Review

Evaluation of Dietary Assessment Tools Used in Bariatric Population

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Abstract: Severe obesity is associated with major health issues and bariatric surgery is still the only treatment to offer significant and durable weight loss. Assessment of dietary intakes is an important component of the bariatric surgery process. Objective: To document the dietary assessment tools that have been used with patients targeted for bariatric surgery and patients who had bariatric surgery and explore the extent to which these tools have been validated. Methods: A literature search was conducted to identify studies that used a dietary assessment tool with patients targeted for bariatric surgery or who had bariatric surgery. Results: 108 studies were included. Among all studies included, 27 used a dietary assessment tool that had been validated either as part of the study per se (n = 11) or in a previous study (n = 16). Every tool validated per se in the cited studies was validated among a bariatric population, while none of the tools validated in previous studies were validated in this population. Conclusion: Few studies in bariatric populations used a dietary assessment tool that had been validated in this population. Additional studies are needed to develop valid and robust dietary assessment tools to improve the quality of nutritional studies among bariatric patients.

Keywords: obesity; dietary assessment tool; 24 h dietary recall; food frequency questionnaire; food record; bariatric surgery

1. Introduction

Obesity is a common, complex chronic disease and its prevalence has increased over the past several years, making it a major public health concern [1]. More importantly, the prevalence of severe obesity (BMI ≥ 35 kg/m2) has increased dramatically in Canada [2]. Severe obesity is associated with major health issues such as an increased risk of hypertension, type 2 diabetes, sleep apnea and cancer [2]. Bariatric surgery is the only treatment for severe obesity to offer significant and durable weight loss as well as improvement of metabolic diseases [3]. Multiple types of surgery exist and are usually classified as restrictive, malabsorptive or mixed-procedures. Restrictive surgery limits the amount of food consumed by reducing stomach size, while malabsorptive surgery limits nutrient absorption by bypassing or reorganizing parts of the small intestine. Mixed-procedures, the most common surgeries, combine both gastric restriction and intestinal malabsorption [4,5]. Assessment of dietary intakes and eating behaviors are important components of the bariatric surgery process especially after surgery, since diet quality of bariatric patients is most likely to impact their risk of developing nutritional deficiencies [6] and their food preferences and choices could impact the success of their weight loss [7].
Many dietary assessment tools are used in nutritional research, especially self-report tools because they are often easier to use and less expensive as opposed to using controlled feeding environments, direct observation or measurements of biomarkers. The most common self-reported tools are food records (FR), 24-h dietary recalls (24HR) and food frequency questionnaires (FFQ). Over the last years, these tools have been adapted for a web-based use, such as self-administered web-based 24HR [8,9] or a web-based FFQ [10,11], to increase cost-efficiency and therefore the applicability to large cohort studies. The FR is a dietary assessment tool where respondents have to report all the foods and beverages consumed during the current day with as many details as possible (portion size, brand, method of cooking, time of the day, location of the eating occasion, etc.), for a variable number of days (often between 3 and 7) [12]. The 24HR consists of listing detailed information about everything the respondent ate and drank from midnight to midnight the previous day, or over the past 24-h period [12]. Finally, FFQ is a fixed-sequence questionnaire based on a predetermined series of foods and beverages consumed over a given period of time, which can be the previous week, month or year. The number and size of portions are often asked subsequently [12]. Of all these dietary assessment tools, the 24HR has been hypothesized as the least biased dietary assessment tool, since FR is more associated to reactivity biases such as a tendency to modify the usual diet for a more socially desirable manner or to simplify the recording task, and FFQ is known to encompass more important systematic biases than 24HR (does not capture the entire diet due to difficulty of the recall task) [12].

One reason explaining the difficulty to select the most appropriate dietary assessment tool with patients targeted for bariatric surgery and patients who had bariatric surgery is the relative lack of validation of these tools within those specific populations. Validity of an instrument is the degree to which an instrument measures what it is supposed to measure [12]. To determine the validity of an instrument, it is often compared with another instrument measuring the same concept and known to be accurate or considered as a gold standard [12]. Validation of dietary assessment is conducted to determine how accurately self-report instruments measure true dietary intakes [13]. It is crucial to develop and use tools that provide an accurate and precise measure of dietary intakes to optimize treatment and the nutritional care provided to patients targeted for or who had bariatric surgery [6,14]. Moreover, as patients who have undergone bariatric surgery have a higher risk of developing nutritional deficiencies [6], it is also essential to select dietary assessment tools validated for global intakes, particularly protein intakes since it is the major macronutrient deficiency after bariatric surgery [14,15].

The aim of this review was to document the dietary assessment tools that have been used in research involving patients targeted for bariatric surgery and patients who had bariatric surgery, and to explore the extent to which these tools have been validated.

2. Methods

2.1. Search Strategy

A literature search was conducted for all articles published on Pubmed up to January 2021 to identify studies that used dietary assessment tool with patients targeted for bariatric surgery or who had bariatric surgery. The search strategy was done using this keywords combination: “food intake”[All Fields] OR “food intake evaluation”[All Fields] OR “dietary intake”[All Fields] OR “dietary intake evaluation”[All Fields] OR “dietary assessment”[All Fields] OR “dietary assessment evaluation” [All Fields] OR “food assessment” [All Fields] OR “food assessment evaluation” [All Fields] AND bariatric [All Fields].

2.2. Selection of Studies

The literature search was performed independently by three authors (G.B.M., M.L., V.L.) and included all studies published on Pubmed up to 2021. Studies were found and retained in three stages: (i) the first stage was a screening done directly on Pubmed according to the title and abstract, (ii) the second one was the complete reading of the articles, and (iii) the third stage was a screening of the references of the retained articles. Inclusion and exclusion
criteria that were used are presented in Table 1. Only original studies were included in this review, based on the inclusion and exclusion criteria.

**Table 1. Inclusion and exclusion criteria.**

| Inclusion Criteria                              | Exclusion Criteria                                      |
|-----------------------------------------------|--------------------------------------------------------|
| (i) Population: \( n \geq 10 \)               | (i) Animal studies                                      |
| (ii) Adult population                         | (ii) Studies evaluating disorders only                  |
| (iii) Bariatric population (pre and post       | (iii) Case report                                       |
| surgery)                                      |                                                         |
| (iv) Use of a dietary assessment tool         | (iv) Review                                             |
| (v) Original research in English or French    | (v) Studies analyzing a cohort already included in the present review |
|                                              | (vi) Studies related to pregnancy                       |

2.3. Data Extraction

The following data were extracted by three authors (M.L., G.B.M., V.D.-L.) for each study: (a) bibliographical data (author, publication year, country); (b) sample characteristics (sample size, type of surgery, mean and standard deviation (SD) for age, sex and body mass index); (c) study design features (objective, study design and dietary assessment tool); (d) outcomes (self-reported energy and nutrient intakes, information on the validity of the dietary assessment tool, if available) (Table 2). Information regarding the validity of the dietary assessment tool was also extracted, such as the reference method used for validation, the population in which the validation has been performed, and information about the validation process (Table 3).
Table 2. Exhaustive description of included articles.

| Study                        | Year  | Country  | PMID      | Population | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design |
|------------------------------|-------|----------|-----------|------------|--------------------|--------------|---------------------------------------------------------------------------|--------------|
| Al Assal et al. [16]         | 2020  | Brazil   | 31973130  | 25         | 45.8 ± 7.9         | 100% women   | 46.4 ± 5.5 Food record (7 days) None RYGB Assess the gut microbiota profile before and after RYGB and the correlation with food intake and postoperative type 2 diabetes remission. Evaluate the use of digital food photography in comparison to conventional methods among patients after sleeve gastrectomy. Compare GB patients experiencing suboptimal weight loss or significant weight regain with successful controls, regarding postoperative food intake, eating behavior, physical activity, and psychometrics. | Prospective  |
| Al-Ozairi et al. [17]        | 2019  | Kuwait   | 30756296  | 50         | 38.8 ± 9.1         | 84% women    | 29.2 ± 6.2 Photo-assisted diet capture method Yes SG Evaluate the use of digital food photography in comparison to conventional methods among patients after sleeve gastrectomy. | Cross-sectional |
| Amundsen et al. [18]         | 2017  | Norway   | 27914028  | 49         | 46                 | 82% women    | 44.1 FFQ Yes GB Compare GB patients experiencing suboptimal weight loss or significant weight regain with successful controls, regarding postoperative food intake, eating behavior, physical activity, and psychometrics. | Case-control  |
| Andersen and Larsen [19]     | 1989  | Denmark  | 2556911   | 18         | 35                 | 89% women    | N/D Food record (7 days) None Gastroplasty Evaluate diet compliance and nutritional safety. | Longitudinal  |
| Anderson et al. [20]         | 2007  | United-| 17557983  | 84         | AA: 41 ± 10; white: 43 ± 10 | 76% women | AA: 55 ± 10; white: 53 ± 11 Food record (N/D) None RYGB Compare weight loss between AA and white severely obese patients after RYGB and examined differences in dietary intake and cardiovascular risk factors before and after weight loss. Examine the accomplishment of the recommended protein intake, and the influence of protein intake on free fat mass and protein status following bariatric surgery. | Retrospective |
| Andreu et al. [21]           | 2010  | Spain    | 20820937  | 101        | 43.2               | 75% women    | 47.7 Food record (3 days) None RYGB (66%) or SG (34%) Examine the accomplishment of the recommended protein intake, and the influence of protein intake on free fat mass and protein status following bariatric surgery. | Longitudinal  |
| Anthone et al. [22]          | 2003  | United-| 14530733  | 701        | 42.3 ± 10.4        | 78% women    | 52.3 ± 9.6 Questionnaire None DS Determine the safety and efficacy of the duodenal switch procedure as surgical treatment of morbid obesity. | Prospective  |
| Study                          | Year | Country          | PMID    | Population | Dietary Assessment | Surgery Type | Objective                                                                                                                                                                                                                                                                                                                                 | Study Design |
|-------------------------------|------|------------------|---------|------------|--------------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Aron-Wisnewsky et al. [23]    | 2016 | France           | 26891123| 22         | GBP: 40.5; AGB 40.5 | 3 × 24-h dietary recall | GBP or AGB | Analyze the effect of food restriction on nutritional parameters in the short-term (≤3 months) period after bariatric surgery in morbid obesity. Study the alterations of the circadian rhythmicity due to morbid obesity and the recovery of the circadian pattern after weight loss in a cohort of patients who underwent sleeve gastrectomy. | Prospective  |
| Barnadas et al. [24]          | 2021 | Spain            | 33435751| 41         | 49.7 ± 10          | Food record (7 days) | None SG     | Study the alterations of the circadian rhythmicity due to morbid obesity and the recovery of the circadian pattern after weight loss in a cohort of patients who underwent sleeve gastrectomy. Assess the metabolic and nutritional profile of grade III obese patients for a period of 12 months after bariatric surgery.                                                                                                                                                  | Prospective  |
| Bavaresco et al. [25]         | 2010 | Brazil           | 18931884| 48         | 41.9               | 24-h dietary recall | None RYGB   | Assess the metabolic and nutritional profile of grade III obese patients for a period of 12 months after bariatric surgery. Evaluate dietary modifications during the preoperative and postoperative periods of bariatric surgery. Evaluate whether or not the individual differences in the substrates content of the diet had any impact on body weight loss and, consequently, could contribute to its variability.                                                                                   | Longitudinal |
| Benaiges et al. [26]          | 2019 | Spain            | 31288988| 60         | 43.1 ± 7.9         | FFQ           | Yes RYGB (43%) | Evaluate dietary modifications during the preoperative and postoperative periods of bariatric surgery. Evaluate whether or not the individual differences in the substrates content of the diet had any impact on body weight loss and, consequently, could contribute to its variability.                                                                                   | Observational, prospective |
| Bobbioni-Harsch et al. [27]   | 2002 | Switzerland      | 12032656| 50         | 38.4               | Food record (3 days) | Yes RYGB    | Evaluate whether or not the individual differences in the substrates content of the diet had any impact on body weight loss and, consequently, could contribute to its variability.                                                                                                                                                                                                                   | Longitudinal |
| Brolin et al. [28]            | 1994 | United-states    | 7986146 | 138        | VBG: 39 ± 9; RYGB: 38 ± 10 | Dietary history + 24-h dietary recall | Yes VBG (30) or RYGB (108) | Determine whether assessment of preoperative eating patterns and food preferences can be used to predict weight loss outcome after surgery. Assess changes in dietary habits in obese patients 6 and 12 months after SG, compare changes in hormonal levels and dietary habits after this procedure.                                                                                   | Prospective longitudinal |
| Buzga et al. [29]             | 2014 | Czech Republic   | 25561993| 37         | 43.5               | Questionnaire None SG | VG | Longitudinal | Longitudinal |
Table 2. Cont.

| Study          | Year | Country | PMID            | Population | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design |
|----------------|------|---------|-----------------|------------|--------------------|--------------|---------------------------------------------------------------------------|--------------|
| Carrasco et al. [30] | 2007 | Chile   | 17658019        | 38         | 36.3               | 89% women    | FFQ + Food record (3 days) None RYGB Detect metabolic or behavioral parameters that could predict the reduction in weight, the loss in body fat and the improvement in cardiovascular risk factors. Evaluate the relation between weight loss and food intake and between weight loss and changes in serum ghrelin concentrations 1 y after GBP with resection of the bypassed stomach and without resection. Evaluate the association between social jet lag, a measure of circadian misalignment, and anthropometric, metabolic and food intake outcomes 6 months after bariatric surgery. | Longitudinal |
| Carrasco et al. [31] | 2012 | Chile   | 22305536        | 50         | 37.6 ± 10.2        | 100% women   | Food record (3 days) None GBP | Prospective |
| Carvalho et al. [32] | 2020 | Brazil  | 32728839        | 122        | 33                 | 77% women    | 2 × 24-h dietary recall Yes RYGB or SG | Longitudinal, observational |
| Casagrande et al. [33] | 2010 | Brazil  | 20411350        | 33         | 35.9               | 100% women   | FFQ + 24-h dietary recall Yes RYGB | Prospective longitudinal |
| Chou et al. [34] | 2017 | Taiwan  | 28589529        | 40         | 33.5 ± 9.7         | 75% women    | FFQ + 24-h dietary recall Yes SG | Retrospective |
| Coluzzi et al. [35] | 2016 | Italy   | 26744284        | 30         | 35                 | 73% women    | 24-h dietary recall None SG | Prospective longitudinal |
| Study            | Year | Country  | PMID          | Population      | Dietary Assessment      | Surgery Type | Objective                                                                 | Study Design |
|------------------|------|----------|---------------|-----------------|-------------------------|--------------|---------------------------------------------------------------------------|--------------|
| Cooper et al. [36] | 1999 | Australia | 10340816     | 26              | 23–59                   | 96% women    | 31.6–52.7 Food record (4 days) None MLVG | Longitudinal |
| Correia Horvath et al. [37] | 2014 | Brazil    | 24528344     | 77              | 44.5                    | 65% women    | 48.8 24-h dietary recall None N/D | Cross-sectional |
| Coupaye et al. [38] | 2014 | France    | 24122661     | 86              | SG: 45 ± 11; RYGB: 44 ± 9 | 72% women    | SG = 48.5 ± 9.6; RYGB = 48.6 ± 7.8 Food record (4 days) + interview None | Prospective |
| Custodio et al. [39] | 2012 | Brazil    | 23165553     | 22              | 37.9 ± 9.1              | 100% women   | 44.3 ± 5.4 Food record (3 days) None RYGB | Prospective |
| Dagan et al. [40] | 2016 | Israel    | 26797718     | 100             | 41.9                    | 60% women    | 42.3 FFQ None SG | Cross-sectional |
| Dagan et al. [41] | 2017 | Israel    | 28303504     | 77              | 43.1                    | 57% women    | 42.1 Food record (3 days) None SG | Prospective |
| Study                  | Year | Country        | PMID     | Population | Dietry Assessment | Surgery Type | Objective                                                                                                                                                                                                 | Study Design |
|-----------------------|------|----------------|----------|------------|------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Davies et al. [42]    | 2020 | New Zealand    | 32447634 | 44         | RYGB: 48.5 ± 5.5; SG: 47.7 ± 6.9 | 52% women    | Food record (5 days) | None | RYGB or SG | Identify whether there were surgery-specific changes in gut microbiota among obese people with Type 2 diabetes randomised to either SG or RYGB and whether there were common taxa and gut microbiota functional capacity changes among those who achieved T2D remission, irrespective of surgery type. |
| da Silva et al. [43]  | 2014 | Brazil         | 25518027 | 10         | 46.5 ± 6.6 | 100% women       | 45.7 ± 4.1 | Food record (7 days) | N/D | RYGB | Compare the Virtual Nutri Plus® and Dietpro® software systems in assessing nutrient intake in obese patients with type 2 diabetes mellitus who underwent a RYGB. |
| da Silva et al. [44]  | 2016 | Brazil         | 27544005 | 80         | 46 | 88.8% women | 49.8 ± 9.3 | 2 × 24-h dietary recall | None | RYGB | Investigate factors associated with weight regain long after RYGB. |
| Dias et al. [45]      | 2006 | Brazil         | 16680324 | 40         | 42.5 ± 10.8 | 100% women       | 51.9 ± 11.8 | 24-h dietary recall | None | RYGB | Systematically document nutrient intake at 3-month intervals, during the first 12 months after uncomplicated RYGB. Evaluate baseline risk factors for stone formation in a group of morbidly obese patients presenting for gastric bypass surgery and the changes that may occur after bariatric surgery. |
| Duffey et al. [46]    | 2007 | United States  | 18289566 | 45         | 47.0 ± 10.5 | 71% women       | 49.5 ± 9.1 | Food record (1 day) | None | N/D | Cross-sectional |
| El Labban et al. [47] | 2015 | Lebanon        | 25982803 | 60         | RYGB: 39.6 ± 11.3; SG: 33.0 ± 12.3 | 60% women    | FFQ + 3 × 24-h dietary recall | Yes | RYGB or SG | Cross-sectional |
**Table 2. Cont.**

| Study            | Year  | Country | PMID          | Population | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design |
|------------------|-------|---------|---------------|------------|--------------------|--------------|---------------------------------------------------------------------------|--------------|
| Ernst et al.     | 2009  | Germany | 19034589      | 121        | RYGB: 40.2 ± 1.5; GB: 44.0 ± 1.2 | 79% women    | RYGB: 46.5 ± 0.7; GB: 44.6 ± 0.5 | FFQ None                               | Cross-sectional |
|                  |       |         |               |            |                    |              | GBP (48) or GB (73) + 45 obese controls                                  |              |
|                  |       |         |               |            |                    |              | Assesse dietary habits in patients who have underwent a bariatric surgery and compare their data with those of an obese as well as a nonobese control group. |              |
| Faria et al.     | 2014  | Brazil  | 25409965      | 60         | N/D                | 87% women    | N/D                                                                 | FFQ None                               | Retrospective |
|                  |       |         |               |            |                    |              | 3 × 24-h dietary recall                                                   |              |
|                  |       |         |               |            |                    |              | Assess weight loss, consumption of macronutrients and the frequency of vomiting among patients who underwent RYGB with and without the placement of a constriction ring around the pouch. |              |
|                  |       |         |               |            |                    |              | Assess dietary intake, the nutritional status, as well as plasma levels of a number of gastrointestinal peptides that regulate food intake and fecal microbiota in severely obese patients and healthy non-obese control subjects and evaluate whether bariatric surgery affected gastrointestinal peptides plasma levels and fecal microbiota. | Prospective |
| Federico et al.  | 2016  | Italy   | 27107092      | 28         | 26–63              | 71% women    | Women: 48.6 ± 8.1; Men: 54.3 ± 18.5 | Food record (7 days) None BI            | Prospective longitudinal |
|                  |       |         |               |            |                    |              | Evaluate the dietary intake, the nutritional status, as well as plasma levels of a number of gastrointestinal peptides that regulate food intake and fecal microbiota in severely obese patients and healthy non-obese control subjects and evaluate whether bariatric surgery affected gastrointestinal peptides plasma levels and fecal microbiota. |              |
| Forbes et al.    | 2016  | United-States | 26328533    | 18         | 36.6 ± 2.3         | 100% women   | 44.0 ± 1.0                  | Food record (3 days) None RYGB (13) or AGB (5) | Longitudinal |
|                  |       |         |               |            |                    |              | Describe compositional changes in plasma phospholipids during 6 months following bariatric surgery procedures. |              |
Table 2. Cont.

| Study            | Year | Country      | PMID       | Population | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design       |
|------------------|------|--------------|------------|------------|--------------------|--------------|---------------------------------------------------------------------------|---------------------|
| Freeth et al.    | 2012 | United-States| 22714824   | 15         | Age ± SD: 18–80    | N/D          | Food record (3 days)           | RYGB (6) or GB (9) | Comprehensively analyze selenium intake before and after bariatric surgery while simultaneous looking at the serum selenium level and functional measurement of selenium. Prospective longitudinal |
| Freeman et al.   | 2013 | Australia    | 24743015   | 130        | N/D                | Control 43.2; AGB 45.5; RYGB 42.4; SG 43.2 | Questionnaire + 24-h dietary recall | None | AGB, SG or RYGB | Assess food tolerance and diet quality in AGB, SG and RYGBP patients 2–4 years post-surgery, comparing findings with an obese control group. Prospective cross-sectional |
| Furet et al.     | 2010 | France       | 20876719   | 30         | nDb: 42 ± 2; Db: 49 ± 5 | nDb: 48.3 ± 1.6; Db: 45.4 ± 3.5 | Questionnaire | None | RYGB | Examine the association between gut microbiota changes and a range of body composition, metabolic, and inflammatory markers. Prospective longitudinal |
| Furtado et al.   | 2018 | Brazil       | 30307293   | 105        | Success group 43.3 ± 11.4; Failure group 43.4 ± 10.7 | SG 48.8 ± 8.4; Failure group 49.9 ± 6.6 | 24-h dietary recall + food record (3 days) + FFQ | None | RYGB | Analyse whether feeding behavior, evaluated by caloric intake, dietary preferences and tolerance, can be considered as a determinant factor for weight loss in obese patients submitted to RYGB. Cross-sectional |
| Gesquiere et al. | 2017 | Belgium      | 27591033   | 54         | 61% women          | 40.4         | Food record (2 days)           | None | RYGB | Study dietary and supplement intake of micronutrients before and after RYGB and examine the association between the total micronutrient intakes and status markers. Prospective longitudinal |
| Gimenes et al.   | 2017 | Brazil       | 28102495   | 25         | 100% women         | 50.1 ± 6.5   | Food record (1 day)           | None | RYGB | Evaluate nutritional and biochemical indicators of women who became pregnant after RYGB. Retrospective |
| Study               | Year | Country | PMID       | Population          | Dietary Assessment | Surgery Type | Objective                                                                                                                                                                                                 | Study Design |
|---------------------|------|---------|------------|---------------------|--------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Giusti et al. [59]  | 2015 | Switzerland | 26675775   | 16 | 39.4 ± 2.4 | 100% women | 44.1 ± 1.6 | Food record (7 days) | None | RYGB | Evaluate energy and macronutrient intakes, body composition, and the basal metabolic rate in obese female patients during the initial 3 y after an RYGB. Evaluate the nutritional status of minerals and vitamins and the food consumption in patients before and after RYGB. Evaluate the overall effect of RYGB by monitoring additional risk factors of related chronic diseases. | Observational |
| Gobato et al. [60]  | 2014 | Brazil   | 25264334   | 36 | 37.7 | 75% women | 44.2 | 24-h dietary recall | None | RYGB | Evaluate the nutritional status of minerals and vitamins and the food consumption in patients before and after RYGB. Evaluate the overall effect of RYGB by monitoring additional risk factors of related chronic diseases. | Prospective longitudinal |
| Gobato et al. [61]  | 2018 | Brazil   | 30306500   | 75 | 38 ± 10 | 89% women | 43.94 ± 5.89 | Food record (3 days) | None | RYGB | Evaluate the food intolerance after banded RYGB, correlating the data of food ingestion. Investigate the possible short-term effects of surgery on vaspin and other metabolic variables relevant to insulin sensitivity and evaluate the possible relationship between dietary intake and serum vaspin. | Observational, prospective |
| Golpaie et al. [62] | 2011 | Iran     | 22266100   | 30 | 32.5 | 70% women | 44.1 ± 4.9 | Food record (3 days) | None | AGB (15) or (16) TGVP | Compare the changes in body composition, dietary intake, and substrate oxidation 6 months post-surgery in obese patients who underwent RYGB and SG. | Longitudinal |
| Golzarand et al. [63]| 2018 | Iran     | 30251098   | 43 | N/D | N/D | RYGB: 45.9 ± 4.6 SG: 39.5 ± 4.2 | Food record (3 days) | Yes | RYGB or SG | Assess dietary habits, nutritional status and biochemical parameters of blood in patients being prepared for different bariatric procedures. | Prospective |
| Jastrzebska-Mierzyńska et al. [64] | 2012 | Poland | 23256020 | 27 | Women: 40.4 ± 13.9; Men: 39.6 ± 12.7 | 68% women | W: 45.9 ± 6.8; M: 48.1 ± 7.7 | 24-h dietary recall | None | N/A | | Cross-sectional |
| Study                | Year | Country | PMID    | Population | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design        |
|---------------------|------|---------|---------|------------|--------------------|--------------|---------------------------------------------------------------------------|---------------------|
| Johnson et al. [65] | 2013 | Norway  | 23110916| 72         | 42.6 ± 11         | 69% women    | 46.2 ± 5.9 FFQ Yes RYGB                                                                                                            | Intervventional (clinical trial) |
| Kanerva et al. [66] | 2017 | Sweden  | 28756049| 1695       | 47.3 ± 5.9        | 69.8% women  | 42.5 ± 4.5 Questionnaire Yes LAGB OR VBG OR RYGB                                                                                     | Prospective, matched, non-randomized, surgical intervention trial |
| Kops et al. [67]    | 2017 | Brazil  | 28760427| 120        | N/D               | Adherent: 74.4% women; Non adherent 81.8% women | 24-h dietary recall (3 ×) Yes N/D                                                                                                  | Cross-sectional     |
| Kruseman et al. [68]| 2010 | Switzerland | 20338278| 141        | 40                | 93% women    | 46 Food record (4 days) None GBP                                                                                                   | Retrospective longitudinal |
| Laurenius et al. [69]| 2013 | Sweden  | 23299713| 43         | 43 ± 10           | 72% women    | 44.3 ± 4.9 Questionnaire Yes RYGB                                                                                                  | Longitudinal        |
| Leite Faria et al. [70]| 2009 | Brazil  | 18830780| 75         | 36.8 ± 10.7      | 80% women    | 43 ± 5.5 Food record (4 days) None RYGB                                                                                             | Cross-sectional     |
Table 2. Cont.

| Study                          | Year | Country | PMID       | Population                          | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design |
|-------------------------------|------|---------|------------|-------------------------------------|--------------------|--------------|-----------------------------------------------------------------------------|--------------|
| Le Roux et al. [71]           | 2011 | Sweden  | 21734019   | N 16 N/D 69% women BMI N/D N/D     | Questionnaire      | RYGB or VBG  | Investigate how RYGB affects intake of and preference for high-fat food in an experimental (rat) study and within a trial setting (human). | Prospective  |
| Ledoux et al. [72]            | 2017 | France  | 27943093   | N 78 43 81% women BMI 44           | Food record (4 days) | None         | Explore whether self-reported preoperative changes in dietary habits and physical activity during a multidisciplinary preparation were predictive of postoperative weight loss. Evaluate the nutritional profile of the patients included into a multidisciplinary program for the treatment of severe obesity and bariatric presurgery. | Interventional|
| Magno et al. [73]             | 2014 | Brazil  | 25409962   | W: N 30 48.4 ± 12.9; M: 49.8 ± 8.1 73% women BMI 50.8 ± 14.5 | 24-h dietary recall | None         | Evaluate the nutritional profile of the patients included into a multidisciplinary program for the treatment of severe obesity and bariatric presurgery. | Retrospective|
| Marin et al. [74]             | 2017 | Brazil  | 28421792   | N 45 20–45 100% women BMI 47.8 Groupe 1: 41.5 | Food record (3 days) | None         | Assess the effect of two micronutrient supplementation schemes on inflammation and iron metabolism in premenopausal women who had undergone RYGB surgery. | Prospective  |
| Marques et Al. [75]           | 2020 | Portugal | 31435901   | N 17 Symptomatic: 46.4 ± 1.7 Control: 42.1 ± 3.4 94% women BMI Symptomatic: 39.4 ± 1.8 Control: 42.4 ± 1.2 | Food and symptom diary (FSD) | None         | Evaluate the influence of meal nutritional composition on interstitial fluid glucose profiles and symptom profile after RYGB. Identify usual dietary habits of black and white women seeking bariatric surgery and examine potential differences between these ethnic groups; to describe participants’ plans to change dietary behaviors after surgery. | Cross-sectional |
| McLean et al. [76]            | 2018 | United States | 29100900 | N 200 46.3 ± 8.5 100% women BMI 48.9 ± 5.8 | FFQ                 | None         | RYGB, SG or LAGB | | Cross-sectional |
| Study               | Year | Country | PMID            | Population | Dietary Assessment | Surgery Type | Objective                                                                                                                                                                                                                                                                                                                                                           | Study Design |
|--------------------|------|---------|-----------------|------------|-------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| Melendez-Araújo et al. [77] | 2012 | Brazil  | 23054569        | 32         | 39 ± 10.6         | N/D          | Evaluate the impact of intensive and standard nutritional interventions on body weight, energy intake, and eating quality.                                                                                                                                                                                                                                           | Retrospective |
| Melo et al. [78]     | 2017 | Brazil  | 28724055        | 61         | 47.1 ± 9.9        | 84% women    | Evaluate parameters of bone and mineral metabolism after bariatric surgery.                                                                                                                                                                                                                                                                                         | Sectional, retrospective |
| Mercachita et al. [79] | 2014 | Portugal| 23955522        | 60         | 41.9 ± 12.2       | 65% women    | Quantify the intake of micronutrients in patients that were submitted to RYGB, determine the micronutrients deficiencies, and verify if the recommended vitamin and mineral supplementation intake would prevent theses deficiencies.                                                                                                           | Retrospective longitudinal |
| Miller et al. [80]   | 2014 | United States | 24748474      | 17         | 47.3 ± 2.2        | 94% women    | Examine changes in macro- and micronutrients, food groups, and selected foods during 12-months follow-up in post RYGB individuals.                                                                                                                                                                                                                       | Prospective |
| Mischler et al. [81] | 2015 | United States | 26806728      | 36         | 45                | 97% women    | Explore the impact of dietary and supplemental sources of iron and absorptive factors on iron status. Evaluate the dietetic intake and the prevalence of nutritional deficiencies in obese patients who are candidates for bariatric surgery.                                                                                                         | Cross-sectional |
| Moizé et al. [82]    | 2011 | Spain   | 21298509        | 231        | 45.6 ± 9.9        | 72.3% women  | Prospectively compare dietary changes and nutritional deficiencies in grade 3 obese patients 5 years after SG and RYGB.                                                                                                                                                                                                                                         | Cross-sectional |
| Moizé et al. [83]    | 2013 | Spain   | 23438491        | 355        | SG = 46.4 ± 11.6; RYGB = 45.2 ± 10.6 | 75% women    |                                                                                                                                                                                                                                                                                                                                                                  | Longitudinal, prospective, observational |
| Study | Year | Country | PMID | Population | Dietary Assessment | Surgery Type | Objective | Study Design |
|-------|------|---------|------|------------|-------------------|--------------|-----------|-------------|
| Molin Netto et al. [84] | 2017 | Brazil | 27474230 | 41 | 39.4 ± 10.9 | 95% women | 44.6 ± 6.3 | FFQ | Yes | RYGB | Evaluate the early post-RYGB changes in the quality of eating patterns and their relationship to weight loss and metabolic parameters. | Longitudinal |
| Moore et al. [85] | 2015 | United-states | 25270794 | 22 | 41 ± 12 | 100% women | 46.7 ± 8 | 24-h dietary recall | None | RYGB (11) or SG (11) | Determine the response to 3 months of thiamin, B12, and folate suppletions. | Prospective observational |
| Nicoletti et al. [86] | 2013 | Brazil | 21978750 | 80 | 45 ± 11 | 81% women | 54 ± 8 | 24-h dietary recall | None | RYGB | Characterize the eating, anthropometric, and biochemical profile of obese candidates for bariatric surgery at a university hospital and assess their preoperative risk of nutritional deficiency. | Retrospective |
| Nicoletti et al. [87] | 2015 | Brazil | 25851774 | 72 | 42 ± 9 | 86% women | 53 ± 8 | 24-h dietary recall | None | RYGB | Evaluate the influence of red meat intolerance on the dietary pattern, biochemical indicators, and clinical symptoms after Roux-en-Y gastric bypass. | Retrospective |
| Nicoletti et al. [88] | 2016 | Brazil | 27256164 | 150 | 47.2 ± 10.5 | 80% women | 51.3 ± 7.3 | 24-h dietary recall | None | RYGB | Investigate the contribution of UCP2 gene variants on energy and macronutrients intake in a population after bariatric surgery. | Retrospective |
| Nicoletti et al. [89] | 2020 | Brazil | 33231819 | 65 | 47.2 ± 11.4 | 86% women | 35.5 ± 6.8 | 3 × 24-h dietary recall | None | RYGB or VBG | Investigate dietary habits and food intake during bariatric surgery. | Cross-sectional |
| Nonino et al. [90] | 2019 | Brazil | 31644673 | 441 | 44 ± 10 | 82.7% women | 50.5 ± 8.0 | 24-h dietary recall | N/D | RYGB | Investigate nutritional status in 10 years follow-up. | Longitudinal retrospective |
| Study                  | Year | Country | PMID     | Population | Dietary Assessment | Surgery Type  | Objective                                                                                                                                                                                                 |
|-----------------------|------|---------|----------|------------|--------------------|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Nosso et al. [91]     | 2017 | Italy   | 28969883 | 22         | 50 ± 9             | 54.5% women   | Food record (7 days)                                                                                       | None                    | RYGB (11) or SG (11) | Evaluate glycemic variability and oxidative stress in patients who achieved type 2 diabetes remission after bariatric surgery. |
| Novais et al. [92]    | 2012 | Brazil  | 22652372 | 141        | 44 ± 9             | 100% women     | 2 × 24-h dietary recall                                                                                   | Yes                     | RYGB                | Assess the adequacy of food intake in women two or more years after bariatric surgery according to the excess weight lost. |
| Olbers et al. [93]    | 2006 | Sweden  | 17060764 | 75         | GB: 37.4 ± 0.4 VGB: 37.4 ± 0.5 | 50% women     | GB: 42.3 ± 4.5; VBG: 42.6 ± 4.2                                                                                | Questionnaire           | RYGB(36) or VBG(39) | Evaluate the effect of dietary intake of on body composition and energy expenditure after surgery. |
| Ortega et al. [94]    | 2012 | Spain   | 22722236 | 107        | 41.8 ± 9.8         | 79% women      | Food record (3 days)                                                                                     | None                    | RYGB                | Analyze the likelihood of patients undergoing RYGB to recover a normal daily food intake, and the possible influence of dietary and exercise habits on long-term weight loss. |
| Papalazarou et al. [95]| 2010 | Greece  | 19834466 | 30         | Usual care: 33.4 ± 2. Lifestyle intervention: 32.7 ± 1.6 | 100% women     | Usual Care: 49.8 ± 1.6. Lifestyle intervention:48.5 ± 2.                                                                                     | None                    | VBG                 | Evaluate the 3 year effects of a lifestyle intervention on weight loss and maintenance, dietary, and physical activity habits and eating behavior of patients following VBG. |
| Pinto et al. [96]     | 2019 | Brazil  | 31376133 | 51         | 39.34 ± 9.38       | 68.7% women    | 24-h dietary recall                                                                                     | None                    | RYGB                | Evaluate changes in dietary intake and predictive factors of obesity remission in the first 12 months after RYGB. Test 6 variations in the Goldberg equation to evaluate underreporting among obese women on a bariatric surgery waiting list. |
| Quesada et al. [97]   | 2014 | Brazil  | 24724773 | 100        | 33.3 ± 6.08        | 100% women     | 24-h dietary recall                                                                                     | Yes                     | Gastroplasty         | Cross-sectional                                              |
| Study                | Year | Country          | PMID           | Population | Dietary Assessment | Surgery Type | Objective                                                                                           | Study Design |
|---------------------|------|------------------|----------------|-------------|--------------------|--------------|-----------------------------------------------------------------------------------------------------|--------------|
| Raatz [98]          | 2020 | United States    | 32418771       | 72          | 44.1 ± 11.7        | 81% women    | 2 × 24-h dietary recall                                                                                | Longitudinal |
| Reid et al. [99]    | 2016 | Canada           | 27744735       | 27          | 53.2 ± 8.3         | 89% women    | Food record (3 days)                                                                                  | Retrospective|
| Ruiz-Lozano et al.  | 2016 | Spain            | 26948400       | 270         | 52 ± 11            | 82% women    | Food record (4 days)                                                                                  | Observational|
| Ruiz-Tovar et al.   | 2017 | Spain            | 29250751       | 93          | 45.7 ± 10.8        | 78% women    | FFQ                                                                                                  | Prospective, observational |
| Sanchez et al. [102] | 2016 | Chile            | 26108638       | 103         | 36 ± 9.6           | 100% women   | FFQ                                                                                                  | Cross-sectional |
| Sarver et al. [103] | 2012 | United States    | 22551576       | 84          | 42 ± 9.9           | 63% women    | FFQ                                                                                                  | Interventional|
### Table 2. Cont.

| Study          | Year   | Country      | PMID          | N  | Age ± SD | Sex | BMI ± SD | Tool          | Validation | Surgery Type | Objective                                                                                                                                                                                                 | Study Design      |
|----------------|--------|--------------|---------------|----|----------|-----|----------|---------------|------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| Sarwer et al.  | 2008   | United States| 18586571      | 200| 43.2 ± 9.8| 82% women| 52.1 ± 9.3 | FFQ            | Yes         | RYGB         | Investigate the relationship between preoperative eating behavior, postoperative dietary adherence and weight loss following gastric bypass surgery. | Prospective       |
| Schoemacher et al. [105] | 2019  | the Netherlands | 31313238     | 135| 46.5 ± 9.5 | 83.7% women| 44.6 ± 6.7 | Food record (2 days) | None        | RYGB or SG    | Explore the relationship between total energy intake and % total body weight loss over a period of 4 years post-surgery. Investigate the impact of metabolic surgery for diabetic patients with body mass index < 35 kg/m² on health-related quality of life, food tolerance, and food satisfaction in a single institution. | Longitudinal, observational |
| Seki et al. [106] | 2019  | Japan        | 30711445      | 46 | 64.5 ± 8.1 | 47% women| 31.7 ± 2.2 | 24-h dietary recall | None        | DBP          | Investigate the impact of metabolic surgery for diabetic patients with body mass index < 35 kg/m² on health-related quality of life, food tolerance, and food satisfaction in a single institution. | Retrospective      |
| Shah et al. [107] | 2013  | United States | 24113734      | 23 | 49.3 ± 10.5 | 91% women| 41.1 ± 6.2 | Food record (3 days) | None        | GB           | Examine whether dietary counseling improves micronutrient and macronutrient intakes in GB surgery patients. Evaluate the long-term nutritional changes that occur in VBG patients compared with their nutrition before surgery. Evaluate the life habits and diet quality of patients who have undergone bariatric surgery (who have been recovering for at least 6 months) based on the specific food pyramid. | Prospective       |
| Shai et al. [108] | 2002  | Israel       | 12568186      | 75 | 34.4 ± 9.4 | 81% women| 41.4 ± 6.0 | FFQ            | None        | VBG          | Evaluate the long-term nutritional changes that occur in VBG patients compared with their nutrition before surgery. Evaluate the life habits and diet quality of patients who have undergone bariatric surgery (who have been recovering for at least 6 months) based on the specific food pyramid. | Retrospective      |
| Soares et al. [109] | 2014  | Brazil       | 24500225      | 172| 42.4 ± 9.0 | 92.5% women| 46.9 ± 6.0 | FFQ            | None        | RYGB         | Evaluate the long-term nutritional changes that occur in VBG patients compared with their nutrition before surgery. Evaluate the life habits and diet quality of patients who have undergone bariatric surgery (who have been recovering for at least 6 months) based on the specific food pyramid. | Retrospective      |
| Solga et al. [110] | 2004  | United states| 15573908      | 70 | 44 ± 9    | 89% women| 55 (median) | 24-h dietary recall | None        | RYGB         | Determine whether overall calorie intake and diet composition are associated with the severity of NAFLD histopathology. | Retrospective      |
| Study                          | Year | Country            | PMID          | Population | Dietary Assessment | Surgery Type | Objective                                                                 | Study Design |
|-------------------------------|------|--------------------|---------------|------------|--------------------|--------------|---------------------------------------------------------------------------|--------------|
| Sovik et al. [111]            | 2013 | Norway/Sweden      | 22951078      | GB: 35.2 ± 7; DS: 36.1 ± 5.26 | GB: 54.8 ± 3.24; DS: 55.2 ± 3.49 | Food record (4 days) | None | Evaluate the gastrointestinal side effects, caloric intake, and changes in obesity-specific quality of life 2 years after surgery. | Prospective longitudinal |
| Torres et al. [112]           | 2012 | Brazil             | 22688468      | GB: 35.2 ± 7; DS: 36.1 ± 5.26 | GB: 54.8 ± 3.24; DS: 55.2 ± 3.49 | Food record (4 days) | None | Evaluate the nutrient intake of women who had undergone RYGB surgery. | Cross-sectional |
| Trostler et al. [113]         | 1995 | Israel             | 10733792      | GB: 35.2 ± 7; DS: 36.1 ± 5.26 | GB: 54.8 ± 3.24; DS: 55.2 ± 3.49 | Food record (4 days) | None | Compare 2 surgeries with a low energy diet and dietary counseling. Compare the food intake pattern and nutritional composition of the food consumed over time. | Longitudinal |
| Ullrich et al. [114]          | 2013 | Switzerland        | 22941334      | GB: 35.2 ± 7; DS: 36.1 ± 5.26 | GB: 54.8 ± 3.24; DS: 55.2 ± 3.49 | Food record (4 days) | None | Investigate changes in the hedonic hunger and dietary habits after RYGB surgery. Analyze food restriction effects on the nutritional adequacy of the diet, on macro- and micronutrient intake evolution, as well as their consequences in terms of bioclinical evolution and micronutrient serum level post surgery. | Longitudinal |
| Vieira et al. [116]           | 2019 | Brazil             | 30565102      | GB: 35.2 ± 7; DS: 36.1 ± 5.26 | GB: 54.8 ± 3.24; DS: 55.2 ± 3.49 | Food record (4 days) | None | Investigate the perception of hunger and satiety and its association with nutrient intake in women who regain weight in the postoperative period after bariatric surgery. | Cross-sectional |
Table 2. Cont.

| Study               | Year | Country     | PMID       | Population | Dietary Assessment | Surgery Type | Objective                                                                                                                                                                                                 |
|---------------------|------|-------------|------------|-------------|--------------------|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Vieira et al. [117] | 2020 | Brazil      | 32022115   | N 60        | 38.8 ± 9.6 78%    | FFQ          | Evaluate the association of food consumption with nutritional status, physical activity and sociodemographic factors in the bariatric surgery period preoperative                                                |
| Vinolas et al. [118]| 2019 | France      | 31102207   | RYGB: 57    | 42.9 ± 11 SG: 45.2 ± 9.2 | N/D          | Evaluate nutritional status, micro- and macronutrient intake, and oral hydration in patients before and regularly during 1 year after RYGB and SG.                                                        |
| Wardé-Kamar et al. [119] | 2004 | United States | 15479596  | N 73        | 46 ± 11 93%    | None         | Investigate self-reported food intake, diet composition and meal patterns, in relation to long-term weight loss outcomes after RYGB.                                                                  |
| Werling et al. [120]| 2013 | Sweden      | 23573244   | GB: 14       | 59.7 GB: 45.2 100% | Questionnaire | Investigate alterations in postprandial EE after gastric bypass and VBG in humans.                                                                                                                        |
| Wolf et al. [121]   | 2015 | Germany     | 25980331   | N 43        | 44 ± 12 63%    | None         | Assess the status of micronutrients in morbidly obese patients seeking bariatric surgery and to correlate extra-cellular nutrient levels with the corresponding nutrient intake.                                    |
| Zaparolli et al. [122]| 2018 | Brazil      | 29972395   | N 106       | 48 (20–64y) 90.5% | None         | Analyze food intake evolution during the first postoperative year of Roux-en-Y gastric bypass in patients with type 2 diabetes or glycemic alteration.                                                                    |
| Ziadlou et al. [123]| 2020 | Iran        | 33046020   | N 58        | 37 ± 8 71%    | None         | Assess the adequacy of dietary nutrient intakes at 6th and 12th month after bariatric surgery.                                                                                                              |

AA, African American; AGB, adjustable gastric banding; BI, bilo-intestinal bypass; BPD, Biliopancreatic diversion with duodenal switch; Ca, calcium; carb, carbohydrates; chol, cholesterol; Db, diabetic; DS, duodenal switch; eq, equivalent; FFQ, Food frequency questionnaire; GB, Gastric banding; GBP, Gastric bypass; MLVG, modified long vertical gastroplasty; NAFLD, non alcoholic fatty liver disease; nDb, non diabetic; N/D, not defined; RYGB, Roux-en-Y gastric bypass; Se, selenium; SG, Sleeve gastrectomy; TGVP, total gastric vertical plication; VBG, vertical banded gastroplasty.
## Table 3. Validation of dietary assessment tools.

| Author                        | Surgery Type | Reference Method                                | Validation | Pre-and/or Post-Surgery | Directly in the Study | Conclusions About Validity                                                                 |
|-------------------------------|--------------|------------------------------------------------|------------|--------------------------|-----------------------|-----------------------------------------------------------------------------------------|
| **Food records (FR)**         |              |                                                 |            |                          |                       |                                                                                         |
| Bobbioni-Harsch et al. [27]   | RYGB         | Indirect calorimetry (resting energy expenditure; glucose, lipid and protein oxidation) | Yes        | Pre-surgery              | Yes                   | The degree of mis-report averages −17% of the evaluated energy requirements, in pre-surgery conditions; it represents a reasonable degree of inaccuracy [27]. |
| Golzarand et al. [63]         | RYGB or SG   | Indirect calorimetry (resting metabolic rate, glucose, lipid and protein oxidation) | Yes        | Pre- & post-surgery      | Yes                   | In accordance with dietary intake reduction, protein and carbohydrate oxidation significantly decreased in both procedures post-surgery, while fat oxidation increased, but was not significant. |
| Reid et al. [99]              | RYGB         | 9-days food record (energy, macro and micronutrients) | No         |                          | No                    | Relative validity of 3-days FR appears to be acceptable as dietary assessment tool [124]. |
| Wolf et al. [121]             | N/A          | Correlation with vitamin A, D, E and C plasmatic values | Yes        | Pre-surgery              | Yes                   | No correlations were found between serum/plasma concentrations and nutritional intake nor associations between low concentrations and inadequate intakes. |

**24-h dietary recall (24HR)**

| Author                        | Surgery Type | Reference Method                                | Validation | Pre-and/or Post-Surgery | Directly in the Study | Conclusions About Validity                                                                 |
|-------------------------------|--------------|------------------------------------------------|------------|--------------------------|-----------------------|-----------------------------------------------------------------------------------------|
| Aron-Wisnewsky et al. [23]    | RYGB or AGB  | 24HR conducted by a dietitian (food consumption, energy and macro- and micronutrient intakes) | No         |                          | No                    | Agreement between the two methods was high, although it may have been overestimated because the two assessments were consecutives to one another. The tool may be highly advantageous for large population-based surveys [125]. |
| Author          | Surgery Type | Reference Method                                                                 | Validation | Conclusion About Validity                                                                 |
|-----------------|--------------|-----------------------------------------------------------------------------------|------------|-----------------------------------------------------------------------------------------|
| Carvalho et al. [32] | RYGB or SG   | Compared to Behavioral Risk Factor Surveillance System’s Fruit and Vegetable Consumption Module and the National Cancer Institute’s Percentage Energy from Fat Screener. | No         | Validity of brief dietary intake measures may vary by demographic characteristics of the sample. Additional measurement work may be needed to accurately measure dietary intake in obese African-American women [126]. |
| Kops et al. [67]  | N/D          | 24-h urine sample (urinary urea to assess protein intake)                           | Yes Pre-surgery Yes | The 24HR was accepted as appropriate. Only 37.4% of patients gave an accurate record; another 37.4% underreported, and 25.2% overreported. |
| Novais et al. [92] | RYGB         | 3-days FR (energy and nutrients)                                                   | Yes Post-surgery Yes | The agreement between the two methods ($r = 0.91$ to $0.98$) evidenced low variability of the meals consumed by the group. |
| Quesada et al. [97] | GP          | Indirect calorimetry (resting metabolic rate, energy requirement)                  | Yes Pre-surgery Yes | Comparing the results obtained for the modified Goldberg equations in this study, there was considerable variation in the proportion of underreporting (55% to 97%). |
| Verger et al. [115] | RYGB or SG   | Indirect calorimetry (basal metabolic rate)                                         | Yes Pre- & post-surgery Yes | Values revealed that patients from both groups underreported their caloric intake by 8% pre-surgery. |
| Amundsen et al. [18] | GB          | Doubly labelled water (total energy expenditure)                                   | No         | The data showed that there was substantial variability in the accuracy of the FFQ at the individual level. Furthermore, the results showed that the questionnaire was more accurate for groups than individuals [127]. |
### Table 3. Cont.

| Author                  | Surgery Type | Reference Method                                      | Validation                  | Conclusions About Validity                                                                 |
|-------------------------|--------------|-------------------------------------------------------|-----------------------------|-------------------------------------------------------------------------------------------|
| Benaiges et al. [26]    | RYGB (43%)   | 3-day FR (dietary intakes)                            | No                          | A reasonable relative validity of the FFQ and 3-day FR for estimating nutrient intake was found [128]. |
| Chou et al. [34]        | SG           | 24HR (energy and macronutrients intakes)              | Yes, Post-surgery           | The energy intake according to the dietary questionnaire was 1230 kcal/day 5 years after LSG, and the 24HR method reported a daily energy intake of approximately 1083 kcal/day. |
| Farias et al. [50]      | RYGB         | 3x 24HR (energy and macronutrients intakes)          | No                          | Food consumption reports of overweight individuals tend to be underestimated. Despite its limitations, FFQ could be used in epidemiological studies to assess the regular food consumption of overweight individuals [129]. |
| Johnson et al. [65]     | RYGB         | 14-day FR (energy from fat and sugar) and correlation of fatty acids and Alpha-tocopherol in adipose tissue with serum | No                          | On average, 39% of the men were classified in the same quartile with the two methods, and 3% in the opposite quartile. Very-long chain n-3 fatty acids in adipose tissue and total serum lipids reflect the dietary intake of very-long-chain n-3 fatty acids to the same degree. No associations were observed between intake of alpha-tocopherol and concentration in adipose tissue and serum [130]. |
| Molin Netto et al. [84] | RYGB         | 3 × 24HR (energy and macronutrients intakes)         | No                          | Idem Farias et al. 2020 [129].                                                             |
| Sarwer et al. 2012 [103]| RYGB or AGB  | 4 and 7-day FR (energy and macronutrients intakes)   | No                          | Correlations between questionnaire and FR for percent of energy from fat were 0.67 and 0.65 respectively in the two groups; most correlations were similar to those achievable by a single 4-day FR [131]. |
| Author                  | Surgery Type       | Reference Method                                                                                                                                                                                                 | Validation                                                                                       | Conclusions About Validity                                                                 |
|------------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| Sarwer et al. 2008 [104] | RYGB              | 4 and 7-day FR (energy and macronutrients intakes) Questionnaires                                                                                                                                           | No                                                                                               | No                                                                                             | Idem Sarwer et al. 2012 [131].                                                               |
| Kanerva et al. [66]    | LAGB or VBG or RYGB | 4-day FR, 24-h energy expenditure and nitrogen excretion (nutrient intake, basal metabolic rate)                                                                                                              | No                                                                                               | No                                                                                             | People with obesity reported energy and protein intakes 35% higher with the questionnaire compared with FR and nitrogen excretion [132]. |
| Laurenius et al. [69]  | RYGB              | 4-day FR, 24-h energy expenditure and nitrogen excretion (nutrient intake, basal metabolic rate)                                                                                                             | No                                                                                               | No                                                                                             | Idem Kaverna et al. 2017 [132].                                                             |
| Le Roux et al. [71]    | RYGB or VBG        | 4-day FR, 24-h energy expenditure and nitrogen excretion (nutrient intake, basal metabolic rate)                                                                                                             | No                                                                                               | No                                                                                             | Idem Kaverna et al. 2017 [132].                                                             |
| Olbers et al. [93]     | RYGB or VBG        | 4-day FR, 24-h energy expenditure and nitrogen excretion (nutrient intake, basal metabolic rate)                                                                                                             | No                                                                                               | No                                                                                             | Idem Kaverna et al. 2017 [132].                                                             |
| Werling et al. [120]   | GB or VBG         | 4-day FR, 24-h energy expenditure and nitrogen excretion (nutrient intake, basal metabolic rate)                                                                                                           | No                                                                                               | No                                                                                             | Idem Kaverna et al. 2017 [132].                                                             |

Other dietary assessment methods
| Author                        | Surgery Type | Reference Method                                                                 | Validation               | Conclusion About Validity                                                                 |
|-------------------------------|--------------|----------------------------------------------------------------------------------|--------------------------|------------------------------------------------------------------------------------------|
| Al-Ozairi et al. [17]         | SG           | 24HR by a dietitian (energy, macronutrients, fiber, total fat, saturated fat, mono- | Yes                      | After SG, patients reported higher total energy intake and energy intake from carbohydrates compared to estimations using photographs. Digital photography appears reliable and accurate in adults in measuring energy intake in a cafeteria setting. |
| Brolin et al. [28]            | VBG or RYGB  | 1 week FFQ (energy, protein, carbohydrate and fat intake)                          | Yes                      | Multiple tools were used to obtain a mean of energy intake and macronutrients.            |
| Casagrande et al. [33]        | RYGB         | FFQ + 24HR (total energy, macro and micronutrients)                               | Yes                      | The FFQ underestimated total energy value intake as compared with the 24HR. Protein and lipid intakes were lower if evaluated by the FFQ as compared to the 24HR. Calcium intake was higher when evaluated by the FFQ as compared with the 24HR. |
| El Labban [47]                | RYG or SG    | N/D                                                                               | No                       | N/D                                                                                      |

AGB, adjustable gastric banding; BDP, biliopancreatic diversion with duodenal switch; FFQ, food frequency questionnaire; GB, Gastric banding; GP, gastroplasty; kcal, Kilocalories; LAGB, Laparoscopic Adjustable Gastric Banding; N/D, Not defined; RYGB, Roux-en-Y gastric bypass; SG, Sleeve gastrectomy; VBG, vertical banded gastroplasty; 24HR, 24-h recall.
3. Results
3.1. General Overview

As shown in Figure 1, a total of 800 references were generated by the search strategy in PubMed, and 108 original studies were included in this review by fulfilling our inclusion and exclusion criteria. Table 2 shows an exhaustive description of the 108 studies included. Studies were published between 1989 and 2021 and were conducted in many countries. These studies represented a total of 10,046 participants (74% females). Twenty-five studies (23%) included more than 100 participants, including one with 1695 participants. The mean BMI was 46.0 kg/m² (between 29.2 and 55 kg/m²) with a mean age of 44 years (between 33 and 65 years old). Among studies, 75 (69%) included Roux-en-Y gastric bypass (RYGB), 26 (24%) sleeve gastrectomy (SG), 19 (17%) gastric banding (GB) and 4 (4%) biliopancreatic diversion (BPD). Thirty-three (31%) studies included more than one type of surgery, and 8 (7%) studies did not specify the type of surgery performed. Almost all studies were classified as prospective (n = 32), cross-sectional (n = 26), retrospective (n = 22) or longitudinal (n = 18).

![Figure 1. Flowchart for selection of included references.](image)

To assess dietary intakes, 38 studies used FR [16,19–21,24,27,31,36,39,41–43,46,51–53, 57–59,61–63,68,70,72,74,80,81,91,94,99,100,105,107,111,112,118,121], 32 used 24HR [23,25, 32,35,37,44,45,49,60,64,67,73,77–79,85–90,92,95–98,106,110,115,119,122,123], 16 used FFQ [18,26,40,48,50,65,76,84,101–104,108,109,114,117], 8 used questionnaires (6 were inspired by FFQ [29,66,69,71,93,120] and 2 did not provide details [22,55]), 2 used other dietary assessment methods (photo-assisted capture method and food and symptom diary) [17,75], and 12 studies used combined tools [28,30,33,34,38,47,56,82,83,113,116] (Table 2). Among all studies included, 27 used a dietary assessment tool that had been validated either as part of the study per se (n = 11) or in a previous study (n = 16) (Figure 2). Table 3 presents the 27 studies included in this review that used a validated dietary assessment tool. Every tool validated per se in the cited studies was validated among a bariatric population, while none of the tools validated in previous studies were validated in this population. Among the 11 studies, 3 validated their tool pre- and post-surgery, 5 validated it only pre-surgery and 3 post-surgery only (Figure 2).

![Figure 2. (a) Number of tools validated and not validated; (b) Number of tools validated within a bariatric population; (c) Number of tools validated pre- and post-bariatric surgery.](image)
3.2. Validation of Dietary Assessment Tools in Bariatric Population

3.2.1. Food Records (FR)

Of the three studies having tested the validity of the FR per se in their bariatric population, two studies [27,63] used indirect calorimetry as a reference and one study [121] used plasma concentrations biomarkers (vitamin A, D, E and C) as reference (Table 3). Regarding the validity of the tools, Bobbioni-Harsh et al. [27] found that the mean self-reported energy intake from their 3-day FR was 17.2% lower than energy requirement evaluated with indirect calorimetry pre-surgery. Golzarand et al. [63] found that protein and carbohydrate oxidation were significantly decreased post-surgery. Wolf et al. [121] found no correlation between self-reported dietary intakes obtained from a 3-day FR pre-surgery and corresponding serum concentrations biomarkers of intake (25-hydroxycholecalciferol, retinol, ascorbic acid, tocopherol/cholesterol ratio, β-carotene, calcium, magnesium, phosphate).

3.2.2. 24-h Dietary Recall (24HR)

Four studies tested the validity of the 24HR per se in their bariatric population [67,92,97,115] (Table 3). In two of those studies, indirect calorimetry (resting metabolic rate, energy requirement) pre-surgery [97] and pre- and post-surgery [115] was used as a reference. Total daily energy intake assessed by 24HR was below measured resting metabolic rate pre-surgery by 8% in Verger et al.’s study [115], while Quesada et al. [97] found that 55 to 97% of their participants underreported their intake compared to resting metabolic rate. Another study [67] tested the validity of their 24HR using 24-h urine recovery biomarker data as a reference for protein intake pre-surgery, and another one [92] used FR post-surgery as a reference (energy, macro and micronutrient intakes). Kops et al. [67] concluded that approximately 37% of bariatric patients underreported protein intakes pre-surgery assessed with 24HR compared to 24-h urinary recovery biomarker data, while 25% overreported it. Novais et al. [92] validated their 24HR by comparing it with a 3-day FR and found a high level of agreement between both tools for energy and nutrient intakes.

3.2.3. FFQ

One study [34] directly tested FFQ validity using a 24HR as a reference in post-surgery patients and found a difference of 150 kcal between the two methods (1230 kcal with the FFQ vs. 1083 kcal with the 24HR) (Table 3).

3.2.4. Questionnaires

None of the studies that used a questionnaire to assess mean daily energy intake used a questionnaire validated in bariatric population. It is important to mention that little information was available about the form of questionnaires used. Five studies [66,69,71,93,120] used the Swedish Obese Subjects (SOS) study questionnaire [132] (Table 3), which was adapted from a simplified dietary history interview and was previously validated using a 4-day FR, nitrogen urinary excretion and 24 h energy expenditure measured by indirect calorimetry in obese and non-obese population, but not in bariatric population.

3.2.5. Other Dietary Assessment Methods

Al-Ozairi et al. [17] used a photo-assisted diet capture method to assess energy intake in post-surgery (Table 3). They found that after SG, patients reported a higher energy intake with the 24HR compared to estimations obtained using photographs, but they suggested that digital photography was more reliable and accurate for measuring energy intake in this specific population than 24HR [17].

3.2.6. Mixed Methods

Two studies validated the use of mixed methods to assess dietary intakes among bariatric population [28,33] (Table 3). Casagrande et al. [33] used both FFQ and 24HR to assess dietary intakes pre-surgery. Protein, cholesterol and sodium intakes were lower with the FFQ than with the 24HR, while calcium intake was higher [33]. To assess the accuracy of the estimated mean dietary intake found with the 24HR, Brolin et al. [28]
used a 1-week FFQ to compare both dietary intakes pre-surgery. They found statistically significant correlations between the tools for total energy intake and intake of milk and ice cream products, sweet/soda and nonliquid sweets [28].

4. Discussion

The objective of this review was to document the dietary assessment tools used among patients targeted for bariatric surgery and those who have undergone bariatric surgery. A total of 108 studies were included in this review; only 27 (25%) validated their dietary assessment tool or used a tool that had been previously validated, and only 11 (10%) were validated in bariatric population. Of these 11 studies, only 3 of them validated the dietary assessment tool before and after surgery, 5 validated it only before surgery, and 3 only after surgery.

The validation process of dietary assessment tools is complex but is imperative in order to evaluate usual dietary intakes and also provide an adequate estimation of nutrient intakes and potential deficiencies following bariatric surgery [6]. As previously mentioned, the dietary assessment tool of interest is often compared with another tool measuring the same concept and known to be accurate or considered as a gold standard to determine the validity [3,4]. Direct observation, which refers to objective assessment of foods and beverages consumed, is also frequently used in a clinical setting [5]. This method remains the best option to exclude risk of estimation bias, which could be present with another dietary assessment tool [2], but it is not representative of usual intakes and can cause other biases such as response bias since participants are being observed. No study using direct observation were found for this review. Most of validation studies included in this review used the comparison with another dietary assessment tool (n = 4; 1 FR, 2 24HR, 1 FFQ) or used indirect calorimetry (n = 4) to assess energy expenditure and macronutrient’s oxidation. Indirect calorimetry is less biased than self-report dietary assessment tools [12], however the later are more commonly selected as they are more accessible [12]. In the general population, FR are the most commonly used self-report tools to validate dietary intakes [8]. In order to improve quality of the validation process, the dietary assessment tool needs to be tested and compared, by direct observation or with a reference method, within the same population [6,7]. In the current review, we found that only 10% of the validated tools were validated in a bariatric population, showing a clear lack of studies that used a tool validated in that specific population. Moreover, conclusions about validity of the tools varied considerably among studies (as seen in Table 3). However, in general, FR were found as acceptable as a dietary assessment tool [27,124]. Authors found underreporting of dietary intake while validating their 24HR [97,115], but it was still deemed appropriate [67,92], particularly when used within epidemiological studies [125]. Studies examining the validation of FFQs found almost the same conclusion, namely more accurate with groups than individuals [127,129] and with a reasonable validity [128,130,131]. The only validated questionnaire had the tendency to report higher dietary intake than FR or nitrogen excretion [132]. Finally, digital photography seems to be a reliable and accurate tool for dietary intakes assessment [17], but more studies are needed to confirm these results.

Factors characterizing the bariatric population such as bias and stigmatization, dietary requirements pre- versus post-surgery and type of surgery might influence the choice of the dietary assessment tool and need to be considered in the validation process. Inclusion of patients who will have bariatric surgery and patients who have undergone bariatric surgery in the same study can be questioned as characteristics of patients and susceptible biases in reporting dietary intakes can broadly differ. For instance, social desirability biases and stigmatization can be stronger prior to than after bariatric surgery [133] since patients want to be eligible for the surgery and do not want to be excluded based on some inadequate eating habits. In addition, because several types of bariatric surgeries exist and have different impact on energy restriction and nutrient’s absorption, the need to categorize individuals according to the type of surgery, more specifically post-surgery, should also
be considered in the validation process. Some studies included in this review evaluated a cohort longitudinally and assessed dietary intakes pre- and post-surgery using the same dietary assessment tool, but none of them differentiated the validity of the tool to measure dietary intakes prior to and after surgery.

This review has strength and limitations. It showed an important lack of studies that used a tool validated in bariatric population and the need to conduct research to address this concern. Indeed, a considerable number of studies used a dietary assessment tool that had been previously validated in a non-bariatric population, such as the Swedish Obese Subjects study questionnaire. Furthermore, only a few studies included in this review specifically aimed to validate the dietary assessment tool used to assess dietary intakes in bariatric population, another indicator of the lack of literature. The interpretation of the results remained difficult considering the limited availability of information regarding the validation process and conclusions about the validity in most studies, and the high level of methodological differences between studies.

Identification of the most relevant dietary assessment tools validated prior to and after bariatric surgery would allow to characterize dietary intakes more accurately while improving nutritional interventions among these patients. Validity of dietary assessment tools should be tested for total daily energy intake and in terms of diet quality. Indeed, quality of dietary intakes of patients targeted for bariatric surgery can impact their risk of developing nutritional deficiencies after the surgery [6] and the success of their weight loss [93]. Moreover, web-based and technology-assisted assessment methods have opened the way to a new wave of self-administered automatic tools [8,9]. Considering that the web-based 24HR has been associated with reduced desirability bias compared to standard administered questionnaires at least in the general population [8], such tools could be an interesting approach to assess dietary intake in bariatric population. The potential benefits and risks associated with these web-based tools need to be evaluated in bariatric population. More studies about the validation of dietary assessment tools in bariatric population are needed, taking into account potential biases in this population.

5. Conclusions

In conclusion, few studies included in the review validated their dietary assessment tool. Additional studies are needed in order to develop valid and robust dietary assessment tools among bariatric population. These tools are essential in evaluating efficacy of nutritional interventions conducted in this population.

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