doi: 10.1111/cob.12203

Review

A systematic review of reviews: exploring the relationship between obesity, weight loss and health-related quality of life

R. L. Kolotkin[1,2,3,4,5,] and J. R. Andersen[3,4]

[1]Quality of Life Consulting, PLLC, Durham, NC, USA; [2]Department of Community and Family Medicine, Duke University School of Medicine, Durham, NC, USA; [3]Faculty of Health Studies, Western Norway University of Applied Sciences, Førde, Norway; [4]Førde Hospital Trust, Førde, Norway; [5]Morbid Obesity Centre, Vestfold Hospital Trust, Tønsberg, Norway

Received 22 March 2017; revised 19 May 2017; accepted 23 May 2017

Address for correspondence: RL Kolotkin, Quality of Life Consulting, PLLC, 732 Ninth Street #563, Durham, NC 27705, USA.
E-mail: rkolotkin@qualityoflifeconsulting.com

Summary

This is the first systematic review of reviews to assess the effect of obesity and weight loss on health-related quality of life (HRQoL). We identified 12 meta-analyses/systematic reviews published between January 2001 and July 2016. They addressed the following themes: (i) the relationship between weight/body mass index and HRQoL (baseline/pre-intervention; n = 2). (ii) HRQoL after weight loss (varied interventions and/or study design; n = 2). (iii) HRQoL after weight loss (randomized controlled trials only; n = 2). (iv) HRQoL after bariatric surgery (n = 6). We found that in all populations, obesity was associated with significantly lower generic and obesity-specific HRQoL. The relationship between weight loss and improved HRQoL was consistently demonstrated after bariatric surgery, perhaps due to a greater than average weight loss compared with other treatments. Improved HRQoL was evident after non-surgical weight loss, but was not consistently demonstrated, even in randomized controlled trials. This inconsistency may be attributed to variation in quality of reporting, assessment measures, study populations and weight-loss interventions. We recommend longer-term studies, using both generic and obesity-specific measures, which go beyond HRQoL in isolation to exploring mediators of HRQoL changes and interactions with other variables, such as comorbidities, fitness level and body image.

Keywords: Obesity, quality of life, weight loss, weight management.

Introduction

People with obesity have an increased risk of a multitude of diseases and early mortality (1–5). Beyond health risks, obesity has also been shown to negatively impact quality of life (QoL) (6), defined as an individual's own assessment of well-being, often with reference to physical and mental health status, social relationships and environmental and economic factors (7–9). When the focus in clinical and health research is on the quantification of QoL related to health status, it is referred to as health-related QoL (HRQoL) (7,8,10). This term is most commonly understood to refer to a multidimensional measurement of the individual's perception of the impact of illness and its treatment (10,11). HRQoL captures, at a minimum, physical, psychological and social functioning (10). The various measures for assessing different aspects of an individual's HRQoL can be grouped into two categories: generic measures and disease-specific measures (7,12). Generic measures assess broad aspects of HRQoL, while disease-specific measures are designed to assess HRQoL in relation to a specific medical condition or clinical population.

Because studies on obesity and/or weight loss increasingly include measures of HRQoL, a large number of review articles have been written on this topic. We considered that a systematic review of review articles, comprising a comprehensive examination of the current state of the field, is needed to evaluate the impact of obesity and weight loss on HRQoL. According to Smith *et al.*, one goal of a

systematic review of reviews is to identify and appraise all published reviews within an area of interest in order to summarize and compare conclusions, as well as discuss the strength of these conclusions (13). The aim of this review is to synthesize the information found in obesity and/or weight-loss reviews that assess HRQoL and to evaluate the impact of obesity and weight reduction on HRQoL.

Methods

We conducted a systematic review of reviews in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) guidelines (http://www.prisma-statement.org/). The PubMed and Embase databases were used to identify review articles that have evaluated the evidence of the impact of obesity and weight management on HRQoL (Fig. 1). The search terms applied to the PubMed and Embase databases are detailed in Fig. 2. A search string was defined and limits were applied (Fig. 2). The search was restricted to January 2001 to July 2016. The selection of review articles to include was performed by three independent reviewers (RK; JRA; AXON) and articles were excluded if they met specific predefined exclusion criteria (Fig. 2).

Results

A total of 540 review articles were retrieved from PubMed and Embase, of which 12 were selected for inclusion in this systematic review of reviews. Table 1 provides a detailed overview of the 12 review articles selected for inclusion; 5 were systematic reviews (16,17,21,22,29), 4 were meta-analyses (14,15,18,19) and 3 were both a systematic review and a meta-analysis (12,20,33). In the 12 reviews, a total of 240 individual studies were reviewed; 64 studies were included in two or more of the 12 reviews, while 176 studies were included in only one of the 12 reviews (Table S1, Supporting Information).

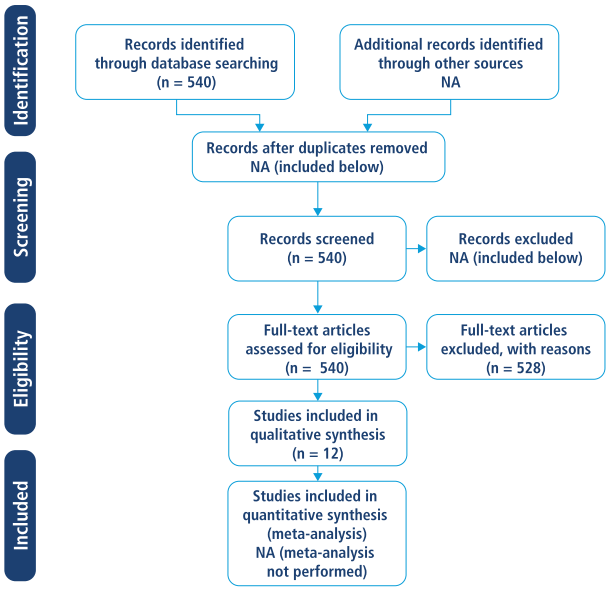

Figure 1 Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) flow chart. NA, not applicable. [Colour figure can be viewed at wileyonlinelibrary.com]

PubMed

Search Set	Terms	Results
#1	obesity[mesh] OR obese[all fields] OR obesity[all fields]	265,584
#2	quality of life[mesh] OR "quality of life"[tiab]	233,078
#3	#1 AND #2	5,563
#4	#3 AND "systematic"[sb], Publication date from 2001/01/01	**330**

Embase

Search Set	Terms	Results
#1	'obesity'/exp OR obesity:ab,ti OR obese:ab,ti	441,889
#2	'quality of life'/exp OR 'quality of life':ab,ti	394,925
#3	#1 AND #2	1,112,771
#4	#3 AND ([cochrane review]/lim OR [systematic review]/lim OR [meta analysis]/lim) AND [2001-2016]/py	491
#5	#4 AND [embase]/lim NOT [medline]/lim	**210**

528 reviews excluded for meeting exclusion criteria:

1. Not a systematic review or meta-analysis
2. A duplicate publication of an already included review
3. Did not answer the clinical question: "What is the impact of obesity and/or weight management on QoL?," or included a brief mention only of how QoL is affected
4. Exclusively reviewed the pediatric population
5. Exclusively reviewed a specific comorbidity of obesity

Figure 2 Identification and selection of published review articles on obesity and/or weight management and quality of life from January 2001 to July 2016. QoL, quality of life. [Colour figure can be viewed at wileyonlinelibrary.com]

Some of the review articles provided a definition of QoL and/or HRQoL (12,16,20,21,29). Definitions were similar and confirmed HRQoL as a multidimensional concept of the individual's perceptions of the impact of their disease on an individual level. All reviews aimed to analyse HRQoL in relation to weight, and could be logically organized into four categories (Table 1). Following a brief discussion of the assessment methods used in all included reviews, the reviews are described by category, below.

Table 1 Review articles focusing on obesity or weight management and HRQoL

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
Category 1: Relationship between weight/BMI and HRQoL (baseline/pre-intervention)						
1	van Nunen *et al.*, 2007 (14)	• Meta-analysis to examine differences in baseline HRQoL among seekers of surgical treatment for obesity, seekers of non-surgical treatment, non-treatment-seeking persons with obesity, general population with obesity and general population	• 54 cross-sectional studies • Dutch, English, French and German • 1996–2006	• Based on both generic and obesity-specific measures, populations with obesity experienced reduced HRQoL ○ For both SF-36 and IWQOL-Lite, the most reduced HRQoL occurred in the surgical patients ○ Comparing patients to non-patients, SF-36 results varied widely by subscale, with only physical functioning showing consistently reduced HRQoL for surgical patient groups ○ However, reduced HRQoL was found on all IWQOL-Lite subscales for patient groups compared with non-patients • After adjustment for BMI, surgical patients still demonstrated reduced HRQoL on most SF-36 subscales, whereas for IWQOL-Lite differences between populations disappeared after adjustment for BMI likely due to the IWQOL-Lite being a weight-related measure of HRQoL	• Analysis of HRQoL in 100 000 geographically diverse individuals in different populations • Articles included both generic (SF-36) and obesity-specific (IWQOL-Lite) HRQoL measures	• The general population with obesity is heterogeneous, including those who intend to seek medical intervention, those who plan their own interventions, and those who do not intend to seek treatment • There is underrepresentation of the intentionally non–treatment-seeking population ○ Included in only 2/54 studies
2	Ul-Haq *et al.*, 2013 (15)	• Meta-analysis to determine the relationships between BMI and physical and mental HRQoL	• 8 cross-sectional studies • English only • 2000–2011	• Physical HRQoL ○ Individuals with higher BMI had significantly reduced physical HRQoL ○ Clear evidence of a dose relationship across all BMI categories • Mental HRQoL ○ Only reduced among individuals classified as Class III obesity (BMI ≥ 40 kg m^{-2})	• Population studies from Australia, Canada, England, Germany, Sweden, USA • Studies included 43 086 participants • Sophisticated methodology ○ Analysed pooled estimates of weighted mean difference in PCS and MCS by BMI in reference to normal weight ○ Determined degree of heterogeneity and assessed publication bias ○ Applied a statistical method to reduce risk of type I errors	• Limited to articles that assessed HRQoL with a single, generic measure only (SF-36) • 1 of 8 studies was based on male Veteran's Administration patients only

Table 1 *Continued*

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
Category 2: HRQoL after weight loss (varied interventions and/or varied study design)						
3	Carson *et al.*, 2014 (16)	• Systematic review to examine the effects of dietary intervention on HRQoL	• 24 studies of ≥12 weeks' duration, including RCTs (21) and non-RCT prospective studies (3) • English, US only • 1990–2012	• In most studies (88%), study participants reported improved HRQoL after dietary intervention ○ 11/24 studies indicated changes in HRQoL were likely a result of weight loss ○ 4/24 studies demonstrated that changes in HRQoL were independent of weight loss ○ In 9/24 studies, it was unclear if changes in HRQoL were a result of weight loss	• Articles included used both generic (QWB, SF-36, SF-12) and obesity-specific (IWQOL, IWQOL-Lite) HRQoL measures	• 4/24 studies used only non-obesity-specific disease measures (e.g. measure of heart failure) ○ 3 of the studies using non-obesity-specific measures reported an improvement in HRQoL over time • 13/24 studies involved short-term follow-ups (12–26 weeks)
4	Kroes *et al.*, 2016 (17)	• Systematic review to review evidence for the impact of weight/BMI change on HRQoL	• 20 studies, including RCTs (8), prospective comparative cohorts (5), prospective single-arm cohorts (5), cross-sectional (1) and retrospective analyses of RCTs (1) • English, US only • ≥1-year follow-up	• Of the studies that explicitly reported on the association between HRQoL and weight change: ○ For lifestyle approach (n = 1): there were significant correlations between weight loss and all IWQOL-Lite subscales except work ○ For pharmaceutical intervention (n = 1): there were larger effect sizes for greater weight reductions for all IWQOL-Lite subscales, PCS, physical functioning, and general health ○ For bariatric surgery at ≥1-year follow-up: greater weight loss showed significant correlations with vitality (n = 1), physical functioning (n = 1), PCS (n = 1), and IWQOL-Lite Total (n = 2) • SF-36 (generic): improvements in physical aspects reported more frequently than mental/psychosocial aspects • IWQOL-Lite (obesity-specific): improvements in all or most subscales	• Unique approach: to investigate the impact of weight change on HRQoL, rather than to compare improvements in HRQoL between interventions • Studies had ≥1-year follow-up	• Included only US, English articles • Studies included were heterogeneous in terms of intervention (bariatric surgery [n = 12]; lifestyle approaches [n = 7]; pharmaceutical intervention [n = 1]), as well as study design and outcomes described, making inferences about associations between weight loss and changes in HRQoL challenging • Although this review included studies using any HRQoL measurement, reporting was limited to SF-36 and IWQOL-Lite
Category 3: HRQoL after weight loss (RCTs only)						
5	Maciejewski *et al.*, 2005 (18)	• Meta-analysis to estimate the effect of various weight-loss interventions	• 34 RCTs	• HRQoL outcomes were not consistently improved in RCTs of weight loss	• Articles included used both generic (GHRI, GWB, SF-36, SIP,	• Review stated that quality of studies examined was poor

Table 1 *Continued*

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
		(e.g. medication, diet, exercise, commercial programme, cognitive behaviour therapy, bariatric surgery) on HRQoL in RCT studies, and a meta-analysis of the effect of weight-loss treatment on depressive symptoms		○ Generic measures: 9/34 studies showed HRQoL improvements in ≥1 domains ○ Obesity-specific measures: 6/11 studies showed positive treatment effects	VAS) and obesity-specific (IWQOL, OP) HRQoL measures • Study duration varied from 6 to 208 weeks; 8 studies of >52 weeks' duration and 26 studies of ≤1 year's duration • Study quality was assessed according to 6 different criteria: concealment of randomization, blinding, loss to follow-up, intention-to-treat analysis, adjustment for mediating effects of weight loss, and adjustment for multiple comparisons	
6	Warkentin *et al.*, 2013 (12)	• Systematic review and meta-analysis to examine the effect of weight loss (any weight-loss intervention vs. no intervention, placebo or active comparator) on HRQoL in RCTs	• 53 RCTs met eligibility • 11/53 included in meta-analysis	• Generic measures: 14/36 studies found significant improvements • Obesity-specific measures: 4/15 studies found significant improvements • Contingency table approach (included all trials): no significant association between weight-loss and overall HRQoL • Quantitative data pooling approach (included 25% of trials): statistically significant improvements in physical but not mental health	• Articles included used both generic (EQ-5D, GHQ, QWB, SF-36, VAS) and obesity-specific (IWQOL-Lite, M-A QoLQII, OAS, OP, ORWELL, WRSM) HRQoL measures • Different analytical methods were used ○ Contingency table approach: incorporates information from all studies examined, but gives them equal weight, such that the magnitude of changes cannot be compared ○ Conventional random effects meta-analytical technique: considered to be more rigorous because uses study-specific values and inverse-variance weighting to generate pooled estimates; however, quantitative data pooling was limited to only 25% of available studies due to the poor quality of reporting	• Data from most studies could not be quantitatively pooled for meta-analysis • In 35/53 RCTs, study duration was <1 year
Category 4: HRQoL after bariatric surgery						
7	Magallares and Schomerus, 2015 (19)	• Meta-analysis to compare HRQoL before and 1 year after bariatric surgery	• 21 studies • English, German, Italian, Portuguese and Spanish	• Compared to pre-surgery, patients scored higher in physical and mental	• Studies drawn from a diverse literature base that encompassed five languages	• Study design of included studies was not indicated

Table 1 *Continued*

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
				components of the SF-36 1 year after bariatric surgery ○ The size of the effect was much greater for the physical component than the mental component, but both effects were very high • There was a large variability/ heterogeneity in amount of improvement in both PCS and MCS		• Limited to those with a follow-up period of ≤1 year and those that administered only SF-36
8	Lindekilde *et al.*, 2015 (20)	• Systematic review and meta-analysis to assess the impact of bariatric surgery (15 different methods) on HRQoL and the between-study variation	• 72 studies, including cohort studies (60), non-randomized studies (5), randomized studies (7)	• Bariatric surgery had a significant positive influence on HRQoL ○ Influence was greater on physical vs. mental HRQoL ○ Greater effects were found for obesity-specific measures of HRQoL than for other types • A large variability (heterogeneity) in HRQoL outcomes was found	• Articles included used 22 HRQoL measures, including generic (EQ-5D, SF-36), obesity-specific (IWQOL, IWQOL-Lite, M-A QoLQII, WRSM), combined generic/obesity-specific (HRQoL-HSP) and gastrointestinal-specific (GIQLI) HRQoL measures • Follow-up ranged from 3 to 120 months • Controlled for multiple other factors (baseline BMI, age, type of measure, type of surgery, months to follow-up, year of publication and country of study) • Provided effect sizes of changes in HRQoL	• HRQoL scales and subscales were categorized into 5 domains (physical, mental, social, functional and total), but authors do not indicate how they assigned scores to the domains • Majority of included studies used a non-randomized design; none of the randomized studies used a non-surgical control group
9	Andersen *et al.*, 2015 (21)	• Systematic review to study the long-term (i.e. ≥5 years) effects of bariatric surgery (6 different methods) on HRQoL	• 7 prospective studies, 2 with control groups • English • ≥5 year follow-up	• 6/7 studies showed improvements in 9 aspects of HRQoL • Peak improvements in HRQoL observed during first 1–2 postoperative years (characterized by the most meaningful amount of weight loss), followed by a gradual decline that stabilized at 5 years • 5-year postoperative scores were an improvement from preoperative scores, but lower than the population norm ○ Of the statistically significant improvements in HRQoL, 92% were clinically meaningful (i.e. >0.5	• Review focuses exclusively on high-quality, long-term (5–10 years), prospective studies of bariatric surgery • All studies included were high quality, defined as attrition rate <50%, and 90% power to detect >0.5 standard deviation change from baseline using a two-sided paired test • Articles included used both generic (15D, GHRI scale, GWB, NHPII, SF-36) and obesity-specific (IWQOL-Lite, OP, Weight Distress) HRQoL measures	• Attrition rates in included studies ranged from 8 to 39.2% • Included studies were heterogeneous with respect to baseline BMI, HRQoL instruments and surgical methods

Table 1 *Continued*

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
				standard deviation change from baseline)		
10	Jumbe, 2015 (22)	• Systematic review to assess psychosocial HRQoL of bariatric surgery patients at a minimum of 1-year follow-up compared to: • Individuals receiving non-surgical interventions • Non-treated comparison groups	• 11 studies, including RCTs (2), prospective cohorts (8) and retrospective analysis (1) (SF-36 measured at follow-up only)	• Bariatric surgery vs. non-surgical treatment ○ For all 3 studies using the SF-36 scale, bariatric surgery groups had better HRQoL outcomes vs. non-surgical interventions ○ 1/3 studies using the SF-36 scale reported significantly better outcomes across all subscales • Bariatric surgery vs. control groups ○ For 5 of the 7 studies assessing generic and/or obesity-specific HRQoL pre-and posttreatment, patients in surgical groups reported higher HRQoL vs. control groups at follow-up ○ Improvements were seen in all or some of the mental/psychosocial aspects of HRQoL	• Articles included both generic (SF-36, SF-12, EQ-5D, SIP), and obesity-specific measures (IWQOL-Lite, OP) • Follow-up ranged from 1 to 10 years • Study quality was evaluated	• 2 studies assessed HRQoL in individuals with both obesity and diabetes (23,24) • 4 studies (25–28) used data from the Utah Obesity Study; thus, reporting these studies separately may skew the conclusions • Conclusion of "persistent psychological issues post-surgery" is an overstatement of the data presented in the reviewed studies • Despite better outcomes reported in 3 of the 4 studies comparing bariatric surgery with non-surgical treatment, authors state that, overall, these studies show moderate evidence of similar improvements in HRQoL in these 2 groups • Despite reporting of improvements in mental/psychosocial HRQoL in several of the studies, authors state that long-term psychosocial HRQoL does not improve after bariatric surgery compared to controls
11	Hachem *et al.*, 2016 (29)	• Systematic review to examine HRQoL as an outcome of bariatric surgery by comparing:	• 13 studies ○ 7 studies (1 RCT, 6 quasi-experimental studies): bariatric	• Significant HRQoL improvements following bariatric surgery ○ Greater improvements in surgical vs. non-surgical interventions	• Articles included used generic (SF-36, M–A QoLQII, SIP, GHRI), obesity-specific (IWQOL-Lite, OWLQOL, WRSM, GIQLI, QOLOD)	• 2 studies measured HRQoL post-surgery only • 6 studies reported follow-ups of ≤1 year

Table 1 *Continued*

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
		○ Bariatric surgery to alternative weight-loss interventions ○ Different types of bariatric surgery	surgery vs. an alternative weight-loss intervention ○ 6 studies (5 RCTs, 1 quasi-experimental study): 1 type of bariatric surgery vs. another • English	• Significant HRQoL improvements in gastric bypass and laparoscopic sleeve gastrectomy vs. vertical banding gastroplasty and laparoscopic adjustable gastric banding, respectively • No differences in HRQoL between variations of the same type of surgery (e.g. gastric bypass vs. mini gastric bypass)	and gastrointestinal-specific HRQoL measures • Follow-up ranged from 2 months to 10 years	• Results were not included for the 10-year follow-up of Karlsson et al. (30) or the 6-year follow-up of Adams et al. (27) • Only 2 studies evaluated between-group differences • Each comparison of different surgery types was made in only a single study • Reporting of HRQoL results was inconsistent, with some reporting overall scores, some reporting composite scores, and some reporting selected subscale scores • 2 included studies (31,32) (studies by Canetti *et al.* in 2009 and 2013) used the same study sample
12	Driscoll *et al.*, 2016 (33)	• Systematic review and meta-analysis of studies reporting HRQoL data ≥5 years after bariatric surgery and in non-surgical control groups with obesity	• 9 studies, including cross-sectional studies (7), prospective cohort study (1), and non-randomized controlled trial (1)	• Systematic review of all studies and measures ○ Greater improvements were noted in both the physical and mental domains of HRQoL for the surgical groups compared with the control groups; however, there were inconsistencies in results (i.e. favouring surgical group, favouring control group, and no difference) in both physical and mental domains • Meta-analysis of SF-36 results ○ Inconsistencies that had been seen in the systematic review were not seen in the meta-analysis ○ Significant improvement in all mental domains after 5 years favouring the surgical group compared with the controls; and 3/4 physical domains	• Articles included used both generic (SF-36, EQ-5D, Current Health Scale from the GHRI and obesity-specific (IWQOL-Lite, OP) measures • Studies had follow-up periods of 5 to 25 years	• Meta-analysis could only be conducted on studies reporting SF-36 scores

Table 1 *Continued*

No.	Author, date	Type/goal of review	Studies	Key findings	Strengths	Limitations
				• The magnitude of improvement in surgical groups vs. control groups was greater for the physical than mental domains		

HRQoL-HSP is sometimes referred to as 'Lewin-TAG'.

15D, 15-dimensional measure; EQ-5D, EuroQuol-5D measure; GHQ, General Health Questionnaire; GHRI, General Health Rating Index; GIQLI, Gastrointestinal Quality of Life measure; GWB, General Well-Being measure; HRQoL, health-related quality of life; HRQoL-HSP, Health-related quality of life-Health State Preference Assessment; IWQOL, Impact of Weight on Quality of Life; IWQOL-Lite, Impact of Weight on Quality of Life-Lite; M–A QoLQII, Moorehead–Ardelt Quality of Life Questionnaire II; NHP, Nottingham Health Profile; OAS, Obesity Adjustment Survey; OP, Obesity-related Problems scale; ORWELL, Obesity-Related Well-Being questionnaire; OWLQOL, Obesity and Weight Loss Quality of Life; QOLOD, Quality of Life, Obesity and Dietetics Rating Scale; QWB, Quality of Well-Being scale; RCT, randomized controlled trial; SF-36, Medical Outcomes Study Short-Form-36; SIP, Sickness Impact Profile; VAS, Visual Analogue Scale; WRSM, Weight-Related Symptoms Measure.

Assessment of health-related quality of life

Among the 12 review articles examined, a total of 23 different measures of HRQoL were identified (Table S2) and could be categorized as follows: 11 generic, 10 obesity-specific, 1 combined generic/obesity-specific and 1 gastrointestinal-specific. We did not report results of measures of depression, anxiety, stress or emotions (12,18,22), nor did we include any non-obesity-specific disease measures (e.g. Minnesota Living with Heart Failure Questionnaire, Pelvic Floor Impact Questionnaire), as these measures are not true assessments of HRQoL (34). We have also not reported results obtained from the Bariatric Analysis and Reporting Outcome System (BAROS) (35), as it can only be applied to post-surgical (not pre- vs. post-surgical) outcomes for bariatric surgery patients.

A total of 10 of the 12 review articles included studies that used both generic and obesity-specific measures of HRQoL (12,14,16–18,20–22,29,33), whereas 2 of the review articles included only generic measures (15,19). The most commonly used measures were the generic Medical Outcomes Study Short-Form-36 (SF-36) (36) and the obesity-specific Impact of Weight on Quality of Life-Lite (IWQOL-Lite) questionnaires (37). A total of 5 of 12 the reviews specified that they included both generic and obesity-specific measures in order to provide a more complete understanding of the patient populations (12,17,18,20,29).

Category 1: Relationship between weight/body mass index and health-related quality of life (baseline/pre-intervention)

A total of 2 of 12 reviews examined the association between weight/body mass index (BMI) and HRQoL without, or prior to, any intervention (14,15). van Nunen *et al.* performed a meta-analysis of cross-sectional differences among five subgroups, including: non-patient subgroups (general population, general population with obesity and non-treatment-seeking people with obesity) and patient subgroups (non-surgical weight-loss patients and bariatric surgery patients) (14) (Table 1). For both SF-36 and IWQOL-Lite, the greatest reduction in HRQoL was observed in the surgical patients. SF-36 results varied widely by subscale, with only a consistent reduction in the physical functioning HRQoL subscale for patient vs. non-patient groups.

However, reduced HRQoL was found on all IWQOL-Lite subscales for patient (compared with non-patient) groups. After adjustment for BMI, reduced HRQoL on most SF-36 subscales remained for surgical patients, whereas for IWQOL-Lite differences between general, non-treatment, conservative treatment and surgical treatment subgroups disappeared, suggesting that when using the IWQOL-Lite questionnaire in cross-sectional analyses, body weight is the main determinant of HRQoL.

Ul-Haq *et al.* evaluated HRQoL across studies that used SF-36 and cross-sectional data from six countries (Table 1) (15). In this well-designed meta-analysis, the authors analysed pooled estimates (totalling 43 086 participants) of the weighted mean difference in the Physical Component Summary (PCS) score and the Mental Component Summary (MCS) score with reference to normal weight, determined the degree of heterogeneity, assessed publication bias and applied a statistical method to reduce the risk of Type I errors. Compared with normal-weight adults, those with higher BMI (≥25 kg m^{-2}) had significantly reduced PCS scores and a dose relationship was evident across all BMI categories. In contrast, compared with the normal-weight adults, MCS scores were significantly reduced only in those with Class III obesity (BMI ≥ 40 kg m^{-2}), but not Class I (BMI 30–34.9 kg m^{-2}) or Class II (BMI 35–39.9 kg m^{-2}) obesity (15).

Category 2: Health-related quality of life after weight loss (varied interventions and/or study design)

Carson *et al.* (16) assessed changes in HRQoL after dietary interventions in 21 randomized controlled trials (RCTs) and 3 non-RCTs (Table 1) (38–61). Twenty-two studies reported improvements in HRQoL over time; (38–50,52–54,56–61) however, 3 of these 22 studies used only non-obesity-specific disease measures to assess HRQoL (38,44,54). Mean weight loss ranged from 2 to 10 kg for the groups receiving active treatment (i.e. calorie restriction, healthy diet or commercial programme).

Four studies demonstrated that changes in HRQoL were independent of weight loss; (39–42) 11 studies indicated that changes in HRQoL were probably a result of weight loss (38,43–52) (three of these included only a non-obesity-specific measure of disease impairment); (38,44,51) and in the remaining nine studies, the role of weight loss in HRQoL changes was unclear (53–61).

Kroes *et al.* assessed the impact of weight/BMI change on HRQoL (SF-36, IWQOL-Lite, or both) in 8 RCTs and 12 non-RCTs following a number of different interventions, including lifestyle approaches (exercise, dietary weight loss or counselling), pharmaceutical intervention and bariatric surgery (17). For the seven studies that reported the association of weight loss and HRQoL, one study of lifestyle change resulted in a median weight loss of 0.36 kg; for the one pharmaceutical intervention, mean weight loss was 2.7%; for the studies of bariatric surgery with ≥1-year follow-up, percent weight reduction was 20–38.8% and percent excess weight loss was 56.4–62.7%. Regardless of intervention, improvements in the physical aspects of the SF-36 were reported more frequently than improvements in mental/psychosocial aspects, whereas improvements in all or most of the obesity-specific IWQOL-Lite subscales were demonstrated. However, a significant degree of heterogeneity in the included studies precluded drawing conclusions about the specific association between weight/BMI change and HRQoL.

Category 3: Health-related quality of life after weight-loss (randomized controlled trials only)

Two reviews described HRQoL outcomes after RCTs of weight-loss interventions, one published in 2005 (18) and the other in 2013 (12) (Table 1). The earlier review included 34 studies, while the later one included 53 studies (with 14 overlapping studies; see Table S1). As well as an increase in the number of studies, the quality of reporting of HRQoL results improved over time, allowing more sophisticated analyses in the more recent review.

One similarity between these two reviews is that weight-loss interventions were quite diverse. Although both reviews included meta-analyses, the 2005 review (18) – due to poor quality of reporting and insufficient data on measures of HRQoL – used a meta-analysis only on the effect of weight-loss treatment on depressive symptoms, whereas in the 2013 review (12) meta-analyses were used to examine the relationship between changes in weight and HRQoL.

In the studies reported in the 2005 review (18), 9 of 34 RCTs demonstrated improvements in generic HRQoL in one or more domains, although the domains varied by study. Six of the 11 that used obesity-specific measures showed positive treatment effects. Weight loss was not reported in this review. In the studies reported in 2013 by Warkentin *et al.* (12), 14 of 36 studies reporting generic measures of HRQoL found significant improvements, whereas 4 of 15 studies reporting obesity-specific measures found significant improvements. Weight loss varied from ≤5 to ≥10% (specific weight loss values were not reported). Conclusions from both of these reviews of RCTs were similar. Maciejewski *et al.* (18) concluded: '*HRQoL outcomes, including depression, were not consistently improved in RCTs of weight loss*.' Warkentin *et al.* (12) concluded: '*Certainly, compelling and definitive RCT-level data to support the notion that HRQoL is consistently and robustly improved following weight loss is not available*.'

Category 4: Health-related quality of life after bariatric surgery

Six reviews examined HRQoL after bariatric surgery (Table 1) (19–22,29,33). Inclusion/exclusion criteria differed between the reviews, resulting in eight overlapping studies between Lindekilde *et al.* (20) and Magallares and Schomerus (19), six between Lindekilde *et al.* (20) and Andersen *et al.* (21), four between Lindekilde *et al.* (20) and Hachem *et al.* (29), and three between Lindekilde *et al.*

(20) and Jumbe *et al.* (Table S1) (22). The remaining review combinations had two or fewer overlapping studies. Each of these reviews of bariatric surgery outcomes has its own strengths and limitations (Table 1).

The six reviews reported and/or analysed HRQoL data using different methods, making a comparison of the results challenging. Only the reviews by Andersen *et al.* (21), Lindekilde *et al.* (20), and Magallares and Schomerus (19) reported results in terms of standardized effect sizes (i.e. the magnitude of the pre- to post-surgery changes were reported in a standardized fashion). Reporting standardized effect sizes allows direct comparisons across studies. Nevertheless, the specific methods used to calculate effect sizes varied across reviews, making comparisons less meaningful.

Additional inconsistencies in HRQoL reporting were observed across studies. In Andersen *et al.* (21), primary outcomes (defined as summary scores of generic or obesity-specific measures or a measure of overall health status or overall well-being) and secondary outcomes (defined as domain scores, such as social interaction, physical appearance and self-regard) were reported separately to minimize multiple comparisons. In the review by Lindekilde *et al.* (20), all of the HRQoL scales and subscales were categorized into five domains: 'physical', 'mental', 'social', 'functional' and 'total', together with 'overall HRQoL' and 'HRQoL for all measures'. However, no information was provided on how the various subscales of each assessment measure were assigned to these domains, nor was the distinction between total HRQoL and overall HRQoL described, making their analyses difficult to replicate and results difficult to interpret. Finally, reporting of study results was inconsistent in the reviews by Hachem *et al.* (29) and Jumbe *et al.* (22), with some reporting overall scores, some reporting composite scores and some reporting subscale scores, also making results difficult to interpret.

Weight loss was reported differently across bariatric surgery reviews, as well as inconsistently within any single review. Study duration ranged from 5 to 72 months. For reviews reporting change in BMI from baseline to end of study (20–22,33), BMI change ranged from 4.6 to 30.6 kg m^{-2}. For reviews reporting mean weight loss in kg (22), weight reduction was 13.5–45.1 kg. Two reviews (19,29) did not report any end-of-trial values for change in BMI or weight.

Medical Outcomes Study Short-Form-36 (SF-36) results of bariatric surgery studies

All bariatric surgery reviews included SF-36 results. Magallares and Schomerus (19) found a large variation in the degree of improvement in both PCS and MCS at ≤1-year post-surgery. Although effect sizes associated with these changes were much greater for the physical component than the mental component, both effects were very large.

Although Lindekilde *et al.* (20) did not report results separately for PCS and MCS, they examined differences between 'physical and mental domains on the SF-36' adjusted for baseline scores, reporting that these differences were significantly greater for the physical than for the mental domains. In addition to the SF-36 analysis, these authors computed physical and mental scores from the various measures administered. The effect size for physical HRQoL was significantly greater than that for mental HRQoL and this difference remained significant, even after adjusting for other factors (baseline BMI, age, type of measure, type of surgery, months to follow-up, year of publication and country in which the study was carried out).

The review by Jumbe *et al.* (22) revealed significantly better SF-36 outcomes in three out of three studies for people who had undergone bariatric surgery compared with those receiving non-surgical interventions. One out of the three RCTs reported significantly better outcomes across all SF-36 subscales. Five out of seven studies in which SF-36 outcomes after bariatric surgery were compared with those obtained in non-treated control groups showed greater improvements in the surgery group compared with the controls, although there was some overlap among the patient populations included in these studies (see Table 1).

Four of the six studies reporting SF-36 results in the review by Hachem *et al.* (29) reported a significant improvement in the physical aspects of HRQoL and three of the studies reported a significant improvement in the mental aspects of HRQoL after bariatric surgery, whereas there were no significant changes in these domains in the non-surgical comparator groups in two of the studies.

Two of the reviews included herein comprised only long-term studies (≥5-year duration) (21,33). In the review by Andersen *et al.* (21), two of the three studies using the SF-36 showed significant improvements in both PCS and MCS at 5–6 years; (25,62) the remaining study showed significant improvements only in PCS (63). Peak improvements in PCS occurred at 1–2 years across all three studies. MCS scores showed a less consistent pattern. While the systematic review conducted by Driscoll *et al.* (33) showed some inconsistencies in SF-36 results, meta-analysis results revealed significant improvements in both physical and mental health domains of the SF-36 after 5 years, favouring surgical over control groups. Improvements were greater in the physical compared with the mental domains.

In general, results of SF-36 scores following bariatric surgery showed improvements in HRQoL relative to non-surgical groups. Moreover, although these changes were seen in both mental and physical domains, improvements in physical domains of HRQoL seem to be greater.

Obesity-specific health-related quality of life results of bariatric surgery studies

Five of the six reviews included obesity-specific HRQoL results (20–22,29,33). In the three studies (25,30,64) reviewed by Andersen *et al.* (21) that used an obesity-specific measure of HRQoL, significant and very large effects were reported at 5–10 years. In addition, effect sizes were generally larger for obesity-specific than for generic measures. Similarly, effect sizes were greater for obesity-specific than for generic measures of HRQoL in the Lindekilde *et al.* (20) review.

Two studies included in the review by Hachem *et al.* reported between-group differences on obesity-specific measures of HRQoL (26,65). Specifically, in the study by Adams *et al.* (26), significant improvements were found on the IWQOL-Lite questionnaire in the post-gastric bypass surgery vs. two comparator groups (people with obesity seeking bariatric surgery who did not have surgery and people with obesity who were not seeking surgery).

In the Brunault *et al.* (65) study, both laparoscopic adjustable gastric banding (LAGB) and laparoscopic sleeve gastrectomy (LSG) resulted in improved physical, psychosocial, sexual and diet experience domains on the QoL, Obesity and Dietetics Rating Scale vs. pre-operative assessments. In addition, the 'comfort with food scale' showed greater improvement in the LSG group compared with the LAGB group at 6, but not at 12, months.

In the review by Driscoll *et al.* (33), three studies (30,66,67) included the Obesity-related Problems scale (OP scale) and one study (25) included the IWQOL-Lite. An observational, cross-sectional study by Raoof *et al.* (66) indicated that OP scores for patients who had undergone gastric bypass surgery an average of 11.5 ± 2.7 years earlier showed improved HRQoL vs. scores obtained by a matched group awaiting bariatric surgery; however, OP scores for the post-surgical group also revealed that HRQoL remained impaired when compared with the general population. In the study by Karlsson *et al.* (30), the OP scale improved significantly for bariatric surgery patients at 10 years vs. pre-surgery and these improvements were greater than those seen in patients treated with non-surgical interventions. In the study by Aftab et al (67),. OP scores obtained in post-bariatric surgery patients at 5 years were superior to those obtained in patients pre-surgery. Kolotkin *et al.* (25) found that patients who had undergone gastric bypass surgery 6 years previously had significantly greater improvements from baseline in all five IWQOL-Lite domains compared with people with obesity who sought but did not receive gastric bypass, and also compared with people with severe obesity in the general population.

In summary, using obesity-specific HRQoL measures, positive effects on HRQoL were seen following bariatric surgery, and these changes tended to be greater than those seen with SF-36.

Discussion

This is the first systematic review of reviews to synthesize published information on the impact of obesity and weight loss on HRQoL. By including only meta-analyses and systematic reviews, and excluding narrative reviews, bias was minimized. Moreover, by reviewing multiple reviews, we were able to integrate information from a large number of studies: only 64 (27%) of the 240 studies were included in more than one review, and this small degree of overlap limited the risk of duplication of conclusions, while ensuring the reviews were not overly selective. This systematic review of reviews illustrates the significant and negative impact that overweight/obesity has on HRQoL, regardless of study population (14,15).

In reviews examining the relationship between HRQoL and obesity in various populations without or prior to intervention, increased obesity was associated with decreased HRQoL, particularly in those with Class III obesity (BMI ≥ 40 kg m^{-2}) (15) and those seeking bariatric surgery (14), suggesting that low HRQoL may provide motivation in these patients to undergo an invasive intervention. Furthermore, the physical aspects of HRQoL seem to be more closely associated with degree of obesity than the mental aspects of HRQoL; in population data from six countries the relationship between BMI and SF-36 PCS was dose-dependent, with poorer physical HRQoL occurring in those with higher BMIs, whereas MCS scores were reduced only in those with Class III obesity.

Reviews limited to RCTs (12,18) represent the most robust dataset available, and although one might expect consistent associations between weight loss and improved HRQoL, these studies are not conclusive, despite inclusion of both generic and obesity-specific data. In the two reviews limited to RCTs, one reported significant improvements in one or more domains of generic HRQoL in 9 out of 34 included RCTs (18), whereas the other review reported improvements in 14 out of 36 included studies evaluating HRQoL using a generic measure (12). Obesity-specific HRQoL results were also inconsistent, with one review reporting improved obesity-specific HRQoL in 6 out of 11 included studies (18) and the other reporting improved obesity-specific HRQoL in 4 out of 15 included studies (12).

The lack of consistently demonstrated associations between weight loss and improved HRQoL in RCTs may be due to the following factors: diverse HRQoL measures have been used; weight-loss interventions have been heterogeneous, with some more successful at inducing weight loss than others; studies may have been underpowered to detect differences in HRQoL outcomes; and there has been poor reporting of HRQoL outcomes (since weight loss, rather than HRQoL, is usually the primary outcome). To bring more clarity to these results, authors of two of the systematic reviews recommend that future research focus on

prospective, long-term studies, especially RCTs or large, well-designed, observational studies with high retention rates, comparator groups and carefully chosen generic and obesity-specific HRQoL measures (12,21).

Results from reviews that include studies of mixed design (RCTs and non-RCTs) and/or mixed interventions are even more difficult to interpret (16,17), especially when treatments are diverse (e.g. bariatric surgery, pharmaceutical interventions and lifestyle treatments) and result in vastly divergent weight loss outcomes (17). Overall, more randomized, controlled, high-quality studies are needed to better understand the relationship between the various possible weight-loss interventions and changes in HRQoL.

When reviews were limited to those undergoing bariatric surgery, there was less variation in results, with post-bariatric surgery patients demonstrating improvements in both physical and mental aspects of generic HRQoL. It is likely that the greater weight reductions seen with bariatric surgery, compared with dietary, medical and lifestyle treatments, contribute to the consistency of improvements in HRQoL. In addition, baseline HRQoL scores are more impaired for people undergoing bariatric surgery than for patients receiving non-surgical treatments (14) allowing the possibility of greater improvement. Improvements in physical aspects were greater and reported more consistently than improvements in mental aspects of HRQoL when assessed with the SF-36. Comparison of post-surgical effect sizes indicated consistently larger effects with obesity-specific measures compared with generic measures, suggesting that obesity-specific measures may be more sensitive to change.

That such effects were generally more marked when obesity-specific measures were utilized is consistent with recommendations made in several reviews that both types of measures be incorporated into future studies (12,17,20,21,29).

In the reviews comparing HRQoL outcomes in patients who have undergone weight-loss surgery with non-surgical comparator groups, improvements in HRQoL were generally greater in the surgical groups, despite some inconsistency of findings. Taken as a whole, these findings suggest the value of assessing HRQoL in patients with clinically severe obesity so that they may receive the HRQoL benefits from bariatric surgery.

It is encouraging that weight loss is often associated with improvements in HRQoL in people with obesity. Nevertheless, some reviews demonstrated significant variability in HRQoL after weight-loss intervention. Articles included in this systematic review of reviews cited several potential limitations, including insufficient data due to patient dropout and lack of follow-up, and a shortage of studies reporting on obesity-specific HRQoL. For example, in the review by Warkentin *et al.* (12), only 25% of studies using SF-36 could be included in the quantitative data pooling due to poor reporting quality. This low quality of reporting and lack of data may be because HRQoL is usually a secondary outcome in studies. Another limitation in the included reviews of weight-loss studies is that length of follow-up varied considerably, some with durations as short as 6 weeks, making it difficult to draw meaningful conclusions about longer-term outcomes. The majority of studies had a short-term (<24 months) or medium-term (24–60 months) follow-up period and only two reviews (both evaluating the effects of bariatric surgery on HRQoL) focused exclusively on studies with long-term follow-up periods (≥5 years) (21,33).

The assessment of the quality of studies included in a review is also an important indicator of the strength of the conclusions of the authors; yet, only approximately 40% of systematic reviews evaluate the quality of included studies (68).

Notably, in this systematic review of reviews, a higher number (9 of the 12 review articles [75%]) concerned themselves with study quality, either by including a direct assessment of study quality (12,16–18,22,33) or by using 'acceptable quality' (variably defined) as selection criteria for study inclusion (20,21).

We also noted differences across the 12 reviews with respect to HRQoL measures, country and language of the studies, reporting of results, method for determining effect sizes, length of follow-up, type of weight-loss intervention and population being studied. We made every effort to describe similarities and differences among reviews and to report the number of reviews that made particular conclusions. We believe our review represents a true synthesis of current and diverse reviews in this field and, as such, has broad applicability.

We make no attempt to draw conclusions about the HRQoL of specific patient populations/subgroups (e.g. different ethnicities/cultures, age or comorbidities). Studies not discussed in this review have shown that these variables may be helpful in predicting the impact that weight and/or weight loss have on HRQoL (69–72). For example, increasing age in people with overweight or obesity is associated with increased impairment in some domains of HRQoL, such as physical function, sexual life and work, but not others (72). Some studies conclude that women with overweight or obesity report more impairment than men in some HRQoL domains (71,72). Furthermore, HRQoL in people with obesity varies depending on presence of comorbidities (69,70). Two reviews (15,17) recommend that future studies assess the impact of comorbidities on HRQoL.

Four reviews (12,16–18) recommended exploring mediators of changes in HRQoL to understand if the driver of HRQoL improvements is weight loss itself, the weight-loss intervention or changes in other variables. A recent study (73) used multiple mediation analysis to explore causal

mechanisms underlying the relationship between weight loss and improved HRQoL in two weight-loss trials investigating phentermine/topiramate. Results indicated that improved HRQoL was primarily mediated by weight loss, but decreased depressive symptoms also accounted for improvements in HRQoL.

Similarly, a mediation analysis of three RCTs with liraglutide 3.0 mg showed that improvements in IWQOL-Lite total and physical function scores in patients with type 2 diabetes were primarily driven by weight loss (74). Several other recommendations for future research were provided in the included reviews (see Fig. 3 for summary).

After conducting this systematic review of reviews, we believe the next wave of research studies should focus on the interactions between HRQoL and other variables, such as gender, fitness level, comorbidities or body image. For example, do the associations between HRQoL and obesity and/or weight loss consistently vary by other variables and how do these variables interact with each other? Is there a gradient in HRQoL by weight-loss treatment, such that treatments inducing greater weight loss are or are not associated with greater HRQoL improvements? How much weight loss is needed for improvement in HRQoL and what is the impact of weight regain on HRQoL? Is improvement in HRQoL after weight-loss treatment dependent primarily on amount of weight loss, or do other factors have a role? Can we predict which individuals will experience improved HRQoL after weight loss?

Inclusion of HRQoL assessments, especially obesity-specific assessments, in regular patient evaluations could guide the development of broad healthcare policies that recognize the bio-psychosocial impact of the growing obesity epidemic. HRQoL assessments can help patients and providers differentiate between treatments that have similar weight-loss patterns but different side-effect profiles or different impacts on HRQoL. It is desirable to reach a consensus for the best way to evaluate the impact of obesity and/or weight loss on HRQoL in future studies to facilitate comparison of results across studies (77).

In summary, this is the first systematic review of reviews to synthesize research on the impact of obesity and weight loss on HRQoL. We found that obesity was associated with significantly lower HRQoL in all populations. We also established an important relationship between weight loss and improved HRQoL, which is demonstrated most consistently following bariatric surgery, but less consistently following non-surgical weight-loss interventions.

In order to build upon these findings, we recommend longer-term studies that use both generic and obesity-specific measures and that evaluate the impact of other factors (e.g. comorbidities, fitness level, body image) on HRQoL after various weight-loss interventions. These findings, plus those of future studies and review articles, will help us better understand the complex and multifaceted nature of obesity and its impact on the daily lives of our patients.

- Report results in terms of standardized effect sizes to allow for comparison of results across studies[18]
- Consider baseline scores when interpreting results, as greater improvements in HRQoL may occur in individuals with a higher baseline BMI and measures may be subject to ceiling effects[17]
- Determine factors that may have a role in the variability of HRQoL outcomes,[19] including ethnicity and gender[17]
- Consider the effects of age on HRQoL in long-term studies of HRQoL (eg, PCS scores decline with age)[17]
- Analyze the role of body image in HRQoL.[19] For example, frequency of body checking and body avoidance, as well as degree of internalized weight bias, have been associated with HRQoL impairment[75,76]
- Consider reasons for dropouts to aid in developing a more unbiased view of HRQoL changes after bariatric surgery[19] and other weight-loss interventions
- When conducting cross-sectional studies, use contemporaneous, rather than historical, comparison groups because societal experiences of obesity are likely to be different at different points in history, especially given the dramatic rise of obesity in recent years[33]
- Determine whether changes in HRQoL are clinically meaningful[18]
- Increase focus on the non-treatment population, especially men, to examine factors that account for reluctance of men to seek professional help to reduce weight, and to improve health and HRQoL[14]
- Design and test the utility of psychological interventions aimed at supporting the needs of the bariatric surgery patient, in order to obtain a better understanding of the mental health of individuals throughout the surgery process[20]
- Develop a nutrition-specific measure of HRQoL[16]

Figure 3 Summary of recommendations for future studies. BMI, body mass index; HRQoL, health-related quality of life; PCS, Physical Component Summary. [Colour figure can be viewed at wileyonlinelibrary.com]

Conflict of Interest Statement

RLK receives royalties from Duke University as IWQOL-Lite developer; support as a consultant to Eisai, Janssen and Novo Nordisk; and grant support from University of Utah (Grant DK055006; the National Institutes of Health/The National Institute of Diabetes and Digestive and Kidney Diseases). JRA has no conflicts to declare.

Author contributions

Both RLK and JRA were responsible for the content and organization of the manuscript, as well as the search parameters of this systematic review of reviews. RLK did the majority of the writing of the manuscript, with JRA contributing significantly to the discussion and recommendations.

Both authors take full responsibility for the content of this manuscript.

Acknowledgements

The authors are grateful to Dr Matthew Maciejewski for his consultation, to Megan von Isenburg for her guidance with the search string and AXON Communications for writing and editorial assistance in the development of this manuscript. Medical writing assistance was funded by Novo Nordisk. Novo Nordisk was also provided with the opportunity to perform a medical accuracy review.

References

1. Adams KF, Schatzkin A, Harris TB *et al*. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. *N Engl J Med* 2006; **355**: 763–778.
2. Kurth T, Gaziano JM, Berger K *et al*. Body mass index and the risk of stroke in men. *Arch Intern Med* 2002; **162**: 2557–2562.
3. Zammit C, Liddicoat H, Moonsie I, Makker H. Obesity and respiratory diseases. *Int J Gen Med* 2010; **3**: 335–343.
4. Centers for Disease Control and Prevention. Overweight & Obesity; 2016 [WWW document]. URL https://www.cdc.gov/obesity/ (accessed 27 January 2017).
5. Young T, Shahar E, Nieto FJ *et al*. Predictors of sleep-disordered breathing in community-dwelling adults: the Sleep Heart Health Study. *Arch Intern Med* 2002; **162**: 893–900.
6. Kolotkin RL, Haaz S, Fontaine KR. Assessment of health-related quality of life in obesity and eating disorders. In: Allison D, Baskin M (eds). *Handbook of Assessment Methods for Eating Behaviors and Weight Related Problems*. Sage Publications, Inc.: Thousand Oaks, CA, 2009.
7. Fontaine KR, Barofsky I. Obesity and health-related quality of life. *Obes Rev* 2001; **2**: 173–182.
8. WHOQOL Group. Development of the World Health Organization WHOQOL-BREF quality of life assessment. The Whoqol Group. *Psychol Med* 1998; **28**: 551–558.
9. Sullivan MB, Sullivan LG, Kral JG. Quality of life assessment in obesity: physical, psychological, and social function. *Gastroenterol Clin North Am* 1987; **16**: 433–442.
10. Andersen JR, Karlsen T-I, Kolotkin RL. Obesity and its impact upon quality of life. In: Mullin G, Cheskin L, Matarese L (eds). *Integrative Weight Management: A Guide for Clinicians*. Springer: New York, 2014, pp. 225–234.
11. Moons P, Budts W, De Geest S. Critique on the conceptualisation of quality of life: a review and evaluation of different conceptual approaches. *Int J Nurs Stud* 2006; **43**: 891–901.
12. Warkentin LM, Das D, Majumdar SR, Johnson JA, Padwal RS. The effect of weight loss on health-related quality of life: systematic review and meta-analysis of randomized trials. *Obes Rev* 2013; **15**: 169–182.
13. Smith V, Devane D, Begley CM, Clarke M. Methodology in conducting a systematic review of systematic reviews of healthcare interventions. *BMC Med Res Methodol* 2011; **11**: 15.
14. van Nunen AM, Wouters EJ, Vingerhoets AJ, Hox JJ, Geenen R. The health-related quality of life of obese persons seeking or not seeking surgical or non-surgical treatment: a meta-analysis. *Obes Surg* 2007; **17**: 1357–1366.
15. Ul-Haq Z, Mackay DF, Fenwick E, Pell JP. Meta-analysis of the association between body mass index and health-related quality of life among adults, assessed by the SF-36. *Obesity (Silver Spring)* 2013; **21**: E322–E327.
16. Carson TL, Hidalgo B, Ard JD, Affuso O. Dietary interventions and quality of life: a systematic review of the literature. *J Nutr Educ Behav* 2014; **46**: 90–101.
17. Kroes M, Osei-Assibey G, Baker-Searle R, Huang J. Impact of weight change on quality of life in adults with overweight/obesity in the United States: a systematic review. *Curr Med Res Opin* 2016; **32**: 485–508.
18. Maciejewski ML, Patrick DL, Williamson DF. A structured review of randomized controlled trials of weight loss showed little improvement in health-related quality of life. *J Clin Epidemiol* 2005; **58**: 568–578.
19. Magallares A, Schomerus G. Mental and physical health-related quality of life in obese patients before and after bariatric surgery: a meta-analysis. *Psychol Health Med* 2015; **20**: 165–176.
20. Lindekilde N, Gladstone BP, Lubeck M *et al*. The impact of bariatric surgery on quality of life: a systematic review and meta-analysis. *Obes Rev* 2015; **16**: 639–651.
21. Andersen JR, Aasprang A, Karlsen TI *et al*. Health-related quality of life after bariatric surgery: a systematic review of prospective long-term studies. *Surg Obes Relat Dis* 2015; **11**: 466–473.
22. Jumbe S, Bartlett C, Jumbe SL, Meyrick J. The effectiveness of bariatric surgery on long term psychosocial quality of life – A systematic review. *Obes Res Clin Pract* 2015; **10**: 225–242.
23. Ding SA, Simonson DC, Wewalka M *et al*. Adjustable gastric band surgery or medical management in patients with type 2 diabetes: a randomized clinical trial. *J Clin Endocrinol Metab* 2015; **100**: 2546–2556.
24. Halperin F, Ding S, Simonson DC *et al*. Roux-en-Y gastric bypass surgery or lifestyle with intensive medical management in patients with type 2 diabetes: feasibility and 1-year results of a randomized clinical trial. *JAMA Surg* 2014; **149**: 716–726.
25. Kolotkin RL, Davidson LE, Crosby RD, Hunt SC, Adams TD. Six-year changes in health-related quality of life in gastric bypass patients versus obese comparison groups. *Surg Obes Relat Dis* 2012; **8**: 625–633.
26. Adams TD, Pendleton RC, Strong MB *et al*. Health outcomes of gastric bypass patients compared to nonsurgical, nonintervened severely obese. *Obesity (Silver Spring)* 2010; **18**: 121–130.
27. Adams TD, Davidson LE, Litwin SE *et al*. Health benefits of gastric bypass surgery after 6 years. *JAMA* 2012; **308**: 1122–1131.
28. Kolotkin RL, Crosby RD, Gress RE, Hunt SC, Adams TD. Two-year changes in health-related quality of life in gastric bypass patients compared with severely obese controls. *Surg Obes Relat Dis* 2009; **5**: 250–256.
29. Hachem A, Brennan L. Quality of life outcomes of bariatric surgery: a systematic review. *Obes Surg* 2016; **26**: 395–409.
30. Karlsson J, Taft C, Ryden A, Sjostrom L, Sullivan M. Ten-year trends in health-related quality of life after surgical and conventional treatment for severe obesity: the SOS Intervention Study. *Int J Obes (Lond)* 2007; **31**: 1248–1261.
31. Canetti L, Elizur Y, Karni Y, Berry EM. Health-related quality of life changes and weight reduction after bariatric surgery vs. a weight-loss program. *Isr J Psychiatry Relat Sci* 2013; **50**: 194–200.
32. Canetti L, Berry EM, Elizur Y. Psychosocial predictors of weight loss and psychological adjustment following bariatric surgery and a weight-loss program: the mediating role of emotional eating. *Int J Eat Disord* 2009; **42**: 109–117.
33. Driscoll S, Gregory DM, Fardy JM, Twells LK. Long-term health-related quality of life in bariatric surgery patients: a systematic review and meta-analysis. *Obesity (Silver Spring)* 2016; **24**: 60–70.

34. Ahmed S, Berzon RA, Revicki DA *et al*, on behalf of the International Society for Quality of Life Research. The use of patient-reported outcomes (PRO) within comparative effectiveness research: implications for clinical practice and health care policy. *Med Care* 2012; **50**: 1060–1070.
35. Oria HE, Moorehead MK. Updated bariatric analysis and reporting outcome system (BAROS). *Surg Obes Relat Dis* 2009; **5**: 60–66.
36. Ware JE Jr. SF-36 health survey update. *Spine (Phila PA 1976)* 2000; **25**: 3130–3139.
37. Kolotkin RL, Crosby RD, Kosloski KD, Williams GR. Development of a brief measure to assess quality of life in obesity. *Obes Res* 2001; **9**: 102–111.
38. Evangelista LS, Heber D, Li Z *et al.* Reduced body weight and adiposity with a high-protein diet improves functional status, lipid profiles, glycemic control, and quality of life in patients with heart failure: a feasibility study. *J Cardiovasc Nurs* 2009; **24**: 207–215.
39. Blissmer B, Riebe D, Dye G *et al.* Health-related quality of life following a clinical weight loss intervention among overweight and obese adults: intervention and 24 month follow-up effects. *Health Qual Life Outcomes* 2006; **4**: 43.
40. Davis NJ, Tomuta N, Isasi CR, Leung V, Wylie-Rosett J. Diabetes-specific quality of life after a low-carbohydrate and low-fat dietary intervention. *Diabetes Educ* 2012; **38**: 250–255.
41. Rejeski WJ, Focht BC, Messier SP *et al.* Obese, older adults with knee osteoarthritis: weight loss, exercise, and quality of life. *Health Psychol* 2002; **21**: 419–426.
42. Yancy WS Jr, Almirall D, Maciejewski ML *et al.* Effects of two weight-loss diets on health-related quality of life. *Qual Life Res* 2009; **18**: 281–289.
43. Ackermann RT, Edelstein SL, Narayan KM *et al.* Changes in health state utilities with changes in body mass in the Diabetes Prevention Program. *Obesity (Silver Spring)* 2009; **17**: 2176–2181.
44. Darga LL, Magnan M, Mood D *et al.* Quality of life as a predictor of weight loss in obese, early-stage breast cancer survivors. *Oncol Nurs Forum* 2007; **34**: 86–92.
45. Fontaine KR, Barofsky I, Andersen RE *et al.* Impact of weight loss on health-related quality of life. *Qual Life Res* 1999; **8**: 275–277.
46. Heshka S, Anderson JW, Atkinson RL *et al.* Weight loss with self-help compared with a structured commercial program: a randomized trial. *JAMA* 2003; **289**: 1792–1798.
47. Imayama I, Alfano CM, Kong A *et al.* Dietary weight loss and exercise interventions effects on quality of life in overweight/obese postmenopausal women: a randomized controlled trial. *Int J Behav Nutr Phys Act* 2011; **8**: 118.
48. Pope L, Harvey-Berino J, Savage P *et al.* The impact of high-calorie-expenditure exercise on quality of life in older adults with coronary heart disease. *J Aging Phys Act* 2011; **19**: 99–116.
49. Rippe JM, Price JM, Hess SA *et al.* Improved psychological well-being, quality of life, and health practices in moderately overweight women participating in a 12-week structured weight loss program. *Obes Res* 1998; **6**: 208–218.
50. Ross KM, Milsom VA, Rickel KA *et al.* The contributions of weight loss and increased physical fitness to improvements in health-related quality of life. *Eat Behav* 2009; **10**: 84–88.
51. von Gruenigen VE, Gibbons HE, Kavanagh MB *et al.* A randomized trial of a lifestyle intervention in obese endometrial cancer survivors: quality of life outcomes and mediators of behavior change. *Health Qual Life Outcomes* 2009; **7**: 17.
52. Williamson DA, Rejeski J, Lang W *et al.* Impact of a weight management program on health-related quality of life in overweight adults with type 2 diabetes. *Arch Intern Med* 2009; **169**: 163–171.
53. Barham K, West S, Trief P *et al.* Diabetes prevention and control in the workplace: a pilot project for county employees. *J Public Health Manag Pract* 2011; **17**: 233–241.
54. Ladson G, Dodson WC, Sweet SD *et al.* The effects of metformin with lifestyle therapy in polycystic ovary syndrome: a randomized double-blind study. *Fertil Steril* 2011; **95**: 1059–1066.e1–7.
55. Kennedy BM, Paeratakul S, Champagne CM *et al.* A pilot church-based weight loss program for African-American adults using church members as health educators: a comparison of individual and group intervention. *Ethn Dis* 2005; **15**: 373–378.
56. Malone M, Alger-Mayer SA, Anderson DA. The lifestyle challenge program: a multidisciplinary approach to weight management. *Ann Pharmacother* 2005; **39**: 2015–2020.
57. Melanson KJ, Dell'Olio J, Carpenter MR, Angelopoulos TJ. Changes in multiple health outcomes at 12 and 24 weeks resulting from 12 weeks of exercise counseling with or without dietary counseling in obese adults. *Nutrition* 2004; **20**: 849–856.
58. Villareal DT, Banks M, Sinacore DR, Siener C, Klein S. Effect of weight loss and exercise on frailty in obese older adults. *Arch Intern Med* 2006; **166**: 860–866.
59. Villareal DT, Chode S, Parimi N *et al.* Weight loss, exercise, or both and physical function in obese older adults. *N Engl J Med* 2011; **364**: 1218–1229.
60. Wolf AM, Conaway MR, Crowther JQ *et al.* Translating lifestyle intervention to practice in obese patients with type 2 diabetes: Improving Control with Activity and Nutrition (ICAN) study. *Diabetes Care* 2004; **27**: 1570–1576.
61. Womble LG, Wadden TA, McGuckin BG *et al.* A randomized controlled trial of a commercial internet weight loss program. *Obes Res* 2004; **12**: 1011–1018.
62. Aasprang A, Andersen JR, Vage V, Kolotkin RL, Natvig GK. Five-year changes in health-related quality of life after biliopancreatic diversion with duodenal switch. *Obes Surg* 2013; **23**: 1662–1668.
63. Zijlstra H, Larsen JK, Wouters EJM, van Ramshorst B, Geenen R. The long-term course of quality of life and the prediction of weight outcome after laparoscopic adjustable gastric banding: a prospective study. *Bariatric Surg Practi Patient Care* 2013; **8**: 18–22.
64. Mathus-Vliegen EM, de Wit LT. Health-related quality of life after gastric banding. *Br J Surg* 2007; **94**: 457–465.
65. Brunault P, Jacobi D, Léger J *et al.* Observations regarding 'Quality of Life' and 'Comfort with Food' after bariatric surgery: comparison between laparoscopic adjustable gastric banding and sleeve gastrectomy. *Obes Surg* 2011; **21**: 1225–1231.
66. Raoof M, Neaslund I, Rask E *et al.* Health-related quality-of-life (HRQoL) on average of 12 years after gastric bypass surgery. *Obes Surg* 2015; **25**: 1119–1127.
67. Aftab H, Risstad H, Sovik TT *et al.* Five-year outcome after gastric bypass for morbid obesity in a Norwegian cohort. *Surg Obes Relat Dis* 2014; **10**: 71–78.
68. Terwee CB, Prinsen CA, Ricci Garotti MG *et al.* The quality of systematic reviews of health-related outcome measurement instruments. *Qual Life Res* 2016; **25**: 767–779.
69. Doll HA, Petersen SE, Stewart-Brown SL. Obesity and physical and emotional well-being: associations between body mass index, chronic illness, and the physical and mental components of the SF-36 questionnaire. *Obes Res* 2000; **8**: 160–170.
70. Ul-Haq Z, Mackay DF, Fenwick E, Pell JP. Impact of metabolic comorbidity on the association between body mass index and health-related quality of life: a Scotland-wide cross-sectional study of 5,608 participants. *BMC Public Health* 2012; **12**: 143.
71. Kolotkin RL, Crosby RD, Gress RE *et al.* Health and health-related quality of life: differences between men and women who

seek gastric bypass surgery. *Surg Obes Relat Dis* 2008; **4**: 651–658.
72. Zabelina DL, Erickson AL, Kolotkin RL, Crosby RD. The effect of age on weight-related quality of life in overweight and obese individuals. *Obesity (Silver Spring)* 2009; **17**: 1410–1413.
73. Kolotkin RL, Gadde KM, Peterson CA, Crosby RD. Health-related quality of life in two randomized controlled trials of phentermine/topiramate for obesity: what mediates improvement? *Qual Life Res* 2016; **25**: 1237–1244.
74. Bays H, Pi-Sunyer X, Hemmingsson JU *et al*. Liraglutide 3.0 mg for weight management: weight-loss dependent and independent effects. *Curr Med Res Opin* 2017; **33**: 225–229.
75. Latner JD, Mond JM, Vallance JK, Gleaves DH, Buckett G. Body checking and avoidance in women: associations with mental and physical health-related quality of life. *Eat Behav* 2012; **13**: 386–389.
76. Latner JD, Barile JP, Durso LE, O'Brien KS. Weight and health-related quality of life: the moderating role of weight discrimination and internalized weight bias. *Eat Behav* 2014; **15**: 586–590.
77. Levine MN, Ganz PA. Beyond the development of quality-of-life instruments: where do we go from here? *J Clin Oncol* 2002; **20**: 2215–2216.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Table S1. Overlap of studies included in the reviews.

Table S2. Health-related quality-of-life measures.