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Cohort Profile: The Bariatric Experience Long Term (BELONG), a Long-Term Prospective Study to Understand the Psychosocial, Environmental, Health, and Behavioral Predictors of Weight Loss and Regain in Patients Who Have Bariatric Surgery

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Cohort Profile: The Bariatric Experience Long Term (BELONG), a Long-Term Prospective Study to Understand the Psychosocial, Environmental, Health, and Behavioral Predictors of Weight Loss and Regain in Patients Who Have Bariatric Surgery

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Abstract

Purpose: The Bariatric Experience Long Term (BELONG) prospective study cohort was created to address limitations in the literature regarding the relationship between surgical weight loss and psychosocial, health, behavior, and environmental factors. The BELONG cohort is unique because it contains 70% gastric sleeve and 59% patients with non-White race/ethnicity and was developed with strong stakeholder engagement including patients and providers. **Participants:** The BELONG cohort study included 1,975 patients preparing to have bariatric surgery who completed a baseline survey in a large integrated health system in Southern California. Patients were primarily women (84%), either non-Hispanic Black or Hispanic (59%), with a body mass index (BMI) of $45.1 \pm 7.4 \text{ kg/m}^2$, age 43.3 ± 11.5 years old, and 32% had at least one comorbidity.

Findings to Date: A total of 5,552 patients were approached before surgery between February 2016 and May 2017 and 1,975 (42%) completed a baseline survey. A total of 1,203 (73%) patients completed the year 1 and 1,033 (74%) patients completed the year 3 post-operative survey. Of these survey respondents, 1,341 at baseline, 999 at year 1, and 951 at year 3 were included in the analyses of all survey and weight outcome data. A total of 803 (60% of eligible patients) had survey data for all time points. Data collected were self-reported constructs to support the proposed theoretical model. Height, weight, and BMI were abstracted from the electronic medical record to obtain the main outcomes of the study: weight loss and regain. **Future Plans:** We will collect self-reported constructs and obtain height, weight and BMI from the electronic medical record 5 years after bariatric surgery between April 2022 and January 2023. We will also collect patient experiences using individual interviews which began in April 2021 and focus groups of 8 – 12 patients each throughout 2022.

Strengths and Limitations of this Study:

- The Bariatric Experience Long Term (BELONG) cohort study is one of the largest longitudinal mixed method (medical record, survey, and qualitative data) studies of bariatric patients that was designed using a comprehensive theoretical model of factors related to surgical weight loss.
- The BELONG cohort study contains a large sample of gastric sleeve patients (70%), the most common bariatric operation in the U.S., and has mostly patients with diverse racial and ethnic backgrounds (59%). These two features are important because the findings of the BELONG cohort study can be applied directly to the current state of bariatric practice (mostly gastric sleeve) and Black and Hispanic patients suffer disproportionately from severe obesity and thus stand the most to gain from bariatric surgery. The BELONG mixed methods cohort study is uniquely positioned to understand how patients not often represented in the literature such as patients of diverse races and ethnicities are experiencing bariatric surgery weight loss.
- Another strength is the involvement of bariatric patients in the design and implementation of the study. Our patient advisory board was created to represent the diversity in our patient population and has insured that we address constructs important to them such as obesity and bariatric surgery stigma, racism, and sexism.
- One of the main limitations of the BELONG cohort is the biased nature of the study sample. These were all patients who were near the end of a preparation course for surgery and thus they were predisposed to have surgery. Our findings may have been different if we had surveyed patients who were simply eligible for surgery, or those referred for surgery before beginning the course.
- Another limitation, also affecting the generalizability of the findings to bariatric surgery patients, is a low enrollment rate in the cohort (42.4%) and only 60% of survey

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respondents had survey data at every time point.

 The year 3 survey was conducted, and year 5 survey will be conducted, during the beginning of the COVID-19 outbreak and thus any conclusions about the impact of bariatric surgery on survey variables and weight loss/regain need to be understood within the context of the global pandemic.

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Competing Interests

None of the authors have any competing interests.

Introduction

Severe obesity (body mass index [BMI] \geq 35 kg/m²) has increased in prevalence over the past several decades.¹ Unfortunately, intensive, multi-component lifestyle interventions have had a minimal impact on severe obesity.² These outcomes have led to the development of surgical treatments, referred to as bariatric surgery, for severe obesity. Studies have found that when compared to conventional weight loss strategies, bariatric surgery resulted in much higher weight loss over a period of 2 – 5 years.³⁻⁶ For patients with severe obesity, bariatric surgery may become the treatment of choice.

There is large variation in weight loss outcomes even within the same bariatric operation. The largest longitudinal cohort study on bariatric patients, the Longitudinal Assessment of Bariatric Surgery (LABS), has identified five weight change trajectories following a single standardized operation, that ranged from 56% total weight loss (%TWL) to 1% gain.⁷ By 1 year almost 25% of all patients in the LABS study these patients began to regain the weight they had lost. We have also shown wide variability in surgical weight loss from less than 10% to over 40% TWL.⁸ Some of this variability may be due to between-patient differences. For example, some Black and Hispanic patients do not lose as much weight as their White counterparts.⁹⁻¹² Given the wide range in weight loss outcomes even following the same operation, it is imperative to understand the factors predicting this variability to improve outcomes for all patients.

In attempting to understand correlates or predictors of bariatric surgical outcomes, there are two general foci in the literature to date: immutable patient characteristics such as demographics and bariatric operation type;^{9,13-16} and modifiable factors such as health behaviors, weight before surgery, mental health, and social support.¹⁷⁻²⁷ In general, the immutable characteristics have been studied in the pre-operative period (if studies have baseline data) and modifiable factors have been studied both before and after surgery. Most of the work on modifiable factors is not grounded in psychosocial theoretical models or theories of

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health behavior change.²⁸ Few attempts have been made to present a unified, comprehensive model of multiple factors that could be predictive of bariatric weight loss and regain.

The Bariatric Experience Long Term (BELONG) prospective mixed methods cohort study was designed to address these limitations in the literature by applying a comprehensive theoretical model of health behavior change (please see **Figure 1**) to the collection of self-reported survey data and qualitative patient experiences before surgery and up to 5 years after surgery to understand weight loss and regain. Our approach to the study of predictors of bariatric weight loss was based on the suggestions of Elder and colleagues²⁹ and Noar and Zimmerman³⁰ that a unified approach be used across the common elements of theories of behavior change, and that these elements be directly relevant to the healthcare setting.²⁹ We also applied findings from published research on factors related to successful behavior change³¹⁻³³ and weight loss using other treatment modalities such as diet and exercise.^{34,35} Finally, a special emphasis was placed on understanding the experiences of patients from racial and ethnic groups and why they may lose less weight than their White counterparts. Constructs such as everyday racism³⁶ and vigilant coping³⁷ were added to both survey and qualitative data collection to address this question.

COHORT DESCRIPTION

Study Design

The Bariatric Experience Long Term (BELONG) study was designed as a prospective mixed methods longitudinal cohort study. The qualitative component of the study was designed to address the bariatric experience of weight loss for racial and ethnic groups of patients, men, and those who lost or did not lose and maintain at least 20% TWL. A 20% TWL threshold was chosen based upon our own work that this amount of weight loss is important for the remission of diabetes.³⁸ All study methods were designed with a patient and provider as part of the study team and a stakeholder advisory group of diverse post-bariatric patients. The stakeholder

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advisory board was specifically focused on addressing issues of structural racism, discrimination, and stigma specific to bariatric surgery.

Participants

<u>Human subjects approval</u>. This study was approved by the Institutional Review Board for Human Subjects of the health system in which the study took place. The reference numbers are 10865 and 11250.

Enrollment and baseline survey completion. Eligibility criteria for inclusion in the BELONG mixed methods cohort study were: 1) being enrolled in a 12-week bariatric surgery preparation course; 2) planning to have a first bariatric operation within 6 months of the baseline survey; 3) being an adult 18 years of age and older; and 4) meeting general eligibility criteria for weight loss surgery in the U.S.³⁹ **Figure 2** provides the recruitment flow for the study. Recruitment for the survey began in February 2016 and ended in May 2017. **Table 1** provides baseline differences in descriptive variables available from the electronic medical record between those who were enrolled in the cohort (n = 1,975; 42% response rate), and the patients who were eligible and contacted but not enrolled (n = 1,239) and those who were contacted but not enrolled because they were determined to be ineligible after they were contacted (n = 2,338). Self-reported survey data were not available for those who were not enrolled.

In addition to the assessment of eligibility at the time of outreach and survey administration, eligibility was also assessed after the collection of the baseline and year 1 surveys which further reduced the number of survey respondents who could be used for outcome analyses. Reasons for this second eligibility assessment are shown in **Figure 2**. Of the 1,975 patients who were surveyed at baseline, 634 patients were determined as ineligible for all years of the study primarily because: they never had surgery (n = 294), they had surgery before the baseline survey (n = 68), or they had surgery more than 6 months after the baseline survey (n = 272). Many of these exclusions were made after patients had completed surveys because of the delays in receiving surgery, reporting errors in the electronic medical record, and delays in case

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validation. After applying all exclusions (please see **Figure 2**) there were 1,341 patients who were considered eligible for the study and used as the baseline analytic cohort for follow-up. Baseline data for these patients are shown in **Table 2**.

Follow-up survey completion. Patients were surveyed at 1 year (between April 2017 and January 2019) and 3 years (between May 2019 and January 2021 after they had bariatric surgery (note the surgery date could have been up to 6 months after the baseline survey). A survey at 5 years is also planned (between April 2022 and January 2023). In addition, weight (lbs), height (in), and BMI (kg/m²) were abstracted from the electronic medical record at all time points. Survey response rates for each year of follow-up are shown in **Figure 2** and were 73% (n = 1,203) for year 1 and 74% (n = 1,033) for year 3. Qualitative interviews began in April 2021 and will continue through March 2022. In addition, focus groups with 8 – 10 patients each will be conducted throughout 2022.

Eligible cohort for weight outcome analyses. Not all patients were eligible for outcome analyses. Patients were excluded because they did not have surgery within 6 months of the baseline survey or they had surgery before their baseline survey; resulting in n = 999 patients with year 1 survey data and n = 951 patients with year 3 survey data for the outcome analyses. There were 803 patients (60% of those eligible) who had survey data for all time points (baseline, year 1, and year 3). **Table 2** provides descriptive statistics for the patients eligible for the outcome analyses. Data are presented for those patients with a baseline survey (n = 1,341) compared to those who had a year 1 survey (n = 999) and a year 3 survey (n = 951).

Measures

Survey. All surveys for the BELONG study were administered using a Computer-Aided Telephone Interview (CATI) system or a self-directed website and took approximately 75 minutes to complete. The baseline survey was for research only and was not used in the patient's preparation/decision process for surgery. Half (n = 978; 50%) of all survey respondents completed the baseline survey using the website and by year 3 this had increased to 70% (n =

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719).

Surveys asked patients to self-report the following information which is presented by model construct in Figure 1. DEMOGRAPHIC: Gender, race/ethnicity, education, income, employment and relationship status, number of people in the home, and socioeconomic status (SES) as calculated with the Hollingshead Index of Social Status (uses education and occupation code).⁴⁰ BEHAVIOR: Adherence measured as attendance at scheduled outpatient visits (12 months before and throughout follow-up) and % TWL in the 12 months before surgery,¹⁸ physical⁴¹ and sedentary⁴² activity, sleep,⁴³ weight control strategies,⁴⁴ problematic eating (binge eating;⁴⁵ loss of control, restrained, and emotional eating⁴⁶), self-care,⁴⁷ smoking,⁴¹ dietary quality,⁴⁸ and brief dietary intake.⁴⁹ **HEALTH**: symptoms of anxiety⁵⁰ and depression,⁵¹ pain,⁵² physical function,⁵³ guality of life,⁵⁴ health literacy,⁵⁵ and addictions such as lifetime drug use,⁵⁶ alcohol use disorder,⁵⁷ gambling,⁵⁸ prescription/illicit drug abuse,⁵⁸ and food.⁵⁹ **PSYCHOSOCIAL**: relationship quality,⁶⁰ motivations for having surgery and weight loss expectations after surgery,⁶¹ weight loss self-efficacy,⁶² loneliness,⁶³ perceived stress,⁶⁴ experiential avoidance,⁶⁵ positive and negative social support for physical activity and healthy eating,⁶⁶ self-confidence for exercise.⁶⁷ internal weight bias (only in year 3 and 5 surveys).⁶⁸ vigilant coping style (only in year 3 and 5 surveys),³⁶ everyday discrimination (only in year 3 and 5 surveys),³⁵ and hedonic adaptation (only in year 1, 3 and 5 surveys).⁶⁹ **PERCEIVED ENVIRONMENT**: perceptions of neighborhood environment for promotion of healthy behaviors and neighborhood proximity of healthy alternatives.⁷⁰

In addition to the broad constructs in **Figure 1**, the BELONG study was also interested in the development of an ADVERSE CONSEQUENCES construct after bariatric surgery. This construct used elements of the HEALTH, PSYCHOSOCIAL, and BEHAVIOR constructs which included the development of loneliness, addictions, problematic eating, and poor relationship quality and loss of relationships (e.g. divorce/separation) as well as increases in stress.

Electronic medical record. The following information was abstracted from the electronic

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medical record at the time of surgery or the baseline survey: diagnoses and pharmacy records to determine disease burden both physical and mental health-related, adherence to scheduled visits for routine medical care in the year before surgery/survey, weight and height to determine both BMI and %TWL in the year before surgery/survey, and date of birth to calculate age. For the follow-up time periods we abstracted weight and height to determine BMI and %TWL. Height and weight were collected by clinical staff as part of routine clinical care.

Qualitative interviews and focus groups. Qualitative interview protocols were designed with the patient stakeholder advisory board and designed to address critical time periods of bariatric surgery: the year before the operation, the 12 - 24 months after surgery, and the longer-term period of 3 - 5 years after surgery. Patients were interviewed at 3 - 5 years after surgery and thus were asked to recall before surgery and 12 - 24-month time points. Across each of these time points, interview domains included personal/family social network, health care teams/health system, and society. Special emphasis was placed on understanding racism and stigma in each domain and we asked about how the pandemic was affecting their weight loss. These domains were chosen based upon the study theoretical model presented in the introduction (see **Figure 1**), with modifications from our stakeholders. Interviews were 60 - 90 minutes each and patients could have up to two interviews each (total time = 120 minutes).

Patient and Public Involvement

From the inception of the study, a bariatric provider and a bariatric patient were included as members of the scientific team. They attend all study meetings and are included as authors in all publications. To create the qualitative study methods, a patient advisory board was formed to design, test, and interpret the data. These advisors were recruited through a network of providers and health system leaders and were either: 1) already engaged in designing the health system program for pre-operative and post-operative care and monitoring, or 2) leading pre- and post-operative patient support groups. Patients were diverse in race/ethnicity (Black, White, and Hispanic) and were an equal mix of men and women. Patients also ranged in time

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out from bariatric surgery from 1 - 10 years. In addition to design, implementation, and interpretation of both qualitative and survey data, the patient advisory board, and the patient and provider co-investigators, will be involved in planning and executing the dissemination of the findings for clinical and professional audiences.

FINDINGS TO DATE

Participants

Descriptive information for the enrolled cohort (n = 1,975) is shown in **Table 1**. In general, when compared to patients who refused participation or did not respond to outreach, patients who completed a baseline survey were *more likely to* be women (84% vs. 77%; p < .001), White (36% vs 28%; p < .001), have a BMI of 40 – 49.99 kg/m² (52% vs. 49%; p = .002), have a mental illness (54% vs. 49% p = .001), and *less likely to* have hypertension (16% vs. 20%; p < .001). Those who completed the baseline survey lost less weight (12.9 vs. 15.6 lbs; p < .001) and had higher attendance at scheduled outpatient visits in the year before surgery (76% vs. 73%; p < .001) when compared to patients who did not respond or refused participation. Characteristics for baseline and follow-up survey participants used in the outcome analyses are shown in **Table 2** (baseline [n = 1,341], year 1 [n = 999], and year 3 [n = 951]). Although there were statistically significant differences between patients in the baseline survey sample compared to the follow-up samples, because of the large sample size, these differences were not clinically meaningful (e.g. an age difference of 0.4 years or a %TWL difference of 1%).

Electronic Medical Record Data

Data from the electronic medical record are shown in **Table 2**. At the time of surgery, patients had a BMI of 43.1 ± 6.4 kg/m² primarily in the 40 - 49 kg/m² (51%) range, most had at least 1 comorbidity (63%) with 28% and 32% having type 2 diabetes mellitus and hypertension respectively. Fourteen percent had a serious mental illness and 34% had mild-to-moderate anxiety and depression. Patients lost $6.6 \pm 4.6\%$ of their weight in the year before surgery and $25.8 \pm 9.0\%$ at year 1 and $22.2 \pm 10.5\%$ at year 3 after surgery.

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Survey Data

Baseline demographics for the analytic cohort (n = 1,341) are shown in **Table 2** and survey variables are shown in **Table 3**. In general, the baseline analytic cohort was primarily women (86%), Hispanic or Black (53%), 43 + 11 years old equally distributed across three age categories (30 - 39, 40 - 49, 50 - 54 years old), had at least some college education (81%) with an annual income of at least \$51,000 (55%), a mid-range socioeconomic status (38 + 13; range 8-67), and the majority were employed outside the home (82%) and were in a relationship (72%). In general patients in the baseline analytic cohort had high health literacy (88%), never smoked (70%), had low self-reported dysfunction (9 + 8 out of a total score of 48 with higher numbers reflecting more dysfunction), low levels of depression (5 + 5 out of 24), anxiety (4 + 4 out of 21), and pain (7 + 3 out of 15) symptoms. Patients rated their overall health at 67 + 21 out of a possible score of 100. Some patients reported having a history of addiction (10% - 18%), with few reporting current symptoms of problems with alcohol (9%), gambling (5%), or drugs (1%). If patients were in a relationship, they were generally satisfied with that relationship (17.5 + 3.5 out of 22). The mean self-reported goal weight loss (expressed as % TWL) was 42% + 19% and the mean self-reported weight loss that patients indicated would be disappointing was 25% + 27% TWL. As mentioned previously, the actual post-operative %TWL for these patients was 25.8 + 9.0% at year 1 and 22.2 + 10.5% at year 3.

Patients reported low levels of loneliness (32 ± 11 out of 80) and moderate perceived stress (22 ± 6 out of 50). Self-confidence for exercise was moderate-to-high (3 ± 1 out of 5), self-efficacy for weight loss was high (32 ± 6 out of 40), and positive social support for healthy behaviors was also high (20 ± 8 out of 30) going into surgery. The most common motivations patients reported for having surgery were to improve their health (96%), to do the things they wanted to do (93%), feel better about themselves (88%), do things that friends and family could do (79%), and to play with their children/grandchildren (76%).

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Over 20% of patients reported symptoms of binge eating with fewer reporting night eating (10%) or night snacking (13%) before surgery. Patients reported loss of control of (21 \pm 8 out of 43), restrained (19 \pm 4 out of 27), and emotional eating behaviors (8 \pm 4 out of 15). In general, patients reported good sleep quality (77% better/somewhat better) and efficiency (85% \pm 17% out of 100%). Almost half (48%) reported meeting guidelines for moderate-to-vigorous physical activity (173 \pm 157 minutes/week) and an average of 1 \pm 2 and 2 \pm 2 days per week of strength and flexibility training respectively. The most common weight control strategies patients reported using before surgery were setting healthy eating goals (76%), eating smaller portions (76%), eating breakfast regularly (71%), eating three meals a day/eating regularly (70%), and using a monitoring device (64%). Only 17% of patients indicated that they used all weight control strategies at least most of the time/always. Finally, most patients felt that locations in their neighborhoods like grocery stores and parks were accessible (4 \pm 2 out of 7 with higher scores being more accessible) and moderately healthy (38 \pm 7 out of 55).

Previously Published Work

Several hundred patients did not have surgery within 6 months of their baseline survey (see **Figure 1**) and thus were not eligible for the analysis of survey and outcome data. In our previously published work, we examined the factors that led BELONG patients to receive or not receive surgery.⁷¹ The strongest predictors of *having* surgery were being a woman and losing at least 5% TWL in the year before surgery. The strongest predictors of *not* having surgery were a BMI \geq 50 kg/m² and having a higher physical comorbidity burden. Having a mental health condition did not predict if a patient had surgery. These findings highlighted why the uptake of bariatric surgery is extremely low; only 1 – 2% of eligible patients have surgery in the U.S.⁷² Practices such as requiring 5%-10% TWL before surgery and selection of patients with safer operative risk profiles (younger with lower comorbidity burden) may inadvertently contribute to under-utilization of bariatric surgery among some subpopulations⁷³ who could most benefit from this intervention.

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STRENGTHS AND LIMITATIONS

One of the main strengths of the BELONG mixed methods cohort study is that it is one of the largest longitudinal mixed methods studies of bariatric patients in the literature that was designed using a comprehensive theoretical model of weight loss and includes medical record, survey, and qualitative data (see **Figure 1**). The only other comparable study is the LABS study which enrolled over 2,500 patients across the U.S. and followed patients for more than 7 years.⁷⁴ However, in comparison to the LABS study, the BELONG mixed methods cohort study contains a large sample of gastric sleeve patients (70%), the most common bariatric operation in the U.S.⁷⁵ and has mostly patients from racial and ethnic groups (59%). The LABS study patients were primarily non-Hispanic white (90%) and <3% had an operation other than gastric bypass or laparoscopic band. These two distinctions are important because the findings of the BELONG cohort can be applied directly to the current state of bariatric practice (mostly gastric sleeve surgical outcomes) and Black and Hispanic patients suffer disproportionately from severe obesity¹ and thus stand the most to gain from bariatric surgery. Despite the promise of this benefit, there are several reports in the literature,¹⁰⁻¹² including our own,⁹ that some Black and Hispanic patients do not lose as much weight as their White counterparts following surgery. The BELONG mixed methods cohort study is uniquely positioned to understand the reasons for these disparities.

In addition, the BELONG study is the first study in this area to have extensive involvement from patients in its design and implementation. Our patient advisory board is instrumental in our selection of variables and outcomes to study and in helping us create patient stories that are meaningful illustrations of the survey findings. Our approach is designed specifically to address gaps in the literature and practice, so that all patients with severe obesity can have the best experience with the most effective treatment available for their condition.

The main limitation of the BELONG cohort is the biased nature of the study sample. These were all patients who were near the end of a preparation course for surgery and thus they were

predisposed to have surgery. Our findings may have been different if we had surveyed patients when they were referred for surgery before beginning the course. In addition, we had a low enrollment rate in the cohort (42.4%) further limiting our generalizability. In addition, limiting our generalizability to the bariatric population as a whole, was only 60% of survey respondents had survey data at every time point although our response rates were excellent for the 1 year (73%) and 3 year (74%) surveys. Another limitation was that the year 3 survey was conducted during the beginning of the COVID-19 outbreak and thus any conclusions about the impact of bariatric surgery on survey variable and weight loss/regain will need to be tempered by the context of a global pandemic. Finally, even though this health system included 23 bariatric surgeons across 9 practices, our findings were based on an insured population in a single health system and may not apply to uninsured patients or other types of bariatric practices and thus should be replicated more systematically in other settings.

Data Sharing and Collaboration

The unpublished data are only available for use through collaboration with the BELONG study investigators, a data use agreement upon which all parties must agree, and external funding. Persons interested in collaborating with the BELONG study team can contact Dr. Karen Coleman [Karen.J.Coleman@kp.org], the lead investigator. We are eager to share this resource with others in collaboration to extend the evidence-base for the most effective treatment available for severe obesity.

Author Contributions

All authors participated in the writing of the manuscript and made substantial contributions to the presentation of the information. KJC obtained the funding for the study, wrote the initial draft of the manuscript, and conducted all analyses. SRP, BBB, and MM were responsible for all data collection. BT, JL, and TKY were responsible for the abstraction of data from the electronic medical record and processing of all survey data for analyses. DEA, CLC, AD, MFG, LDH, MJ, KHL, DDM, SBM, and DRY were responsible for the conceptualization of the study design,

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variables and survey instruments to include, and recruitment and enrollment strategies used in all surveys and qualitative interviews.

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Table 1. Descriptive statistics for the formation of the Bariatric Experience Long Term (BELONG) mixed methods study cohort. Data are shown for those who were outreached for the study based upon initial eligibility (n = 5,552). Why patients were not eligible is in Figure 2.

	Enrolled	Enrolled Refused or Non-Response		Ineligible	Total Outreached
	1975	2686		891	5552
Women	1660 (84%)	2071 (77%)	< .001	712 (80%)	4443 (80%)
Race/Ethnicity			< .001		
Asian	26 (1%)	47 (2%)		14 (2%)	87 (2%)
Black	344 (17%)	580 (29%)		158 (18%)	1082 (19%)
Hispanic	838 (42%)	1222 (45%)		389 (44%)	2449 (44%)
Native Am Alaskan	8 (<1%)	8 (<1%)		2 (<1%)	18 (<1%)
Pacific Islander	10 (<1%)	20 (<1%)		6 (<1%)	36 (<1%)
White	716 (36%)	764 (28%)		307 (34%)	1787 (32%)
Multiple	11 (<1%)	9 (<1%)		3 (<1%)	23 (<1%)
Other	10 (<1%)	16 (<1%)		8 (<1%)	34 (<1%)
Unknown	12 (<1%)	20 (<1%)		4 (<1%)	36 (<1%)
Age (years)	43.3 <u>+</u> 11.6 <	44.8 <u>+</u> 8.0	.43	43.3 <u>+</u> 8.2	44.7 <u>+</u> 7.9
Age categories (years)			.09		
18-29	250 (13%)	337 (13%)		102 (11%)	689 (12%)
30-39	565 (29%)	751 (28%)		248 (28%)	1564 (28%)
40-49	550 (28%)	822 (31%)		248 (28%)	1620 (29%)
50-64	543 (27%)	663 (25%)		257 (29%)	1463 (26%)
65+	67 (3%)	110 (4%) 🧹		36 (4%)	213 (4%)
Body Mass Index (kg/m2)	45.1 <u>+</u> 7.4	44.8 <u>+</u> 8.0	.20	43.3 <u>+</u> 8.2	44.7 <u>+</u> 7.9
BMI Categories (kg/m2)			.002		
30-34.99	62 (3%)	145 (5%)		74 (8%)	281 (5%)
35-39.99	447 (23%)	616 (23%)		204 (23%)	1267 (23%)
40-49.99	1026 (52%)	1314 (49%)		422 (47%)	2762 (50%)
50-59.99	351 (18%)	451 (17%)		120 (13%)	922 (17%)
60+ 85 (4%)		132 (5%)		35 (4%)	252 (5%)
Comorbidity Burden			.55		
0	932 (47%)	1243 (46%)		417 (47%)	2592 (47%)
1-2	939 (48%)	1309 (49%)		411 (46%)	2659 (48%)
3+	104 (5%)	134 (5%)		63 (7%)	301 (5%)
Type 2 Diabetes	478 (24%)	587 (22%)	.06	178 (20%)	1243 (22%)
Hypertension	311 (16%)	534 (20%)	<.001	158 (18%)	1003 (18%)

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	Enrolled	Refused or	р	Ineligible	Total	
		Non-Response			Outreached	
	1975	2686		891	5552	
Mental Illness			.001			
Serious Mental Illness	132 (7%)	137 (5%)		58 (7%)	327 (6%)	
Severe Anxiety/Depression	178 (9%)	188 (7%)		75 (8%)	441 (8%)	
Mild-to-Moderate Anxiety/Depression	741 (38%)	965 (36%)		344 (39%)	2050 (37%)	
Substance Abuse/Eating Disorder	13 (<1%)	20 (<1%)		5 (<1%)	38 (<1%)	
None	911 (46%)	1376 (51%)		409 (46%)	2696 (49%)	
Weight Loss (lbs) in year before surgery/survey	12.9 <u>+</u> 13.6	15.6 <u>+</u> 16.2	<.001	16.2 <u>+</u> 16.3	14.7 <u>+</u> 15.4	
Scheduled Visit Attendance (%) in year before surgery/survey (range 0 - 100%)	76 <u>+</u> 13	73 <u>+</u> 14	<.001 72 <u>+</u> 13		74 <u>+</u> 14	

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<u>**Table 2.**</u> Descriptive statistics for the Bariatric Experience Long Term (BELONG) mixed methods study cohort in each survey period: Baseline survey cohort (n = 1,975), baseline analytic sample (n = 1,341), year 1 analytic sample (n = 999), and year 3 analytic sample (n = 951). The formation of each of these analytic samples is shown in **Figure 2**.

	Baseline	Year 1		Year 3	
	(n = 1.341)	(n = 999)	p¥	(n = 951)	p¥
Women	1.150 (86%)	860 (86%)	0.92	824 (87%)	0.73
Race/Ethnicity	,				
Hispanic	504 (38%)	370 (37%)	0.75	345 (36%)	0.41
White	440 (33%)	340 (34%)	0.45	324 (34%)	0.43
Black	196 (15%)	137 (14%)	0.38	134 (14%)	0.61
Native American/Alaskan Native	17 (1%)	12 (1%)	0.81	9 (1%)	0.27
Asian	9 (<1%)	6 (<1%)	0.58	7 (<1%)	0.75
Native Hawaiian/Pacific Islander	18 (1%)	15 (1.5%)	0.65	14 (1.5%)	0.65
Mixed	127 (10%)	96 (10%)	0.86	98 (10%)	0.35
Other	29 (2%)	22 (2%)	0.86	19 (2%)	0.70
Unknown	1 (<1%)	1 (<1%)	0.79	1 (<1%)	0.74
Age (years)	43.4 + 11.3	43.8 + 11.6	.02	43.8 + 11.6	.04
Age Categories (years)					
18-29	160 (12%)	117 (12%)	0.81	114 (12%)	0.92
30-39	385 (29%)	278 (28%)	0.53	265 (28%)	0.57
40-49	384 (29%)	274 (27%)	0.42	259 (27%)	0.32
50-64	371 (28%)	295 (30%)	0.21	282 (30%)	0.18
65+	41 (3%)	35 (3.5%)	0.38	31 (3%)	0.65
Socioeconomic Status (range 8 – 67)	38 <u>+</u> 13	38 <u>+</u> 12	.40	39 <u>+</u> 13	<.001
Body Weight (Ibs)	262.5 + 48.1	261.0 + 47.9	.06	261.9 + 47.2	.53
Body Mass Index (kg/m ²)	43.1 + 6.4	42.9 + 6.4	.07	43.1 + 6.5	.81
Body Mass Index Categories (kg/r	n²)				
30-34.99	76 (6%)	59 (6%)	0.74	59 (6%)	0.44
35-39.99	401 (30%)	302 (30%)	0.84	275 (29%)	0.51
40-49.99	685 (51%)	510 (51%)	1.00	488 (51%)	0.92
50-59.99	157 (12%)	113 (11%)	<.001	112 (12%)	0.92
60+	22 (2%)	15 (1.5%)	0.65	17 (2%)	0.68
Comorbidity Burden (# of condition	ons)				
0	494 (37%)	359 (36%)	0.58	356 (37%)	0.72
1-2	671 (50%)	506 (51%)	0.76	466 (49%)	<.001
3+	176 (13%)	134 (13%)	0.76	129 (13.5%)	0.65
Type 2 Diabetes	375 (28%)	285 (28.5%)	0.68	263 (28%)	0.84
Hypertension	430 (32%)	326 (33%)	0.70	312 (33%)	0.63
Mental Illness Burden					
Serious Mental Illness	150 (11%)	119 (12%)	0.43	108 (11%)	0.86
Severe Anxiety/Depression	46 (3%)	34 (3%)	1.00	33 (3.5%)	0.89
Mild-to-Moderate Anxiety/Depression	450 (34%)	329 (33%)	0.71	325 (34%)	0.71
Substance Abuse/Eating Disorder	1 (<1%)	0	1.00	1 (<1%)	0.74
None	694 (52%)	517 (52%)	1.00	484 (51%)	0.65

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	Baseline	Year 1	p¥	Year 3 $(n = 0.51)$	р¥
Tupo of Surgory	(n = 1,341)	(n = 999)		(n = 951)	
I ype of ourgery	038 (70%)	603 (30%)	0.70	652 (60%)	0 52
Roux-en-Y Gastric Rypass	400 (30%)	305 (30 5%)	< 0.19	297 (31%)	0.35
Other	3 (<1%)	1 (<1%)	0.14	1 (<1%)	0.00
% Total Weight Loss year before surgery	6.6 <u>+</u> 4.6	6.6 <u>+</u> 4.6	.35	6.7 <u>+</u> 4.7	.04
Scheduled Visit Attendance (%) year before surgery (range 0 - 100%)	77 <u>+</u> 11	77.5 <u>+</u> 11	.04	78 <u>+</u> 11	.006
% Total Weight Loss at 1 year (outcome)	25.8 <u>+</u> 9.0	26.3 <u>+</u> 8.7	<.001	26.2 <u>+</u> 8.9	.006
Body Mass Index at 1 Year (kg/m²)	32.1 <u>+</u> 5.9	31.8 <u>+</u> 5.8	.001	32.0 <u>+</u> 5.9	.16
Weight at 1 Year (lbs)	194.3 <u>+</u> 41.8	191.9 <u>+</u> 40.4	<.001	192.9 <u>+</u> 40.6	.05
% Total Weight Loss at 3 years (outcome)	22.2 <u>+</u> 10.5	22.7 <u>+</u> 10.4	.005	22.6 <u>+</u> 10.5	.06
Body Mass Index at 3 Years (kg/m²)	33.5 <u>+</u> 6.4	33.2 <u>+</u> 6.2	.001	33.4 <u>+</u> 6.3	.20
Weight at 3 Years (lbs)	203.5 <u>+</u> 43.9	200.9 <u>+</u> 42.3	<.001	202.0 <u>+</u> 42.2	.06

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Table 3. Descriptive statistics from the survey for the patients in the baseline analytic cohort (n

= 1,341). Data for variables from the electronic medical record for this cohort are provided in

 Table 2. The theoretical model illustrating the domains is shown in Figure 1.

Survey Variable	n (%) or mean <u>+</u> sd
Demographic Construct (in addition to variables in Table 2)	
Education (% with some college or higher)	1,080 (81%)
Annual Income (≥ \$51,000)	734 (55%)
Socioeconomic Status (range 8 – 67)	38 <u>+</u> 13
Employed	1,102 (82%)
In a Relationship	961 (72%)
Live Alone	107 (8%)
# Living in the Home	
Behavior Construct (in addition to variables in Table 2)	
Physical Activity	
Moderate-to-Vigorous Physical Activity (MVPA) Min/Week	173 <u>+</u> 157
Meet Guidelines for MVPA (150 min/week)	650 (48%)
Strength Training Days/Week	1 <u>+</u> 2
Flexibility Exercise Days/Week	2 <u>+</u> 2
Sedentary Activity Min/Day	226 <u>+</u> 206
Sleep	
Poor Sleep Quality (% better/somewhat better)	1,033 (77%)
Sleep Efficiency (range 0% - 100%)	85% <u>+</u> 17%
Weight Control Strategies (% used most of the time/always)	
Sets Healthy Eating Goals	1,014 (76%)
Sets Exercise Goals	749 (56%)
Sets Weight Goals	673 (50%)
Reward for Meeting Goals	304 (23%)
Adjusts Goals if not Met	448 (33%)
Plans for Problems that Interfere with Goals	705 (53%)
Makes Daily/Weekly Exercise/Meal Plans	746 (56%)
Weighs Daily/Weekly	850 (63%)
Keeps Record of Behavior	724 (54%)
Graphs Behavior	432 (32%)
Uses Reminders to Exercise/Eat Healthy	786 (59%)
Avoids Places Where Overeats/Does not Eat Healthy	601 (45%)
Exercises with Friends/Family	351 (26%)
Does not Keep Unhealthy Food/Drinks at Home	733 (55%)
Uses Smaller Plates for Meals	777 (58%)
Eats Smaller Portions	1,014 (76%)
Does not Snack Between Meals	621 (46%)
Eats Breakfast Regularly	954 (71%)
Tries to Eat Three Meals/Day Regularly	937 (70%)
Frequency All Weight Control Strategies Used Most of the Time/Always	231 (17%)
Used a Self-Monitoring Device in Last 30 Days	864 (64%)
Total Weight Control Strategies Used \geq 50% (range 0 – 19)	13 <u>+</u> 4

Problematic Fating	
Binge Fating	276 (21%)
Night Fating	129 (10%)
Night Edding Night Spacking	172 (13%)
$1 \cos \alpha f$ Control of Fating (range $9 - 43$)	21 + 8
Restrained Eating (range 6 – 27)	<u> </u>
Emotional Eating (range 3 – 15)	<u> </u>
	<u> </u>
Sell-Gale (Tallye 4 - 20)	15 <u>+</u> 5
Silloking Never Smelled	024 (700/)
Never Smoked	934 (70%)
Quit	385 (29%)
Current Smoker	15 (1%)
Health Construct (in addition to variables in Table 2)	
Anxiety Symptoms (range 0 – 21)	4 <u>+</u> 4
Depression Symptoms (range 0 – 24)	5 <u>+</u> 5
Pain (range 3 - 15)	7 <u>+</u> 3
Total Dysfunction in Last 30 Days (range 0 - 48)	9 <u>+</u> 8
Quality of Life Rating (range 0 - 100)	67 <u>+</u> 21
High Health Literacy (% total score of 3)	1,185 (88%)
Addictions	· ·
Any Lifetime Addictions	239 (18%)
Any Lifetime Problems with Prescription Medication	137 (10%)
Alcohol Use/Abuse (% moderate to severe risk)	122 (9%)
Gambling Problem (% possibly)	62 (5%)
Problem with Drug Use (% possibly)	13 (1%)
Food Addiction (% experienced these symptoms)	
Consuming greater amounts for longer periods of time	310 (23%)
Tried quitting certain foods	147 (11%)
More time to obtain	377 (28%)
Give up things to obtain food	265 (20%)
Experience withdrawal	203(2070)
	277(2170)
Significant impairment/distress	140 (11%)
Psychosocial Construct	475,05
Relationship Quality (range 1 – 22)	<u> </u>
Loneliness (range 20 – 80)	<u>32 + 11</u>
Positive Social Support (range 6 - 30)	20 + 8
Weight Loss Self-Efficacy (range 8 – 40)	<u>32 + 6</u>
Self-Confidence for Exercise (range 1 – 5)	<u>3 +</u> 1
Motivations for Surgery (% important/very important)	
Improve Appearance	688 (51%)
New Clothes	749 (56%)
Outcome Expectations for Weight Loss	
Goal % Total Weight Loss (%TWL) After Surgery	42% <u>+</u> 19%
Disappointing %TWL After Surgery	25% <u>+</u> 27%
Perceived Stress (range 10 – 50)	22 <u>+</u> 6
Experiential Avoidance (range 15 - 75)	43 + 11
Perceived Environment Construct	
Perception of Neighborhood Proximity (range 0 – 7)	4 + 2
Percention of Neighborhood as Healthy (range 11 55)	38 + 7

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Figure 1. Theoretical model upon which the Bariatric Experience Long Term (BELONG) study is based.

Figure 2. The Bariatric Experience Long Term (BELONG) study cohort recruitment, enrollment, and year 5 . with in Table 1 and Tau. and follow-up for year 1 and year 3 surveys. Differences between different groups of patients in this study flow are shown in Table 1 and Table 2.


Theoretical model upon which the Bariatric Experience Long Term (BELONG) study is based.

256x199mm (300 x 300 DPI)

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The Bariatric Experience Long Term (BELONG) study cohort recruitment, enrollment, and follow-up for year 1 and year 3 surveys. Differences between different groups of patients in this study flow are shown in Table 1 and Table 2.

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Cohort Profile: The Bariatric Experience Long Term (BELONG), a Long-Term Prospective Study to Understand the Psychosocial, Environmental, Health, and Behavioral Predictors of Weight Loss and Regain in Patients Who Have Bariatric Surgery

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Cohort Profile: The Bariatric Experience Long Term (BELONG), a Long-Term Prospective Study to Understand the Psychosocial, Environmental, Health, and Behavioral Predictors of Weight Loss and Regain in Patients Who Have Bariatric Surgery

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Abstract

Purpose: The Bariatric Experience Long Term (BELONG) prospective study cohort was created to address limitations in the literature regarding the relationship between surgical weight loss and psychosocial, health, behavior, and environmental factors. The BELONG cohort is unique because it contains 70% gastric sleeve and 59% patients with non-White race/ethnicity and was developed with strong stakeholder engagement including patients and providers. **Participants:** The BELONG cohort study included 1,975 patients preparing to have bariatric surgery who completed a baseline survey in a large integrated health system in Southern California. Patients were primarily women (84%), either Black or Hispanic (59%), with a body mass index (BMI) of $45.1 \pm 7.4 \text{ kg/m}^2$, age 43.3 ± 11.5 years old, and 32% had at least one comorbidity.

Findings to Date: A total of 5,552 patients were approached before surgery between February 2016 and May 2017 and 1,975 (42%) completed a baseline survey. A total of 1,203 (73%) patients completed the year 1 and 1,033 (74%) patients completed the year 3 post-operative survey. Of these survey respondents, 1,341 at baseline, 999 at year 1, and 951 at year 3 were included in the analyses of all survey and weight outcome data. A total of 803 (60% of eligible patients) had survey data for all time points. Data collected were self-reported constructs to support the proposed theoretical model. Height, weight, and BMI were abstracted from the electronic medical record to obtain the main outcomes of the study: weight loss and regain. **Future Plans:** We will collect self-reported constructs and obtain height, weight and BMI from the electronic medical record 5 years after bariatric surgery between April 2022 and January 2023. We will also collect patient experiences using focus groups of 8 – 12 patients each throughout 2022.

 One of the main strengths of the Bariatric Experience Long Term (BELONG) cohort study is it is one of the largest longitudinal mixed methods (medical record, survey, and qualitative data) studies of bariatric patients that was designed using a comprehensive theoretical model of factors related to surgical weight loss.

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- Another main strength is the BELONG cohort study contains a large sample of gastric sleeve patients (70%), the most common bariatric operation in the U.S., and has mostly patients with diverse racial and ethnic backgrounds (59%).
- Finally, the involvement of bariatric patients in the design and implementation of the study is a strength and unique aspect of the study.
- Some of the main limitations of the BELONG cohort are the low enrollment rate in the cohort (42.4%) and only 60% of survey respondents had survey data at every time point.
- Finally, the year 3 survey was conducted, and year 5 survey will be conducted, during the beginning of the COVID-19 outbreak and thus any conclusions about the impact of bariatric surgery on survey variables and weight loss/regain need to be understood within the context of the global pandemic.

Funding

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Competing Interests

None of the authors have any competing interests.

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Introduction

Severe obesity (body mass index [BMI] \geq 35 kg/m²) has increased in prevalence over the past several decades.¹ Unfortunately, intensive, multi-component lifestyle interventions have had a minimal impact on severe obesity.² These outcomes have led to the development of surgical treatments, referred to as bariatric surgery, for severe obesity. Studies have found that when compared to conventional weight loss strategies, bariatric surgery resulted in much higher weight loss over a period of 2 – 5 years.³⁻⁶ For patients with severe obesity, bariatric surgery may become the treatment of choice.

There is large variation in weight loss outcomes even within the same bariatric operation. The largest longitudinal cohort study on bariatric patients, the Longitudinal Assessment of Bariatric Surgery (LABS), has identified five weight change trajectories following a single standardized operation, that ranged from 56% total weight loss (%TWL) to 1% gain.⁷ By 1 year almost 25% of all patients in the LABS study began to regain the weight they had lost. We have also shown wide variability in surgical weight loss from less than 10% to over 40% TWL.⁸ Some of this variability may be due to between-patient differences. For example, some Black and Hispanic patients do not lose as much weight as their White counterparts.⁹⁻¹² Given the wide range in weight loss outcomes following the same operation, it is imperative to understand the factors predicting this variability to improve outcomes for all patients.

In attempting to understand correlates or predictors of bariatric surgical outcomes, there are two general foci in the literature to date: immutable patient characteristics such as demographics and bariatric operation type;^{9,13-16} and modifiable factors such as health behaviors, weight before surgery, mental health, and social support.¹⁷⁻³¹ In general, the immutable characteristics have been studied in the pre-operative period (if studies have baseline data) and modifiable factors have been studied both before and after surgery. Most of the work on modifiable factors is not grounded in psychosocial theoretical models or theories of

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health behavior change.³² Few attempts have been made to present a unified, comprehensive model of multiple factors that could predict bariatric weight loss and regain.

The Bariatric Experience Long Term (BELONG) prospective mixed methods cohort study was designed to address these limitations by applying a comprehensive theoretical model of health behavior change (please see **Figure 1**) to the collection of self-reported survey data and qualitative patient experiences before surgery and up to 5 years after surgery to understand weight loss and regain. Our approach to the study of predictors of bariatric weight loss was based on the suggestions of Elder and colleagues³³ and Noar and Zimmerman³⁴ that a unified approach be used across the common elements of theories of behavior change, and that these elements be directly relevant to the healthcare setting.³³ We also applied findings from published research on factors related to successful behavior change^{35,37} and weight loss using other treatment modalities such as diet and exercise.^{38,39} Finally, a special emphasis was placed on understanding the experiences of Black and Hispanic patients and why they may lose less weight than their White counterparts. Constructs such as everyday racism⁴⁰ and vigilant coping⁴¹ were added to both survey and qualitative data collection to address this question.

Based upon our *a priori* theoretical model, we hypothesized the following: 1) Baseline predictors of weight loss/regain would be BMI, race/ethnicity, gender, social support, perceptions of the nutrition and PA environment, binge eating, and disease burden/severity; 2) the effects of baseline predictors on weight loss/regain will be mediated by changes in social support, health behaviors, and problematic eating; 3) the effects of both baseline and follow-up predictors in weight loss/regain will be mediated by the development of adverse psychosocial consequences.

For Black and Hispanic patients we also hypothesized that: 1) Black and Hispanic patients will lose less and regain more weight compared to White patients *mediated by*: low socioeconomic status; living in neighborhoods with high crime and poverty rates; higher comorbidity burden; lower utilization of follow-up care; higher rates of internalized racism,

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depression, anxiety, and stress; and use of vigilance and food to cope with stress; and 2) Hispanic patients will lose more and regain less weight than Black patients, which will be *mediated by*: living in majority Hispanic neighborhoods, higher socioeconomic status, greater use of post-operative care services, lower internalized racism, and less frequent use of vigilant coping to deal with stress.

The purpose of the qualitative component of the BELONG study was to explore in greater depth than allowed in questionnaires the sociocultural norms, health behaviors, and environmental factors associated with a patient's weight loss/regain. The qualitative and quantitative components of the BELONG study will be combined using the *QUAN* + *QUAL* structure in Palinkas and colleague's mixed methods framework,⁴² here both sources of data have equal importance in the exploration of a phenomenon. Once analyses are complete, we will be able to address if our *a priori* theoretical model of bariatric weight loss/regain in diverse patients is appropriate or should be revised. Results from our work will provide the evidence needed to design patient-centered, culturally appropriate pre-operative preparation and post-operative care programs so that *all* patients achieve the maximum benefits from this highly effective treatment for severe obesity.

COHORT DESCRIPTION

Study Design

The Bariatric Experience Long Term (BELONG) study was designed as a prospective mixed methods longitudinal cohort study. The qualitative component of the study was designed to address the bariatric experience of weight loss for racial and ethnic groups of patients, men, and those who lost or did not lose and maintain at least 20% TWL. A 20% TWL threshold was chosen based upon our own work that this amount of weight loss is important for the remission of diabetes.⁴³ All study methods were designed with a patient and provider as part of the study team and a stakeholder advisory group of diverse post-bariatric patients. The stakeholder

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advisory board was specifically focused on addressing issues of structural racism, discrimination, and stigma specific to bariatric surgery.

Participants

<u>Human subjects approval</u>. This study was approved by the Institutional Review Board for Human Subjects of the health system in which the study took place. The reference numbers are 10865 and 11250.

Enrollment and baseline survey completion. Eligibility criteria for inclusion in the BELONG mixed methods cohort study were: 1) being enrolled in a 12-week bariatric surgery preparation course; 2) planning to have a first bariatric operation within 6 months of the baseline survey; 3) being an adult 18 years of age and older; and 4) meeting general eligibility criteria for weight loss surgery in the U.S.⁴⁴ **Figure 2** provides the recruitment flow for the study. Recruitment for the survey began in February 2016 and ended in May 2017. **Table 1** provides baseline differences in descriptive variables available from the electronic medical record between those who were enrolled in the cohort (n = 1,975; 42% response rate), and the patients who were eligible and contacted but not enrolled (n = 1,239) and those who were contacted but not enrolled because they were determined to be ineligible after they were contacted (n = 2,338). Self-reported survey data were not available for those who were not enrolled.

In addition to the assessment of eligibility at the time of outreach and survey administration, eligibility was also assessed after the collection of the baseline and year 1 surveys, which further reduced the number of survey respondents who could be used for outcome analyses. Reasons for this second eligibility assessment are shown in **Figure 2**. Of the 1,975 patients who were surveyed at baseline, 634 patients were determined as ineligible for all years of the study primarily because: they never had surgery (n = 294), they had surgery before the baseline survey (n = 68), or they had surgery more than 6 months after the baseline survey (n = 272). Many of these exclusions were made after patients had completed surveys because of the delays in receiving surgery, reporting errors in the electronic medical record, and delays in case

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validation. After applying all exclusions (please see **Figure 2**) there were 1,341 patients who were considered eligible for the study and used as the baseline analytic cohort for follow-up. Baseline data for these patients are shown in **Table 2**.

Follow-up survey completion. Patients were surveyed at 1 year (between April 2017 and January 2019) and 3 years (between May 2019 and January 2021 after they had bariatric surgery (note the surgery date could have been up to 6 months after the baseline survey). A survey at 5 years is also planned (between April 2022 and January 2023). In addition, weight (lbs), height (in), and BMI (kg/m²) were abstracted from the electronic medical record at all time points. Survey response rates for each year of follow-up were 73% (n = 1,203) for year 1 and 74% (n = 1,033) for year 3 (see **Figure 2**). Qualitative interviews began in April 2021 and were completed in March 2022 (n = 68). In addition, focus groups with 8 – 10 patients each will be conducted throughout 2022.

Eligible cohort for weight outcome analyses. Not all patients were eligible for outcome analyses. There were 803 patients (60% of those eligible) who had survey data for all time points (baseline, year 1, and year 3). **Table 2** provides descriptive statistics for the patients eligible for the outcome analyses. Data are presented for those patients with a baseline survey (n = 1,341) compared to those who had a year 1 survey (n = 999) and a year 3 survey (n = 951).

Measures

Survey. All surveys for the BELONG study were administered using a Computer-Aided Telephone Interview (CATI) system or a self-directed website and took approximately 75 minutes to complete. The baseline survey was for research only and was not used in the patient's preparation/decision process for surgery. Half (n = 978; 50%) of all survey respondents completed the baseline survey using the website and by year 3 this had increased to 70% (n = 719).

Surveys asked patients to self-report the following information which is presented by model

construct in Figure 1. DEMOGRAPHIC: Gender, race/ethnicity, education, income, employment and relationship status, number of people in the home, and socioeconomic status (SES) as calculated with the Hollingshead Index of Social Status (uses education and occupation code).⁴⁵ BEHAVIOR: Adherence measured as attendance at scheduled outpatient visits (12 months before and throughout follow-up) and % TWL in the 12 months before surgery.¹⁸ physical⁴⁶ and sedentary⁴⁷ activity, sleep.⁴⁸ weight control strategies.⁴⁹ problematic eating (binge eating;⁵⁰ loss of control, restrained, and emotional eating⁵¹), self-care,⁵² smoking,⁴⁶ dietary guality,⁵³ and brief dietary intake.⁵⁴ **HEALTH**: symptoms of anxiety⁵⁵ and depression,⁵⁶ pain,⁵⁷ physical function,⁵⁸ quality of life,⁵⁹ health literacy,⁶⁰ and addictions such as lifetime drug use,⁶¹ alcohol use disorder,⁶² gambling,⁶³ prescription/illicit drug abuse,⁶³ and food.⁶⁴ **PSYCHOSOCIAL**: relationship quality,⁶⁵ motivations for having surgery and weight loss expectations after surgery,⁶⁶ weight loss self-efficacy,⁶⁷ loneliness,⁶⁸ perceived stress,⁶⁹ experiential avoidance,⁷⁰ positive and negative social support for physical activity and healthy eating.⁷¹ self-confidence for exercise,⁷² internal weight bias (only in year 3 and 5 surveys),⁷³ vigilant coping style (only in year 3 and 5 surveys),⁴¹ everyday discrimination (only in year 3 and 5 surveys),⁴⁰ and hedonic adaptation (only in year 1, 3 and 5 surveys).⁷⁴ **PERCEIVED ENVIRONMENT**: perceptions of neighborhood environment for promotion of healthy behaviors and neighborhood proximity of healthy alternatives.75

In addition to the broad constructs in **Figure 1**, investigators from the BELONG study were also interested in the development of an <u>ADVERSE CONSEQUENCES</u> construct after bariatric surgery. This construct used elements of the HEALTH, PSYCHOSOCIAL, and BEHAVIOR constructs which included the development of loneliness, addictions, problematic eating, and poor relationship quality and loss of relationships (e.g. divorce/separation) as well as increases in stress.

<u>Electronic medical record</u>. The following information was abstracted from the electronic medical record at the time of surgery or the baseline survey: diagnoses and pharmacy records

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to determine disease burden both physical and mental health-related, adherence to scheduled visits for routine medical care in the year before surgery/survey, weight and height to determine both BMI and %TWL in the year before surgery/survey, and date of birth to calculate age. For the follow-up time periods we abstracted weight and height to determine BMI and %TWL. Height and weight were collected by clinical staff as part of routine clinical care.

Qualitative interviews and focus groups. Qualitative interview protocols were designed with the patient stakeholder advisory board and designed to address critical time periods of bariatric surgery: the year before the operation, the 12 - 24 months after surgery, and the longer-term period of 3 – 5 years after surgery. Patients were interviewed at 3 – 5 years after surgery and thus were asked to recall before surgery and 12 – 24-month time points. Across each of these time points, interview domains included personal/family social network, health care teams/health system, and society. Special emphasis was placed on understanding racism and stigma in each domain, and we asked about how the pandemic was affecting their weight loss. These domains were chosen based upon the study theoretical model presented in the introduction (see **Figure 1**), with modifications from our stakeholders. Interviews were 60 - 90 minutes each and patients could have up to two interviews each (total time = 120 minutes).

Patient and Public Involvement

From the inception of the study, a bariatric provider and a bariatric patient were included as members of the scientific team. They attend all study meetings and are included as authors in all publications. To create the qualitative study methods, a patient advisory board was formed to design, test, and interpret the data. These advisors were recruited through a network of providers and health system leaders and were either: 1) already engaged in designing the health system program for pre-operative and post-operative care and monitoring, or 2) leading pre- and post-operative patient support groups. Patients were diverse in race/ethnicity (Black, White, and Hispanic) and were an equal mix of men and women. Patients also ranged in time out from bariatric surgery from 1 - 10 years. In addition to design, implementation, and

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interpretation of both qualitative and survey data, the patient advisory board, and the patient and provider co-investigators, will be involved in planning and executing the dissemination of the findings for clinical and professional audiences.

FINDINGS TO DATE

Participants

Descriptive information for the enrolled cohort (n = 1,975) is shown in **Table 1**. In general, when compared to patients who refused participation or did not respond to outreach, patients who completed a baseline survey were *more likely to* be women (84% vs. 77%; p < .001), White (36% vs 28%; p < .001), have a BMI of 40 – 49.99 kg/m² (52% vs. 49%; p = .002), have a mental illness (54% vs. 49% p = .001), and *less likely to* have hypertension (16% vs. 20%; p < .001). Those who completed the baseline survey lost less weight (12.9 vs. 15.6 lbs; p < .001) and had higher attendance at scheduled outpatient visits in the year before surgery (76% vs. 73%; p < .001) when compared to patients who did not respond or refused participation. Characteristics for baseline and follow-up survey participants used in the outcome analyses are shown in **Table 2** (baseline [n = 1,341], year 1 [n = 999], and year 3 [n = 951]). Although there were statistically significant differences between patients in the baseline survey sample compared to the follow-up samples, because of the large sample size, these differences were not clinically meaningful (e.g. an age difference of 0.4 years or a %TWL difference of 1%).

Electronic Medical Record Data

Data from the electronic medical record are shown in **Table 2**. At the time of surgery, patients had a BMI of 43.1 ± 6.4 kg/m² primarily in the 40 - 49 kg/m² (51%) range, most had at least 1 comorbidity (63%) with 28% and 32% having type 2 diabetes mellitus and hypertension, respectively. Fourteen percent had a serious mental illness and 34% had mild-to-moderate anxiety and depression. Patients lost $6.6 \pm 4.6\%$ of their weight in the year before surgery and $25.8 \pm 9.0\%$ at year 1 and $22.2 \pm 10.5\%$ at year 3 after surgery.

Survey Data

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Baseline demographics for the analytic cohort (n = 1,341) are shown in **Table 2** and survey variables are shown in **Table 3**. In general, the baseline analytic cohort was primarily women (86%), Hispanic or Black (53%), 43 + 11 years old equally distributed across three age categories (30 - 39, 40 - 49, 50 - 54 years old), had at least some college education (81%) with an annual income of at least \$51,000 (55%), a mid-range socioeconomic status (38 + 13; range 8-67), and the majority were employed outside the home (82%) and were in a relationship (72%). In general patients in the baseline analytic cohort had high health literacy (88%), never smoked (70%), had low self-reported dysfunction (9 + 8 out of a total score of 48 with higher numbers reflecting more dysfunction), low levels of depression (5 + 5 out of 24), anxiety (4 + 4 out of 21), and pain (7 + 3 out of 15) symptoms. Patients rated their overall health at 67 + 21 out of a possible score of 100. Some patients reported having a history of addiction (10% - 18%), with few reporting current symptoms of problems with alcohol (9%), gambling (5%), or drugs (1%). If patients were in a relationship, they were generally satisfied with that relationship (17.5 + 3.5 out of 22). The mean self-reported goal weight loss (expressed as % TWL) was 42% + 19% and the mean self-reported weight loss that patients indicated would be disappointing was 25% + 27% TWL. As mentioned previously, the actual post-operative %TWL for these patients was 25.8 + 9.0% at year 1 and 22.2 + 10.5% at year 3.

Patients reported low levels of loneliness (32 ± 11 out of 80) and moderate perceived stress (22 ± 6 out of 50). Self-confidence for exercise was moderate-to-high (3 ± 1 out of 5), self-efficacy for weight loss was high (32 ± 6 out of 40), and positive social support for healthy behaviors was also high (20 ± 8 out of 30) going into surgery. The most common motivations patients reported for having surgery were to improve their health (96%), to do the things they wanted to do (93%), feel better about themselves (88%), do things that friends and family could do (79%), and to play with their children/grandchildren (76%).

Over 20% of patients reported symptoms of binge eating with fewer reporting night eating (10%) or night snacking (13%) before surgery. Patients reported loss of control of (21 ± 8 out of

43), restrained (19 \pm 4 out of 27), and emotional eating behaviors (8 \pm 4 out of 15). In general, patients reported good sleep quality (77% better/somewhat better) and efficiency (85% \pm 17% out of 100%). Almost half (48%) reported meeting guidelines for moderate-to-vigorous physical activity (173 \pm 157 minutes/week) and an average of 1 \pm 2 and 2 \pm 2 days per week of strength and flexibility training respectively. The most common weight control strategies patients reported using before surgery were setting healthy eating goals (76%), eating smaller portions (76%), eating breakfast regularly (71%), eating three meals a day/eating regularly (70%), and using a monitoring device (64%). Only 17% of patients indicated that they used all weight control strategies at least most of the time/always. Finally, most patients felt that locations in their neighborhoods like grocery stores and parks were accessible (4 \pm 2 out of 7 with higher scores being more accessible) and moderately healthy (38 \pm 7 out of 55).

Previously Published Work

Several hundred patients did not have surgery within 6 months of their baseline survey (see **Figure 1**) and thus were not eligible for the analysis of survey and outcome data. In our previously published work, we examined the factors that led BELONG patients to receive or not receive surgery.⁷⁶ The strongest predictors of *having* surgery were being a woman and losing at least 5% TWL in the year before surgery. The strongest predictors of *not* having surgery were a BMI \geq 50 kg/m² and having a higher physical comorbidity burden. Having a mental health condition did not predict if a patient had surgery. These findings highlighted why the uptake of bariatric surgery is extremely low; only 1 – 2% of eligible patients have surgery in the U.S.⁷⁷ Practices such as requiring 5%-10% TWL before surgery and selection of patients with safer operative risk profiles (younger with lower comorbidity burden) may inadvertently contribute to under-utilization of bariatric surgery among some subpopulations^{78,79} who could most benefit from this intervention.

STRENGTHS AND LIMITATIONS

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One of the main strengths of the BELONG mixed methods cohort study is that it is one of the largest longitudinal mixed methods studies of bariatric patients that was designed using a comprehensive theoretical model of weight loss and includes medical record, survey, and gualitative data (see **Figure 1**). The only other comparable study is the LABS study which enrolled over 2,500 patients across the U.S. and followed patients for more than 7 years.⁸⁰⁴ However, in comparison to the LABS study, the BELONG mixed methods cohort study contains a large sample of gastric sleeve patients (70%), the most common bariatric operation in the U.S.⁸¹ and has mostly patients from various racial and ethnic groups (59%). The LABS study patients were primarily White (90%) and <3% had an operation other than gastric bypass or laparoscopic band. These two distinctions are important because the findings of the BELONG cohort can be applied directly to the current state of bariatric practice and Black and Hispanic patients suffer disproportionately from severe obesity¹ and thus stand the most to gain from bariatric surgery. Despite the promise of this benefit, there are several reports in the literature.¹⁰⁻ ¹² including our own,⁹ that some Black and Hispanic patients do not lose as much weight as their White counterparts following surgery. The BELONG mixed methods cohort study is uniquely positioned to understand the reasons for these disparities.

In addition, the BELONG study is the first study in this area to have extensive involvement from patients in its design and implementation. Our patient advisory board is instrumental in our selection of variables and outcomes to study and in helping us create patient stories that are meaningful illustrations of the survey findings. Our approach is designed specifically to address gaps in the literature and practice, so that all patients with severe obesity can have the best experience with the most effective treatment available for their condition.

The main limitation of the BELONG cohort is the biased nature of the study sample. These were all patients who were near the end of a preparation course for surgery and thus they were predisposed to have surgery. Our findings may have been different if we had surveyed patients when they were referred for surgery before beginning the course. In addition, we had a low

enrollment rate in the cohort (42.4%) further limiting our generalizability. Limiting our generalizability to the bariatric population as a whole, was only 60% of survey respondents had survey data at every time point although our response rates were excellent for the 1-year (73%) and 3-year (74%) surveys. Another limitation was that the year 3 survey was conducted during the beginning of the COVID-19 outbreak. Any conclusions about the impact of bariatric surgery on survey responses and weight loss/regain will need to be tempered by the context of a global pandemic. Finally, even though this health system included 23 bariatric surgeons across 9 practices, our findings were based on an insured population in a single health system and may not apply to uninsured patients or other types of bariatric practices and thus should be replicated more systematically in other settings.

Data Sharing and Collaboration

The unpublished data are only available for use through collaboration with the BELONG study investigators, a data use agreement upon which all parties must agree, and external funding. Persons interested in collaborating with the BELONG study team can contact Dr. Karen Coleman [Karen.J.Coleman@kp.org], the lead investigator. We are eager to share this resource with others in collaboration to extend the evidence-base for the most effective treatment available for severe obesity.

Author Contributions

All authors participated in the writing of the manuscript and made substantial contributions to the presentation of the information. KJC obtained the funding for the study, wrote the initial draft of the manuscript, and conducted all analyses. SRP, BBB, and MM were responsible for all data collection. BT, JL, and TKY were responsible for the abstraction of data from the electronic medical record and processing of all survey data for analyses. DEA, CLC, AD, MFG, LDH, MJ, KHL, DDM, SBM, and DRY were responsible for the conceptualization of the study design, variables and survey instruments to include, and recruitment and enrollment strategies used in all surveys and qualitative interviews. BMJ Open: first published as 10.1136/bmjopen-2021-059611 on 24 May 2022. Downloaded from http://bmjopen.bmj.com/ on June 11, 2025 at Agence Bibliographique de Enseignement Superieur (ABES) . Protected by copyright, including for uses related to text and data mining, Al training, and similar technologies.

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Table 1. Descriptive statistics for the formation of the Bariatric Experience Long Term (BELONG) mixed methods study cohort. Data are shown for those who were outreached for the study based upon initial eligibility (n = 5,552). Why patients were not eligible is in Figure 2.

	Enrolled	Refused or Non-Response	р	Ineligible	Total Outreached
	1975	2686		891	5552
Women	1660 (84%)	2071 (77%)	< .001	712 (80%)	4443 (80%)
Race/Ethnicity			< .001		
Asian	26 (1%)	47 (2%)		14 (2%)	87 (2%)
Black	344 (17%)	580 (29%)		158 (18%)	1082 (19%)
Hispanic	838 (42%)	1222 (45%)		389 (44%)	2449 (44%)
Native Am Alaskan	8 (<1%)	8 (<1%)		2 (<1%)	18 (<1%)
Pacific Islander	10 (<1%)	20 (<1%)		6 (<1%)	36 (<1%)
White	716 (36%)	764 (28%)		307 (34%)	1787 (32%)
Multiple	11 (<1%)	9 (<1%)		3 (<1%)	23 (<1%)
Other	10 (<1%)	16 (<1%)		8 (<1%)	34 (<1%)
Unknown	12 (<1%)	20 (<1%)		4 (<1%)	36 (<1%)
Age (years)	43.3 <u>+</u> 11.6	44.8 <u>+</u> 8.0	.43	43.3 <u>+</u> 8.2	44.7 <u>+</u> 7.9
Age categories (years)			.09		
18-29	250 (13%)	337 (13%)		102 (11%)	689 (12%)
30-39	565 (29%)	751 (28%)		248 (28%)	1564 (28%)
40-49	550 (28%)	822 (31%)		248 (28%)	1620 (29%)
50-64	543 (27%)	663 (25%)		257 (29%)	1463 (26%)
65+	67 (3%)	110 (4%)		36 (4%)	213 (4%)
Body Mass Index (kg/m2)	45.1 <u>+</u> 7.4	44.8 <u>+</u> 8.0	.20	43.3 <u>+</u> 8.2	44.7 <u>+</u> 7.9
BMI Categories (kg/m2)			.002		
30-34.99	62 (3%)	145 (5%)		74 (8%)	281 (5%)
35-39.99	447 (23%)	616 (23%)		204 (23%)	1267 (23%)
40-49.99	1026 (52%)	1314 (49%)		422 (47%)	2762 (50%)
50-59.99	351 (18%)	451 (17%)		120 (13%)	922 (17%)
60+	85 (4%)	132 (5%)		35 (4%)	252 (5%)
Comorbidity Burden			.55		
0	932 (47%)	1243 (46%)		417 (47%)	2592 (47%)
1-2	939 (48%)	1309 (49%)		411 (46%)	2659 (48%)
3+	104 (5%)	134 (5%)		63 (7%)	301 (5%)
Type 2 Diabetes	478 (24%)	587 (22%)	.06	178 (20%)	1243 (22%)
Hypertension	311 (16%)	534 (20%)	<.001	158 (18%)	1003 (18%)

					1
	Enrolled	Refused or Non-Response	р	Ineligible	Total Outreached
	1975	2686		891	5552
Mental Illness			.001		
Serious Mental Illness	132 (7%)	137 (5%)		58 (7%)	327 (6%)
Severe Anxiety/Depression	178 (9%)	188 (7%)		75 (8%)	441 (8%)
Mild-to-Moderate Anxiety/Depression	741 (38%)	965 (36%)		344 (39%)	2050 (37%)
Substance Abuse/Eating Disorder	13 (<1%)	20 (<1%)		5 (<1%)	38 (<1%)
None	911 (46%)	1376 (51%)		409 (46%)	2696 (49%)
Weight Loss (lbs) in year	12.9 <u>+</u> 13.6	15.6 <u>+</u> 16.2	<.001	16.2 <u>+</u> 16.3	14.7 <u>+</u> 15.4
Scheduled Visit Attendance (%) in year before surgery/survey (range 0 - 100%)	76 <u>+</u> 13	73 <u>+</u> 14	<.001	72 <u>+</u> 13	74 <u>+</u> 14

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<u>**Table 2.**</u> Descriptive statistics for the Bariatric Experience Long Term (BELONG) mixed methods study cohort in each survey period: Baseline survey cohort (n = 1,975), baseline analytic sample (n = 1,341), year 1 analytic sample (n = 999), and year 3 analytic sample (n = 951). The formation of each of these analytic samples is shown in **Figure 2**.

Women Race/Ethnicity Hispanic White Black	baseline (n = 1,341) 1,150 (86%) 504 (38%) 440 (33%) 196 (15%)	(n = 999) 860 (86%) 370 (37%) 340 (34%)	p¥ 0.92	(n = 951) 824 (87%)	р¥ 0.73
Women Race/Ethnicity Hispanic White Black	(n = 1,341) $1,150 (86%)$ $504 (38%)$ $440 (33%)$ $196 (15%)$ $17 (1%)$	(n = 999) 860 (86%) 370 (37%) 340 (34%)	0.92	(n = 951) 824 (87%)	0.73
women Race/Ethnicity Hispanic White Black	1,150 (86%) 504 (38%) 440 (33%) 196 (15%)	370 (37%) 340 (34%)	0.92	824 (87%)	0.73
Hispanic White Black	504 (38%) 440 (33%) 196 (15%) 17 (1%)	370 (37%) 340 (34%)	0.75		
Hispanic White Black	<u>504 (38%)</u> 440 (33%) 196 (15%) 17 (1%)	340 (34%)	11/5	0.45 (0.00()	0.44
Black	<u>440 (33%)</u> <u>196 (15%)</u> 17 (1%)	340 (34%)	0.75	345 (36%)	0.41
Black	<u>196 (15%)</u> 17 (1%)		0.45	324 (34%)	0.43
	17 (1%)	137 (14%)	0.38	134 (14%)	0.61
Native American/Alaskan Native	17 (170)	12 (1%)	0.81	9 (1%)	0.27
Asian	9 (<1%)	6 (<1%)	0.58	7 (<1%)	0.75
Native Hawaiian/Pacific Islander	18 (1%)	15 (1.5%)	0.65	14 (1.5%)	0.65
Mixed	127 (10%)	96 (10%)	0.86	98 (10%)	0.35
Other	29 (2%)	22 (2%)	0.86	19 (2%)	0.70
Unknown	1 (<1%)	1 (<1%)	0.79	1 (<1%)	0.74
Age (years)	43.4 <u>+</u> 11.3	43.8 <u>+</u> 11.6	.02	43.8 <u>+</u> 11.6	.04
Age Categories (years)					
18-29	160 (12%)	117 (12%)	0.81	114 (12%)	0.92
30-39	385 (29%)	278 (28%)	0.53	265 (28%)	0.57
40-49	384 (29%)	274 (27%)	0.42	259 (27%)	0.32
50-64	371 (28%)	295 (30%)	0.21	282 (30%)	0.18
65+	41 (3%)	35 (3.5%)	0.38	31 (3%)	0.65
Socioeconomic Status (range 8 – 67)	38 <u>+</u> 13	38 <u>+</u> 12	.40	39 <u>+</u> 13	<.001
Body Weight (lbs)	262.5 + 48.1	261.0 + 47.9	.06	261.9 + 47.2	.53
Body Mass Index (kg/m ²)	43.1 + 6.4	42.9 + 6.4	.07	43.1 + 6.5	.81
Body Mass Index Categories (kg/m	2)				
30-34.99	76 (6%)	59 (6%)	0.74	59 (6%)	0.44
35-39.99	401 (30%)	302 (30%)	0.84	275 (29%)	0.51
40-49.99	685 (51%)	510 (51%)	1.00	488 (51%)	0.92
50-59.99	157 (12%)	113 (11%)	< 001	112 (12%)	0.92
60+	22 (2%)	15 (1 5%)	0.65	17 (2%)	0.62
Comorbidity Burden (# of condition	<u> </u>	10 (1.070)	0.00	11 (270)	0.00
	494 (37%)	359 (36%)	0.58	356 (37%)	0.72
1_2	671 (50%)	506 (51%)	0.76	466 (49%)	< 0.01
2+	176 (13%)	134 (13%)	0.76	129 (13 5%)	0.65
Type 2 Diabetes	375 (28%)	285 (28 5%)	0.70	263 (28%)	0.00
Hypertension	430 (32%)	326 (33%)	0.00	312 (33%)	0.63
Mental Illness Burden	+00 (02 /0)		0.70		0.00
Serious Mental Illness	150 (11%)	119 (12%)	0.43	108 (11%)	0.86
Severe Anviety/Denression	46 (3%)	34 (3%)	1.00	33 (3 5%)	0.00
Mild to Moderato	+0 (370)	34 (370)	1.00	33 (3.378)	0.09
Δnviety/Depression	450 (34%)	329 (33%)	0.71	325 (34%)	0.71
Substance Abuse/Eating Disorder	1(<10/)	0	1.00	1 (<1%)	0.74
Substance Abuse/Lating Disolder	1 (~170)	0	1.00	1 (1 / 0)	0.74
None	694 (52%)	517 (52%)	1.00	484 (51%)	0.65

	Baseline	Year 1		Year 3	
	(n = 1.341)	(n = 999)	p¥	(n = 951)	р¥
Type of Surgery	(
Sleeve Gastrectomy	938 (70%)	693 (39%)	0.79	652 (69%)	0.53
Roux-en-Y Gastric Bypass	400 (30%)	305 (30.5%)	<.001	297 (31%)	0.35
Other	3 (<1%)	1 (<1%)	0.14	1 (<1%)	0.18
% Total Weight Loss year before surgery	6.6 <u>+</u> 4.6	6.6 <u>+</u> 4.6	.35	6.7 <u>+</u> 4.7	.04
Scheduled Visit Attendance (%) year before surgery (range 0 - 100%)	77 <u>+</u> 11	77.5 <u>+</u> 11	.04	78 <u>+</u> 11	.006
% Total Weight Loss at 1 year (outcome)	25.8 <u>+</u> 9.0	26.3 <u>+</u> 8.7	<.001	26.2 <u>+</u> 8.9	.006
Body Mass Index at 1 Year (kg/m²)	32.1 <u>+</u> 5.9	31.8 <u>+</u> 5.8	.001	32.0 <u>+</u> 5.9	.16
Weight at 1 Year (lbs)	194.3 <u>+</u> 41.8	191.9 <u>+</u> 40.4	<.001	192.9 <u>+</u> 40.6	.05
% Total Weight Loss at 3 years outcome)	22.2 <u>+</u> 10.5	22.7 <u>+</u> 10.4	.005	22.6 <u>+</u> 10.5	.06
Body Mass Index at 3 Years (kg/m²)	33.5 <u>+</u> 6.4	33.2 <u>+</u> 6.2	.001	33.4 <u>+</u> 6.3	.20
	000 5 . 40.0				
Compared to Baseline Analytic Coho	203.5 <u>+</u> 43.9 ort	200.9 <u>+</u> 42.3	<.001	202.0 <u>+</u> 42.2	.06
Weight at 3 Years (Ibs) Compared to Baseline Analytic Coho	<u>203.5 +</u> 43.9 ort	200.9 <u>+</u> 42.3	<.001	202.0 <u>+</u> 42.2	.06

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Table 3. Descriptive statistics from the survey for the patients in the baseline analytic cohort (n

= 1,341). Data for variables from the electronic medical record for this cohort are provided in

 Table 2. The theoretical model illustrating the domains is shown in Figure 1.

Survey Variable	n (%) or mean <u>+</u> sd
Demographic Construct (in addition to variables in Table 2)	
Education (% with some college or higher)	1,080 (81%)
Annual Income (≥ \$51,000)	734 (55%)
Socioeconomic Status (range 8 – 67)	38 <u>+</u> 13
Employed	1,102 (82%)
In a Relationship	961 (72%)
Live Alone	107 (8%)
# Living in the Home	
Behavior Construct (in addition to variables in Table 2)	
Physical Activity	
Moderate-to-Vigorous Physical Activity (MVPA) Min/Week	173 <u>+</u> 157
Meet Guidelines for MVPA (150 min/week)	650 (48%)
Strength Training Days/Week	1 <u>+</u> 2
Flexibility Exercise Days/Week	2 <u>+</u> 2
Sedentary Activity Min/Day	226 <u>+</u> 206
Sleep	
Poor Sleep Quality (% better/somewhat better)	1,033 (77%)
Sleep Efficiency (range 0% - 100%)	85% <u>+</u> 17%
Weight Control Strategies (% used most of the time/always)	
Sets Healthy Eating Goals	1,014 (76%)
Sets Exercise Goals	749 (56%)
Sets Weight Goals	673 (50%)
Reward for Meeting Goals	304 (23%)
Adjusts Goals if not Met	448 (33%)
Plans for Problems that Interfere with Goals	705 (53%)
Makes Daily/Weekly Exercise/Meal Plans	746 (56%)
Weighs Daily/Weekly	850 (63%)
Keeps Record of Behavior	724 (54%)
Graphs Behavior	432 (32%)
Uses Reminders to Exercise/Eat Healthy	786 (59%)
Avoids Places Where Overeats/Does not Eat Healthy	601 (45%)
Exercises with Friends/Family	351 (26%)
Does not Keep Unhealthy Food/Drinks at Home	733 (55%)
Uses Smaller Plates for Meals	777 (58%)
Eats Smaller Portions	1,014 (76%)
Does not Snack Between Meals	621 (46%)
Eats Breakfast Regularly	954 (71%)
Tries to Eat Three Meals/Day Regularly	937 (70%)
Frequency All Weight Control Strategies Used Most of the Time/Always	231 (17%)
Used a Self-Monitoring Device in Last 30 Days	864 (64%)
Total Weight Control Strategies Used \geq 50% (range 0 – 19)	13 <u>+</u> 4
Problematic Eating	
--	--------------
Binge Eating	276 (21%)
Night Eating	129 (10%)
Night Snacking	172 (13%)
Loss of Control of Eating (range 9 – 43)	21 + 8
Restrained Eating (range 6 – 27)	19 + 4
Emotional Eating (range 3 – 15)	8 + 4
Self-Care (range 4 - 20)	13 + 5
Smoking	
Never Smoked	934 (70%)
Quit	385 (29%)
Current Smoker	15 (1%)
Health Construct (in addition to variables in Table 2)	
Anxiety Symptoms (range 0 – 21)	4 <u>+</u> 4
Depression Symptoms (range 0 – 24)	5 <u>+</u> 5
Pain (range 3 - 15)	7 <u>+</u> 3
Total Dysfunction in Last 30 Days (range 0 - 48)	9 <u>+</u> 8
Quality of Life Rating (range 0 - 100)	67 + 21
High Health Literacy (% total score of 3)	1,185 (88%)
Addictions	· · · · ·
Any Lifetime Addictions	239 (18%)
Any Lifetime Problems with Prescription Medication	137 (10%)
Alcohol Use/Abuse (% moderate to severe risk)	122 (9%)
Gambling Problem (% possibly)	62 (5%)
Problem with Drug Use (% possibly)	13 (1%)
Food Addiction (% experienced these symptoms)	
Consuming greater amounts for longer periods of time	310 (23%)
Tried guitting certain foods	147 (11%)
More time to obtain	377 (28%)
Give up things to obtain food	265 (20%)
Experience withdrawal	277 (21%)
Significant impairment/distress	146 (11%)
Psychosocial Construct	X /
Relationship Quality (range 1 – 22)	17.5 + 3.5
Loneliness (range 20 – 80)	32 + 11
Positive Social Support (range 6 - 30)	
Weight Loss Self-Efficacy (range 8 – 40)	32 + 6
Self-Confidence for Exercise (range 1 – 5)	3+1
Motivations for Surgery (% important/very important)	
Improve Appearance	688 (51%)
New Clothes	749 (56%)
Outcome Expectations for Weight Loss	
Goal % Total Weight Loss (%TWL) After Surgerv	42% + 19%
Disappointing %TWL After Surgery	25% + 27%
Perceived Stress (range 10 – 50)	22 + 6
Experiential Avoidance (range 15 - 75)	43 + 11
Perceived Environment Construct	
Perception of Neighborhood Proximity (range 0 – 7)	4 + 2
Percention of Neighborhood as Healthy (range 11 - 55)	38 + 7

Figure Captions

Figure 1. Theoretical model upon which the Bariatric Experience Long Term (BELONG) study is based.

Figure 2. The Bariatric Experience Long Term (BELONG) study cohort recruitment, enrollment, x_µ and year 3 s.. wn in **Table 1** and **Tab.** and follow-up for year 1 and year 3 surveys. Differences between different groups of patients in this study flow are shown in Table 1 and Table 2.

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Theoretical model upon which the Bariatric Experience Long Term (BELONG) study is based.

256x199mm (300 x 300 DPI)



The Bariatric Experience Long Term (BELONG) study cohort recruitment, enrollment, and follow-up for year 1 and year 3 surveys. Differences between different groups of patients in this study flow are shown in Table 1 and Table 2.

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238x199mm (300 x 300 DPI)