

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

Protocol for a one-year prospective, longitudinal cohort study of patients undergoing Roux-en-Y gastric bypass and sleeve gastrectomy: the BARI-LIFESTYLE observational study.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-020659
Article Type:	Protocol
Date Submitted by the Author:	15-Nov-2017
Complete List of Authors:	<p>Jassil, Friedrich; University College London, Centre for Obesity Research, Division of Medicine; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery</p> <p>Carnemolla, Alisia; University College London, Centre for Obesity Research, Division of Medicine; National Institute of Health Research, University College London Hospitals Biomedical Research Centre</p> <p>Kingett, Helen; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; National Institute of Health Research, University College London Hospitals Biomedical Research Centre</p> <p>Paton, Bruce; Institute of Sport, Exercise and Health</p> <p>O'Keeffe, Aidan; University College London, Department of Statistical Science</p> <p>Doyle, Jacqueline; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; National Institute of Health Research, University College London Hospitals Biomedical Research Centre</p> <p>Morris, Stephen; University College London, Department of Applied Health Research</p> <p>Lewis, Neville; University College London, The Hatter Cardiovascular Institute, Institute of Cardiovascular Science</p> <p>Kirk, Amy; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; National Institute of Health Research, University College London Hospitals Biomedical Research Centre</p> <p>Pucci, Andrea; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; University College London, Centre for Obesity Research, Division of Medicine</p> <p>Chaiyasoot, Kusuma; University College London, Centre for Obesity Research, Division of Medicine; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery</p> <p>Batterham, Rachel; University College London, Centre for Obesity Research, Division of Medicine; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery</p>
Keywords:	Obesity, Bariatric Surgery, Body Composition, Physical Activity, Diet, Quality of Life

SCHOLARONE™
Manuscripts

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 1 **Protocol for a one-year prospective, longitudinal cohort study of patients undergoing**
4
5 2 **Roux-en-Y gastric bypass and sleeve gastrectomy: the BARI-LIFESTYLE observational study.**
6
7 3

8
9 4 Friedrich C. Jassil ^{1,2}, Alisia Carnemolla ^{1,3}, Helen Kingett ^{2,3}, Bruce Paton ⁴, Aidan G. O’Keeffe ⁵,
10 5 Jaqueline Doyle ^{2,3}, Stephen Morris ⁶, Neville Lewis ⁷, Amy Kirk ^{2,3}, Andrea Pucci ^{1,2}, Kusuma
11 6 Chaiyasoot ^{1,2} and Rachel L. Batterham ^{1,2,3*}
12
13
14
15
16
17

18 8 **Author affiliations**

19
20 9 ¹ Centre for Obesity Research, Division of Medicine, University College London, London, United
21 10 Kingdom

22
23
24 11 ² University College London Hospitals, Bariatric Centre for Weight Management and Metabolic
25 12 Surgery, London, United Kingdom

26
27
28 13 ³ National Institute of Health Research University College London Hospitals Biomedical Research
29 14 Centre, London, United Kingdom

30
31
32 15 ⁴ Institute of Sport, Exercise and Health, London, United Kingdom

33
34
35 16 ⁵ Department of Statistical Science, University College London, London, United Kingdom

36
37 17 ⁶ Department of Applied Health Research, University College London, London, United Kingdom

38
39 18 ⁷ The Hatter Cardiovascular Institute, Institute of Cardiovascular Science, University College London,
40 19 London, United Kingdom

41
42
43 20
44
45 21 *Corresponding author: Professor Rachel L. Batterham; r.batterham@ucl.ac.uk

46
47 22 Address: Centre for Obesity Research
48
49 23 Division of Medicine
50
51 24 University College London
52
53 25 Rayne Building, 5 University Street
54
55 26 London WC1E 6JF, United Kingdom
56
57
58
59
60

1
2
3 27 **ABSTRACT**
4

5 28 **Introduction:** Roux-en-Y gastric bypass and sleeve gastrectomy are the two most common bariatric
6
7 29 surgery performed in the UK that result in comparable weight loss and remission of obesity-
8
9 30 associated co-morbidities. However, there is a paucity of studies examining the impact of these
10
11 31 procedures upon body composition, physical activity levels, sedentary behaviour, physical function
12
13 32 and strength, dietary intake, health-related quality of life and costs.
14
15

16 33
17
18 34 **Methods and analysis:** The BARI-LIFESTYLE observational study is a one-year prospective,
19
20 35 longitudinal cohort study aiming to recruit 100 patients with severe obesity undergoing either
21
22 36 primary Roux-en-Y gastric bypass or primary sleeve gastrectomy from two bariatric centres in
23
24 37 London, UK. Participants will be followed-up four times during the study period; pre-surgery baseline
25
26 38 (T0) and at 3 (T1), 6 (T2), and 12-month (T3) post-surgery. In addition to the standard follow-up
27
28 39 investigations, assessments including dual-energy X-ray absorptiometry scan, bioelectric impedance
29
30 40 analysis, 6-minute walk test, sit-to-stand test, and handgrip test will be undertaken together with
31
32 41 completion of questionnaires. Physical activity levels and sedentary behaviour will be assessed using
33
34 42 accelerometer, and dietary intake will be recorded using a 3-day food diary. Outcome measures will
35
36 43 include: body weight, body fat mass, lean muscle mass, bone mineral density, physical activity levels,
37
38 44 sedentary behaviour, physical function and strength, dietary intake, health-related quality of life,
39
40 45 remission of co-morbidities, healthcare resource utilisation and costs.
41
42

43 46
44
45 47 **Ethics and dissemination:** This study has been reviewed and given a favourable ethical opinion by
46
47 48 London-Dulwich Research Ethics Committee (17/LO/0950). The results will be presented to
48
49 49 stakeholder groups locally, nationally and internationally and published in peer-reviewed medical
50
51 50 journals. The lay-person summary of the findings will be published on the Centre for Obesity
52
53 51 Research, University College London website (<http://www.ucl.ac.uk/obesity>).
54
55

56 52
57
58
59
60

53 **Strengths and limitations of this study**

- 54 • A comprehensive prospective, longitudinal study with detailed assessments undertaken
55 prior to and for one year following bariatric surgery examining changes in body composition,
56 physical activity (PA) levels, sedentary behaviour, physical function and strength, dietary
57 intake, health-related quality of life and costs, relative to baseline pre-surgery.
- 58 • The use of validated research tools (accelerometer to assess PA levels and sedentary
59 behaviour, dual-energy X-ray absorptiometry [DXA] scan to assess body composition and
60 validated questionnaires) will generate high-quality data.
- 61 • A potential sample selection bias due to exclusion of patients with functional limitation
62 and/or non-ambulatory and patients with more than 200 kg of body weight owing to the
63 weight limit of the DXA scan.
- 64 • A relatively small sample size, nevertheless, this number is adequate to generate in-depth
65 insights into the various outcomes of Roux-en-Y gastric bypass and sleeve gastrectomy as
66 delivered in the UK healthcare setting.

79 INTRODUCTION

80 Bariatric surgery engenders marked sustained weight loss and is recommended by the National
81 Institute for Health and Care Excellence (NICE) as a treatment option for people of severe obesity¹,
82 estimated to affect approximately 2.6 million adults in the UK². Roux-en-Y gastric bypass (RYGB) and
83 sleeve gastrectomy (SG) are now the two most common procedures performed in the UK, which
84 result in comparable weight loss and remission of obesity associated co-morbidities³. However,
85 there is a paucity of studies examining the impact of these procedures upon body composition,
86 particularly bone mineral density (BMD), physical activity (PA) levels, sedentary behaviour, physical
87 function and strength, dietary intake, health-related quality of life (HRQoL) and costs.

88
89 Bariatric surgery leads to a marked decrease in fat mass (FM), but fat free mass (FFM) particularly
90 bone mass is also reduced post-surgery⁴, potentially negatively impacting on physical function and
91 strength, and putting patients at increased risk of osteoporotic fracture in the future^{5 6}. Surgical
92 modification of the gastrointestinal tract impairs the intake and/or absorption of essential nutrients
93 for bone health that consequently perturbs bone metabolism, leading to BMD deterioration⁵⁻⁸.
94 Significant bone mass loss has been reported to occur rapidly in the first year of surgery and
95 continues to deteriorate up to 3 years even after maximum weight loss has been achieved⁷.
96 However, these data, are mainly based on studies undertaken in patients who underwent RYGB
97 whereas SG is now the most common procedure undertaken both in the UK and globally^{3 9}.
98 Currently, it is unclear whether the rate of bone mass loss following SG parallels weight loss¹⁰⁻¹².
99 Given that the number of younger patients and women of childbearing age undergoing bariatric
100 surgery continues to increase and BMD measurement is not a routine follow-up investigation¹³,
101 there is an urgent need to assess the impact of RYGB and SG on bone health in the UK bariatric
102 population.

103

1
2
3 104 Adherence to a post-bariatric lifestyle changes is the cornerstone of a successful weight loss¹⁴.
4
5 105 Studies have shown that greater PA, lower sedentary time and high compliance to dietary
6
7 106 recommendation post-surgery associate with greater weight loss, preservation of lean muscle mass
8
9 107 (LMM) and bone mass, as well as improvement in HRQoL¹⁵⁻¹⁸. However, patients spend 80% of their
10
11 108 waking time in sedentary behaviour post-surgery¹⁹, activity that associates with increased risk of
12
13 109 cardiometabolic disease and mortality²⁰. Following surgery, patients are advised to undertake at
14
15 110 least 150 minutes of moderate-to-vigorous physical activity (MVPA) per week, a duration and
16
17 111 intensity that are recommended to reap the metabolic benefit of PA²¹. However, objectively
18
19 112 measured MVPA decreases post-surgery with only 10% of patients achieving the recommended
20
21 113 MVPA levels²². Likewise, a recent study undertaken in the UK has reported that weight loss post-
22
23 114 surgery did not correspond to improvement in MVPA and sedentary behaviour. However, the small
24
25 115 sample size of this study (n=22) together with relatively short follow-up period limited its
26
27 116 generalisability²³. Further studies are therefore required to expand the information in this regard. In
28
29 117 terms of dietary recommendations, daily protein intake of 60 g or more post-surgery is crucial for
30
31 118 increasing satiety, preserving LMM, improving body composition and preventing against weight
32
33 119 regain²⁴⁻²⁷. However, most patients are unable to achieve this in the first postoperative year, the
34
35 120 period when rapid weight loss occurs²⁸. Whether this is also the case for UK bariatric population is
36
37 121 not known as no such data has ever been reported thus far²⁸.
38
39
40
41
42

43 123 Impaired HRQoL is common in obesity²⁹ and often one of the driving factors for seeking weight loss
44
45 124 surgery³⁰. HRQoL is defined as individuals' perception of well-being that refers to physical,
46
47 125 psychological and social domains of health³¹. Most studies reported improvement in all HRQoL
48
49 126 domains with greater scores observed in the first post-operative year although some studies showed
50
51 127 that the improvement is limited to only the physical domain but not the mental health component
52
53 128 of HRQoL³². Despite mounting evidence in the international literature reporting the beneficial impact
54
55 129 of bariatric surgery on HRQoL, data from the UK bariatric population does not exist³³. There is some

130 evidence that bariatric surgery can reduce in cost savings that offset the initial costs of surgery,
131 though little UK evidence for RYGB and SG³⁴⁻³⁶.

132

133 Taken together the lack of post-operative data coupled with recommendations from systematic
134 reviews^{22 28} provide a strong rationale to undertake a prospective study to evaluate the impact of
135 RYGB and SG upon body composition particularly BMD, PA levels, sedentary behaviour, physical
136 function and strength, dietary intake, HRQoL and costs in a UK bariatric population. Information
137 gained from this study will provide valuable data to inform the implementation of future post-
138 surgery lifestyle programmes with the aim of maximising the beneficial outcomes of bariatric surgery
139 as highlighted by NICE¹. This paper details the study design and outcomes of the BARI-LIFESTYLE
140 observational study.

141

142 **OBJECTIVES**

143 The overall objective of BARI-LIFESTYLE observational study is to evaluate the impact of RYGB and SG
144 on changes in body weight, body composition, PA levels, sedentary behaviour, physical function and
145 strength, dietary intake, HRQoL, remission of co-morbidities, healthcare resource utilisation and
146 costs in a cohort of 100 patients.

147

148 The specific objectives are to evaluate post-surgery changes in:

- 149 1. Percentage weight loss (%WL) at one year post-surgery, relative to baseline pre-surgery
150 weight.
- 151 2. Body fat mass, assessed using dual-energy X-ray absorptiometry (DXA) scan and bioelectrical
152 impedance analysis (BIA), relative to pre-surgery at 12 months post-surgery.
- 153 3. LMM, assessed using DXA scan and BIA, relative to pre-surgery at 12 months post-surgery.
- 154 4. BMD, assessed using DXA scan and BIA, relative to pre-surgery at 12 months post-surgery.

- 1
2
3 155 5. PA levels (light, moderate, vigorous), percentage achieving 150 minutes of MVPA in a week
4
5 156 and sedentary behaviour assessed using accelerometer at 3, 6, and 12 months post-surgery,
6
7 157 relative to pre-surgery.
8
9 158 6. Physical function and strength assessed using 6-minute walk test (6MWT), sit-to-stand (STS)
10
11 159 test and handgrip test at 3, 6 and 12 months post-surgery, relative to pre-surgery.
12
13 160 7. Dietary intake assessed using food diary at 3, 6 and 12 months post-surgery, relative to pre-
14
15 161 surgery.
16
17 162 8. HRQoL assessed using EuroQoL-5D-3L (EQ-5D-3L) and Impact of Weight on Quality of Life-
18
19 163 Lite (IWQOL-Lite) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
20
21 164 9. Characteristics of attitude and symptoms of depression assessed using Beck Depression
22
23 165 Inventory-II (BDI-II) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
24
25 166 10. Obesity-associated comorbidities (type 2 diabetes [T2D], dyslipidaemia, hypertension,
26
27 167 obstructive sleep apnoea [OSA]) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
28
29 168 11. Healthcare resource utilisation and costs assessed using an adapted version of the Client
30
31 169 Service Receipt Inventory (CSRI) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
32
33
34
35
36

171 **METHODS AND ANALYSIS**

172 **Study design and setting**

173 BARI-LIFESTYLE observational study is a prospective, longitudinal cohort study of patients
174 undergoing bariatric surgery conducted in London, UK (Figure 1). A total of 100 patients will be
175 recruited over a 2-year period from 2018 to 2019, and will be followed for up to 12 months post-
176 surgery. Recruitment will take place at the Bariatric Centre for Weight Management and Metabolic
177 Surgery, University College London Hospitals (UCLH) (study site) and the Bariatric and Obesity
178 Surgery Clinic at the Whittington Hospital that acts as a participant identification centre (PIC).
179 Participants recruited from the Whittington Hospital will have their surgical procedure undertaken at
180 the same centre, but all study procedures such as written informed consent, baseline assessment,

1
2
3 181 post-surgery follow-up care and study assessments will be undertaken by the bariatric team at
4
5 182 UCLH. This study is carried out by the Centre for Obesity Research, Division of Medicine, University
6
7 183 College London (UCL), with an expected total duration of 36 months, from the first participant
8
9 184 enrolled to last participant follow-up.
10

11 185

12 13 186 **Participants and recruitment**

14
15 187 Patients who are planned to undergo either primary RYGB or primary SG will be screened for
16
17 188 suitability for the study by the bariatric team at the study site and PIC based on the inclusion and
18
19 189 exclusion criteria when they attend the standard pre-surgical assessment (Table 1). Verbal consent
20
21 190 will be sought from those fulfilling the eligibility criteria and interested in participating to be
22
23 191 approached by a research investigator. Patients will be given a participant information sheet inviting
24
25 192 them to participate in a one-year prospective, longitudinal cohort study looking at the effect of
26
27 193 bariatric surgery on body weight, body composition, PA levels, sedentary behaviour, physical
28
29 194 function and strength, dietary intake, HRQoL, remission of co-morbidities, healthcare resource
30
31 195 utilisation and costs. Consented participants will then be scheduled to attend a baseline assessment,
32
33 196 approximately 6 weeks before surgery day at the study site. Each participant will be given a Fitbit
34
35 197 Alta HR to enable them to self-monitor their activity levels and to reduce sedentary behaviour.
36
37 198 Based on the weekly number of bariatric procedures undertaken at UCLH and Whittington Hospital
38
39 199 and after considering the eligibility criteria, estimated recruitment rate is approximately 7
40
41 200 participants per month. Hence, the expected recruitment period for the study is 15 to 20 months.
42
43
44

45 201

46
47 202 All participants will receive the standardised post-bariatric care as stipulated by NICE¹. Participants
48
49 203 will attend the study site for monitoring of nutritional intake, vitamin and mineral deficiencies,
50
51 204 comorbidities and medication review. Participants will receive verbal PA and dietary advice from a
52
53 205 specialist nurse and dietitian at weeks 12 and 36 post-surgery, respectively.
54

55 206
56
57
58
59
60

1
2
3 207 **Outcomes measures**

4
5 208 Outcome measures will be collected at four study time points, designed to coincide with normal
6
7 209 follow-up care visits; baseline visit at approximately 6 weeks before surgery (T0) then at 3 (T1), 6
8
9 210 (T2), and 12-month (T3) post-surgery (Table 2).

10
11 211

12
13 212 ***Sociodemographic, medical history, and physical examination***

14
15 213 Participants' sociodemographic data, medical history, and physical examination will be completed by
16
17 214 the bariatric team at the baseline visit. Data to be captured including age, gender, ethnicity,
18
19 215 educational level, marital status, medication intake, weight history, pregnancy history, alcohol
20
21 216 consumption using the AUDIT-C questionnaire³⁷, smoking habits and family history of obesity and
22
23 217 comorbidities.

24
25 218

26
27 219 **Primary outcome**

28
29 220 Body weight will be measured using a weighing scale (Model VT200/220, Vishay Transducers Ltd.,
30
31 221 CA, USA) with participants wearing light clothes and without shoes and heavy accessories, to the
32
33 222 nearest 0.1 kg. Similarly, height will be determined using a stadiometer (Seca 217, Seca GmbH & Co.
34
35 223 KG, Hamburg, Germany) to the nearest 0.01 m. %WL will be calculated using the following formula:
36
37 224 %WL = [(weight on the day of surgery – weight at time-point after surgery)/weight on the day of
38
39 225 surgery] × 100, measured at each study time point.

40
41 226

42
43 227 **Secondary outcomes**

44
45 228 ***Body composition (body fat mass, LMM and BMD)***

46
47 229 Body composition will be assessed at baseline and 12-months post-surgery using DXA scan (Horizon
48
49 230 W DXA system, Hologic, Inc., MA, USA). DXA scan uses ionising radiation to measure different body
50
51 231 compartments. This is the current reference standard for assessing body composition and a gold
52
53 232 standard method to diagnose osteopenia and osteoporosis³⁸. In addition, body composition will be

233 measured using BIA (Tanita DC-430MAS, Tanita Corp., Tokyo, Japan) at each study visit. This is a non-
234 invasive, easy to perform and cheaper option to measure body composition that is based on the
235 differences in electrical conductivity of FM and FFM tissues³⁹.

236

237 ***PA levels and sedentary behaviour***

238 PA and time spent in light, moderate and vigorous activities, and sedentary behaviour will be
239 measured objectively using ActiGraph wGT3X-BT (Pensacola, FL, USA), an accelerometer-based
240 activity monitor⁴⁰. Participants will be instructed to wear the ActiGraph on their dominant hip for
241 one week, from waking in the morning until going to bed at night, and to remove it only during
242 water-based activities. Additionally, participants will be asked to keep an activity diary throughout
243 the week, to assist interpretation of data from the device. Both the device and activity diary have to
244 be returned to the investigators for data analysis (ActiLife 6 software, Pensacola, FL, USA).

245

246 ***Physical function and strength***

247 Participants' functional capacity will be assessed using a 6MWT, a self-paced, submaximal
248 assessment of functional capacity used to prescribe appropriate exercise⁴¹. Lower body functional
249 capacity and strength will be assessed using the STS test⁴². Static muscle strength will be assessed
250 using Jamar Hydraulic Hand Dynamometer (Petterson Medical, IL, USA)⁴³.

251

252 ***Dietary intake***

253 All participants will be required to keep a 3-day food diary (2 working days and 1 weekend day) for
254 one week at each study time point. This method has a higher agreement with the 9 days food diary
255 compared to the food frequency questionnaire⁴⁴ whilst reducing the burden to patients and thus
256 promoting better compliance for documenting food intake. The completed food diary will be
257 returned to the investigators together with the ActiGraph and activity diary by using a stamped
258 addressed envelope provided to participants.

1
2
3 2594
5 260 **HRQoL**

6
7 261 HRQoL will be assessed using EQ-5D-3L and IWQOL-Lite. The EQ-5D-3L descriptive system is a 5-item
8
9 262 self-report questionnaire that assesses the following domains: mobility, self-care, usual activities,
10
11 263 pain/discomfort and anxiety/depression, and a visual analogue scale, which records self-rated health
12
13 264 on a 0 to 100 scale⁴⁵. EQ-5D-3L health states will be converted into utility values using a formula that
14
15 265 attaches weights to each level in each dimension based on valuations by general population
16
17 266 samples. We will use a value set for the UK population to calculate utility values at each time point
18
19 267 for every participant⁴⁶. The IWQOL-Lite is a 31-item, self-report, obesity and overweight-specific
20
21 268 measure of HRQoL⁴⁷. This tool consists of a total score and scores on each of five scales – physical
22
23 269 function, self-esteem, sexual life, public distress, and work; higher scores indicate better HRQoL.
24
25

26 270

27
28 271 **Attitude and symptoms of depression**

29
30 272 BDI-II is a 21-item self-report questionnaire that assesses mood over the past week⁴⁸. Symptoms of
31
32 273 depression are classified by the total score: minimal, mild, moderate, and severe symptoms.
33
34 274

35

36 275 **Obesity-associated comorbidities**

37
38 276 Co-morbidities (T2D, dyslipidaemia, hypertension, OSA) and medication review will be carried out at
39
40 277 each study time point.
41
42 278

43

44
45 279 **Healthcare resource utilisation and costs**

46
47 280 Resource use data will be collected using an adapted version of the CSRI⁴⁹, including the costs of
48
49 281 bariatric surgery plus pre-surgery visits, number of contacts with healthcare professionals, visits to
50
51 282 specialist clinics, the emergency department, admissions to the hospital, primary care contacts, and
52
53 283 medications. Resource use data will be converted into costs using published unit costs⁵⁰⁻⁵². In
54
55 284 addition, information regarding support from informal carers, employment status and time off work
56
57

285 will be collected. Resource use data will be collected for the previous 6 months at the baseline visit
286 and since participants' last study visit at each post-surgery study time point.

287

288 **Statistical analysis**

289 The demographic and medical history information collected at baseline shall be presented in a table.

290 Categorical variables shall be reported as raw numbers and percentages. Reports of continuous

291 variables shall include mean, median, range and standard deviation.

292

293 **Primary outcome analysis**

294 The primary outcome is the %WL measured longitudinally at baseline and 12 months post-surgery.

295 %WL will be analysed using a linear mixed effects model over the three post-surgery time points (3

296 months, 6 months and 12 months) after controlling for the baseline body weight measure and

297 height. Model assumptions shall be checked and suitable transforms of the primary outcome

298 variable considered if necessary. In addition, overall percentage change in weight since baseline shall

299 be computed marginally at each of 3, 6 and 12 months and displayed graphically.

300

301 **Secondary outcomes analyses**

302 Analyses of longitudinal secondary outcomes shall be performed using linear mixed effects

303 regression models, with a normal distribution assumed for continuous outcomes (or a suitable

304 transform of these outcomes). Model parameter estimates together with appropriate 95%

305 confidence intervals shall be reported. Categorical outcomes (e.g. proportions of participants with

306 co-morbidities) shall be summarised in tabular form at each time point. Where appropriate (for

307 example, for proportions), estimates and 95% confidence intervals will be presented. To analyse

308 costs, we will assume the costs measured at baseline for the preceding 6 months would persist

309 during follow-up in the absence of surgery; we will then compare post-surgery costs with predicted

1
2
3 310 costs that would have been incurred in the absence of surgery. To account for skewness of the cost
4
5 311 data, we will use a generalised linear model with gamma family and log link⁵³.

6
7 312

8
9 313 **Missing data**

10
11 314 Bias due to missing data will be investigated by comparing the baseline characteristics of participants
12
13 315 with and without missing values. Depending on the extent of missingness, the predictors of missing
14
15 316 values will be identified. The primary outcome analysis will be adjusted for those predictors of
16
17 317 missing values, which are related to missingness. Multiple imputation using chained equations shall
18
19 318 be considered as part of a sensitivity analysis for missing data in the primary outcome model.
20

21
22 319

23
24 320 **Data storage and retention**

25
26 321 All data will be handled in accordance with the UK Data Protection Act 1998. Physical data will be
27
28 322 stored in a secure room with limited access to only members of the research team, whereas
29
30 323 computers storing electronic data will be encrypted and password protected. Each participant will be
31
32 324 given a unique study identification number and used on their records instead of their name. The
33
34 325 master list linking participants' name and the study identification number will be kept in a secure
35
36 326 location. This way, participants' personal identity and data collected in the study cannot be linked by
37
38 327 anyone outside the study team. This study is registered with the UCL Data Protection (Reference:
39
40 328 Z6364106/2017/04/43). At the end of the study, all essential documentation will be archived
41
42 329 securely for a minimum of 20 years from the declaration of the end of study.
43

44
45 330

46
47 331 **ETHICS AND DISSEMINATION**

48
49 332 This study has been reviewed and given a favourable ethical opinion by London-Dulwich Research
50
51 333 Ethics Committee (Reference: 17/LO/0950). Potential participants will be explained in detail
52
53 334 regarding the aims, methods, anticipated advantages and disadvantages of participation in the study
54
55 335 by Good Clinical Practice (GCP) trained investigators prior to obtaining their written informed
56
57
58
59

1
2
3 336 consent. Participants will be informed that their participation is on a voluntary basis, and they have
4
5 337 the right to withdraw from the study at any time without affecting their present and future medical
6
7 338 care. No research procedures will be undertaken prior to patients giving written informed consent.
8
9 339 As a duty of care, all possible adverse events will be collected from the day participants consented
10
11 340 for the study to monitor their safety.

12
13 341

14
15 342 The findings will be presented to stakeholder groups locally, nationally and internationally and
16
17 343 published in peer-reviewed medical journals. The lay-person summary of the findings will be
18
19 344 published on the Centre for Obesity Research, University College London website
20
21 345 (<http://www.ucl.ac.uk/obesity>). The results will be fully anonymised, and none of the participants
22
23 346 will be identified in any report or publication.

24
25
26 347

27 28 348 **ADVANTAGE AND LIMITATION**

29
30 349 This observational study will address the need for more high-quality data that examine the
31
32 350 outcomes of RYGB and SG derived from the UK bariatric population. It will involve a comprehensive
33
34 351 assessment and data collection at four study time points in the first year of surgery enabling an in-
35
36 352 depth analysis of changes in body composition, PA levels, sedentary behaviour, physical function and
37
38 353 strength, dietary intake, HRQoL and costs, relative to pre-surgery. Data collection will be carried out
39
40 354 by using validated assessment methods and questionnaires. Another advantage of this study is the
41
42 355 use of DXA scan, a reference standard to measure body composition³⁸. Also, the use of
43
44 356 accelerometer will generate high-quality data to measure objective PA levels and sedentary
45
46 357 behaviour. Studies have shown that bariatric patients tend to over-report their PA levels when
47
48 358 assessed using the conventional PA questionnaires²².

49
50
51 359

52
53 360 Limitations of this study include a potential sample selection bias, due to the exclusion of patients
54
55 361 with functional limitation (e.g. cognitive impairment, walking difficulties) and/or non-ambulatory

1
2
3 362 and patients with more than 200 kg of body weight owing to the weight limit of the DXA scan. Also,
4
5 363 given resource limitations, only approximately 100 patients will be recruited in this one year
6
7 364 observational cohort study. Nevertheless, this sample size is adequate to generate in-depth insights
8
9 365 into the various outcomes of RYGB and SG.

10
11 366

12 13 367 **CONCLUSION**

14
15 368 BARI-LIFESTYLE observational study will produce a comprehensive data on the broad range of RYGB
16
17 369 and SG outcomes derived from the UK bariatric population that is still scarce in the literature. The
18
19 370 information gained from this study will inform future lifestyle programmes for post-bariatric
20
21 371 patients.

22
23
24 372

25 26 373 **Acknowledgements**

27
28 374 We wish to thank Professor Rumana Omar for her input with regards to the statistical analysis plan.
29
30 375 We gratefully acknowledge our Patient and Public Involvement group for their contribution to the
31
32 376 study design as to ensure participants' acceptability. We would also like to thank all members of the
33
34 377 Steering Committee and our research team at the Centre for Obesity Research, UCL for their
35
36 378 invaluable inputs in the study.

37
38
39 379

40 41 380 **Authors' contributions**

42
43 381 RLB and FCJ designed the overall study and drafted the manuscript; AC coordinated the study to
44
45 382 ensure GCP compliance; HK, JD and AK planned the assessment for dietary intake and HRQoL; BP
46
47 383 and NL planned the assessment for PA levels, sedentary behaviour and physical function and
48
49 384 strength; AGO advised on the statistical analysis plan; SM contributed to the analysis plan for
50
51 385 healthcare resource utilisation and costs; AP and KC planned the assessment for body composition
52
53 386 and review of comorbidities. RLB is the grant holder and chief investigator for the study. All authors

387 have contributed to the refinement of the study protocol and editing the manuscript. All authors
388 have read and approved the final manuscript.

389

390 **Funding**

391 This study is supported by National Institute for Health Research (NIHR), the Sir Jules Thorn
392 Charitable Trust and the Rosetrees Trust. The funders were not involved in decisions relating to the
393 study design and data collection. They will not have any role in the study execution, analyses,
394 interpretation of data nor in the writing of the manuscript and decision to submit results.

395

396 **Competing interests**

397 The authors declare that they have no conflict of interest.

398

399 **REFERENCES**

- 400 1. NICE. Obesity: Identification, assessment and management of overweight and obesity in
401 children, young people and adults. London: NICE, 2014.
- 402 2. Ahmad A, Lavery AA, Aasheim E, et al. Eligibility for bariatric surgery among adults in
403 England: analysis of a national cross-sectional survey. *JRSM open*
404 2014;5(1):2042533313512479.
- 405 3. Booth HP, Khan O, Fildes A, et al. Changing Epidemiology of Bariatric Surgery in the UK:
406 Cohort Study Using Primary Care Electronic Health Records. *Obes Surg* 2016;26(8):1900-5.
- 407 4. Schneider J, Peterli R, Gass M, et al. Laparoscopic sleeve gastrectomy and Roux-en-Y gastric
408 bypass lead to equal changes in body composition and energy metabolism 17 months
409 postoperatively: a prospective randomized trial. *Surg Obes Relat Dis* 2016;12(3):563-70.
- 410 5. Nakamura KM, Haglund EG, Clowes JA, et al. Fracture risk following bariatric surgery: a
411 population-based study. *Osteoporosis international : a journal established as result of*
412 *cooperation between the European Foundation for Osteoporosis and the National*
413 *Osteoporosis Foundation of the USA* 2014;25(1):151-8.
- 414 6. Lu CW, Chang YK, Chang HH, et al. Fracture Risk After Bariatric Surgery: A 12-Year
415 Nationwide Cohort Study. *Medicine* 2015;94(48):e2087.
- 416 7. Liu C, Wu D, Zhang JF, et al. Changes in Bone Metabolism in Morbidly Obese Patients After
417 Bariatric Surgery: A Meta-Analysis. *Obes Surg* 2016;26(1):91-7.
- 418 8. Yu EW. Bone metabolism after bariatric surgery. *J Bone Miner Res* 2014;29(7):1507-18.
- 419 9. Angrisani L, Santonicola A, Iovino P, et al. Bariatric Surgery Worldwide 2013. *Obes Surg*
420 2015;25(10):1822-32.
- 421 10. Pluskiewicz W, Buzga M, Holeczy P, et al. Bone mineral changes in spine and proximal femur
422 in individual obese women after laparoscopic sleeve gastrectomy: a short-term study. *Obes*
423 *Surg* 2012;22(7):1068-76.

- 1
2
3 424 11. Ruiz-Tovar J, Oller I, Priego P, et al. Short- and mid-term changes in bone mineral density
4 425 after laparoscopic sleeve gastrectomy. *Obes Surg* 2013;23(7):861-6.
- 5 426 12. Carrasco F, Basfi-Fer K, Rojas P, et al. Changes in bone mineral density after sleeve
6 427 gastrectomy or gastric bypass: relationships with variations in vitamin D, ghrelin, and
7 428 adiponectin levels. *Obes Surg* 2014;24(6):877-84.
- 8 429 13. Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative
9 430 nutritional, metabolic, and nonsurgical support of the bariatric surgery patient--2013
10 431 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity
11 432 Society, and American Society for Metabolic & Bariatric Surgery. *Endocrine practice : official
12 433 journal of the American College of Endocrinology and the American Association of Clinical
13 434 Endocrinologists* 2013;19(2):337-72.
- 14 435 14. Sheets CS, Peat CM, Berg KC, et al. Post-operative psychosocial predictors of outcome in
15 436 bariatric surgery. *Obes Surg* 2015;25(2):330-45.
- 16 437 15. Sarwer DB, Wadden TA, Moore RH, et al. Preoperative eating behavior, postoperative
17 438 dietary adherence, and weight loss after gastric bypass surgery. *Surg Obes Relat Dis*
18 439 2008;4(5):640-6.
- 19 440 16. Herman KM, Carver TE, Christou NV, et al. Keeping the weight off: physical activity, sitting
20 441 time, and weight loss maintenance in bariatric surgery patients 2 to 16 years postsurgery.
21 442 *Obes Surg* 2014;24(7):1064-72.
- 22 443 17. Bond DS, Phelan S, Wolfe LG, et al. Becoming physically active after bariatric surgery is
23 444 associated with improved weight loss and health-related quality of life. *Obesity (Silver
24 445 Spring)* 2009;17(1):78-83.
- 25 446 18. Campanha-Versiani L, Pereira DA, Ribeiro-Samora GA, et al. The Effect of a Muscle Weight-
26 447 Bearing and Aerobic Exercise Program on the Body Composition, Muscular Strength,
27 448 Biochemical Markers, and Bone Mass of Obese Patients Who Have Undergone Gastric
28 449 Bypass Surgery. *Obes Surg* 2017.
- 29 450 19. Reid RE, Carver TE, Andersen KM, et al. Physical activity and sedentary behavior in bariatric
30 451 patients long-term post-surgery. *Obes Surg* 2015;25(6):1073-7.
- 31 452 20. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease
32 453 incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis.
33 454 *Annals of internal medicine* 2015;162(2):123-32.
- 34 455 21. O'Donovan G, Blazevich AJ, Boreham C, et al. The ABC of Physical Activity for Health: a
35 456 consensus statement from the British Association of Sport and Exercise Sciences. *J Sports Sci*
36 457 2010;28(6):573-91.
- 37 458 22. Herring LY, Stevinson C, Davies MJ, et al. Changes in physical activity behaviour and physical
38 459 function after bariatric surgery: a systematic review and meta-analysis. *Obes Rev*
39 460 2016;17(3):250-61.
- 40 461 23. Afshar S, Seymour K, Kelly SB, et al. Changes in physical activity after bariatric surgery: using
41 462 objective and self-reported measures. *Surg Obes Relat Dis* 2017;13(3):474-83.
- 42 463 24. Raftopoulos I, Bernstein B, O'Hara K, et al. Protein intake compliance of morbidly obese
43 464 patients undergoing bariatric surgery and its effect on weight loss and biochemical
44 465 parameters. *Surg Obes Relat Dis* 2011;7(6):733-42.
- 45 466 25. Sherf Dagan S, Tovim TB, Keidar A, et al. Inadequate protein intake after laparoscopic sleeve
46 467 gastrectomy surgery is associated with a greater fat free mass loss. *Surg Obes Relat Dis*
47 468 2017;13(1):101-09.
- 48 469 26. Moize V, Andreu A, Rodriguez L, et al. Protein intake and lean tissue mass retention
49 470 following bariatric surgery. *Clinical nutrition* 2013;32(4):550-5.
- 50 471 27. Faria SL, Faria OP, Buffington C, et al. Dietary protein intake and bariatric surgery patients: a
51 472 review. *Obes Surg* 2011;21(11):1798-805.
- 52 473 28. Ito MK, Goncalves VSS, Faria S, et al. Effect of Protein Intake on the Protein Status and Lean
53 474 Mass of Post-Bariatric Surgery Patients: a Systematic Review. *Obes Surg* 2017;27(2):502-12.

- 1
2
3 475 29. Kolotkin RL, Meter K, Williams GR. Quality of life and obesity. *Obes Rev* 2001;2(4):219-29.
4 476 30. Munoz DJ, Lal M, Chen EY, et al. Why patients seek bariatric surgery: a qualitative and
5 477 quantitative analysis of patient motivation. *Obes Surg* 2007;17(11):1487-91.
6 478 31. Testa MA, Simonson DC. Assessment of quality-of-life outcomes. *N Engl J Med*
7 479 1996;334(13):835-40.
8 480 32. Kolotkin RL, Andersen JR. A systematic review of reviews: exploring the relationship between
9 481 obesity, weight loss and health-related quality of life. *Clinical obesity* 2017.
10 482 33. Lindekilde N, Gladstone BP, Lubeck M, et al. The impact of bariatric surgery on quality of life:
11 483 a systematic review and meta-analysis. *Obes Rev* 2015;16(8):639-51.
12 484 34. Pollock RF, Chilcott J, Muduma G, et al. Laparoscopic adjustable gastric banding vs standard
13 485 medical management in obese patients with type 2 diabetes: a budget impact analysis in the
14 486 UK. *Journal of medical economics* 2013;16(2):249-59.
15 487 35. Terranova L, Busetto L, Vestri A, et al. Bariatric surgery: cost-effectiveness and budget
16 488 impact. *Obes Surg* 2012;22(4):646-53.
17 489 36. Ackroyd R, Mouiel J, Chevallier JM, et al. Cost-effectiveness and budget impact of obesity
18 490 surgery in patients with type-2 diabetes in three European countries. *Obes Surg*
19 491 2006;16(11):1488-503.
20 492 37. Bush K, Kivlahan DR, McDonell MB, et al. The AUDIT alcohol consumption questions (AUDIT-
21 493 C): an effective brief screening test for problem drinking. Ambulatory Care Quality
22 494 Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Archives of*
23 495 *internal medicine* 1998;158(16):1789-95.
24 496 38. Lee SY, Gallagher D. Assessment methods in human body composition. *Current opinion in*
25 497 *clinical nutrition and metabolic care* 2008;11(5):566-72.
26 498 39. Faria SL, Faria OP, Cardeal MD, et al. Validation study of multi-frequency bioelectrical
27 499 impedance with dual-energy X-ray absorptiometry among obese patients. *Obes Surg*
28 500 2014;24(9):1476-80.
29 501 40. Migueles JH, Cadenas-Sanchez C, Ekelund U, et al. Accelerometer Data Collection and
30 502 Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and
31 503 Practical Considerations. *Sports medicine* 2017.
32 504 41. A. T. S. Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories.
33 505 ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med*
34 506 2002;166(1):111-7.
35 507 42. Pataky Z, Armand S, Muller-Pinget S, et al. Effects of obesity on functional capacity. *Obesity*
36 508 *(Silver Spring)* 2014;22(1):56-62.
37 509 43. Sousa-Santos AR, Amaral TF. Differences in handgrip strength protocols to identify
38 510 sarcopenia and frailty - a systematic review. *BMC geriatrics* 2017;17(1):238.
39 511 44. Yang YJ, Kim MK, Hwang SH, et al. Relative validities of 3-day food records and the food
40 512 frequency questionnaire. *Nutrition research and practice* 2010;4(2):142-8.
41 513 45. Brooks R. EuroQol: the current state of play. *Health policy* 1996;37(1):53-72.
42 514 46. Dolan P. Modeling valuations for EuroQol health states. *Medical care* 1997;35(11):1095-108.
43 515 47. Kolotkin RL, Crosby RD, Kosloski KD, et al. Development of a brief measure to assess quality
44 516 of life in obesity. *Obes Res* 2001;9(2):102-11.
45 517 48. Beck AT, Steer RA, Brown GK. Manual for the Beck Depression Inventory-II. San Antonio, TX,
46 518 1996.
47 519 49. Beecham J, Knapp M. Costing psychiatric interventions, in G. Thornicroft (ed.) *Measuring*
48 520 *Mental Health Needs*. 2nd edition ed: Gaskell, 2001.
49 521 50. Curtis L, Burns A. *Unit Costs of Health and Social Care 2015: Personal Social Services*
50 522 *Research Unit, University of Kent, Canterbury, 2015.*
51 523 51. Department of Health. *National Schedule of Reference Costs: DOH, London, 2015.*
52 524 52. British National Formulary. <https://www.bnf.org/>.

525 53. Barber J, Thompson S. Multiple regression of cost data: use of generalised linear models. J
526 Health Serv Res Policy 2004;9(4):197-204.

527

528

529

530

531 **Figure**

532

533 **Figure 1 Flow diagram of participant enrolment, consent, assessment and associated timeline.**

534

535

RECRUITMENT: Eligibility check and consent.

(T0) BASELINE ASSESSMENT (- 6 WEEKS)

SURGERY: Body weight measured.

(T1) 3-MONTH FOLLOW-UP ASSESSMENT

(T2) 6-MONTH FOLLOW-UP ASSESSMENT

(T3) 12-MONTH FOLLOW-UP ASSESSMENT

CLOSEOUT: Analysis and dissemination of findings.

536

537

538

539

540

541

542

543

544

545

546

547

548

549

550

551

1
2
3 552
4
5 553
6
7 554
8
9 555
10
11
12 556
13
14 557
15 558
16 559
17 560
18

Table**Table 1 Participant eligibility criteria for participation in the BARI-LIFESTYLE observational study.**

INCLUSION CRITERIA	
1	Adult aged between 18 to 65 years.
2	Planned to undergo either primary RYGB or primary SG surgery and fulfilling NICE eligibility criteria for bariatric surgery ¹ .
3	Able to read and write in English.
4	Willing and able to provide written informed consent.
5	Able to comply with study protocol.
6	Willing and able to wear a Fitbit wrist-based activity tracker device and an ActiGraph device.
EXCLUSION CRITERIA	
1	More than 200 kg of body weight due to the limitation of DXA scan.
2	Non-ambulatory.
3	Functional limitation.

19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35 561
36 562
37 563
38 564
39 565
40 566
41 567
42 568
43 569
44 570
45 571
46 572
47 573
48 574
49 575
50 576
51 577
52 578
53
54
55
56
57
58
59
60

579
580
581
582
583

For peer review only

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

584 **Table 2 Study timeline and investigations.**

585

	Baseline (T0)	Day of surgery	3-month post-surgery (T1)	6-month post-surgery (T2)	12-month post-surgery (T3)
Sociodemographic data	✓				
Height	✓				
Weight	✓	✓	✓	✓	✓
Blood pressure and heart rate	✓		✓	✓	✓
Dual-energy X-ray absorptiometry scan	✓				✓
Bioelectrical impedance analysis	✓		✓	✓	✓
Laboratory test	✓		✓	✓	✓
Physical activity levels (ActiGraph) and activity diary	✓		✓	✓	✓
Physical function and strength:					
6-minute walk test (6MWT)	✓		✓	✓	✓
Sit-to-stand (STS) test	✓		✓	✓	✓
Handgrip test	✓		✓	✓	✓
Dietary intake (3-day food diary)	✓		✓	✓	✓
Completion of questionnaires:					
EuroQol-5D-3L (EQ-5D-3L)	✓		✓	✓	✓
Impact of weight on Quality of Life-Lite (IWQOL-Lite)	✓		✓	✓	✓
Beck Depression Inventory-II (BDI-II)	✓		✓	✓	✓
Client Service Receipt Inventory (CSRI)	✓		✓	✓	✓
Review of medication	✓		✓	✓	✓
Review of comorbidities	✓		✓	✓	✓

586



SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description
Administrative information		
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym Page 1
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry N/A
	2b	All items from the World Health Organization Trial Registration Data Set N/A
Protocol version	3	Date and version identifier N/A
Funding	4	Sources and types of financial, material, and other support Page 16
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors Page 1 and page 15
	5b	Name and contact information for the trial sponsor N/A
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities Page 16
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee) N/A

Introduction

Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention Page 4
	6b	Explanation for choice of comparators N/A
Objectives	7	Specific objectives or hypotheses Page 6
Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory) Page 7

Methods: Participants, interventions, and outcomes

Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained Page 7
Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists) Page 20 (Table 1)
Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered N/A
	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease) N/A
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests) N/A
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial N/A

1	Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended Page 9
2			
3			
4			
5			
6			
7			
8			
9			
10	Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure) Page 19 (Figure 1) and Page 21 (Table 2)
11			
12			
13			
14			
15	Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations Page 7 and page 15
16			
17			
18			
19			
20			
21	Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size Page 8
22			
23			
24			

Methods: Assignment of interventions (for controlled trials)

Allocation:

25			
26			
27			
28			
29	Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions N/A
30			
31			
32			
33			
34			
35			
36			
37			
38	Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned N/A
39			
40			
41			
42			
43			
44	Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions N/A
45			
46			
47			
48	Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how N/A
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

17b If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial

N/A

Methods: Data collection, management, and analysis

23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

Data collection methods 18a Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data collection forms can be found, if not in the protocol

Page 9 and 21 (Table 2)

18b Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols

N/A

Data management 19 Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol

Page 13

Statistical methods 20a Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol

Page 12

20b Methods for any additional analyses (eg, subgroup and adjusted analyses)

Page 12

20c Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)

Page 13

Methods: Monitoring

Data monitoring 21a Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol.

Alternatively, an explanation of why a DMC is not needed

N/A

1		21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial
2			N/A
3			
4			
5			
6			
7	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct
8			Page 14
9			
10			
11			
12	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor
13			N/A
14			
15			
16			
17			
18	Ethics and dissemination		
19			
20	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval
21			Page 13
22			
23			
24	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)
25			N/A
26			
27			
28			
29			
30	Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)
31			Page 8
32			
33			
34			
35		26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable
36			N/A
37			
38			
39	Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial
40			Page 13
41			
42			
43			
44	Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site
45			Page 16
46			
47			
48	Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators
49			Page 13
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

1			
2	Ancillary and	30	Provisions, if any, for ancillary and post-trial care, and for
3	post-trial care		compensation to those who suffer harm from trial participation
4			N/A
5			
6	Dissemination	31a	Plans for investigators and sponsor to communicate trial results to
7	policy		participants, healthcare professionals, the public, and other relevant
8			groups (eg, via publication, reporting in results databases, or other
9			data sharing arrangements), including any publication restrictions
10			Page 13
11			
12		31b	Authorship eligibility guidelines and any intended use of professional
13			writers
14			N/A
15			
16		31c	Plans, if any, for granting public access to the full protocol, participant-
17			level dataset, and statistical code
18			N/A
19			
20			
21	Appendices		
22			
23	Informed consent	32	Model consent form and other related documentation given to
24	materials		participants and authorised surrogates
25			N/A
26			
27	Biological	33	Plans for collection, laboratory evaluation, and storage of biological
28	specimens		specimens for genetic or molecular analysis in the current trial and for
29			future use in ancillary studies, if applicable
30			N/A
31			

32 *It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013
 33 Explanation & Elaboration for important clarification on the items. Amendments to the
 34 protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT
 35 Group under the Creative Commons "[Attribution-NonCommercial-NoDerivs 3.0 Unported](https://creativecommons.org/licenses/by-nc-nd/3.0/)"
 36 license.
 37
 38
 39
 40
 41
 42
 43
 44
 45
 46
 47
 48
 49
 50
 51
 52
 53
 54
 55
 56
 57
 58
 59
 60

BMJ Open

Protocol for a one-year prospective, longitudinal cohort study of patients undergoing Roux-en-Y gastric bypass and sleeve gastrectomy: the BARI-LIFESTYLE observational study.

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-020659.R1
Article Type:	Protocol
Date Submitted by the Author:	05-Jan-2018
Complete List of Authors:	Jassil, Friedrich; University College London, Centre for Obesity Research, Division of Medicine; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery Carnemolla, Alisia; University College London, Centre for Obesity Research, Division of Medicine; National Institute of Health Research, University College London Hospitals Biomedical Research Centre Kingett, Helen; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; National Institute of Health Research, University College London Hospitals Biomedical Research Centre Paton, Bruce; Institute of Sport, Exercise and Health O'Keeffe, Aidan; University College London, Department of Statistical Science Doyle, Jacqueline; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; National Institute of Health Research, University College London Hospitals Biomedical Research Centre Morris, Stephen; University College London, Department of Applied Health Research Lewis, Neville; University College London, The Hatter Cardiovascular Institute, Institute of Cardiovascular Science Kirk, Amy; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; National Institute of Health Research, University College London Hospitals Biomedical Research Centre Pucci, Andrea; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery; University College London, Centre for Obesity Research, Division of Medicine Chaiyasoot, Kusuma; University College London, Centre for Obesity Research, Division of Medicine; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery Batterham, Rachel; University College London, Centre for Obesity Research, Division of Medicine; University College London Hospitals, Bariatric Centre for Weight Management and Metabolic Surgery
Primary Subject Heading:	Surgery
Secondary Subject Heading:	Diabetes and endocrinology, Nutrition and metabolism, Gastroenterology and hepatology
Keywords:	Obesity, Bariatric Surgery, Body Composition, Physical Activity, Diet,

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

	Quality of Life

SCHOLARONE™
Manuscripts

For peer review only

1 **Protocol for a one-year prospective, longitudinal cohort study of patients undergoing**
2 **Roux-en-Y gastric bypass and sleeve gastrectomy: the BARI-LIFESTYLE observational study.**

3
4 Friedrich C. Jassil ^{1,2}, Alisia Carnemolla ^{1,3}, Helen Kingett ^{2,3}, Bruce Paton ⁴, Aidan G. O’Keeffe ⁵,
5 Jaqueline Doyle ^{2,3}, Stephen Morris ⁶, Neville Lewis ⁷, Amy Kirk ^{2,3}, Andrea Pucci ^{1,2}, Kusuma
6 Chaiyasoot ^{1,2} and Rachel L. Batterham ^{1,2,3*}

7
8 **Author affiliations**

9 ¹ Centre for Obesity Research, Division of Medicine, University College London, London, United
10 Kingdom

11 ² University College London Hospitals, Bariatric Centre for Weight Management and Metabolic
12 Surgery, London, United Kingdom

13 ³ National Institute of Health Research University College London Hospitals Biomedical Research
14 Centre, London, United Kingdom

15 ⁴ Institute of Sport, Exercise and Health, London, United Kingdom

16 ⁵ Department of Statistical Science, University College London, London, United Kingdom

17 ⁶ Department of Applied Health Research, University College London, London, United Kingdom

18 ⁷ The Hatter Cardiovascular Institute, Institute of Cardiovascular Science, University College London,
19 London, United Kingdom

20
21 *Corresponding author: Professor Rachel L. Batterham; r.batterham@ucl.ac.uk

22 Address: Centre for Obesity Research
23 Division of Medicine
24 University College London
25 Rayne Building, 5 University Street
26 London WC1E 6JF, United Kingdom

1
2
3 27 **ABSTRACT**
4

5 28 **Introduction:** Roux-en-Y gastric bypass and sleeve gastrectomy are the two most common bariatric
6
7 29 surgery performed in the UK that result in comparable weight loss and remission of obesity-
8
9 30 associated co-morbidities. However, there is a paucity of studies examining the impact of these
10
11 31 procedures upon body composition, physical activity levels, sedentary behaviour, physical function
12
13 32 and strength, dietary intake, health-related quality of life and costs.
14
15
16 33

17
18 34 **Methods and analysis:** The BARI-LIFESTYLE observational study is a one-year prospective,
19
20 35 longitudinal cohort study within a real-world routine clinical care setting aiming to recruit 100
21
22 36 patients with severe obesity undergoing either primary Roux-en-Y gastric bypass or sleeve
23
24 37 gastrectomy from two bariatric centres in London, UK. Participants will be followed-up four times
25
26 38 during the study period; pre-surgery baseline (T0) and at 3 (T1), 6 (T2), and 12-month (T3) post-
27
28 39 surgery. In addition to the standard follow-up investigations, assessments including dual-energy X-
29
30 40 ray absorptiometry scan, bioelectric impedance analysis, 6-minute walk test, sit-to-stand test, and
31
32 41 handgrip test will be undertaken together with completion of questionnaires. Physical activity levels
33
34 42 and sedentary behaviour will be assessed using accelerometer, and dietary intake will be recorded
35
36 43 using a 3-day food diary. Outcome measures will include: body weight, body fat mass, lean muscle
37
38 44 mass, bone mineral density, physical activity levels, sedentary behaviour, physical function and
39
40 45 strength, dietary intake, health-related quality of life, remission of co-morbidities, healthcare
41
42 46 resource utilisation and costs.
43
44

45 47
46
47 48 **Ethics and dissemination:** This study has been reviewed and given a favourable ethical opinion by
48
49 49 London-Dulwich Research Ethics Committee (17/LO/0950). The results will be presented to
50
51 50 stakeholder groups locally, nationally and internationally and published in peer-reviewed medical
52
53 51 journals. The lay-person summary of the findings will be published on the Centre for Obesity
54
55 52 Research, University College London website (<http://www.ucl.ac.uk/obesity>).
56
57
58
59
60

1
2
3 53
4
5 54
6
7 55
8
9 56
10
11 57
12
13 58
14
15 59
16
17 60
18
19 61
20
21 62
22
23 63
24
25 64
26
27 65
28
29 66
30
31 67
32
33 68
34
35 69
36
37 70
38
39 71
40
41 72
42
43 73
44
45 74
46
47 75
48
49 76
50
51 77
52
53 78
54
55
56
57
58
59
60

Strengths and limitations of this study

- A comprehensive prospective, longitudinal study with detailed assessments undertaken prior to and for one year following bariatric surgery examining changes in body composition, physical activity (PA) levels, sedentary behaviour, physical function and strength, dietary intake, health-related quality of life and costs, relative to baseline pre-surgery.
- The use of validated research tools (accelerometer to assess PA levels and sedentary behaviour, dual-energy X-ray absorptiometry [DXA] scan to assess body composition and validated questionnaires) will generate high-quality data.
- The study design does not include a conventional intensive lifestyle intervention (non-surgical) as a comparator group and patients will not be randomised to RYGB or SG in order to reflect current real-world clinical care.
- A potential sample selection bias due to exclusion of patients with functional limitation and/or non-ambulatory and patients with more than 200 kg of body weight owing to the weight limit of the DXA scan.
- A relatively small sample size, nevertheless, this number is adequate to generate in-depth insights into the various outcomes of Roux-en-Y gastric bypass and sleeve gastrectomy as delivered in the UK healthcare setting.

79

80 INTRODUCTION

81 Bariatric surgery engenders marked sustained weight loss and is recommended by the National
82 Institute for Health and Care Excellence (NICE) as a treatment option for people of severe obesity¹,
83 estimated to affect approximately 2.6 million adults in the UK². Roux-en-Y gastric bypass (RYGB) and
84 sleeve gastrectomy (SG) are now the two most common procedures performed in the UK, which
85 result in comparable weight loss and remission of obesity associated co-morbidities³. However,
86 there is a paucity of studies examining the impact of these procedures upon body composition,
87 particularly bone mineral density (BMD), physical activity (PA) levels, sedentary behaviour, physical
88 function and strength, dietary intake, health-related quality of life (HRQoL) and costs. Furthermore,
89 current eligibility and success criteria of bariatric surgery are mainly based on body weight, body
90 mass index (BMI) and excess weight loss but evidence have shown various beneficial outcomes of
91 the surgery above and beyond weight loss alone, hence highlighting the need for more functional
92 pre- and post-operative patient assessment^{4,5}.

93

94 Bariatric surgery leads to a marked decrease in fat mass (FM), but fat free mass (FFM) particularly
95 bone mass is also reduced post-surgery⁶, potentially negatively impacting on physical function and
96 strength, and putting patients at increased risk of osteoporotic fracture in the future^{7,8}. Moreover, a
97 recent study has revealed a positive association between changes in adiposity with cardiometabolic
98 outcomes post-surgery, indicating the usefulness of incorporating body composition assessment⁹.
99 Surgical modification of the gastrointestinal tract impairs the intake and/or absorption of essential
100 nutrients for bone health that consequently perturbs bone metabolism, leading to BMD
101 deterioration^{7,8,10,11}. Significant bone mass loss has been reported to occur rapidly in the first year of
102 surgery and continues to deteriorate up to 3 years even after maximum weight loss has been
103 achieved¹⁰. However, these data, are mainly based on studies undertaken in patients who
104 underwent RYGB whereas SG is now the most common procedure undertaken both in the UK and

4

1
2
3 105 globally^{3 12}. Currently, it is unclear whether the rate of bone mass loss following SG parallels weight
4
5 106 loss¹³⁻¹⁵. Given that the number of younger patients and women of childbearing age undergoing
6
7 107 bariatric surgery continues to increase and BMD measurement is not a routine follow-up
8
9 108 investigation¹⁶, there is an urgent need to assess the impact of RYBG and SG on bone health in the
10
11 109 UK bariatric population.

12
13 110

14
15 111 Adherence to a post-bariatric lifestyle changes is the cornerstone of a successful weight loss¹⁷.
16
17 112 Studies have shown that greater PA, lower sedentary time and high compliance to dietary
18
19 113 recommendation post-surgery associate with greater weight loss and FM loss, preservation of lean
20
21 114 muscle mass (LMM) and bone mass, as well as improvement in HRQoL¹⁸⁻²². However, patients spend
22
23 115 80% of their waking time in sedentary behaviour post-surgery²³, activity that associates with
24
25 116 increased risk of cardiometabolic disease and mortality²⁴. ²²Following surgery, patients are advised
26
27 117 to undertake at least 150 minutes of moderate-to-vigorous physical activity (MVPA) per week, a
28
29 118 duration and intensity that are recommended to reap the metabolic benefit of PA²⁵. However,
30
31 119 objectively measured MVPA decreases post-surgery with only 10% of patients achieving the
32
33 120 recommended MVPA levels²⁶. Likewise, a recent study undertaken in the UK has reported that
34
35 121 weight loss post-surgery did not correspond to improvement in MVPA and sedentary behaviour.
36
37 122 However, the small sample size of this study (n=22) together with relatively short follow-up period
38
39 123 limited its generalisability²⁷. Further studies are therefore required to expand the information in this
40
41 124 regard. In terms of dietary recommendations, daily protein intake of 60 g or more post-surgery is
42
43 125 crucial for increasing satiety, preserving LMM, improving body composition and preventing against
44
45 126 weight regain²⁸⁻³¹. However, most patients are unable to achieve this in the first postoperative year,
46
47 127 the period when rapid weight loss occurs³². Whether this is also the case for UK bariatric population
48
49 128 is not known as no such data has ever been reported thus far³².

50
51
52
53 129

1
2
3 130 Impaired HRQoL is common in obesity³³ and often one of the driving factors for seeking weight loss
4
5 131 surgery³⁴. HRQoL is defined as individuals' perception of well-being that refers to physical,
6
7 132 psychological and social domains of health³⁵. Most studies reported improvement in all HRQoL
8
9 133 domains with greater scores observed in the first post-operative year although some studies showed
10
11 134 that the improvement is limited to only the physical domain but not the mental health component
12
13 135 of HRQoL³⁶. Despite mounting evidence in the international literature reporting the beneficial impact
14
15 136 of bariatric surgery on HRQoL, data from the UK bariatric population does not exist³⁷. There is some
16
17 137 evidence that bariatric surgery can reduce in cost savings that offset the initial costs of surgery,
18
19 138 though little UK evidence for RYGB and SG³⁸⁻⁴⁰.

20
21
22 139

23
24 140 Taken together the lack of post-operative data coupled with recommendations from systematic
25
26 141 reviews^{26 32} provide a strong rationale to undertake a prospective study to evaluate the impact of
27
28 142 RYGB and SG upon body composition particularly BMD, PA levels, sedentary behaviour, physical
29
30 143 function and strength, dietary intake, HRQoL and costs in a UK bariatric population. Information
31
32 144 gained from this study will provide valuable data to inform the implementation of future post-
33
34 145 surgery lifestyle programmes with the aim of maximising the beneficial outcomes of bariatric surgery
35
36 146 as highlighted by NICE¹. This paper details the study design and outcomes of the BARI-LIFESTYLE
37
38 147 observational study.

39
40
41 148

42 43 149 **OBJECTIVES**

44
45 150 The overall objective of BARI-LIFESTYLE observational study is to evaluate the impact of RYGB and SG
46
47 151 on changes in body weight, body composition, PA levels, sedentary behaviour, physical function and
48
49 152 strength, dietary intake, HRQoL, remission of co-morbidities, healthcare resource utilisation and
50
51 153 costs in a cohort of 100 patients.

52
53 154

54
55 155 The specific objectives are to evaluate post-surgery changes in:

- 156 1. Percentage weight loss (%WL) at one year post-surgery, relative to baseline pre-surgery
- 157 weight.
- 158 2. Body fat mass, assessed using dual-energy X-ray absorptiometry (DXA) scan and bioelectrical
- 159 impedance analysis (BIA), relative to pre-surgery at 12 months post-surgery.
- 160 3. LMM, assessed using DXA scan and BIA, relative to pre-surgery at 12 months post-surgery.
- 161 4. BMD, assessed using DXA scan and BIA, relative to pre-surgery at 12 months post-surgery.
- 162 5. PA levels (light, moderate, vigorous), percentage achieving 150 minutes of MVPA in a week
- 163 and sedentary behaviour assessed using accelerometer at 3, 6, and 12 months post-surgery,
- 164 relative to pre-surgery.
- 165 6. Physical function and strength assessed using 6-minute walk test (6MWT), sit-to-stand (STS)
- 166 test and handgrip test at 3, 6 and 12 months post-surgery, relative to pre-surgery.
- 167 7. Dietary intake assessed using food diary at 3, 6 and 12 months post-surgery, relative to pre-
- 168 surgery.
- 169 8. HRQoL assessed using EuroQol-5D-3L (EQ-5D-3L) and Impact of Weight on Quality of Life-
- 170 Lite (IWQOL-Lite) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
- 171 9. Characteristics of attitude and symptoms of depression assessed using Beck Depression
- 172 Inventory-II (BDI-II) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
- 173 10. Obesity-associated comorbidities (type 2 diabetes [T2D], dyslipidaemia, hypertension,
- 174 obstructive sleep apnoea [OSA]) at 3, 6 and 12 months post-surgery, relative to pre-surgery.
- 175 11. Healthcare resource utilisation and costs assessed using an adapted version of the Client
- 176 Service Receipt Inventory (CSRI) at 3, 6 and 12 months post-surgery, relative to pre-surgery.

177

178 **METHODS AND ANALYSIS**

179 **Study design and setting**

180 BARI-LIFESTYLE observational study is a prospective, longitudinal cohort study within routine clinical
181 care setting of patients undergoing bariatric surgery conducted in London, UK (Figure 1). A total of

1
2
3 182 100 patients who are planned to undergo either primary RYGB or SG will be recruited over a 2-year
4
5 183 period from 2018 to 2019, and will be followed for up to 12 months post-surgery. Recruitment will
6
7 184 take place at the Bariatric Centre for Weight Management and Metabolic Surgery, University College
8
9 185 London Hospitals (UCLH) (study site) and the Bariatric and Obesity Surgery Clinic at the Whittington
10
11 186 Hospital that acts as a participant identification centre (PIC). Participants recruited from the
12
13 187 Whittington Hospital will have their surgical procedure undertaken at the same centre, but all study
14
15 188 procedures such as written informed consent, baseline assessment, post-surgery follow-up care and
16
17 189 study assessments will be undertaken by the bariatric team at UCLH. In both centres, the decision
18
19 190 for procedure selection is based on informed patient preference after standardised counselling
20
21 191 including details, potential risks, and benefits of each procedure that adheres to the current
22
23 192 international guideline for the surgical recommendation for obesity and weight-related disease⁴¹.
24
25 193 This study is carried out by the Centre for Obesity Research, Division of Medicine, University College
26
27 194 London (UCL), with an expected total duration of 36 months, from the first participant enrolled to
28
29 195 last participant follow-up.
30
31
32
33

34 197 **Participants and recruitment**

35
36 198 Patients will be screened for suitability for the study by the bariatric team at the study site and PIC
37
38 199 based on the inclusion and exclusion criteria when they attend the standard pre-surgical assessment
39
40 200 (Table 1). Verbal consent will be sought from those fulfilling the eligibility criteria and interested in
41
42 201 participating to be approached by a research investigator. Patients will be given a participant
43
44 202 information sheet inviting them to participate in a one-year prospective, longitudinal cohort study
45
46 203 looking at the effect of bariatric surgery on body weight, body composition, PA levels, sedentary
47
48 204 behaviour, physical function and strength, dietary intake, HRQoL, remission of co-morbidities,
49
50 205 healthcare resource utilisation and costs. Consented participants will then be scheduled to attend a
51
52 206 baseline assessment, approximately 6 weeks before surgery day at the study site. Each participant
53
54 207 will be given a Fitbit Alta HR to enable them to self-monitor their activity levels and to reduce
55
56
57
58
59
60

1
2
3 208 sedentary behaviour. Based on the weekly number of bariatric procedures undertaken at UCLH and
4
5 209 Whittington Hospital and after considering the eligibility criteria, estimated recruitment rate is
6
7 210 approximately 7 participants per month. Hence, the expected recruitment period for the study is 15
8
9 211 to 20 months.

10
11 212

12
13 213 All participants will receive the standardised post-bariatric care as stipulated by NICE¹. Participants
14
15 214 will attend the study site for monitoring of nutritional intake, vitamin and mineral deficiencies,
16
17 215 comorbidities and medication review. Participants will receive verbal PA and dietary advice from a
18
19 216 specialist nurse and dietitian at weeks 12 and 36 post-surgery, respectively.

20
21
22 217

23 218 **Outcomes measures**

24
25 219 Outcome measures will be collected at four study time points, designed to coincide with normal
26
27 220 follow-up care visits; baseline visit at approximately 6 weeks before surgery (T0) then at 3 (T1), 6
28
29 221 (T2), and 12-month (T3) post-surgery (Table 2).

30
31
32 222

33 223 ***Sociodemographic, medical history, and physical examination***

34
35 224 Participants' sociodemographic data, medical history, and physical examination will be completed by
36
37 225 the bariatric team at the baseline visit. Data to be captured including age, gender, ethnicity,
38
39 226 educational level, marital status, medication intake, weight history, pregnancy history, alcohol
40
41 227 consumption using the AUDIT-C questionnaire⁴², smoking habits and family history of obesity and
42
43 228 comorbidities.

44
45
46 229

47 230 **Primary outcome**

48
49 231 Body weight will be measured using a weighing scale (Model VT200/220, Vishay Transducers Ltd.,
50
51 232 CA, USA) with participants wearing light clothes and without shoes and heavy accessories, to the
52
53 233 nearest 0.1 kg. Similarly, height will be determined using a stadiometer (Seca 242, Seca GmbH & Co.

234 KG, Hamburg, Germany) to the nearest 0.01 m. %WL will be calculated using the following formula:

235 $\%WL = [(weight\ on\ the\ day\ of\ surgery - weight\ at\ time-point\ after\ surgery) / weight\ on\ the\ day\ of$
236 $surgery] \times 100$, measured at each study time point.

237

238 **Secondary outcomes**

239 ***Body composition (body fat mass, LMM and BMD)***

240 Body composition will be assessed at baseline and 12-months post-surgery using DXA scan
241 (Discovery™ A DXA system, software v13.4.2, Hologic®, Inc., MA, USA). DXA scan uses ionising
242 radiation to measure different body compartments. This is the current reference standard for
243 assessing body composition and a gold standard method to diagnose osteopenia and osteoporosis⁴³.

244 In addition, body composition will be measured using BIA (Tanita DC-430MAS, Tanita Corp., Tokyo,
245 Japan) at each study visit. This is a non-invasive, easy to perform and cheaper option to measure
246 body composition that is based on the differences in electrical conductivity of FM and FFM tissues⁴⁴.

247

248 ***PA levels and sedentary behaviour***

249 PA and time spent in light, moderate and vigorous activities, and sedentary behaviour will be
250 measured objectively using ActiGraph wGT3X-BT (Pensacola, FL, USA), an accelerometer-based
251 activity monitor⁴⁵. Participants will be instructed to wear the ActiGraph on their dominant hip for
252 one week, from waking in the morning until going to bed at night, and to remove it only during
253 water-based activities. Additionally, participants will be asked to keep an activity diary throughout
254 the week, to assist interpretation of data from the device. Both the device and activity diary have to
255 be returned to the investigators for data analysis (ActiLife software v6.13.3, Pensacola, FL, USA).

256

257 ***Physical function and strength***

258 Participants' functional capacity will be assessed using a 6MWT, a self-paced, submaximal
259 assessment of functional capacity used to prescribe appropriate exercise⁴⁶. Lower body functional

260 capacity and strength will be assessed using the STS test⁴⁷. Static muscle strength will be assessed
261 using Jamar Hydraulic Hand Dynamometer (Pettersen Medical, IL, USA)⁴⁸.

262

263 ***Dietary intake***

264 All participants will be required to keep a 3-day food diary (2 working days and 1 weekend day) for
265 one week at each study time point. This method has a higher agreement with the 9 days food diary
266 compared to the food frequency questionnaire⁴⁹ whilst reducing the burden to patients and thus
267 promoting better compliance for documenting food intake. The completed food diary will be
268 returned to the investigators together with the ActiGraph and activity diary by using a stamped
269 addressed envelope provided to participants.

270

271 ***HRQoL***

272 HRQoL will be assessed using EQ-5D-3L and IWQOL-Lite. The EQ-5D-3L descriptive system is a 5-item
273 self-report questionnaire that assesses the following domains: mobility, self-care, usual activities,
274 pain/discomfort and anxiety/depression, and a visual analogue scale, which records self-rated health
275 on a 0 to 100 scale⁵⁰. EQ-5D-3L health states will be converted into utility values using a formula that
276 attaches weights to each level in each dimension based on valuations by general population
277 samples. We will use a value set for the UK population to calculate utility values at each time point
278 for every participant⁵¹. The IWQOL-Lite is a 31-item, self-report, obesity and overweight-specific
279 measure of HRQoL⁵². This tool consists of a total score and scores on each of five scales – physical
280 function, self-esteem, sexual life, public distress, and work; higher scores indicate better HRQoL.

281

282 ***Attitude and symptoms of depression***

283 BDI-II is a 21-item self-report questionnaire that assesses mood over the past week⁵³. Symptoms of
284 depression are classified by the total score: minimal, mild, moderate, and severe symptoms.

285

1
2
3 286 ***Obesity-associated comorbidities***

4
5 287 Co-morbidities (T2D, dyslipidaemia, hypertension, OSA) and medication review will be carried out at
6
7 288 each study time point.
8

9 289

10
11 290 ***Healthcare resource utilisation and costs***

12
13 291 Resource use data will be collected using an adapted version of the CSRI⁵⁴, including the costs of
14
15 292 bariatric surgery plus pre-surgery visits, number of contacts with healthcare professionals, visits to
16
17 293 specialist clinics, the emergency department, admissions to the hospital, primary care contacts, and
18
19 294 medications. Resource use data will be converted into costs using published unit costs⁵⁵⁻⁵⁷. In
20
21 295 addition, information regarding support from informal carers, employment status and time off work
22
23 296 will be collected. Resource use data will be collected for the previous 6 months at the baseline visit
24
25 297 and since participants' last study visit at each post-surgery study time point.
26
27

28 298

29
30 299 **Sample size**

31
32 300 A sample size of 100 patients will be enough to model the primary outcome and the range of
33
34 301 secondary outcomes with a reasonable level precision and with regard to the number of patients
35
36 302 who are likely to be recruited within the study's time frame. Also, a sample size of 100 patients will
37
38 303 be sufficient to estimate the %WL at one year post-surgery to within $\pm 2.5\%$ using a 95% confidence
39
40 304 interval. This calculation accounts for a possible drop-out rate of up to 25% and assumes a
41
42 305 conservative estimate for standard deviation of %WL of 10%. This sample size should also ensure
43
44 306 that there are enough data points for linear mixed effects models to be fitted with parameter
45
46 307 estimates that have a satisfactory level of precision and where the model fitting algorithm will
47
48 308 converge.
49

50
51 309

52
53 310 **Statistical analysis**
54
55
56
57
58
59
60

1
2
3 311 The demographic and medical history information collected at baseline shall be presented in a table.
4
5 312 Categorical variables shall be reported as raw numbers and percentages. Reports of continuous
6
7 313 variables shall include mean, median, range and standard deviation.
8

9 314

10
11 315 ***Primary outcome analysis***

12
13 316 The primary outcome is the %WL measured longitudinally at baseline and 12 months post-surgery.
14
15 317 %WL will be analysed using a linear mixed effects model over the three post-surgery time points (3
16
17 318 months, 6 months and 12 months) after controlling for the baseline body weight measure and
18
19 319 height. Model assumptions shall be checked and suitable transforms of the primary outcome
20
21 320 variable considered if necessary. In addition, overall percentage change in weight since baseline shall
22
23 321 be computed marginally at each of 3, 6 and 12 months and displayed graphically.
24
25

26 322

27
28 323 ***Secondary outcomes analyses***

29
30 324 Analyses of longitudinal secondary outcomes shall be performed using linear mixed effects
31
32 325 regression models, with a normal distribution assumed for continuous outcomes (or a suitable
33
34 326 transform of these outcomes). Model parameter estimates together with appropriate 95%
35
36 327 confidence intervals shall be reported. Categorical outcomes (e.g. proportions of participants with
37
38 328 co-morbidities) shall be summarised in tabular form at each time point. Where appropriate (for
39
40 329 example, for proportions), estimates and 95% confidence intervals will be presented. To analyse
41
42 330 costs, we will assume the costs measured at baseline for the preceding 6 months would persist
43
44 331 during follow-up in the absence of surgery; we will then compare post-surgery costs with predicted
45
46 332 costs that would have been incurred in the absence of surgery. To account for skewness of the cost
47
48 333 data, we will use a generalised linear model with gamma family and log link⁵⁸.
49

50 334

51
52
53 335 ***Missing data***

1
2
3 336 Bias due to missing data will be investigated by comparing the baseline characteristics of participants
4
5 337 with and without missing values. Depending on the extent of missingness, the predictors of missing
6
7 338 values will be identified. The primary outcome analysis will be adjusted for those predictors of
8
9 339 missing values, which are related to missingness. Multiple imputation using chained equations shall
10
11 340 be considered as part of a sensitivity analysis for missing data in the primary outcome model.
12

13 341

14 15 342 **Data storage and retention**

16
17 343 All data will be handled in accordance with the UK Data Protection Act 1998. Physical data will be
18
19 344 stored in a secure room with limited access to only members of the research team, whereas
20
21 345 computers storing electronic data will be encrypted and password protected. Each participant will be
22
23 346 given a unique study identification number and used on their records instead of their name. The
24
25 347 master list linking participants' name and the study identification number will be kept in a secure
26
27 348 location. This way, participants' personal identity and data collected in the study cannot be linked by
28
29 349 anyone outside the study team. This study is registered with the UCL Data Protection (Reference:
30
31 350 Z6364106/2017/04/43). At the end of the study, all essential documentation will be archived
32
33 351 securely for a minimum of 20 years from the declaration of the end of study.
34
35

36 352

37 38 353 **ETHICS AND DISSEMINATION**

39
40
41 354 This study has been reviewed and given a favourable ethical opinion by London-Dulwich Research
42
43 355 Ethics Committee (Reference: 17/LO/0950). Potential participants will be explained in detail
44
45 356 regarding the aims, methods, anticipated advantages and disadvantages of participation in the study
46
47 357 by Good Clinical Practice (GCP) trained investigators prior to obtaining their written informed
48
49 358 consent. Participants will be informed that their participation is on a voluntary basis, and they have
50
51 359 the right to withdraw from the study at any time without affecting their present and future medical
52
53 360 care. No research procedures will be undertaken prior to patients giving written informed consent.
54
55
56
57
58
59

1
2
3 361 As a duty of care, all possible adverse events will be collected from the day participants consented
4
5 362 for the study to monitor their safety.
6

7 363

8
9 364 The findings will be presented to stakeholder groups locally, nationally and internationally and
10
11 365 published in peer-reviewed medical journals. The lay-person summary of the findings will be
12
13 366 published on the Centre for Obesity Research, University College London website
14
15 367 (<http://www.ucl.ac.uk/obesity>). The results will be fully anonymised, and none of the participants
16
17 368 will be identified in any report or publication.
18

19
20 369

21 370 **ADVANTAGE AND LIMITATION**

22
23
24 371 This observational study will address the need for more high-quality data that examine the
25
26 372 outcomes of RYGB and SG derived from the UK bariatric population. It will involve a comprehensive
27
28 373 assessment and data collection at four study time points in the first year of surgery enabling an in-
29
30 374 depth analysis of changes in body composition, PA levels, sedentary behaviour, physical function and
31
32 375 strength, dietary intake, HRQoL and costs, relative to pre-surgery. Data collection will be carried out
33
34 376 by using validated assessment methods and questionnaires. Another advantage of this study is the
35
36 377 use of DXA scan, a reference standard to measure body composition⁴³. Also, the use of
37
38 378 accelerometer will generate high-quality data to measure objective PA levels and sedentary
39
40 379 behaviour. Studies have shown that bariatric patients tend to over-report their PA levels when
41
42 380 assessed using the conventional PA questionnaires²⁶.
43

44
45 381

46
47 382 This protocol for an observational study is not without limitations. First, the study design does not
48
49 383 include a conventional intensive lifestyle intervention (non-surgical) as a comparator group. Second,
50
51 384 patients will not be randomised for surgical procedure as this study does not aim to compare
52
53 385 between RYGB and SG but aims to examine 'real-world' clinical outcomes where the
54
55 386 patient/healthcare professional make an informed choice about which procedures is best. However,
56

1
2
3 387 data that will be generated from this study will allow us to power a subsequent randomised study.
4
5 388 Third, a potential sample selection bias due to the exclusion of patients with functional limitation
6
7 389 (e.g. cognitive impairment, walking difficulties) and/or non-ambulatory and patients with more than
8
9 390 200 kg of body weight owing to the weight limit of the DXA scan. Finally, given resource limitations,
10
11 391 only approximately 100 patients will be recruited in this one year observational cohort study.
12
13 392 Nevertheless, this sample size is adequate to generate in-depth insights into the various outcomes of
14
15 393 RYGB and SG.
16

17 394

19 395 **CONCLUSION**

21
22 396 BARI-LIFESTYLE observational study will produce a comprehensive data on the broad range of RYGB
23
24 397 and SG outcomes derived from the UK bariatric population that is still scarce in the literature. The
25
26 398 information gained from this study will inform future lifestyle programmes for post-bariatric
27
28 399 patients.
29

30 400

32 401 **Acknowledgements**

34 402 We wish to thank Professor Rumana Omar for her input with regards to the statistical analysis plan.
35
36 403 We gratefully acknowledge our Patient and Public Involvement group for their contribution to the
37
38 404 study design as to ensure participants' acceptability. We would also like to thank all members of the
39
40 405 Steering Committee and our research team at the Centre for Obesity Research, UCL for their
41
42 406 invaluable inputs in the study.
43
44

45 407

47 408 **Authors' contributions**

49 409 RLB and FCJ designed the overall study and drafted the manuscript; AC coordinated the study to
50
51 410 ensure GCP compliance; HK, JD and AK planned the assessment for dietary intake and HRQoL; BP
52
53 411 and NL planned the assessment for PA levels, sedentary behaviour and physical function and
54
55 412 strength; AGO advised on the statistical analysis plan; SM contributed to the analysis plan for
56
57

1
2
3 413 healthcare resource utilisation and costs; AP and KC planned the assessment for body composition
4
5 414 and review of comorbidities. RLB is the grant holder and chief investigator for the study. All authors
6
7 415 have contributed to the refinement of the study protocol and editing the manuscript. All authors
8
9 416 have read and approved the final manuscript.

10
11 417

12 13 418 **Funding**

14
15 419 This study is supported by National Institute for Health Research (NIHR), the Sir Jules Thorn
16
17 420 Charitable Trust and the Rosetrees Trust. The funders were not involved in decisions relating to the
18
19 421 study design and data collection. They will not have any role in the study execution, analyses,
20
21 422 interpretation of data nor in the writing of the manuscript and decision to submit results.
22

23
24 423

25 26 424 **Competing interests**

27
28 425 The authors declare that they have no conflict of interest.
29

30
31 426

32 33 427 **REFERENCES**

- 34
35 428 1. NICE. Obesity: Identification, assessment and management of overweight and obesity in
36 429 children, young people and adults. London: NICE 2014.
- 37 430 2. Ahmad A, Laverty AA, Aasheim E, et al. Eligibility for bariatric surgery among adults in
38 431 England: analysis of a national cross-sectional survey. *JRSM open*
39 432 2014;5(1):2042533313512479. doi: 10.1177/2042533313512479
- 40 433 3. Booth HP, Khan O, Fildes A, et al. Changing Epidemiology of Bariatric Surgery in the UK:
41 434 Cohort Study Using Primary Care Electronic Health Records. *Obes Surg* 2016;26(8):1900-5.
42 435 doi: 10.1007/s11695-015-2032-9
- 43 436 4. Fruhbeck G. Bariatric and metabolic surgery: a shift in eligibility and success criteria. *Nature*
44 437 *reviews Endocrinology* 2015;11(8):465-77. doi: 10.1038/nrendo.2015.84
- 45 438 5. Cummings DE, Cohen RV. Beyond BMI: the need for new guidelines governing the use of
46 439 bariatric and metabolic surgery. *Lancet Diabetes Endocrinol* 2014;2(2):175-81. doi:
47 440 10.1016/S2213-8587(13)70198-0 [published Online First: 2014/03/14]
- 48 441 6. Schneider J, Peterli R, Gass M, et al. Laparoscopic sleeve gastrectomy and Roux-en-Y gastric
49 442 bypass lead to equal changes in body composition and energy metabolism 17 months
50 443 postoperatively: a prospective randomized trial. *Surg Obes Relat Dis* 2016;12(3):563-70. doi:
51 444 10.1016/j.soard.2015.07.002
- 52 445 7. Nakamura KM, Haglind EG, Clowes JA, et al. Fracture risk following bariatric surgery: a
53 446 population-based study. *Osteoporosis international : a journal established as result of*
54 447 *cooperation between the European Foundation for Osteoporosis and the National*
55 448 *Osteoporosis Foundation of the USA* 2014;25(1):151-8. doi: 10.1007/s00198-013-2463-x

- 1
2
3 449 8. Lu CW, Chang YK, Chang HH, et al. Fracture Risk After Bariatric Surgery: A 12-Year
4 450 Nationwide Cohort Study. *Medicine* 2015;94(48):e2087. doi:
5 451 10.1097/MD.0000000000002087
6 452 9. Gomez-Ambrosi J, Andrada P, Valenti V, et al. Dissociation of body mass index, excess weight
7 453 loss and body fat percentage trajectories after 3 years of gastric bypass: relationship with
8 454 metabolic outcomes. *Int J Obes (Lond)* 2017;41(9):1379-87. doi: 10.1038/ijo.2017.134
9 455 [published Online First: 2017/06/07]
10 456 10. Liu C, Wu D, Zhang JF, et al. Changes in Bone Metabolism in Morbidly Obese Patients After
11 457 Bariatric Surgery: A Meta-Analysis. *Obes Surg* 2016;26(1):91-7. doi: 10.1007/s11695-015-
12 458 1724-5
13 459 11. Yu EW. Bone metabolism after bariatric surgery. *J Bone Miner Res* 2014;29(7):1507-18. doi:
14 460 10.1002/jbmr.2226
15 461 12. Angrisani L, Santonicola A, Iovino P, et al. Bariatric Surgery Worldwide 2013. *Obes Surg*
16 462 2015;25(10):1822-32. doi: 10.1007/s11695-015-1657-z
17 463 13. Pluskiewicz W, Buzga M, Holeczy P, et al. Bone mineral changes in spine and proximal femur
18 464 in individual obese women after laparoscopic sleeve gastrectomy: a short-term study. *Obes*
19 465 *Surg* 2012;22(7):1068-76. doi: 10.1007/s11695-012-0654-8
20 466 14. Ruiz-Tovar J, Oller I, Priego P, et al. Short- and mid-term changes in bone mineral density
21 467 after laparoscopic sleeve gastrectomy. *Obes Surg* 2013;23(7):861-6. doi: 10.1007/s11695-
22 468 013-0866-6
23 469 15. Carrasco F, Basfi-Fer K, Rojas P, et al. Changes in bone mineral density after sleeve
24 470 gastrectomy or gastric bypass: relationships with variations in vitamin D, ghrelin, and
25 471 adiponectin levels. *Obes Surg* 2014;24(6):877-84. doi: 10.1007/s11695-014-1179-0
26 472 16. Mechanick JI, Youdim A, Jones DB, et al. Clinical practice guidelines for the perioperative
27 473 nutritional, metabolic, and nonsurgical support of the bariatric surgery patient--2013
28 474 update: cosponsored by American Association of Clinical Endocrinologists, the Obesity
29 475 Society, and American Society for Metabolic & Bariatric Surgery. *Endocrine practice : official*
30 476 *journal of the American College of Endocrinology and the American Association of Clinical*
31 477 *Endocrinologists* 2013;19(2):337-72. doi: 10.4158/EP12437.GL
32 478 17. Sheets CS, Peat CM, Berg KC, et al. Post-operative psychosocial predictors of outcome in
33 479 bariatric surgery. *Obes Surg* 2015;25(2):330-45. doi: 10.1007/s11695-014-1490-9
34 480 18. Sarwer DB, Wadden TA, Moore RH, et al. Preoperative eating behavior, postoperative
35 481 dietary adherence, and weight loss after gastric bypass surgery. *Surg Obes Relat Dis*
36 482 2008;4(5):640-6. doi: 10.1016/j.soard.2008.04.013
37 483 19. Herman KM, Carver TE, Christou NV, et al. Keeping the weight off: physical activity, sitting
38 484 time, and weight loss maintenance in bariatric surgery patients 2 to 16 years postsurgery.
39 485 *Obes Surg* 2014;24(7):1064-72. doi: 10.1007/s11695-014-1212-3
40 486 20. Bond DS, Phelan S, Wolfe LG, et al. Becoming physically active after bariatric surgery is
41 487 associated with improved weight loss and health-related quality of life. *Obesity (Silver*
42 488 *Spring)* 2009;17(1):78-83. doi: 10.1038/oby.2008.501
43 489 21. Campanha-Versiani L, Pereira DA, Ribeiro-Samora GA, et al. The Effect of a Muscle Weight-
44 490 Bearing and Aerobic Exercise Program on the Body Composition, Muscular Strength,
45 491 Biochemical Markers, and Bone Mass of Obese Patients Who Have Undergone Gastric
46 492 Bypass Surgery. *Obes Surg* 2017 doi: 10.1007/s11695-017-2618-5
47 493 22. Vatier C, Henegar C, Ciangura C, et al. Dynamic relations between sedentary behavior,
48 494 physical activity, and body composition after bariatric surgery. *Obes Surg* 2012;22(8):1251-6.
49 495 doi: 10.1007/s11695-012-0619-y
50 496 23. Reid RE, Carver TE, Andersen KM, et al. Physical activity and sedentary behavior in bariatric
51 497 patients long-term post-surgery. *Obes Surg* 2015;25(6):1073-7. doi: 10.1007/s11695-015-
52 498 1624-8
53
54
55
56
57
58
59
60

- 1
2
3 499 24. Biswas A, Oh PI, Faulkner GE, et al. Sedentary time and its association with risk for disease
4 500 incidence, mortality, and hospitalization in adults: a systematic review and meta-analysis.
5 501 *Annals of internal medicine* 2015;162(2):123-32. doi: 10.7326/M14-1651
6 502 25. O'Donovan G, Blazevich AJ, Boreham C, et al. The ABC of Physical Activity for Health: a
7 503 consensus statement from the British Association of Sport and Exercise Sciences. *J Sports Sci*
8 504 2010;28(6):573-91. doi: 10.1080/02640411003671212
9 505 26. Herring LY, Stevinson C, Davies MJ, et al. Changes in physical activity behaviour and physical
10 506 function after bariatric surgery: a systematic review and meta-analysis. *Obes Rev*
11 507 2016;17(3):250-61. doi: 10.1111/obr.12361
12 508 27. Afshar S, Seymour K, Kelly SB, et al. Changes in physical activity after bariatric surgery: using
13 509 objective and self-reported measures. *Surg Obes Relat Dis* 2017;13(3):474-83. doi:
14 510 10.1016/j.soard.2016.09.012
15 511 28. Raftopoulos I, Bernstein B, O'Hara K, et al. Protein intake compliance of morbidly obese
16 512 patients undergoing bariatric surgery and its effect on weight loss and biochemical
17 513 parameters. *Surg Obes Relat Dis* 2011;7(6):733-42. doi: 10.1016/j.soard.2011.07.008
18 514 29. Sherf Dagan S, Tovim TB, Keidar A, et al. Inadequate protein intake after laparoscopic sleeve
19 515 gastrectomy surgery is associated with a greater fat free mass loss. *Surg Obes Relat Dis*
20 516 2017;13(1):101-09. doi: 10.1016/j.soard.2016.05.026
21 517 30. Moize V, Andreu A, Rodriguez L, et al. Protein intake and lean tissue mass retention
22 518 following bariatric surgery. *Clinical nutrition* 2013;32(4):550-5. doi:
23 519 10.1016/j.clnu.2012.11.007
24 520 31. Faria SL, Faria OP, Buffington C, et al. Dietary protein intake and bariatric surgery patients: a
25 521 review. *Obes Surg* 2011;21(11):1798-805. doi: 10.1007/s11695-011-0441-y
26 522 32. Ito MK, Goncalves VSS, Faria S, et al. Effect of Protein Intake on the Protein Status and Lean
27 523 Mass of Post-Bariatric Surgery Patients: a Systematic Review. *Obes Surg* 2017;27(2):502-12.
28 524 doi: 10.1007/s11695-016-2453-0
29 525 33. Kolotkin RL, Meter K, Williams GR. Quality of life and obesity. *Obes Rev* 2001;2(4):219-29.
30 526 34. Munoz DJ, Lal M, Chen EY, et al. Why patients seek bariatric surgery: a qualitative and
31 527 quantitative analysis of patient motivation. *Obes Surg* 2007;17(11):1487-91.
32 528 35. Testa MA, Simonson DC. Assessment of quality-of-life outcomes. *N Engl J Med*
33 529 1996;334(13):835-40. doi: 10.1056/NEJM199603283341306
34 530 36. Kolotkin RL, Andersen JR. A systematic review of reviews: exploring the relationship between
35 531 obesity, weight loss and health-related quality of life. *Clinical obesity* 2017 doi:
36 532 10.1111/cob.12203
37 533 37. Lindekilde N, Gladstone BP, Lubeck M, et al. The impact of bariatric surgery on quality of life:
38 534 a systematic review and meta-analysis. *Obes Rev* 2015;16(8):639-51. doi: 10.1111/obr.12294
39 535 38. Pollock RF, Chilcott J, Muduma G, et al. Laparoscopic adjustable gastric banding vs standard
40 536 medical management in obese patients with type 2 diabetes: a budget impact analysis in the
41 537 UK. *Journal of medical economics* 2013;16(2):249-59. doi: 10.3111/13696998.2012.751388
42 538 39. Terranova L, Busetto L, Vestri A, et al. Bariatric surgery: cost-effectiveness and budget
43 539 impact. *Obes Surg* 2012;22(4):646-53. doi: 10.1007/s11695-012-0608-1
44 540 40. Ackroyd R, Mouiel J, Chevallier JM, et al. Cost-effectiveness and budget impact of obesity
45 541 surgery in patients with type-2 diabetes in three European countries. *Obes Surg*
46 542 2006;16(11):1488-503. doi: 10.1381/096089206778870067
47 543 41. De Luca M, Angrisani L, Himpens J, et al. Indications for Surgery for Obesity and Weight-
48 544 Related Diseases: Position Statements from the International Federation for the Surgery of
49 545 Obesity and Metabolic Disorders (IFSO). *Obes Surg* 2016;26(8):1659-96. doi:
50 546 10.1007/s11695-016-2271-4
51 547 42. Bush K, Kivlahan DR, McDonnell MB, et al. The AUDIT alcohol consumption questions (AUDIT-
52 548 C): an effective brief screening test for problem drinking. *Ambulatory Care Quality*

- 1
2
3 549 Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Archives of*
4 550 *internal medicine* 1998;158(16):1789-95.
5 551 43. Lee SY, Gallagher D. Assessment methods in human body composition. *Current opinion in*
6 552 *clinical nutrition and metabolic care* 2008;11(5):566-72. doi:
7 553 10.1097/MCO.0b013e32830b5f23
8 554 44. Faria SL, Faria OP, Cardeal MD, et al. Validation study of multi-frequency bioelectrical
9 555 impedance with dual-energy X-ray absorptiometry among obese patients. *Obes Surg*
10 556 2014;24(9):1476-80. doi: 10.1007/s11695-014-1190-5
11 557 45. Migueles JH, Cadenas-Sanchez C, Ekelund U, et al. Accelerometer Data Collection and
12 558 Processing Criteria to Assess Physical Activity and Other Outcomes: A Systematic Review and
13 559 Practical Considerations. *Sports medicine* 2017 doi: 10.1007/s40279-017-0716-0
14 560 46. A. T. S. Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories.
15 561 ATS statement: guidelines for the six-minute walk test. *Am J Respir Crit Care Med*
16 562 2002;166(1):111-7. doi: 10.1164/ajrccm.166.1.at1102
17 563 47. Pataky Z, Armand S, Muller-Pinget S, et al. Effects of obesity on functional capacity. *Obesity*
18 564 *(Silver Spring)* 2014;22(1):56-62. doi: 10.1002/oby.20514
19 565 48. Sousa-Santos AR, Amaral TF. Differences in handgrip strength protocols to identify
20 566 sarcopenia and frailty - a systematic review. *BMC geriatrics* 2017;17(1):238. doi:
21 567 10.1186/s12877-017-0625-y
22 568 49. Yang YJ, Kim MK, Hwang SH, et al. Relative validities of 3-day food records and the food
23 569 frequency questionnaire. *Nutrition research and practice* 2010;4(2):142-8. doi:
24 570 10.4162/nrp.2010.4.2.142
25 571 50. Brooks R. EuroQol: the current state of play. *Health policy* 1996;37(1):53-72.
26 572 51. Dolan P. Modeling valuations for EuroQol health states. *Medical care* 1997;35(11):1095-108.
27 573 52. Kolotkin RL, Crosby RD, Kosloski KD, et al. Development of a brief measure to assess quality
28 574 of life in obesity. *Obes Res* 2001;9(2):102-11. doi: 10.1038/oby.2001.13
29 575 53. Beck AT, Steer RA, Brown GK. Manual for the Beck Depression Inventory-II. San Antonio,
30 576 TX1996.
31 577 54. Beecham J, Knapp M. Costing psychiatric interventions, in G. Thornicroft (ed.) Measuring
32 578 Mental Health Needs. 2nd edition ed: Gaskell 2001:200-224.
33 579 55. Curtis L, Burns A. Unit Costs of Health and Social Care 2015: Personal Social Services
34 580 Research Unit, University of Kent, Canterbury, 2015.
35 581 56. Department of Health. National Schedule of Reference Costs: DOH, London, 2015.
36 582 57. British National Formulary. [Available from: <https://www.bnf.org/>.
37 583 58. Barber J, Thompson S. Multiple regression of cost data: use of generalised linear models. *J*
38 584 *Health Serv Res Policy* 2004;9(4):197-204. doi: 10.1258/1355819042250249
39
40
41 585
42
43 586
44
45 587
46
47 588
48
49 589
50
51 590
52
53 591
54
55 592
56
57 593
58
59
60

1
2
3 594
4
5 595
6 596
7
8 597
9
10 598
11 599
12
13 600
14
15 601
16
17 602
18
19 603
20
21 604
22
23 605
24
25 607
26 608

Table**Table 1** Participant eligibility criteria for participation in the BARI-LIFESTYLE observational study

INCLUSION CRITERIA	
1	Adult aged between 18 to 65 years.
2	Planned to undergo either primary RYGB or SG surgery and fulfilling NICE eligibility criteria for bariatric surgery ¹ .
3	Able to read and write in English.
4	Willing and able to provide written informed consent.
5	Able to comply with study protocol.
6	Willing and able to wear a Fitbit wrist-based activity tracker device and an ActiGraph device.
EXCLUSION CRITERIA	
1	More than 200 kg of body weight due to the limitation of DXA scan.
2	Non-ambulatory.
3	Functional limitation.

27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43 609
44 610
45 611
46 612
47 613
48 614
49 615
50 616
51 617
52 618
53 619
54 620
55
56
57
58
59
60

1
2
3 621
4 622
5 623
6 624
7 625
8 626
9 627
10 628
11 629
12 630
13 631
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

632 **Table 2** Study timeline and investigations

633

	Baseline (T0)	Day of surgery	3-month post-surgery (T1)	6-month post-surgery (T2)	12-month post-surgery (T3)
Sociodemographic data	✓				
Height	✓				
Weight	✓	✓	✓	✓	✓
Blood pressure and heart rate	✓		✓	✓	✓
Dual-energy X-ray absorptiometry scan	✓				✓
Bioelectrical impedance analysis	✓		✓	✓	✓
Laboratory test	✓		✓	✓	✓
Physical activity levels (ActiGraph) and activity diary	✓		✓	✓	✓
Physical function and strength:					
6-minute walk test (6MWT)	✓		✓	✓	✓
Sit-to-stand (STS) test	✓		✓	✓	✓
Handgrip test	✓		✓	✓	✓
Dietary intake (3-day food diary)	✓		✓	✓	✓
Completion of questionnaires:					
EuroQol-5D-3L (EQ-5D-3L)	✓		✓	✓	✓
Impact of weight on Quality of Life-Lite (IWQOL-Lite)	✓		✓	✓	✓
Beck Depression Inventory-II (BDI-II)	✓		✓	✓	✓
Client Service Receipt Inventory (CSRI)	✓		✓	✓	✓
Review of medication	✓		✓	✓	✓
Review of comorbidities	✓		✓	✓	✓

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

634 **Figure**

635

636 **Figure 1** Flow diagram of participant enrolment, consent, assessment and associated timeline

637

For peer review only

BMJ Open: first published as 10.1136/bmjopen-2017-020659 on 16 March 2018. Downloaded from <http://bmjopen.bmj.com/> on April 18, 2024 by guest. Protected by copyright.

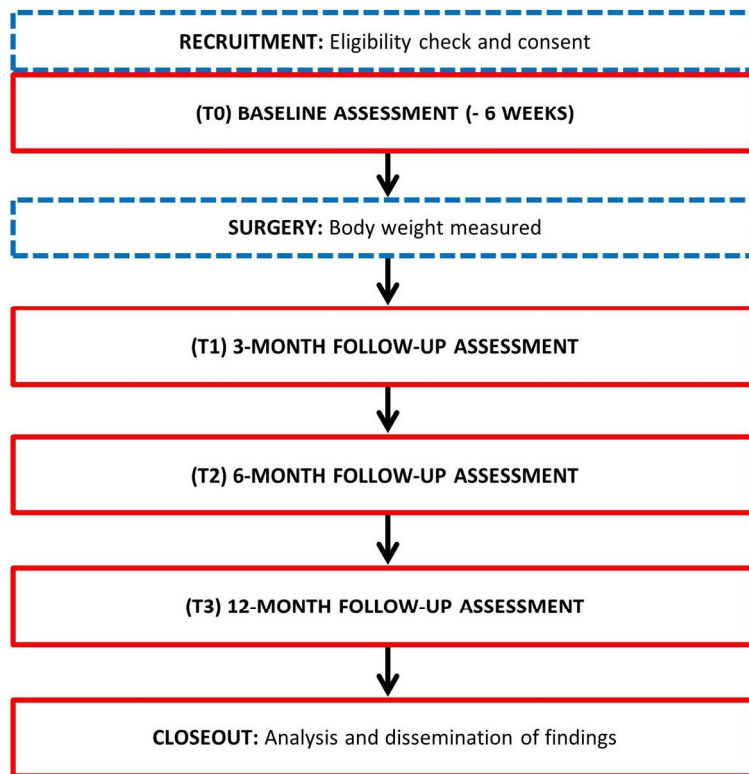


Figure 1 Flow diagram of participant enrolment, consent, assessment and associated timeline

150x150mm (300 x 300 DPI)



SPIRIT 2013 Checklist: Recommended items to address in a clinical trial protocol and related documents*

Section/item	Item No	Description
Administrative information		
Title	1	Descriptive title identifying the study design, population, interventions, and, if applicable, trial acronym Page 1
Trial registration	2a	Trial identifier and registry name. If not yet registered, name of intended registry N/A
	2b	All items from the World Health Organization Trial Registration Data Set N/A
Protocol version	3	Date and version identifier N/A
Funding	4	Sources and types of financial, material, and other support Page 16
Roles and responsibilities	5a	Names, affiliations, and roles of protocol contributors Page 1 and page 16
	5b	Name and contact information for the trial sponsor N/A
	5c	Role of study sponsor and funders, if any, in study design; collection, management, analysis, and interpretation of data; writing of the report; and the decision to submit the report for publication, including whether they will have ultimate authority over any of these activities Page 16
	5d	Composition, roles, and responsibilities of the coordinating centre, steering committee, endpoint adjudication committee, data management team, and other individuals or groups overseeing the trial, if applicable (see Item 21a for data monitoring committee) N/A

Introduction

Background and rationale	6a	Description of research question and justification for undertaking the trial, including summary of relevant studies (published and unpublished) examining benefits and harms for each intervention Page 4
	6b	Explanation for choice of comparators N/A
Objectives	7	Specific objectives or hypotheses Page 6
Trial design	8	Description of trial design including type of trial (eg, parallel group, crossover, factorial, single group), allocation ratio, and framework (eg, superiority, equivalence, noninferiority, exploratory) Page 7

Methods: Participants, interventions, and outcomes

Study setting	9	Description of study settings (eg, community clinic, academic hospital) and list of countries where data will be collected. Reference to where list of study sites can be obtained Page 7
Eligibility criteria	10	Inclusion and exclusion criteria for participants. If applicable, eligibility criteria for study centres and individuals who will perform the interventions (eg, surgeons, psychotherapists) Page 21 (Table 1)
Interventions	11a	Interventions for each group with sufficient detail to allow replication, including how and when they will be administered N/A
	11b	Criteria for discontinuing or modifying allocated interventions for a given trial participant (eg, drug dose change in response to harms, participant request, or improving/worsening disease) N/A
	11c	Strategies to improve adherence to intervention protocols, and any procedures for monitoring adherence (eg, drug tablet return, laboratory tests) N/A
	11d	Relevant concomitant care and interventions that are permitted or prohibited during the trial N/A

1	Outcomes	12	Primary, secondary, and other outcomes, including the specific measurement variable (eg, systolic blood pressure), analysis metric (eg, change from baseline, final value, time to event), method of aggregation (eg, median, proportion), and time point for each outcome. Explanation of the clinical relevance of chosen efficacy and harm outcomes is strongly recommended Page 9
2			
3			
4			
5			
6			
7			
8			
9			
10	Participant timeline	13	Time schedule of enrolment, interventions (including any run-ins and washouts), assessments, and visits for participants. A schematic diagram is highly recommended (see Figure) Page 23 (Figure 1) and Page 22 (Table 2)
11			
12			
13			
14			
15	Sample size	14	Estimated number of participants needed to achieve study objectives and how it was determined, including clinical and statistical assumptions supporting any sample size calculations Page 12
16			
17			
18			
19			
20			
21	Recruitment	15	Strategies for achieving adequate participant enrolment to reach target sample size Page 8
22			
23			
24			

Methods: Assignment of interventions (for controlled trials)

Allocation:

25			
26			
27			
28			
29	Sequence generation	16a	Method of generating the allocation sequence (eg, computer-generated random numbers), and list of any factors for stratification. To reduce predictability of a random sequence, details of any planned restriction (eg, blocking) should be provided in a separate document that is unavailable to those who enrol participants or assign interventions N/A
30			
31			
32			
33			
34			
35			
36			
37			
38	Allocation concealment mechanism	16b	Mechanism of implementing the allocation sequence (eg, central telephone; sequentially numbered, opaque, sealed envelopes), describing any steps to conceal the sequence until interventions are assigned N/A
39			
40			
41			
42			
43			
44	Implementation	16c	Who will generate the allocation sequence, who will enrol participants, and who will assign participants to interventions N/A
45			
46			
47			
48	Blinding (masking)	17a	Who will be blinded after assignment to interventions (eg, trial participants, care providers, outcome assessors, data analysts), and how N/A
49			
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

17b If blinded, circumstances under which unblinding is permissible, and procedure for revealing a participant's allocated intervention during the trial

N/A

Methods: Data collection, management, and analysis

Data collection methods 18a Plans for assessment and collection of outcome, baseline, and other trial data, including any related processes to promote data quality (eg, duplicate measurements, training of assessors) and a description of study instruments (eg, questionnaires, laboratory tests) along with their reliability and validity, if known. Reference to where data collection forms can be found, if not in the protocol

Page 9 and Page 22 (Table 2)

18b Plans to promote participant retention and complete follow-up, including list of any outcome data to be collected for participants who discontinue or deviate from intervention protocols

N/A

Data management 19 Plans for data entry, coding, security, and storage, including any related processes to promote data quality (eg, double data entry; range checks for data values). Reference to where details of data management procedures can be found, if not in the protocol

Page 14

Statistical methods 20a Statistical methods for analysing primary and secondary outcomes. Reference to where other details of the statistical analysis plan can be found, if not in the protocol

Page 12

20b Methods for any additional analyses (eg, subgroup and adjusted analyses)

Page 12

20c Definition of analysis population relating to protocol non-adherence (eg, as randomised analysis), and any statistical methods to handle missing data (eg, multiple imputation)

Page 13

Methods: Monitoring

Data monitoring 21a Composition of data monitoring committee (DMC); summary of its role and reporting structure; statement of whether it is independent from the sponsor and competing interests; and reference to where further details about its charter can be found, if not in the protocol.

Alternatively, an explanation of why a DMC is not needed

N/A

1		21b	Description of any interim analyses and stopping guidelines, including who will have access to these interim results and make the final decision to terminate the trial
2			N/A
3			
4			
5			
6			
7	Harms	22	Plans for collecting, assessing, reporting, and managing solicited and spontaneously reported adverse events and other unintended effects of trial interventions or trial conduct
8			Page 14
9			
10			
11			
12	Auditing	23	Frequency and procedures for auditing trial conduct, if any, and whether the process will be independent from investigators and the sponsor
13			N/A
14			
15			
16			
17			
18	Ethics and dissemination		
19			
20	Research ethics approval	24	Plans for seeking research ethics committee/institutional review board (REC/IRB) approval
21			Page 13
22			
23			
24	Protocol amendments	25	Plans for communicating important protocol modifications (eg, changes to eligibility criteria, outcomes, analyses) to relevant parties (eg, investigators, REC/IRBs, trial participants, trial registries, journals, regulators)
25			N/A
26			
27			
28			
29			
30	Consent or assent	26a	Who will obtain informed consent or assent from potential trial participants or authorised surrogates, and how (see Item 32)
31			Page 8
32			
33			
34			
35		26b	Additional consent provisions for collection and use of participant data and biological specimens in ancillary studies, if applicable
36			N/A
37			
38			
39	Confidentiality	27	How personal information about potential and enrolled participants will be collected, shared, and maintained in order to protect confidentiality before, during, and after the trial
40			Page 14
41			
42			
43			
44	Declaration of interests	28	Financial and other competing interests for principal investigators for the overall trial and each study site
45			Page 17
46			
47			
48	Access to data	29	Statement of who will have access to the final trial dataset, and disclosure of contractual agreements that limit such access for investigators
49			Page 14
50			
51			
52			
53			
54			
55			
56			
57			
58			
59			
60			

1	Ancillary and	30	Provisions, if any, for ancillary and post-trial care, and for
2	post-trial care		compensation to those who suffer harm from trial participation
3			N/A
4			
5	Dissemination	31a	Plans for investigators and sponsor to communicate trial results to
6	policy		participants, healthcare professionals, the public, and other relevant
7			groups (eg, via publication, reporting in results databases, or other
8			data sharing arrangements), including any publication restrictions
9			Page 14
10			
11		31b	Authorship eligibility guidelines and any intended use of professional
12			writers
13			N/A
14			
15		31c	Plans, if any, for granting public access to the full protocol, participant-
16			level dataset, and statistical code
17			N/A
18			
19			
20			
21	Appendices		
22			
23	Informed consent	32	Model consent form and other related documentation given to
24	materials		participants and authorised surrogates
25			N/A
26			
27	Biological	33	Plans for collection, laboratory evaluation, and storage of biological
28	specimens		specimens for genetic or molecular analysis in the current trial and for
29			future use in ancillary studies, if applicable
30			N/A
31			

32 *It is strongly recommended that this checklist be read in conjunction with the SPIRIT 2013
 33 Explanation & Elaboration for important clarification on the items. Amendments to the
 34 protocol should be tracked and dated. The SPIRIT checklist is copyrighted by the SPIRIT
 35 Group under the Creative Commons "[Attribution-NonCommercial-NoDerivs 3.0 Unported](https://creativecommons.org/licenses/by-nc-nd/3.0/)"
 36 license.
 37
 38
 39
 40
 41
 42
 43
 44
 45
 46
 47
 48
 49
 50
 51
 52
 53
 54
 55
 56
 57
 58
 59
 60