



Does the socio-demographic profile of patients limit access to bariatric surgery?

Viviane Richard^{1,6} · Christof Stähli¹ · Guillaume Giudicelli^{1,7} · Marc Daniel Worreth^{1,2} · Nicole Krähenbühl² · Emilie Greiner² · Chrysoula Papastathi² · Michele Diana^{1,3,4} · Alend Saadi^{1,2,5}

Received: 28 April 2021 / Accepted: 3 August 2021 / Published online: 24 August 2021
© The Author(s) 2021

Abstract

Purpose Surgery remains the only treatment allowing for a significant and sustainable weight loss in case of severe obesity. Patients undergo a specific multidisciplinary preparation and selection before the operation. This study aims to correlate the psychosocial profile with the likelihood of undergoing bariatric surgery in patients enrolled in the preparation program of a Swiss reference center.

Methods All patients referred to an obesity center between January 1, 2016, and June 30, 2017, seeking a first bariatric procedure were included. Socio-demographic data, BMI, preoperative psychological and dietary evaluations were collected. Usually, the preoperative process lasts 1 year. Patients who left the preparation or who had not undergone surgery after more than 2 years of follow-up were considered withdrawers. Surgery completion predictors were reviewed with bivariate analysis and socio-demographic clusters established using the K-means method.

Results Out of a total of 221 patients, 99 (45%) patients had not undergone bariatric surgery 2 years after their first consultation. The patients were divided into four distinct socio-demographic clusters, among which a particularly deprived one. Criteria such as unfavorable psychological ($p < 0.001$) and dietary ($p < 0.001$) evaluations, and male gender ($p < 0.05$) were significantly associated with non-operation, unlike socio-demographic indicators and clusters ($p > 0.1$).

Conclusion Almost half of the patients starting a bariatric program are not operated on, which is related to an unfavorable psychological or dietary evaluation and to the male gender. This study also demonstrates that a significant share of patients combines several factors of social deprivation, without influencing the likelihood of surgery completion.

Level of evidence Level V: Descriptive study.

Keywords Bariatric surgery · Non-operation · Socio-demographic clusters

Introduction

Severe obesity is a metabolic disease and a well-known risk factor for multiple other chronic disorders [1]. It also presents an important societal dimension, as it is more common among deprived socio-economic subgroups of the population and constitutes a factor of social exclusion in developed countries [2].

Bariatric surgery remains the only effective and long-term treatment of severe obesity [3–7]. However, obesity surgery is still disregarded by many, including healthcare professionals [8]. Patients must overcome an important psychological stigma before deciding to consult a bariatric center, even though weight loss surgery is highly regulated. In Switzerland, among different criteria, we can mention a BMI ≥ 35 kg/m² with comorbidities and an unsuccessful non-operative treatment [9]. An adequate eating behavior and psychological stability are required for several months before surgery, imperatively supported by a multidisciplinary team approach. Nevertheless, numerous initially motivated patients do not achieve the preoperative process and do not benefit from the bariatric treatment. In weight loss intervention programs, the most common attrition reasons are practical difficulties, such as family or work problems,

Viviane Richard and Christof Stähli have equally contributed to the study.

✉ Viviane Richard
viviane.richard@etu.unige.ch

Extended author information available on the last page of the article

as well as living far from the center [10]. The socio-demographic profile of patients could be associated with such difficulties.

Socio-demographic characteristics of people with obesity have already been investigated in the general population [2, 11–13]. However, we do not clearly know how these characteristics are reflected in patients referred to a bariatric center for surgery. The presence of patterns in their distribution among patients and their possible influence on patients' trajectories in the bariatric project remains largely unknown. Furthermore, there is limited understanding of the determinants of preoperative attrition for bariatric surgery. Existing studies often consider medical and surgical treatments altogether and do not allow to identify specific determinants of surgical attrition. Additionally, socio-demographic factors are examined separately [14–16], although several characteristics may frequently be combined and associated with a specific outcome, as found in close fields [17, 18].

Better understanding attrition may help to improve access to surgery, but also cost-effectiveness by reducing the number of potentially useless preoperative medical interventions [14]. For example, in the studied center at least 20 consultations and 8 group sessions are routinely performed prior to surgery, resulting in a substantial cost which may not be fully beneficial if surgery is not performed. As reported by Bairdain and Samnaliev [19], the cost of the preoperative follow-up may be as high as 2081 USD. In a system with universal health insurance as the Swiss one, the cost is not paid directly by patients but remains borne by society.

The aim of the present study is to identify the profile of patients applying to a Swiss referral center for bariatric surgery, as well as factors contributing to attrition.

Methods

The institutional review board approved this retrospective cross-sectional study, and a signed informed consent was obtained from all patients.

The Obesity and Metabolic Diseases Center (OC) is part of a Swiss regional non-university teaching hospital in a peripheral setting. It offers a standard multidisciplinary preoperative and postoperative program for bariatric surgery candidates. After the initial introduction in the bariatric program by a surgeon and a dietitian, there are 8 theoretical and practical collective courses given by an endocrinologist, a dietitian, a psychologist, and a physiotherapist over approximately 6 months.

The evaluation process is then performed by the same team, consisting of at least three individual consultations with the dietitian and three consultations with the psychologist, consisting of qualitative and semi-directive clinical interviews. In addition to the pre-existing conditions,

all aspects discussed in the courses are reviewed with the patients. The psychological interview examines 4 aspects of the patients' history: cognitive, psychosocial, psychiatric, and weight evolution. The following surgery eligibility criteria are investigated: no current substance use, emotional stability, eating disorder management, understanding of the surgical procedure, as well as its potential consequences, and realistic weight loss expectation. Dietary evaluation focuses on the stability of the present eating disorder, weight stability during the process, a balanced relationship with food, and the implementation of behavior modifications towards the postoperative phase.

The operative indication and/or additional management recommendation is separately reported on a four-level scale by each the psychologist and the dietician:

- Favorable to surgery: there is no contra-indication.
- Favorable with close postoperative follow-up: there are no formal contra-indications but there is some fragility concerning dietary, psychological aspects or the patient's environment.
- Favorable with close preoperative follow-up: there is no formal contra-indication, but the dietary and psychological aspects have not been stable for long enough. A longer preparation is needed.
- Unfavorable at this stage: there is a formal contra-indication, for example, substance abuse, persistent eating disorders, unstable psychological situation or unwillingness to change lifestyle.

Based on each patient's course, operative decision-making is finally discussed collectively throughout an "obesity board meeting". Some patients with operative contraindications withdraw before this stage because they feel that they do not fulfill the surgery criteria. Therefore, it is delicate to distinguish if non-operation is due to self-withdrawal or medical contraindications. The preoperative program lasts about one year. Significantly longer preparations often reflect the need or wish for external follow-up, without definitive withdrawal from the OC.

All consecutive patients referred for primary bariatric surgery at the OC were retrospectively included from January 1, 2016, to June 30, 2017. Socio-demographic data such as age, gender, marital status, parenthood, country of birth, education level, and employment status, as well as BMI, preoperative psychological and dietary evaluations were manually extracted from patients' medical records in June 2019, with a hindsight of at least 2 years or until the patient's operation or dropout. For the present study, patients who had left the program or who had not undergone surgery after more than 2 years of follow-up were considered temporary or definitive dropouts for surgery. As non-operation reason may be complex and multifactorial, no distinction was made in this

study between self-withdrawal and contraindications. Due to the Swiss federal healthcare system and to the lack of a close alternative to the OC, it is unlikely that any of the patients got operated on in another center.

To group patients with similar socio-demographic characteristics and BMI, the K-means clustering method was performed. It is an unsupervised approach to group data in a specified number of clusters K , by minimizing the within-cluster variation. A cluster is randomly assigned to each observation and the centroid of each of these clusters is computed. Each observation is then reassigned to the closest centroid, using the Euclidian distance. These steps are iterated until the within-cluster variation is minimized. To avoid a suboptimal local optimum, the complete process was repeated 40 times with different start random assignment and the result with the smallest within-cluster variation was kept.

Differences between clusters and variables related to non-operation were identified using the chi-square tests, with a significance level set at $p < 0.05$. Should there be less than five observations in a category, a Fisher's exact chi-squared test was computed instead.

All analyses were performed with R-3.6.3.

Results

Patients' socio-demographic profiles and clusters

A total of 221 patients were included in the study. Mean age was 42 (range: 17–75) and 179 (81%) were female. Mean BMI was 41.8 (range: 32–67). The most frequently reported birth countries were Switzerland (54.4%) and Portugal (21.3%). Most patients were married (47.1%) or divorced/separated (22.2%) and had children (78.4%). 31.5% attended mandatory school only, 58% had an upper secondary education level and 10.5% had tertiary level. Altogether, 52.9% were professionally active (Table 1).

Using the above-mentioned variables, different numbers of clusters were tested from 3 to 6. There were no differences between these classifications towards the operation status. Given the clinical relevance of the results and their readability, the analysis of the 4 clusters was kept.

Patients' distribution into four distinct clusters based on socio-demographic variables ($p < 0.05$, except for BMI) is presented in Table 1. The clustering approach allowed to identify patients' subgroups with various socio-demographic profiles. Cluster 1 was mainly composed of young (mean age = 31.4 years old), single (90.5%) people without children (97.1%), who were born in Switzerland (63.3%). An important proportion had an upper secondary education (74.1%) and all students fell in this cluster. Clusters 2 and 3, respectively, regrouped men and women with similar profiles:

middle-aged married parents who were professionally active. Finally, cluster 4 was made of women with children. Compared to the rest of the patients, they tended to be more frequently born outside Switzerland (75.7%), divorced, or separated (32.4%) and with a mandatory education level (54.8%). Most of them were unemployed, 42.3% being housewives and 50.6% living on social insurances (disability, employment insurance or social aid). Psychological and dietary preoperative evaluations were not associated with clusters ($p > 0.1$; Table 1). A summary of the patients' typical profile is presented for each cluster in Table 2.

Surgery determinants

After an early dropout or a follow-up of at least 2 years, 99 (45%) patients did not undergo bariatric surgery. The standard multidisciplinary preoperative program lasted 12.4 months on average (standard deviation: 4.9; range: 3.0–29.4).

Psychological and dietary preoperative evaluations were highly associated with the operation status, the more favorable the evaluation, the more likely to get operated on ($p < 0.001$, Table 3). Indeed, unfavorable psychological evaluation concerned 65.5% of the non-operated patients, but only 3.6% of the operated ones. The same pattern was observed with dietary evaluations.

Gender was the only socio-demographic variable statistically related to surgery ($p < 0.05$), males being underrepresented among patients operated on. They represent 13.9% of the operated patients versus 25.3% of the non-operated ones. None of the clusters defined above were significantly associated with access to surgery (Table 3).

As a sensitivity analysis, multivariate models were also performed on a data subset without missing values. The main results (details not shown) were similar to the ones presented above, i.e. unfavorable psychological and dietary evaluations were highly associated with non-operation ($p < 0.001$), whereas demographic variables and clusters were not ($p > 0.1$).

Discussion

In this study, a 45% rate of surgical non-completion is found in a Swiss bariatric program with a hindsight of at least 2 years. Non-operation is highly associated with unfavorable preoperative psychological and dietary evaluations, and to a lesser extent with the male gender. Interestingly and somehow counterintuitively, socio-demographic characteristics are not related to the operation status.

Similar or slightly higher attrition rates are found elsewhere, such as 43% in Merrell et al. [20] or 50% in Sala et al. [21]. In comparison, Gill et al. [22] reported a much lower

Table 1 Descriptive and clustering analysis of patients in terms of socio-demographic and follow-up characteristics

| | All N=221 N | Proportion | | Cluster 1 ¹ N=42 | | Cluster 2 ¹ N=29 | | Cluster 3 ¹ N=79 | | Cluster 4 ¹ N=71 | | Fisher's exact test P value |
|--------------------------|-------------------|------------|------|--------------------------------|-------|--------------------------------|-------|-----------------------------|---|-----------------------------|--|-----------------------------------|
| | | % | % | % | % | % | % | % | % | | | |
| Age | | | | | | | | | | | | |
| 17–24 | 16/221 | 7.2 | 23.8 | 0.0 | 0.0 | 1.3 | 7.0 | 0.000 | | | | |
| 25–34 | 48/221 | 21.7 | 54.8 | 10.3 | 15.2 | 14.1 | | | | | | |
| 35–44 | 57/221 | 25.8 | 7.1 | 24.1 | 36.7 | 25.4 | | | | | | |
| 45–54 | 68/221 | 30.8 | 7.1 | 51.7 | 36.7 | 29.6 | | | | | | |
| 55 + | 32/221 | 14.5 | 7.1 | 13.8 | 10.1 | 23.9 | | | | | | |
| Gender | | | | | | | | | | | | |
| Female | 179/221 | 81.0 | 69.0 | 0.0 | 100.0 | 0.000 | | | | | | |
| Male | 42/221 | 19.0 | 31.0 | 100.0 | 0.0 | | | | | | | |
| Marital status | | | | | | | | | | | | |
| Single | 62/221 | 28.1 | 90.5 | 6.9 | 12.7 | 16.9 | 0.000 | | | | | |
| Married | 104/221 | 47.1 | 4.8 | 69.0 | 60.8 | 47.9 | | | | | | |
| Divorced/separated | 49/221 | 22.2 | 4.8 | 20.7 | 22.8 | 32.4 | | | | | | |
| Widowed | 6/221 | 2.7 | 0.0 | 3.4 | 3.8 | 2.8 | | | | | | |
| Parenthood | | | | | | | | | | | | |
| Yes | 149/190 | 78.4 | 2.9 | 90.0 | 93.3 | 98.4 | 0.000 | | | | | |
| No | 41/190 | 21.6 | 97.1 | 10.0 | 6.7 | 1.6 | | | | | | |
| Country of birth | | | | | | | | | | | | |
| Switzerland | 92/169 | 54.4 | 63.3 | 52.4 | 63.5 | 40.0 | 0.034 | | | | | |
| Portugal | 36/169 | 21.3 | 10.0 | 14.3 | 23.8 | 27.3 | | | | | | |
| Other (21 countries) | 41/169 | 24.3 | 26.7 | 33.3 | 12.7 | 32.7 | | | | | | |
| Education level | | | | | | | | | | | | |
| Mandatory | 45/143 | 31.5 | 11.1 | 25.0 | 25.9 | 54.8 | 0.007 | | | | | |
| Upper secondary | 83/143 | 58.0 | 74.1 | 62.5 | 63.8 | 38.1 | | | | | | |
| Tertiary | 15/143 | 10.5 | 14.8 | 12.5 | 10.3 | 7.1 | | | | | | |
| Employment status | | | | | | | | | | | | |
| Employed | 117/221 | 52.9 | 52.4 | 65.5 | 94.9 | 1.4 | 0.000 | | | | | |
| Stay at home | 31/221 | 14.0 | 0.0 | 0.0 | 1.3 | 42.3 | | | | | | |
| Disability insurance | 24/221 | 10.9 | 9.5 | 10.3 | 1.3 | 22.5 | | | | | | |
| Social aid | 19/221 | 8.6 | 2.4 | 10.3 | 0.0 | 21.1 | | | | | | |
| Employment insurance | 16/221 | 7.2 | 14.3 | 10.3 | 2.5 | 7.0 | | | | | | |
| At school | 7/221 | 3.2 | 16.7 | 0.0 | 0.0 | 0.0 | | | | | | |
| Retired | 7/221 | 3.2 | 4.8 | 3.4 | 0.0 | 5.6 | | | | | | |

Table 1 (continued)

| | All N=221 N | Proportion | | Cluster 1 ¹ N=42 | | Cluster 2 ¹ N=29 | | Cluster 3 ¹ N=79 | | Cluster 4 ¹ N=71 | | Fisher's exact test P value |
|---------------------------------|-------------------|------------|------|--------------------------------|------|--------------------------------|---|-----------------------------|---|-----------------------------|-------|-----------------------------------|
| | | % | % | % | % | % | % | % | % | | | |
| BMI (kg/m²) | | | | | | | | | | | | |
| 30–34 | 7/220 | 3.2 | 2.4 | 6.9 | 2.5 | 2.9 | | | | | 0.088 | |
| 35–39 | 75/220 | 34.1 | 21.4 | 31.0 | 34.2 | 42.9 | | | | | | |
| 40–44 | 82/220 | 37.3 | 38.1 | 27.6 | 48.1 | 28.6 | | | | | | |
| 45–49 | 40/220 | 18.2 | 28.6 | 24.1 | 11.4 | 17.1 | | | | | | |
| 50 + | 16/220 | 7.3 | 9.5 | 10.3 | 3.8 | 8.6 | | | | | | |
| Psychological evaluation | | | | | | | | | | | | |
| Favorable | 20/139 | 14.4 | 17.9 | 0.0 | 17.5 | 12.2 | | | | | 0.806 | |
| Close postop follow-up | 37/139 | 26.6 | 25.0 | 23.1 | 24.6 | 31.7 | | | | | | |
| Close preop follow-up | 59/139 | 42.4 | 35.7 | 61.5 | 40.4 | 43.9 | | | | | | |
| Unfavorable | | | | | | | | | | | | |
| Dietary evaluation | | | | | | | | | | | | |
| Favorable | 17/99 | 17.2 | 15.8 | 8.3 | 12.5 | 25.0 | | | | | 0.326 | |
| Close postop follow-up | 31/99 | 31.3 | 31.6 | 16.7 | 37.5 | 30.6 | | | | | | |
| Close preop follow-up | 41/99 | 41.4 | 42.1 | 75.0 | 31.3 | 38.9 | | | | | | |

^aDefined with socio-demographic variables and BMI (upper lines, without psychological and dietary evaluations)

Table 2 Main characteristics of the four clusters defined by means of socio-demographic variables and BMI

| Cluster | Patients number (%) | Characteristics | |
|---------|---------------------|---|--|
| | | Demographics | Education and employment |
| 1 | 42 (19%) | Young women and men Single Without children Born in Switzerland | Employed and students Upper secondary education |
| 2 | 29 (13%) | Middle-aged men Married With children Born in Switzerland and abroad | Employed Upper secondary education |
| 3 | 79 (36%) | Middle-aged women Married With children Born in Switzerland | Employed Upper secondary education |
| 4 | 71 (32%) | Middle-aged women Married and divorced With children Born abroad | Unemployed Mandatory education |

rate of 11.9% in the surgical branch of a weight loss management program. Differences in the referring process, inclusion criteria in the bariatric program, or requirements to be met prior to surgery may account for these heterogeneous results.

The highly significant association between unfavorable psychological and dietary evaluations and non-operation is in line with other studies showing that patients presenting with depression [23], binge-eating disorder [24], history of substance use or anxiety [25] are less likely to get operated on. Selecting psychologically stable patients with an appeased eating behavior is essential as it leads to better surgical outcomes in terms of weight loss and adaptation to new conditions [26]. Currently, individual consultations with the psychologist often occur at the stage of operative decision-making in the OC. Shifting this evaluation to an earlier stage in the program may help to more quickly detect people at risk for attrition and to put forward a tailored process.

Preoperative evaluations are strong determinants of bariatric surgery, but not absolute ones. In the present case, the operation is exceptionally definitively denied to patients because of these evaluations. Rather, at-risk patients are required to follow a longer preoperative and personalized preparation, as explained by Pawlow et al. [24]. Patients may drop out at this stage because of the delay or additional efforts required. It shows that attrition can be more complex than a simple one-sided decision and it is often the result of multiple factors and actors.

In addition, as found elsewhere [16, 27], a larger proportion of female patients commit all the way to the operation, as compared to males. An explanation may be that women suffer from greater social and professional consequences of obesity, which can drive them to more actively trying to lose weight [28]. In line with that hypothesis, Libeton et al. [29] found that one of the main motivations of women to undergo bariatric surgery is to better their self-image, whereas men

rather aim to improve their health conditions. Consequently, to lower male attrition, health benefits from bariatric surgery could be emphasized, and additional information provided.

In the present study, age and BMI are not associated with surgery completion, as found by Sala et al. [21]. Conversely, Diamant et al. [27] identified that a BMI > 40 kg/m² and age > 60 years were predictors of attrition. Such discrepancies may be due to different referring or preparation processes. Each bariatric center has its own program and comparisons are delicate to draw. Very interestingly, the analyses do not reveal any relationship between non-operation and socio-demographic characteristics (except gender) or above-defined socio-demographic clusters. It could be expected that a lower educational or social position would be a barrier, as found by Doumouras et al. [16]. However, the results show that once patients have been included in the preparation program, bariatric surgery is accessible regardless of the social situation. This result may be conditional to a setting with a dedicated multidisciplinary care and the reimbursement of bariatric surgery by a universal healthcare insurance as in the present case. Access to surgery does not seem to be associated with a specific demographic profile but rather with psychological problems and related dietary impacts.

Although unrelated to the operation status, the present study shows that beyond their weight condition, patients seeking bariatric surgery represent a very specific population, mainly made up of middle-aged women with children. In addition, an important proportion is of foreign origin, which often goes hand in hand with less favorable socio-economic situations.

As obesity is more prevalent among people with a low socio-economic status [2], it is expected to find a significant share of OC patients experiencing difficult social situations. The cluster analysis further demonstrates that these characteristics vary widely among patients. Very different life

Table 3 Operation status according to socio-demographic and follow-up variables

| | Operated on <i>N</i> =122 | | Non-operated on <i>N</i> =99 | | Chi ² /Fisher's exact test [*] <i>P</i> value |
|--------------------------|------------------------------|------|---------------------------------|------|--|
| | <i>N</i> | % | <i>N</i> | % | |
| Age (years) | | | | | |
| 17–24 | 4/122 | 3.3 | 12/99 | 12.1 | 0.152 |
| 25–34 | 27/122 | 22.1 | 21/99 | 21.2 | |
| 35–44 | 34/122 | 27.9 | 23/99 | 23.2 | |
| 45–54 | 40/122 | 32.8 | 28/99 | 28.3 | |
| 55+ | 17/122 | 13.9 | 15/99 | 15.2 | |
| Gender | | | | | |
| Female | 105/122 | 86.1 | 74/98 | 74.7 | 0.039 |
| Male | 17/122 | 13.9 | 25/98 | 25.3 | |
| Marital status | | | | | |
| Single | 32/122 | 26.2 | 30/98 | 30.3 | 0.701 |
| Married | 61/122 | 50.0 | 43/98 | 43.4 | |
| Divorced/separated | 25/122 | 20.5 | 24/98 | 24.2 | |
| Widowed | 4/122 | 3.3 | 2/98 | 2.0 | |
| Parenthood | | | | | |
| Yes | 92/117 | 78.6 | 57/73 | 78.1 | 0.999 |
| No | 25/117 | 21.4 | 16/73 | 21.9 | |
| Country of birth | | | | | |
| Switzerland | 63/113 | 55.8 | 29/56 | 51.8 | 0.651 |
| Portugal | 25/113 | 22.1 | 11/56 | 19.6 | |
| Other (21 countries) | 25/113 | 22.1 | 16/56 | 28.6 | |
| Education | | | | | |
| Mandatory school | 36/110 | 32.7 | 9/33 | 27.3 | 0.595 |
| Upper secondary level | 64/110 | 58.2 | 19/33 | 57.6 | |
| Tertiary level | 10/110 | 9.1 | 5/33 | 15.2 | |
| Employment status | | | | | |
| Employed | 68/122 | 55.7 | 49/99 | 49.5 | 0.174 |
| Stay at home | 20/122 | 16.4 | 11/99 | 11.1 | |
| Disability insurance | 10/122 | 8.2 | 14/99 | 14.1 | |
| Social aid | 7/122 | 5.7 | 12/99 | 12.1 | |
| Employment insurance | 11/122 | 9.0 | 5/99 | 5.1 | |
| At school | 2/122 | 1.6 | 5/99 | 5.1 | |
| Retired | 4/122 | 3.3 | 3/99 | 3.0 | |
| BMI (kg/m ²) | | | | | |
| 30–34 | 2/122 | 1.6 | 5/98 | 5.1 | 0.152 |
| 35–39 | 38/122 | 31.1 | 37/98 | 37.8 | |
| 40–44 | 50/122 | 41.0 | 32/98 | 32.7 | |
| 45–49 | 24/122 | 19.7 | 16/98 | 16.3 | |
| 50+ | 8/122 | 6.6 | 8/98 | 8.2 | |
| Cluster | | | | | |
| Cluster 1 | 21/122 | 17.2 | 21/99 | 21.2 | 0.189 |
| Cluster 2 | 13/122 | 10.7 | 16/99 | 16.2 | |
| Cluster 3 | 51/122 | 41.8 | 28/99 | 28.3 | |
| Cluster 4 | 37/122 | 30.3 | 34/99 | 34.3 | |

circumstances must be considered. A substantial share of patients seems to have a stable social situation, for instance, cluster 3, which is made up of employed women with upper

secondary degrees. On the other hand, women included in cluster 4 combine factors of potential deprivation such as elementary education, unemployment, foreign origin, and

Table 3 (continued)

| | Operated on <i>N</i> =122 | Proportion | Non-operated on <i>N</i> =99 | Proportion | Chi ² /Fisher's exact test [*] <i>P</i> value |
|--------------------------|------------------------------|------------|---------------------------------|------------|---|
| | <i>N</i> | % | <i>N</i> | % | |
| Psychological evaluation | | | | | |
| Favorable | 20/110 | 18.2 | 0/29 | 0.0 | 0.000 |
| Close postop follow-up | 35/110 | 31.8 | 2/29 | 6.9 | |
| Close preop follow-up | 51/110 | 46.4 | 8/29 | 27.6 | |
| Unfavorable | 4/110 | 3.6 | 19/29 | 65.5 | |
| Dietary evaluation | | | | | |
| Favorable | 16/75 | 21.3 | 1/24 | 4.2 | 0.000 |
| Close postop follow-up | 26/75 | 34.7 | 5/24 | 20.8 | |
| Close preop follow-up | 32/75 | 42.7 | 9/24 | 37.5 | |
| Unfavorable | 1/75 | 1.3 | 9/24 | 37.5 | |

*Regular chi-square tests are performed by default. Should there be less than five observations in a category, a Fisher's exact chi-squared test is computed instead

a higher divorce rate. They represent more than 30% of the total and appear to be a particularly fragile population, which does not limit their access to surgery in the OC. In an institution proposing both medical and surgical obesity treatments, Martin [30] similarly concludes that patients suffering from obesity are a heterogeneous population in terms of socio-demographic characteristics, as also demonstrated for personality traits [31].

The four cluster classification cannot be used to detect patients at risk for surgical non-completion in the OC. However, it can be valuable as an additional tool for psychologists to help understand the patient background and offer a tailored therapeutic approach. Various measures are possible to provide patients with optimal care, including specific health insurance claims, direct collaboration with social workers, appointment times adapted to childcare, or translation of documents into their native languages. The presented clusters are based on the OC patients and are likely to vary in other bariatric centers according to regional specificities. The same methodology can be applied to find locally relevant and useful clusters. Further multicenter research is necessary to explore common cluster patterns throughout bariatric centers.

Strength and limits

The main limitation of this study lies in the high percentage of missing values and its non-random distribution, missing values being more common among non-operated patients (Fisher's exact test; $p < 0.05$). Data were extracted from consultation reports. However, non-operated patients may drop out before getting the entire gamut of consultations and their medical record was less complete as compared to patients following the whole program. However, when performed

only in patients without missing values, the analysis of non-operation factors retrieved similar results to the ones presented here. It was decided to keep all patients to remain coherent with the retrospective study design and to allow for a more informative clustering. Another limit is the use of non-standardized dietary and psychological evaluations. Despite that, the current study is able to show the importance of these appraisals in clinical practice. One of the key strengths is the implementation of a clustering approach to identifying subgroups of patients seeking bariatric surgery.

What is already known on this subject?

Little is known about the socio-demographic profile of persons seeking bariatric surgery, as well as its potential association to non-operation, especially in Europe. Better understanding non-operation patterns may help to prevent it and to improve cost-effectiveness.

What this study adds?

This study is one of the only ones which examines the association of education and employment status with bariatric attrition, and to propose a socio-demographic cluster analysis to investigate the profiles of candidates. It shows that under specific conditions, bariatric surgery is accessible regardless of socio-demographic condition and that patient socio-demographic profile is very heterogeneous. Additionally, the literature on bariatric surgery attrition remains scarce, and more particularly so in Europe, and this study contributes to filling this gap by giving an insight into this topic in Switzerland.

Conclusion

This study shows that with a hindsight of at least 2 years, almost half of the patients starting a bariatric approach in the OC do not get operated on, which is related to unfavorable psychological or dietary evaluations, as well as to the male gender. It also demonstrates that a significant share of OC patients combines factors of social deprivation, which has no impact on surgery completion under conditions of multidisciplinary care and universal health insurance. Such framework conditions seem important and should be fostered to ease bariatric surgery access for fragile populations. Based on this article's results, the OC team is currently considering the reshaping of bariatric pathways and approaches. For instance, the individual psychological assessment could be shifted to an earlier stage in the program and the cluster classification could be used as a complementary tool for professionals.

Acknowledgements We especially thank Samuel Colin from the University of Geneva for his precious statistical inputs. Authors also are grateful to Coralie Khellouf, Solenne Nguyen and Julie Ballester, OC secretaries, for their dedicated work and to Jean-Luc Richard, Guy Temporal and Christopher Burel for their kind external lecture and assistance in the language revision of the manuscript. We acknowledge that reprints will not be available from the author(s).

Author contributions All authors contributed to the study conception and design. Material preparation and data collection were done by Christof Stähli, Alend Saadi and Viviane Richard. Analyses were performed by Guillaume Giudicelli, Christof Stähli, Alend Saadi and Viviane Richard. The first draft of the manuscript was written by Viviane Richard. All authors critically revised the manuscript and approved the final version.

Funding Open Access funding provided by Université de Genève.

Availability of data and material Not applicable.

Code availability Not applicable.

Declarations

Conflict of interest Michele Diana reports being a Member of the Advisory Board of Diagnostic Green and grants from ARC Foundation for Cancer Research, outside the submitted work. The other authors report no conflict of interest.

Ethics approval The institutional review board approved this study.

Consent to participate A signed informed consent was obtained from all patients.

Consent for publication All authors gave their consent for the submission of the manuscript.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long

as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.


References

1. Jastreboff AM, Kotz CM, Kahan S et al (2019) Obesity as a Disease: The Obesity Society 2018 Position Statement. *Obesity* 27:7–9. <https://doi.org/10.1002/oby.22378>
2. Gallus S, Lugo A, Murisic B et al (2015) Overweight and obesity in 16 European countries. *Eur J Nutr* 54:679–689. <https://doi.org/10.1007/s00394-014-0746-4>
3. Billeter AT, Senft J, Gotthardt D et al (2016) Combined Non-alcoholic Fatty Liver Disease and Type 2 Diabetes Mellitus: Sleeve Gastrectomy or Gastric Bypass? A Controlled Matched Pair Study of 34 Patients. *Obes Surg* 26:1867–1874. <https://doi.org/10.1007/s11695-015-2006-y>
4. Nickel F, Schmidt L, Bruckner T et al (2017) Gastrointestinal Quality of Life Improves Significantly After Sleeve Gastrectomy and Roux-en-Y Gastric Bypass—a Prospective Cross-Sectional Study Within a 2-Year Follow-up. *Obes Surg* 27:1292–1297. <https://doi.org/10.1007/s11695-016-2464-x>
5. Maciejewski ML, Arterburn DE, Van Scoyoc L et al (2016) Bariatric Surgery and Long-term Durability of Weight Loss. *JAMA Surg* 151:1046–1055. <https://doi.org/10.1001/jamasurg.2016.2317>
6. Schauer PR, Bhatt DL, Kirwan JP et al (2017) Bariatric Surgery versus Intensive Medical Therapy for Diabetes — 5-Year Outcomes. *N Engl J Med* 376:641–651. <https://doi.org/10.1056/NEJMoa1600869>
7. Mingrone G, Panunzi S, De Gaetano A et al (2015) Bariatric–metabolic surgery versus conventional medical treatment in obese patients with type 2 diabetes: 5 year follow-up of an open-label, single-centre, randomised controlled trial. *The Lancet* 386:964–973. [https://doi.org/10.1016/S0140-6736\(15\)00075-6](https://doi.org/10.1016/S0140-6736(15)00075-6)
8. Vartanian LR, Fardouly J (2013) The stigma of obesity surgery: negative evaluations based on weight loss history. *Obes Surg* 23:1545–1550. <https://doi.org/10.1007/s11695-013-0918-y>
9. Fried M, Yumuk V, Oppert JM et al (2014) Interdisciplinary European Guidelines on Metabolic and Bariatric Surgery. *Obes Surg* 24:42–55. <https://doi.org/10.1007/s11695-013-1079-8>
10. Grossi E, Dalle Grave R, Mannucci E et al (2006) Complexity of attrition in the treatment of obesity: clues from a structured telephone interview. *Int J Obes* 30:1132–1137. <https://doi.org/10.1038/sj.ijo.0803244>
11. Newton S, Braithwaite D, Akinyemiju TF (2017) Socio-economic status over the life course and obesity: Systematic review and meta-analysis. *PLoS ONE* 12:e0177151. <https://doi.org/10.1371/journal.pone.0177151>
12. Marques A, Peralta M, Naia A et al (2018) Prevalence of adult overweight and obesity in 20 European countries, 2014. *Eur J Public Health* 28:295–300. <https://doi.org/10.1093/eurpub/ckx143>
13. Ogden CL, Fakhouri TH, Carroll MD, et al (2017) Prevalence of Obesity Among Adults, by Household Income and Education — United States, 2011–2014. *MMWR Morb Mortal Wkly Rep* 66:1369–1373. <https://doi.org/10.15585/mmwr.mm6650a1>
14. Moroshko I, Brennan L, O'Brien P (2011) Predictors of dropout in weight loss interventions: a systematic review of the literature.

- Obes Rev 12:912–934. <https://doi.org/10.1111/j.1467-789X.2011.00915.x>
15. Grave RD, Calugi S, Molinari E et al (2005) Weight loss expectations in obese patients and treatment attrition: An observational multicenter study. *Obes Res* 13:1961–1969. <https://doi.org/10.1038/oby.2005.241>
 16. Doumouras AG, Lee Y, Babe G et al (2020) The hidden cost of an extensive preoperative work-up: predictors of attrition after referral for bariatric surgery in a universal healthcare system. *Surg Endosc* 34:988–995. <https://doi.org/10.1007/s00464-019-06894-9>
 17. Frank LD, Kerr J, Sallis JF et al (2008) A hierarchy of sociodemographic and environmental correlates of walking and obesity. *Prev Med* 47:172–178. <https://doi.org/10.1016/j.ypmed.2008.04.004>
 18. Conroy RM, Golden J, Jeffares I et al (2010) Boredom-proneness, loneliness, social engagement and depression and their association with cognitive function in older people: A population study. *Psychol Health Med* 15:463–473. <https://doi.org/10.1080/13548506.2010.487103>
 19. Bairdain S, Samnaliev M (2015) Cost-effectiveness of Adolescent Bariatric Surgery *Cureus* 7:e248–e248. <https://doi.org/10.7759/cureus.248>
 20. Merrell J, Ashton K, Windover A, Heinberg L (2012) Psychological risk may influence drop-out prior to bariatric surgery. *Surg Obes Relat Dis* 8:463–469. <https://doi.org/10.1016/j.soard.2012.01.018>
 21. Sala M, Haller DL, Laferrère B et al (2017) Predictors of Attrition Before and After Bariatric Surgery. *Obes Surg* 27:548–551. <https://doi.org/10.1007/s11695-016-2510-8>
 22. Gill RS, Karmali S, Hadi G et al (2012) Predictors of attrition in a multidisciplinary adult weight management clinic. *Can J Surg J Can Chir* 55:239–243. <https://doi.org/10.1503/cjs.035710>
 23. Benediktsdottir A, Halldorsson TI, Bragadottir GJ et al (2016) Predictors of dropout and bariatric surgery in Icelandic morbidly obese female patients. *Obes Res Clin Pract* 10:63–69. <https://doi.org/10.1016/j.orcp.2015.03.009>
 24. Pawlow LA, O'Neil PM, White MA, Byrne TK (2005) Findings and outcomes of psychological evaluations of gastric bypass applicants. *Surg Obes Relat Dis Off J Am Soc Bariatr Surg* 1:523–527; discussion 528–529. <https://doi.org/10.1016/j.soard.2005.08.007>
 25. Sockalingam S, Cassin S, Crawford SA et al (2013) Psychiatric Predictors of Surgery Non-completion Following Suitability Assessment for Bariatric Surgery. *Obes Surg* 23:205–211. <https://doi.org/10.1007/s11695-012-0762-5>
 26. Aubert N, Lyon-Pagès I, Carrard I et al (2010) The predictive value of psychological assessment of candidates for gastric bypass: A medical chart review. *Eur J Psychiatry* 24:114–123. <https://doi.org/10.4321/S0213-61632010000200006>
 27. Diamant A, Milner J, Cleghorn M et al (2014) Analysis of Patient Attrition in a Publicly Funded Bariatric Surgery Program. *J Am Coll Surg* 219:1047–1055. <https://doi.org/10.1016/j.jamcollsurg.2014.08.003>
 28. Belle SH, Berk PD, Chapman W et al (2013) Baseline characteristics of participants in the Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) study. *Surg Obes Relat Dis Off J Am Soc Bariatr Surg* 9:926–935. <https://doi.org/10.1016/j.soard.2013.01.023>
 29. Libeton M, Dixon JB, Laurie C, O'Brien PE (2004) Patient Motivation for Bariatric Surgery: Characteristics and Impact on Outcomes. *Obes Surg* 14:392–398. <https://doi.org/10.1381/096089204322917936>
 30. Martin LF (1999) The biopsychosocial characteristics of people seeking treatment for obesity. *Obes Surg* 9:235–243. <https://doi.org/10.1381/09608929976553098>
 31. Rydén A, Sullivan M, Torgerson JS et al (2003) Severe obesity and personality: a comparative controlled study of personality traits. *Int J Obes* 27:1534–1540. <https://doi.org/10.1038/sj.ijo.0802460>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Authors and Affiliations

Viviane Richard^{1,6}  · Christof Stähli¹ · Guillaume Giudicelli^{1,7} · Marc Daniel Worreth^{1,2} · Nicole Krähenbühl² · Emilie Greiner² · Chrysoula Papastathi² · Michele Diana^{1,3,4} · Alend Saadi^{1,2,5}

Christof Stähli
christof.stahli@rhne.ch

Guillaume Giudicelli
guillaume.giudicelli@hcuge.ch

Marc Daniel Worreth
marc.worreth@rhne.ch

Nicole Krähenbühl
nicole.krahenbuhl@rhne.ch

Emilie Greiner
emilie.greiner@rhne.ch

Chrysoula Papastathi
chrysoula.papastathi@rhne.ch

Michele Diana
michele.diana@ircad.fr

Alend Saadi
alend.saadi@rhne.ch

¹ Surgery Department, Neuchâtel Hospital, Neuchâtel, Switzerland

² Obesity and Metabolic Diseases Centre, Neuchâtel Hospital, Neuchâtel, Switzerland

³ IRCAD, Research Institute Against Digestive Cancer, Strasbourg, France

⁴ Surgery Department, Strasbourg University Hospital, Strasbourg, France

⁵ Faculty of Biology and Medicine, University of Lausanne, Lausanne, Switzerland

⁶ Service of Populational Epidemiology, Geneva University Hospital, Geneva, Switzerland

⁷ Visceral Surgery Service, Geneva University Hospital, Geneva, Switzerland