0.94	0.97	<0.001
Domain 3. Social relationships	68.1 ± 21.4	0.90	0.94	73.3 ± 20.3	0.93	0.96	<0.05
Domain 4. Environmental health	71.7 ± 17.3	0.95	0.97	78.5 ± 16.9	0.96	0.98	<0.001

*Paired *t* test was used for comparison, *P* < 0.001 indicating a statistically highly significant difference.

TABLE 11. Preoperative and Postoperative Scores for the Lipedema Symptom Scale

		Preoperative	Postoperative	Item-Total		
Item		Score, Mean ± SD	Score, Mean ± SD	Correlation Coefficients*	Cronbach α*	P†
1	How do you rate your pain intensity	3.31 ± 1.00	2.19 ± 1.01	0.69	0.93	<0.001
2	How often are the affected areas painful	3.91 ± 0.88	2.49 ± 1.11	0.79	0.94	<0.001
3	Spontaneous bruising	4.00 ± 1.01	2.63 ± 1.18	0.65	0.94	<0.001
4	Legs feel heavy	4.56 ± 0.92	2.57 ± 1.39	0.73	0.93	<0.001
5	The affected areas on my legs feel cold	3.72 ± 1.40	2.50 ± 1.32	0.74	0.94	<0.001
6	The affected areas on my arms feel cold	2.97 ± 1.50	2.46 ± 1.40	0.67	0.94	<0.05
7	Ankle swelling	3.84 ± 1.25	2.91 ± 1.23	0.65	0.94	<0.001
8	Lower back pain	3.50 ± 1.10	2.66 ± 1.38	0.65	0.94	<0.001
9	Difficulty climbing stairs	3.40 ± 1.50	2.31 ± 1.45	0.82	0.94	<0.001
10	Difficulty kneeling down	3.99 ± 1.32	3.09 ± 1.51	0.79	0.94	<0.001
11	The affected areas are sensitive to touch or pressure	4.12 ± 1.20	2.97 ± 1.38	0.76	0.94	<0.001
12	Knee pain	3.96 ± 1.06	2.81 ± 1.42	0.78	0.94	<0.001
13	Difficulty walking	3.24 ± 1.46	2.10 ± 1.37	0.86	0.94	<0.001
14	I am unhappy with the appearance of my legs	4.85 ± 0.58	3.06 ± 1.33	0.70	0.93	<0.001
15	I find it difficult to get clothes that fit	4.71 ± 0.83	2.88 ± 1.41	0.74	0.93	<0.001
16	I find it difficult to get shoes/boots that fit	4.53 ± 1.03	3.13 ± 1.48	0.66	0.94	<0.001
17	I am self-conscious of showing my legs in public	4.85 ± 0.58	3.44 ± 1.38	0.68	0.93	<0.001

*Item-total correlation and Cronbach α are the same for both preoperative and postoperative datasets.
†Paired *t* test was used for comparison, *P* < 0.05 indicating a statistically significant difference, <0.001 indicating a highly significant difference.

a general lack of awareness in society.^{38,39} Indeed, in a survey of UK District General Hospital Consultants, only 46.2% had seen or recognized lipedema. Delayed diagnosis can result in numerous issues, including gait problems, depression, weight gain, and reduced quality of life.

This study demonstrates lipedema liposuction significantly improves quality of life of lipedema sufferers. There was a statistically significant improvement across all measured domains of quality of life, in both SF-36 and WHOQOL-BREF.

The SF-36 domains that exhibited the largest improvement were PF, RP, RE, and BP. Two of these domains, RP and BP, exhibited low preoperative scores of below 50.

The improvements seen in the SF-36 HRQoL domains are also seen with WHOQOL-BREF. Indeed, there was a highly significant (*P* < 0.001) improvement in the 2 items and all 4 domains of the WHOQOL-BREF. The greatest change was seen with overall quality of life, satisfaction with health, and physical health domain.

In a study by Hamatschek et al, in which they surveyed 333 patients with lipedema with WHOQOL-BREF, the mean value of all the domains was 60.5 ± 16.02.² The lowest score was obtained in the physical (mean, 54.54 ± 20.1) and psychological (mean, 51.91 ± 18.67) health domains, whereas the highest mean score was obtained in the environmental health domain (mean, 71.85 ± 16.00).² Interestingly, these scores were consistent with our scores. Indeed, there was no statistical difference between their scores and ours (2-sample *t* test, *P* > 0.05).

The Cronbach α for both SF-36 and WHOQOL-BREF exceeded 0.90, indicating excellent internal consistency among the items. However, the high value might suggest that some of the items are redundant and may be measuring the same underlying construct. Although a high Cronbach α indicates good internal consistency, it does not necessarily mean that the instruments are unidimensional. To assess dimensionality, factor analysis can be performed, but given our sample size of 76, the results would have been unreliable.

Good to excellent internal consistency was further supported by the high item-total correlation for both SF-36 and WHOQOL-BREF, which exceeded 0.68.

When comparing lipedema preoperative SF-36 scores with English normative data, there were significant deficits across the 8 domains (*P* < 0.001). These improved substantially after liposuction, with several domains reaching normative levels. However, HRQoL still remained significantly lower with regard to physical functioning (*P* < 0.001), social functioning (*P* < 0.05), and general health (*P* < 0.05). Thus, lipedema liposuction seems to have provided considerable improvement in HRQoL, but not complete restoration to normative levels.

Several factors may contribute to lipedema patients not achieving normative quality-of-life levels after liposuction, despite substantial improvements. These include ongoing symptoms or progression of the disease after liposuction, residual pain in areas that had not been liposuctioned, mobility limitations due to chronic arthritis, psychosocial factors (some patients may still struggle with body image issues or social anxiety, leading to lower social functioning scores), and the need for ongoing management (the need for continuous management may affect their perception of overall health and HRQoL).

When comparing the preoperative and postoperative scores of the Lipedema Symptom Scale, there was a statistically highly significant improvement of all 17 symptoms (*P* < 0.001 and *P* < 0.05 for “The affected areas on my arms feel cold”). This indicates liposuction was effective in improving mobility and reducing pain, discomfort, and other symptoms associated with lipedema. This is consistent with previously published studies that have shown liposuction to reduce the level of pain and general limitations in everyday or professional life and increase quality of life.^{19,20,37,40}

The Lipedema Symptom Scale high Cronbach α values (0.93–0.94) and strong item-total correlation coefficients (0.65–0.86) indicate the questionnaire's internal consistency and the ability of the questions to measure the impact of lipedema symptoms on patients.

Our data show significant improvements in psychosocial aspects, such as self-consciousness about showing legs in public (question 17) and difficulty in finding clothes that fit (question 15). This indicates that the treatment had positively impacted patients' self-image and daily functioning.

TABLE 12. Concurrent Validity: Pearson Correlations (n = 76) Between SF-36 Domains and 17-Item Lipedema Symptom Scale

Lipedema Symptom Scale																
SF-36	How Do You Rate Your Pain Intensity			How Often Are the Areas Painful			Spontaneous Bruising			Legs Feel Heavy			The Affected Areas on My Legs Feel Cold			I Am Unhappy With the Appearance of My Legs
	Pain	Intensity	Your	Areas	Painful	Affected	Bruising	Feel Heavy	My Legs	Feel Cold	My Arms	Feel Cold	Swelling	Lower Back Pain	Difficulty Climbing Stairs	Difficulty Kneeling Down
PF	-0.63	-0.66	-0.51	-0.65	-0.61	-0.59	-0.52	-0.51	-0.70	-0.66	-0.64	-0.65	-0.72	-0.60	-0.62	-0.59
RP	-0.50	-0.57	-0.55	-0.64	-0.63	-0.53	-0.53	-0.42	-0.67	-0.63	-0.59	-0.62	-0.69	-0.57	-0.64	-0.55
RE	-0.25	-0.27	-0.24	-0.32	-0.30	-0.28	-0.21	-0.18	-0.43	-0.38	-0.34	-0.38	-0.46	-0.31	-0.40	-0.32
VT	-0.63	-0.62	-0.55	-0.67	-0.65	-0.59	-0.53	-0.49	-0.69	-0.65	-0.63	-0.65	-0.74	-0.62	-0.63	-0.57
MH	-0.65	-0.64	-0.50	-0.65	-0.67	-0.61	-0.58	-0.51	-0.70	-0.64	-0.65	-0.66	-0.72	-0.66	-0.68	-0.64
SF	-0.63	-0.57	-0.49	-0.64	-0.62	-0.56	-0.54	-0.45	-0.59	-0.55	-0.60	-0.59	-0.64	-0.63	-0.58	-0.57
BP	-0.80	-0.72	-0.56	-0.71	-0.71	-0.66	-0.58	-0.56	-0.74	-0.72	-0.70	-0.71	-0.76	-0.66	-0.65	-0.61
GH	-0.53	-0.57	-0.56	-0.67	-0.62	-0.59	-0.54	-0.54	-0.65	-0.66	-0.63	-0.63	-0.70	-0.66	-0.69	-0.65

With regard to concurrent validity (correlation between SF-36 domain scores and Lipedema Symptom Scale scores), the strongest correlations were observed between the SF-36 BP domain and various Lipedema Symptom Scale questions, particularly pain intensity ($r = -0.80$), difficulty walking ($r = -0.76$), and difficulty climbing stairs ($r = -0.74$). This suggests that pain and mobility limitations are key factors influencing the quality of life in individuals with lipedema.

Other SF-36 domains, such as PF, VT, MH, and GH, also showed strong negative correlations with multiple Lipedema Symptom Scale questions. This highlights the multifaceted impact of lipedema symptoms on various aspects of HRQoL.

The RE domain showed relatively weaker correlations with the Lipedema Symptom Scale questions compared with other SF-36 domains. This may suggest that the emotional impact of lipedema is less pronounced than the physical and social aspects or that the RE domain is less sensitive to lipedema-specific emotional challenges.

The strong negative correlations between the SF-36 domains and the Lipedema Symptom Scale questions provide evidence for the concurrent validity of the Lipedema Symptom Scale and underscore the significant impact of lipedema symptoms on HRQoL. These findings emphasize the importance of addressing both the physical and psychosocial aspects of lipedema in patient care and future research.

This study has several strengths. First, the utilization of 2 distinct HRQoL instruments minimizes the risk of overlooking significant aspects of patients' experiences, thereby offering a more comprehensive assessment of the impact of lipedema and its treatment on quality of life. Second, patients completed the HRQoL instruments before their initial liposuction, mitigating the potential for recall bias.

The SF-36 questionnaire has been validated in many studies and is suitable for evaluating HRQoL of patients with different stages of lipedema.⁴¹ Furthermore, the results can be compared with age-related normative data. This comparison revealed lower HRQoL in lipedema patients before liposuction and improvement of HRQoL after liposuction to match normative data in relation to 5 of 8 domains.

It is recognized that SF-36 is a generic questionnaire and has the potential disadvantage of being less sensitive to clinical change in patients with specific complaints.⁴² However, our use of disease-specific symptom scale alongside the SF-36 provides a more comprehensive understanding of the impact of liposuction on patients with lipedema. The significant improvements observed in both the SF-36 HRQoL and lipedema symptoms demonstrate that liposuction not only enhances quality of life but also effectively addresses the specific symptoms and concerns faced by patients with this condition.

The complementary nature of these 2 instruments strengthens the validity of our findings and highlights the positive outcomes achieved through lipedema liposuction.

This study has a number of limitations. First, as this was a single-surgeon study, there is a risk of selection bias and influence of practices unique to the surgeon. Second, as the study population represented 50.3% of eligible patients, there is a risk of sampling bias, selection bias, and nonresponse bias. Third, as the mean follow-up period was 25.3 months, the long-term effects of lipedema liposuction may not have been captured. Given that lipedema is a chronic condition, it is possible the beneficial effects of liposuction actually diminish after a longer period.

Several factors contributed to the exclusion of patients from the study. First, a number of patients were apathetic toward completing either the preoperative or postoperative questionnaire. Second, many patients lived far away and did not return for follow-up appointments. The inconvenience of traveling for follow-up visits may have discouraged these patients from participating in the study. Additionally, some patients might have felt that their condition had improved significantly after the treatment, leading them to believe that further follow-up was unnecessary. These reasons, among others, resulted in a reduced sample size and potentially limited the generalizability of the study findings.

A multicenter study with longer follow-up period is needed to confirm the long-term benefits of lipedema liposuction.

In this study, large volumes of fat were safely removed using either PAL or WAL in an outpatient setting, without major complication. It is the author's observation that there is less bleeding and improved recovery with WAL. In certain health care settings, a restriction of 5 L is imposed on the maximum volume of fat that can be safely removed during an outpatient liposuction procedure. However, there is insufficient scientific evidence to support this volume limit as a necessary safety precaution. The arbitrary nature of this restriction highlights the need for further research to establish evidence-based guidelines that prioritize patient safety while optimizing treatment outcomes for lipedema patients.

CONCLUSION

This study demonstrates that liposuction for lipedema significantly improves health-related quality of life and symptoms in patients, though it does not fully restore all aspects to normative levels. The findings support liposuction as an effective treatment option, potentially guiding decisions for patients and policymakers.

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REFERENCES

- Wold LE, Hines EA Jr., Allen EV. Lipedema of the legs; a syndrome characterized by fat legs and edema. *Ann Intern Med.* 1951;34:1243–1250.
- Hamatschek M, Knors H, Kletz ML, et al. Characteristics and patient reported outcome measures in lipedema patients - establishing a baseline for treatment evaluation in a high-volume center. *J Clin Med.* 2022;11:2836.
- Allen EVN, Hines EA. Lipedema of the legs: a syndrome characterised by fat legs and orthostatic edema. *Proc Staff Meet Mayo Clin.* 1940;15:184–187.
- Langendoen SI, Habbema L, Nijsten TEC, et al. Lipodema: from clinical presentation to therapy. A review of the literature. *Br J Dermatol.* 2009;161:980–986.
- Herpetz U. Lipedema. *Z Lymphol.* 1995;19:1–11.
- Herbst KL, Mirkovskaya L, Bharhagava L, et al. Lipedema fat and signs and symptoms of illness, increase with advancing stage. *Arch Med.* 2015;7:1–8.
- Herbst KL. Rare adipose disorders (RADs) masquerading as obesity. *Acta Pharmacol Sin.* 2012;33:155–172.
- Child AH, Gordon KD, Sharpe P, et al. Lipedema: an inherited condition. *Am J Med Genet A.* 2010;152A:970–976.
- Alwardat N, Di Renzo L, Alwardat M, et al. The effect of lipedema on health-related quality of life and psychological status: a narrative review of the literature. *Eat Weight Disord.* 2020;25:851–856.
- Fetzer A, Fetzer S. Early lipodema diagnosis and the RCGP e-learning course. *Br J Community Nurs.* 2015;(4 Suppl):S22, S24, S26–8.
- Romeijn JRM, de Rooij MJM, Janssen L, et al. Exploration of patient characteristics and quality of life in patients with lipodema using a survey. *Dermatol Ther (Heidelb).* 2018;8:303–311.
- Dudek JE, Bialaszek W, Ostaszewski P, et al. Depression and appearance-related distress in functioning with lipedema. *Psychol Health Med.* 2018;23:846–853.
- Fetzer A. Specialist approaches to managing lipodema. *Br J Community Nurs.* 2016;21(Suppl 4):S30–S35.
- Rapprich S, Baum S, Kaur I, et al. Treatment of lipedema using liposuction. Results of our own surveys. *Phlebologie.* 2015;3:1–13.
- Rudkin GH, Miller TA. Lipedema: a clinical entity distinct from lymphedema. *Plast Reconstr Surg.* 1994;94:841–847; discussion 848–849.
- Sattler G. Liposuction in lipedema. *Ann Dermatol Venerol.* 2002;129:1S103.
- Rapprich S, Loehnert M, Hagedorn M. Therapy of lipodema syndrome by liposuction under tumescent local anaesthesia. *Ann Dermatol Venerol.* 2002;129:1S71.
- Rapprich S, Dingler A, Podda M. Liposuction is an effective treatment for lipedema—results of a study with 25 patients. *J Dtsch Dermatol Ges.* 2011;9:33–40.
- Dadras M, Malliges PJ, Corterier CC, et al. Liposuction in the treatment of lipedema: a longitudinal study. *Arch Plast Surg.* 2017;44:324–331.
- Witte T, Dadras M, Heck F-C, et al. Water-jet-assisted liposuction for the treatment of lipedema: standardized treatment protocol and results of 63 patients. *J Plast Reconstr Aesthet Surg.* 2020;73:1637–1644.
- Baumgartner A, Hueppe M, Meier-Vollrath I, et al. Improvements in patients with lipedema 4, 8 and 12 years after liposuction. *Phlebologie.* 2021;36:152–159.
- Schlosshauer T, Heiss C, von Hollen A-K, et al. Liposuction improves disease-specific quality of life in lipodema patients. *Int Wound J.* 2021;18:923–931.
- Schmeller W, Hueppe M, Meier-Vollrath I. Tumescence liposuction in lipodema yields good longterm results. *Br J Dermatol.* 2012;166:161–168.
- Baumgartner A, Hueppe M, Schmeller W. Longterm benefit of liposuction in patients with lipodema: a follow-up study after an average of 4 and 8 years. *Br J Dermatol.* 2016;174:1061–1067.
- Liposuction for chronic lipodema. Available at: <https://www.nice.org.uk/guidance/ipg721>. Accessed February 17, 2024.
- Buck DW, Herbst KL. Lipedema: a relatively common disease with extremely common misconceptions. *Plast Reconstr Surg Glob Open.* 2016;4:e1043.
- Meier-Vollrath I, Schneider W, Schmeller W. Lipodem: Verbesserte Lebensqualität durch Therapiekombination. *Dtsch Arztebl.* 2005;7:A1061–A1067.
- Hays RD, Morales LS. The RAND-36 measure of health-related quality of life. *Ann Med.* 2001;33:350–357.
- Garratt A, Schmidt L, Mackintosh A, et al. Quality of life measurement: bibliographic study of patient assessed health outcome measures. *BMJ.* 2002;324:1417.
- Jenkinson C, Coulter A, Wright L. Short Form 36 (SF36) health survey questionnaire: normative data for adults of working age. *BMJ.* 1993;306:1437–1440.
- Skevington SM, Lotfy M, O'Connell KA, WHOQOL Group. The World Health Organization's WHOQOL-BREF quality of life assessment: psychometric properties and results of the international field trial. A report from the WHOQOL group. *Qual Life Res.* 2004;13:299–310.
- World Health Organization. Programme on mental health: WHOQOL user manual, 2012 revision. Available at: <https://iris.who.int/handle/10665/77932>. Accessed February 17, 2024.
- Ware JE Jr., Gandek B. Methods for testing data quality, scaling assumptions, and reliability: the IQOLA project approach. International quality of life assessment. *J Clin Epidemiol.* 1998;51:945–952.
- McHorney CA, Ware JE Jr., Lu LF, et al. The MOS 36-item Short-Form Health Survey (SF-36): III. Tests of data quality, scaling assumptions, and reliability across diverse patient group. *Med Care.* 1994;32:40–66.
- Falck J, Rolander B, Nygårdh A, et al. Women with lipodema: a national survey on their health, health-related quality of life, and sense of coherence. *BMC Womens Health.* 2022;22:457.
- Cost of living and depression in adults, Great Britain. Available at: <https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/mentalhealth/articles/costoflivinganddepressioninadultsgreatbritain/29septemberto23october2022>. Accessed February 17, 2024.
- Ghods M, Georgiou I, Schmidt J, et al. Disease progression and comorbidities in lipedema patients: a 10-year retrospective analysis. *Dermatol Ther.* 2020;33:e14534.
- Fonder MA, Loveless JW, Lazarus GS. Lipedema, a frequently unrecognized problem. *J Am Acad Dermatol.* 2007;57:S1–S3.
- Fife CE, Maus EA, Carter MJ. Lipedema: a frequently misdiagnosed and misunderstood fatty deposition syndrome. *Adv Skin Wound Care.* 2010;23:81–92; quiz 93–94.
- Baumgartner A, Hueppe M, Schmeller W. Long-term benefit of liposuction in patients with lipodema: a follow-up study after an average of 4 and 8 years. *Br J Dermatol.* 2016;174:1061–1067.
- Bjorner JB, Wallenstein GV, Martin MC, et al. Interpreting score differences in the SF-36 vitality scale: using clinical conditions and functional outcomes to define the minimally important difference. *Curr Med Res Opin.* 2007;23:731–739.
- Wada T, Kawai A, Ihara K, et al. Construct validity of the Enneking score for measuring function in patients with malignant or aggressive benign tumours of the upper limb. *J Bone Joint Surg Br.* 2007;89:659–663.