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Review

Grazing in adults with obesity and eating disorders: A systematic review of associated clinical features and meta-analysis of prevalence

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HIGHLIGHTS

- Grazing is widely prevalent in eating disorders and obesity.
- Associations exist with psychopathology, poorer treatment outcomes and lower QoL.
- Future research using valid and reliable measures of grazing is required.
- The role of "loss of control" over eating in grazing needs to be clarified.
- Determining a full range of target eating patterns may inform future interventions.

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ABSTRACT

Grazing, the unstructured, repetitive eating of small amounts of food, is a pattern of eating which has been associated with negative outcomes following bariatric surgery. Less is known about grazing in eating disorders and in non-surgical obese samples. This review aims to critically examine the existing research on the prevalence of grazing, associated treatment outcomes, and clinical correlates in adults with eating disorders and/or obesity, in clinical and community settings. A systematic electronic database search yielded 38 studies which met inclusion criteria for the review. A meta-analysis was conducted using prevalence data from 32 studies (31 datasets). Mean pooled prevalence in obesity (n = 26 studies) was 33.20% (95% CI [27.54, 39.11]) at pre-weight loss treatment, 28.16% (95% CI [17.86, 39.73]) at follow-up, and 23.32% (95% CI [3.07, 52.04]) in the community. Nine studies provided prevalence estimates in eating disorders: 58.25% (95% CI [52.75, 63.66]) in bulimia nervosa; 67.77% (95% CI [44.96, 87.13]) in binge eating disorder; and 34.31% (95% CI [26.56, 42.49]) in anorexia nervosa. The results suggest that grazing is widely prevalent within obesity and eating disorders. There is mixed evidence to suggest that grazing (especially a "compulsive" subtype including a sense of loss of control) is associated with poorer weight loss treatment outcomes in obesity, lower mood, increased eating disorder symptomatology, and decreased mental health-related quality of life. Differences in the operationalisation of grazing may account for inconsistent findings in regards to specific correlates and risks associated with this behaviour; therefore, there is an urgent need to refine and adopt a consistent definition of grazing.

1. Introduction

Obesity and eating disorders both represent significant global causes of morbidity, mortality and disability (Arcelus, Mitchell, Wales, & Nielsen, 2011; World Health Organization, 2000, 2009). In 2014 it was estimated that 13% of the world's adult population was obese, with rates rising (World Health Organization, 2016). Eating disorders (EDs[1]) such as anorexia nervosa (AN), bulimia nervosa (BN) and binge eating disorder (BED) are associated with impairments in psychological (Kessler et al., 2013), physical (Mehler & Brown, 2015; Mehler & Rylander, 2015) and social functioning, and quality of life (QoL; Jenkins, Hoste, Meyer, & Blissett, 2011). An increase in EDs and

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[1] Abbreviations: AN = anorexia nervosa; BE = binge eating; BED = binge eating disorder; BMI = body mass index; BN = bulimia nervosa; CI = confidence interval; ED = eating disorder; EWL = excess weight loss; LOC = loss of control; MDD = Major Depressive Disorder; OBE = objective binge episode; QoL = quality of life; SBE = subjective binge episode; VLCD = very low calorie diet.

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in atypical eating patterns such as binge eating and weight control behaviours associated with EDs and obesity has been reported globally (e.g. Darby et al., 2009; Makino, Tsuboi, & Dennerstein, 2004; Pike & Dunne, 2015). Although obesity and EDs have generally been treated as independent public health matters, they have considerable psychological, physiological and epidemiological overlap (Berridge, Ho, Richard, & DiFeliceantonio, 2010; Fairburn & Brownell, 2005; Neumark-Sztainer, 2005). In order to reduce the burden of both obesity and EDs, an increased understanding of contributing processes, behaviours and maintaining mechanisms is required.

To date, research into abnormal eating patterns present in EDs and obesity has predominantly focused on binge eating (Lane & Szabó, 2013), which refers to discrete eating episodes characterised by the intake of an excessive amount of food in the case of objective binge episodes (OBEs), or viewed as excessive by the patient, in the case of subjective binge episodes (SBEs) in a discrete period of time, accompanied by a sense of loss of control (LOC) over eating (American Psychiatric Association, 2013). Eating behaviours in EDs and obesity are highly heterogeneous, however, and especially in obesity, the full range of eating behaviours to be targeted in treatment is not clear (Carter & Jansen, 2012). For example, some research indicates that treatment for obese patients with binge eating did not result in significant weight loss despite the resolution of bingeing behaviour (Grilo, Masheb, Wilson, Gueorguieva, & White, 2011; Wonderlich, de Zwaan, Mitchell, Peterson, & Crow, 2003), implicating other overeating processes. A more fine-grained approach to the analysis of eating patterns has identified grazing as an eating pattern of interest associated with both obesity and EDs (Conceição et al., 2013; Saunders, 2004).

Grazing lacks a consistent definition and operationalisation across the literature (for example, it has been termed "constant overeating" (Mitchell, Devlin, de Zwaan, Crow, & Peterson, 2008), "picking and nibbling" (Fairburn, Cooper, & O'Connor, 2008) and "chaotic/unstructured eating" (Hagan et al., 2002)). A validated self-report measure of grazing has only relatively recently been developed (Lane & Szabó, 2013), and a definition of grazing based on expert consensus was only proposed in 2014 by Conceição, Mitchell, Engel, et al. Based on these recent attempts to define and operationalise this concept, grazing can be regarded as the unstructured, repetitive eating of small amounts of food over a longer time period, outside of planned meals and snacks and/or not in response to hunger or satiety sensations. Although similarities exist with other patterns of eating, such as snacking and SBEs, both of which involve the consumption of smaller amounts of food than would normally constitute a meal or an OBE, these eating patterns exhibit features that can discriminate them from grazing. Snacking is defined (e.g. by Fairburn et al., 2008) as an eating episode in which the amount is known at the outset with some certainty, and which lacks a repetitious element. SBEs, on the other hand, are usually rated as discrete episodes which always entail a sense of loss of control, and where the amount consumed is considered "large" by those engaging in this behaviour.

One of the major dimensions along which definitions within the available literature vary is loss of control over eating. Some studies (e.g. Kofman, Lent, & Swencionis, 2010) consider loss of control to be an important facet of grazing, while others (e.g. Reslan, Saules, Greenwald, & Schuh, 2014) specifically exclude loss of control from their provided definition of grazing. Accordingly, there is some debate as to whether the different terms which have been used to describe grazing (such as "picking and nibbling" and "uncontrolled eating") actually represent distinct behaviours. Some authors (e.g. Conceição et al., 2014; Masheb, Roberto, & White, 2013) explicitly differentiate between these eating patterns and grazing, on the grounds that they have either been conceptualised as excluding a sense of loss of control, or at least as not specifically including a sense of loss of control. Conceição et al. (2014) noted that "a sense of loss of control" was the dimension with the least agreement among the surveyed experts.

Some research has found that grazing is a common eating behaviour in healthy-weight non-clinical samples; Reas, Wisting, Kapstad, and Lask (2012) found that 40% of the young adult university students surveyed reported "nibbling" on 14–28 days out of the past 28, and that this pattern of eating was not associated with increased BMI, binge eating, compensatory behaviours or other eating psychopathology. Lane and Szabó (2013), however, found (also in a young adult university student sample) that grazing was associated with shape and weight concern and a tendency to binge eat, indicating that at least a subsample of the population does experience grazing as a problematic eating behaviour (Conason, 2014). Most of the currently-available information about grazing in groups other than healthy community participants has resulted from research in obese populations undergoing bariatric surgery (Lane & Szabó, 2013). In this group, there has been some indication that patients who binge eat pre-surgery convert to a grazing pattern post-surgery, once binge episodes are no longer physically possible (Saunders, 2004). Grazing has also been observed in the obese population prior to bariatric surgery, and has been linked to reduced treatment success for obesity (Colles, Dixon, & O'Brien, 2008). Some research, however, has also found that pre-surgical grazing may have some positive effects in terms of weight loss maintenance post-surgery (Legenbauer, de Zwaan, Muhlhans, Petrak, & Herpertz, 2010). Grazing has been linked to negative affect and stress in both clinical (Colles et al., 2008) and non-clinical samples (Lane & Szabó, 2013), which is similar to other problematic eating behaviours. Given its unplanned and repetitious nature, and considering associations with external and emotional eating (Lane & Szabó, 2013), grazing may also be conceptually regarded as a habitual behaviour, performed automatically in response to internal emotional states, and/or food-related cues in the environment (Davis et al., 2008).

1.1. Rationale and aims for the current review

There is a need to explore the full range of problematic eating patterns manifesting in both obesity and EDs, which have the potential to detrimentally affect treatment outcomes. We are not aware of a recent systematic review examining the prevalence and correlates of grazing in both community-dwelling and treatment-seeking individuals with ED and/or obesity, including all treatment modalities for obesity reduction and/or treatment of ED symptomatology (for a review aimed more specifically at examining the prevalence of grazing in bariatric surgery samples, and the impact of grazing on bariatric surgery outcomes, see Conceição et al., 2014). A broad investigation is therefore warranted to determine if grazing is a clinically significant pattern of eating in obese and ED populations, in order to inform the development of assessment and treatment components specifically aimed at this behaviour. Therefore, we conducted a systematic review and meta-analysis aiming to: (1) derive prevalence estimates of grazing (pre- and post-treatment, and in the community) and (2) determine clinical correlates and treatment outcomes, in adults with grazing and an eating disorder and/or obesity.

2. Method

2.1. Search strategy

A search strategy was designed to identify all studies of adults with eating disorders or obesity, in which the prevalence and/or associated features or treatment outcomes of grazing had been assessed. A literature search of published studies was conducted in May 2014 and updated in July 2016. The following electronic databases were systematically searched: Medline (1950–present), PsycINFO (1806–present), Web of Science (1900–present), Embase (1974–present), and CINAHL (1982–present). See Fig. 1 for search terms. All subject headings were exploded in order to expand the search. Search limiters included English language, human research, peer-reviewed journal articles, and adult participants. Additionally, a manual search of the reference

(graz* OR pick* or nibbl* OR maladaptive eating OR atypical eating OR unplanned eating OR repetitious eating OR frequent eating OR compulsive eating OR subjective bing* OR partial eating syndrome OR subclinical eating OR uncontrolled eating OR repetitive eating OR constant overeating OR content eating OR chaotic eating OR unstructured eating OR continuous eating OR external eating OR hyperphagia OR stuffing syndrome OR between-meal snack OR between-mean eating OR snack*)
AND
(obesity OR anorexia nervosa OR bulimia nervosa OR binge eating disorder OR ednos OR eating disorder not otherwise specified OR other specified feeding or eating disorder OR unspecified feeding or eating disorder)
NOT
(pick disease OR skin pick* OR excoriation OR scratch* OR dermatillomania OR sheep OR cow OR cattle OR herbivore OR livestock).

Fig. 1. Search terms used in electronic databases to identify relevant articles.

sections of eligible studies was performed, and the main search terms were also used in a Google Scholar search.

2.2. Selection of studies

The review process is shown in Fig. 2 (figure format taken from Moher, Liberati, Tetzlaff, Altman, & The PRISMA Group, 2009). In total, 2815 articles were retrieved from the electronic database search, and 18 additional articles were selected from relevant reference lists and a Google Scholar search. After removing 371 duplicates, titles and abstracts were screened to determine the suitability of papers. Based on title, 1072 articles were excluded, and a further 1002 articles were excluded based on the abstract, leaving 388 articles for full-text review. From reviewing the full-text articles if was concluded that 350 did not meet the inclusion criteria. In total, 38 studies (comprising 37 data sets) were included in the review; of these, 32 studies (31 data sets) included

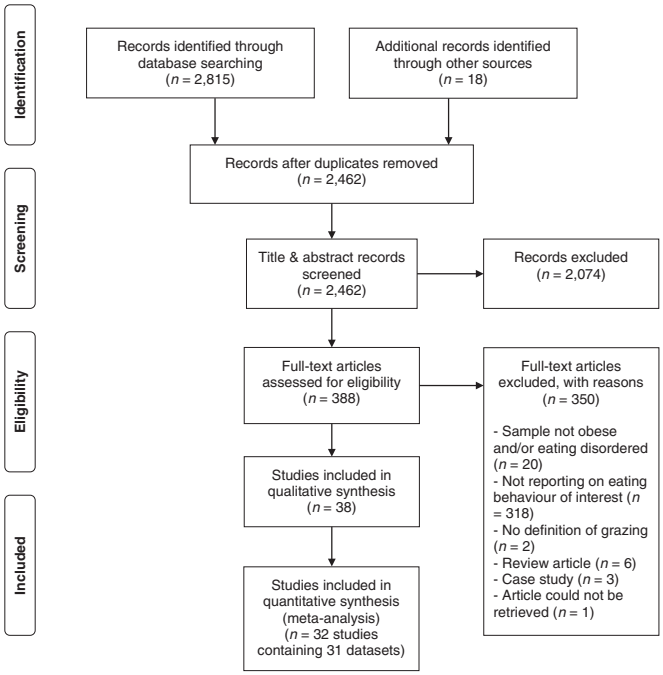


Fig. 2. PRISMA flow diagram for publication selection.

prevalence data, which was meta-analysed. To reduce selection bias, a second author (ST) independently screened a proportion of abstracts and full-text articles according to the inclusion and exclusion, leading to substantial agreement (k = 0.7). Disagreements between the two reviewers were discussed and resolved during a consensus meeting.

The inclusion criteria were: (1) prevalence of grazing and/or correlates of grazing (such as psychopathology, or treatment outcomes) were reported; (2) a definition of grazing was provided, or could be inferred from the assessment instrument used; (3) participants met the diagnostic criteria for current or lifetime anorexia nervosa, bulimia nervosa, binge eating disorder, Eating Disorder Not Otherwise Specified, or Other Specified/Unspecified Feeding or Eating Disorder according to DSM-5 (American Psychiatric Association, 2013), DSM-IV-TR (American Psychiatric Association, 2000), DSM-IV (American Psychiatric Association, 1994), DSM-III-R (American Psychiatric Association, 1987), DSM-III (American Psychiatric Association, 1980) or ICD-9 (World Health Organization, 1977) or 10 (World Health Organization, 1992) criteria, or were classified as obese on the basis of a BMI of $\geq 30\ kg/m^2$; (4) participants were over 18 years of age and under 65 years of age; (5) publication in a peer-reviewed journal; (6) available in English.

Studies that did not include a relevant ED or obesity sample or subsample were excluded. Papers were also excluded if they were review articles or case studies, and also conference abstracts, dissertations, government reports and issue papers, as a complete systematic search of these sources was not possible. No restrictions were placed on year of publication, sex of participants, or study type (e.g. observational, interventional). The search was not restricted to studies using reliable and valid instruments for assessing grazing, in order to better capture this behaviour which has only recently started to gain research and clinical attention.

2.3. Quality assessment

The final retrieved articles were assessed using a version of the Quality Index amended by Ferro and Speechley (2009) from Downs and Black (1998), modified to exclude 12 items addressing characteristics of intervention studies, such as blinding, withdrawals, and randomisation. The Quality Index is a valid and reliable tool for measuring the methodological quality of epidemiology and health research (The Standards of Reporting Trials Group, 1994). The amended version comprises 15 items, each of which is scored as “0” (“No”/“Unable to determine”) or “1” (“Yes”). The minimum score is 0 and the maximum score is 15, with

Table 1
Key characteristics of included studies and reported prevalence and/or clinical associations of grazing.

Author (Year)	Country	QIS	Type of sample/ subsample used	Participants	Pre-treatment (point)	Prevalence		Community	Higher BMI or WR/Lower WL	ED diag.	Associations	Mental health	QoL	Other psych. Factors
						Post-treatment (point)	Lifetime				ED symptoms			
Alfonsson, Parling, and Ghaderi (2012)	Sweden	11	OB	OB BS candidates	46.2%									
Burgmer et al. (2005)	Germany	12	OB	OB BS patients with and without ED	19.5%		24%		No assoc.					
Busetto et al. (2002)	Italy	10	OB	OB BS patients with and without BED	42.7%				No assoc.					
Colles et al. (2008).	Australia	12	OB/ED	OB BS patients with and without BED	26.4% (overall)	37.98% (overall); 61.1% (BED)			Pos. assoc.	Pos. assoc.	Pos. assoc.	Neg. assoc.	Neg. assoc.	
Conceição et al. (2013)	Portugal/USA	10	ED	Treatment-seeking participants with BED, BN and AN	57.6% (BN); 34.3% (AN); 44.0% (BN)				No assoc.	Pos. assoc.	No assoc.			
Conceição et al. (2014)	Portugal/USA	10	OB	OB BS patients	29.5%	16.7% (6mth). 36.4% (1 yr). 5.3% (2 yr).			Mixed assoc.		Mixed assoc.			
De Cesare et al. (2014)	Italy	7	OB	OB BS patients	29.4%	24.1%			No assoc.					
de Zwaan et al. (2010)	Germany/USA	11	OB/ED	OB BS patients with and without ED		32.2% (overall)			No assoc.	No assoc.				
Goodpaster et al. (2016)	USA	10	OB/ED	OB BS patients with and without BED	33.0% (overall); 39.7% (BED)					Pos. assoc.	Pos. assoc.	Neg. assoc.		No assoc.
Gowey et al. (2016)	USA	10	OB	OB participants in youth non-surgical lifestyle change programs	29.6%									Pos. assoc.
Harvey et al. (1994)	USA	10	ED	Participants with BN in inpatient program	62.0% (BN)	32.0% (BN)								
Herpertz et al. (2006)	Germany	13	OB	Treatment-seeking OB participants and OB and HW community controls.	26.7% (overall); 19.0% (BS); 31.5% (other tx.)		29.7% (overall); 23.5% (BS); 33.5% (other tx.)	14.1% (point); 14.1% (lifetime)						
Hsu, Betancourt, and Sullivan (1996)	USA	10	OB	OB BS patients	8.3%									
Keski-Rahkonen et al. (2007)	USA/Finland	9	OB	Community OB sub-group within larger twin study.					Pos. assoc.					
Kofman et al. (2010)	USA	11	OB	OB BS patients		46.6%			Pos. assoc.				Neg. assoc.	
Legenbauer et al. (2010)	Germany	12	OB	OB participants in VLCD program	33.1%	22.9%	34.3%		Mixed assoc.					
Levin et al. (2014)	USA	9	OB	OB BS patients	52.3%							No assoc.		Mixed assoc.
Mack et al. (2016)	Germany	12	OB	OB BS patients		39.0%			Pos. assoc.			Neg. assoc.		
Masheb et al. (2011)	USA	10	ED	Community sample of women with BN, BED and healthy controls.					No assoc.	Pos. assoc.	No assoc.			

(*continued on next page*)

Table 1 (*continued*)

Author (Year)	Country	QIS	Type of sample/ subsample used	Participants	Pre-treatment (point)	Prevalence		Community	Higher BMI or WR/Lower WL	ED diag.	Associations	Mental health	QoL	Other psych. Factors
						Post-treatment (point)	Lifetime				ED symptoms			
Masheb et al. (2013)	USA	12	ED	Treatment-seeking OB participants with BED	89.8% (BED)				No assoc.		No assoc.			
Mazzeo et al. (2005)	USA	8	OB	OB BS patients										
Mazzeo et al. (2006)	USA	8	OB	OB BS patients										
Melo et al. (2015)	Brazil	13	OB	Treatment-seeking OB participants	50.0%						Pos. assoc.			
Micanti et al. (2016)	Italy	9	OB	Treatment-seeking OB participants	23.3%						Mixed assoc.	Mixed assoc.	Mixed assoc.	Mixed assoc.
Mitchell et al. (2015)	USA	11	OB/ED	OB BS patients	43.4% (overall); 78.4% (BED)					Pos. assoc.				
Nicolau et al. (2015)	Spain	10	OB/ED	OB BS patients		41.7% (overall)			Pos. assoc.	No assoc.		No assoc.	Mixed assoc.	Pos. assoc.
Parker, Mitchell, O'Brien, and Brennan (2015)	Australia	9	OB	OB BS patients		19.6% (EDE-Q); 16% (QEWP-R).								
Poole et al. (2005)	UK	10	OB	OB BS patients	50.0% (overall); 78.0% (poor compliers); 22.0% (controls)									Pos. assoc.
Rasheed (1998)	Saudi Arabia	10	OB	Community sample with OB sub-group.				38.6%	Pos. assoc.					
Reslan et al. (2014)	USA	10	OB	OB BS patients							Mixed assoc.	No assoc.		
Robinson et al. (2014)	USA	10	OB	OB BS patients					Pos. assoc.					
Rossiter et al. (1992)	USA	10	ED	Treatment-seeking atypical BN participants	27.3% (BN)									
Saunders (1998)	USA	11	OB	OB BS patients	59.8%						Pos. assoc.			
Saunders (1999)	USA	11	OB	OB BS patients	59.8% (same dataset as Saunders 1998)									
Silva et al. (2008)	Portugal	8	OB	OB BS patients	13.7%				No assoc.				Mixed assoc.	
Succurro et al. (2015)	Italy	10	OB/ED	Treatment-seeking OB participants with and without BED	55.7% (overall); 77% (BED); 48% (non-BED)					Pos. assoc.				
Tordjman (1994)	France/USA	9	ED	Community sample with BN sub-group.				100.0% (BN)		Pos. assoc.				
van Hout, Jakimowicz, Fortuin, Pelle, and van Heck (2007)	Netherlands	10	OB	OB BS patients	9.4%	0–2.0%								

Note. AN = anorexia nervosa; BED = binge eating disorder; BMI = Body Mass Index; BN = bulimia nervosa; BS = bariatric surgery; BST = brief strategic therapy; Diag. = diagnosis; ED = eating disorder; HW = healthy weight; LS = lifestyle change; Mixed assoc. = mixed findings; No assoc. = no association; OB = obese; Pos. assoc. = positive association; QIS = Quality Index Score; QoL = quality of life; tx. = treatment; VLCD = very low calorie diet; WL = weight loss; WR = weight regain.

higher scores indicating greater methodological quality. Scores of above 10 were considered to represent studies of high quality. This categorisation of scores represents a similar approach to that employed in a recent systematic review of another atypical eating behaviour (chew and spit; Aouad, Hay, Soh, & Touyz, 2016) which also used a cut-off of > 10 on the QIS to assess study quality.

2.4. Assessment of grazing definition and of grazing measure used

The 38 included papers were also rated along three additional dimensions, to define groups for conducting sensitivity analyses. A score of 0–3 was given to papers based on the comprehensiveness of the definition of grazing used, i.e. whether their definition of grazing included the three main features endorsed by expert consensus in Conceição et al. (2014): (1) "repetitive" eating (i.e., more than two eating occasions over the same time period); (2) "small/modest amount of food" (i.e. smaller than would constitute a meal); and (3) unplanned (i.e. outside of planned meals and snacks).

Two binary 0/1 ratings were also applied for instruments used to assess grazing. The first rating assessed whether studies used a grazing-specific instrument, such as the Grazing Questionnaire (Lane & Szabó, 2013) or the REP(EAT) assessment proposed by Conceição et al. (2014), with studies receiving a score of "1" if they did use such an instrument, or "0" if they did not.

The second binary rating was based on whether assessment of grazing was conducted using a validated instrument (whether or not it was grazing-specific). A rating of "1" was given if studies used a validated instrument such as the SIAB (Fichter, Herpertz, Quadflieg, & Herpertz-Dahlmann, 1998), and "0" if the instrument was not validated (e.g. if grazing was assessed by custom clinical interview).

2.5. Meta-analysis of prevalence data

Meta-analysis of prevalence data was conducted using the MetaXL v5.3 software (Barendregt & Doi, 2011–2016). Given the multiple sources of heterogeneity between included studies (e.g. due to differing study designs, methodological quality, and measures used to assess grazing) random effects models were used. Freeman-Tukey double arcsine transformations and back-transformations were employed to generate weighted summary prevalence proportions and 95% CIs (Barendregt, Doi, Lee, Norman, & Vos, 2013). Additionally, Cochran's Q and I^2 statistics were generated where possible for the assessment of heterogeneity (Julian, Thompson, Deeks, & Altman, 2003). Heterogeneity was indicated through a significant Cochran's Q statistic ($p < 0.05$), and also through an elevated I^2 value (representing the percentage of total variation across studies that is due to heterogeneity, rather than to chance). Where the number of cases of grazing was not available, this was derived from percentages provided and total sample size. Most studies which reported information on rate of grazing used point prevalence, i.e. rate of grazing in the study sample at the time of the assessment. A small number of studies provided lifetime rates, i.e. the number of participants who had engaged in grazing at any point in time (not only at the point of study assessment), out of the study sample. These two types of prevalence rates were analysed and reported separately.

In addition to overall analyses of prevalence, sensitivity analyses were conducted using: (1) studies which received a 3/3 score for their definition of grazing; (2) studies which used a grazing-specific instrument; and (3) studies which used a validated assessment method.

3. Results

3.1. Description of studies

The 38 studies reviewed are indicative of the research conducted on the topic of grazing in adults with eating disorders or obesity over a 24-year period, from 1992 to 2016. There were seven studies published between 1990 and 1999, 10 between 2000 and 2009, and 21 between 2010 and 2016, indicating increasing interest in the topic of grazing. For key study characteristics and results across all included studies, see Table 1. For key characteristics of the subset of studies included in sensitivity analyses, see Table 6, available as a supplementary eComponent; for detailed study and sample characteristics, definitions of grazing, descriptions of measures, associations found, and limitations for all included studies, see eComponent Tables 7 and 8.

All but six studies reported the prevalence of grazing in their study sample or in a sub-sample of interest. Thirty-three studies took place in health services such as hospital bariatric surgery programs, or obesity specialty clinics. Three studies involved data collection from community samples that included a sub-group of interest (EDs or obesity), and two studies examined post-bariatric surgery patients in the community. Of the 34 treatment studies (comprising 33 individual data sets), 24 studies (23 data sets) involved bariatric surgery only, five involved only psychological, nutritional or lifestyle interventions for obesity or EDs, while four involved both bariatric surgery and other treatment aimed at reducing obesity. One study did not specify treatment type. Six studies investigated baseline predictors of treatment success (such as percentage excess weight loss/EWL, weight loss maintenance, or compliance with post-treatment medical advice) while nine studies investigated associations between post-treatment factors and treatment success. Most studies utilised a cross-sectional design. The included studies were conducted predominantly in the USA (18 studies) and Europe (16 studies), but also in Australia (2 studies), Brazil (1 study), and Saudi Arabia (1 study).

3.2. Quality assessment

The mean total score on the Quality Index was 10.21/15.00 (SD = 1.36), with scores ranging from 7 to 13. The mean subscale scores were: 5.95/7.00 (SD = 0.84; range 3–7) for quality of reporting, 1.39/3.00 (SD = 0.64; range 1–3) for external validity and 2.84 (SD = 0.64; range 2–4) for internal validity. Most studies clearly described hypotheses, sample characteristics and main findings, and applied appropriate statistical methods. However, many studies did not demonstrate that participants were representative of the population from which they came (i.e. by using a random or consecutive sample, considering the distribution of confounding factors in the sample vs. the originating population), did not use valid/reliable instruments for the assessment of grazing, and did not report a power/sample size calculation. Of the 38 studies, 13 had a QIS of over 10, indicating that approximately one third of the included studies were of high methodological quality. A majority of studies (32 studies; 84.2%) obtained a score between 9 and 12.

3.3. Measures

3.3.1. Assessment of grazing: instruments

Of the 38 included studies, six used validated instruments for assessing grazing: four used the SIAB, which defines grazing as "atypical 'binges' extending over a longer period of time, without planning meals" (assessed as distinct from OBE/SBE; Fichter et al., 1991; Fichter et al., 1998; Fichter & Quadflieg, 2000), and two used EDE 16.0D (Fairburn et al., 2008), which define grazing as "picking at (or nibbling) food in between meals, in an unplanned and repetitious way, without loss of control." The remaining 32 studies used unvalidated measures. Of these, three studies used the EDE-BSV (or EDE-BSV items), an adapted version of the EDE modified to account for post-operative eating patterns resulting from bariatric surgery (de Zwaan et al., 2010). Six studies added grazing items to existing questionnaires: EDE-Q/EDE-Q6 (Fairburn & Beglin, 1994; Fairburn & Beglin, 2008) (two studies), QWEP/QWEP-R (Spitzer et al., 1992; Spitzer et al., 1993) (four studies, including one study which also used a modified version of the EDE-Q6)

Table 2
Definition of grazing and validated assessment measures used across studies selected for inclusion in sensitivity analyses.

Author (Year)	Measure	Validated	Definition of grazing	Definition score/3
Studies using validated measures				
Burgmer et al. (2005)	SIAB	Yes	"Atypical "binges" (or grazing) extending over a larger period of time. Eating the whole day long or during part of the day (e.g. in the evening) without planning meals. The amounts of food consumed are small."	2
Conceição et al. (2013)	EDE 16.0D	Yes	"Picking at (or nibbling) food in between meals, in an unplanned and repetitious way. The amount eaten should not be trivial and should be uncertain at the outset of the episode (typically constitutes part of something or a less-than-usual amount)."	3
Herpertz et al. (2006)	SIAB	Yes	As above for the SIAB	2
Legenbauer et al. (2010)	SIAB	Yes	As above for the SIAB	2
Mack et al. (2016)	SIAB	Yes	As above for the SIAB	2
Masheb et al. (2013)	EDE 16.0D	Yes	As above for the EDE	3
Studies using a comprehensive definition of grazing				
Conceição et al. (2013)	EDE 16.0D	Yes	As above for the EDE	3
Conceição et al. (2014)	EDE-BSV	No	"Picking or nibbling": "Eating modest amounts of food in an unplanned and repetitious way, without a sense of loss of control."	3
Masheb et al. (2013)	EDE 16.0D	Yes	As above for the EDE	3
Robinson et al. (2014)	Custom	No	Grazing frequency: "How often do you graze (defined as nibbling, snacking, or eating small amounts of food in an unplanned and repetitious way) over an extended period of time?"	3
Succurro et al. (2015)	Custom	No	Grazing: "as repetitive, unplanned eating of small amounts of food, constantly throughout the day, in response to stress, boredom or other non-hunger cues, frequently with sense of loss of control, more than twice a week."	3

Note. EDE = Eating Disorder Examination; EDE-BSV = Eating Disorder Examination - Bariatric Surgery Version; SIAB = Structured Interview for Anorexia and Bulimia Nervosa.

and EEBQ (Brandon, 1988) (one study). Fifteen studies used custom unstructured, structured or semi-structured clinical interviews to obtain information on grazing, which was operationalised in various ways, for example as "eating small quantities of food repetitively between meals, typically triggered by inactivity and/or loneliness" (Busetto et al., 2002), "the consumption of smaller amounts of food continuously over an extended period of time, eating more than the subject considers best for them" (Colles et al., 2008), "continual grazing on food" (Poole et al., 2005), "continuous nibbling" (Silva, Pais-Ribeiro, & Cardoso, 2008), and as "regularly eating significant amounts of food between meals" (assessed as distinct from binge eating episodes) by Tordjman, Zittoun, Anderson, Flament, and Jeammet (1994). Nine studies used custom questionnaires to administer to participants, including the following items: "I graze throughout the evening" (Keski-Rahkonen et al., 2007), "nibbling continuously at least two days a week for a six-month period, in addition to an inability to stop or control eating while nibbling" (Kofman et al., 2010), "nibbling at food without being aware of it" (Rasheed, 1998), and "eating small portions of food continuously, or larger amounts of food over an extended time in the past six months" (Saunders, 1999). A single study used a self-reported food diary (Rossiter, Agras, Telch, & Bruce, 1992); in this study, grazing was conceptualised as consisting of at least four repetitive eating occasions, no more than 30 min apart.

3.3.2. Assessment of grazing: loss of control

Six studies (Goodpaster et al., 2016; Gowey et al., 2016; Kofman et al., 2010; Micanti et al., 2016; Mitchell et al., 2015; Succurro et al., 2015) used a definition of grazing which incorporated a sense of loss of control. This included one study which assessed grazing with and without a sense of loss of control (Gowey et al., 2016), and another (Goodpaster et al., 2016) which specifically compared grazing with and without loss of control. Five studies stated that they excluded loss of control from their definition of grazing (Conceição et al., 2013; Conceição et al., 2014; de Zwaan et al., 2010; Masheb et al., 2013; Reslan et al., 2014). The remaining twenty-seven studies used definitions which did not specifically include or exclude a sense of loss of control.

3.3.3. BMI assessment

In 19 studies, trained clinical/research staff collected anthropometric measurements, five studies used self-reported height/weight/BMI, two studies only collected self-report data at follow-up but had trained staff collect this data at baseline, two used hospital records, and in ten studies the method for collecting weight and height data was unclear.

3.3.4. Eating disorder assessment

Of the 12 studies that collected data on EDs and associations or prevalence of grazing in their sample, six used custom clinical interviews or semi-structured clinical interviews to establish eating disorder diagnoses (Colles et al., 2008; Goodpaster et al., 2016; Harvey, Rawson, Alexander, & Bachar, 1994; Nicolau et al., 2015; Rossiter et al., 1992; Tordjman et al., 1994), while four used established semi-structured interviews (EDE-16.0D: Conceição et al., 2013; Masheb et al., 2013; EDE-BSV: de Zwaan et al., 2010; SCID: Succurro et al., 2015). One study used a custom self-report screening measure (Mitchell et al., 2015), while one used the EDE-Q (Masheb, Grilo, & White, 2011).

3.4. Sensitivity analyses

Only five out of the 38 studies met all three definitional criteria derived through expert consensus in Conceição et al. (2014). Ten studies met 2/3 criteria; 12 studies met 1/3 criteria, while 11 studies did not meet any of the three criteria. The criterion least often met was "repetitive eating" (not met in 26/38 studies), followed by "unplanned" (22/38 studies), while the "small amount" criterion was unmet by 19/38 studies. Six studies used validated instruments to assess grazing, with two instruments used in these studies: the EDE 16.0D (Fairburn et al., 2008) and the SIAB (Fichter et al., 1998). None of the 38 studies used a grazing-specific measure to assess this eating behaviour, hence a sensitivity analysis based on this criterion could not be performed.

Definitions of grazing and measures used in the studies which were included in the two sensitivity analyses are presented in Table 2. The prevalence of grazing according to the two sensitivity analyses performed is described below for major study groups, and full sensitivity analysis results are displayed in Tables 4 and 5. Results regarding clinical correlates of grazing within the papers included in the two sensitivity analyses are discussed below, and are also listed in Table 6 (available as an eComponent).

Table 3
Prevalence of grazing across obesity and ED studies.

Group	n (studies)	n (ppts)	Reported range (%)	Mean pooled prev.	*SE*	95% LL	95% UL	Cochran's Q	Chi-sq *p*	I^2	95% LL I^2	95% UL I^2
Obesity												
OB pre-treatment	19	6567	8.33–59.84	33.20%	0.063	27.54%	39.11%	371.73	< 0.001	95.16	93.61	96.33
OB pre-surgery	15	4824	8.33–59.84	30.86%	0.074	24.30%	37.82%	273.59	< 0.001	94.88	92.95	96.28
OB pre-nonsurgical treatment	2	417	31.47–33.13	32.17%	0.049	27.77%	36.74%	0.13	0.72	–	–	–
OB pre-treatment LT	3	719	24.16–34.34	29.50%	0.055	24.68%	34.56%	3.90	0.14	48.74	0.00	85.08
OB pre-surgery LT	2	302	23.53–24.16	23.93%	0.057	19.28%	28.91%	0.02	0.90	–	–	–
OB pre-nonsurgical treatment LT	2	417	33.47–34.34	33.85%	0.049	29.38%	38.47%	0.04	0.85	–	–	–
OB post-treatment	11	1731	1.12–47.08	28.16%	0.123	17.86%	39.73%	241.30	< 0.001	95.86	94.09	97.09
OB post-surgery	9	1511	1.12–47.08	28.53%	0.147	16.28%	42.54%	235.74	< 0.001	96.61	95.08	97.66
OB post-nonsurgical treatment	2	220	22.89–29.63	24.62%	0.068	19.06%	30.64%	1.02	0.31	1.91	–	–
OB community	2	185	14.06–38.60	23.32%	0.284	3.07%	52.04%	12.82	< 0.001	92.20	73.29	97.72
OB community LT	1	128	14.06	14.06%	0.088	8.52%	20.67%	–	–	–	–	–
Eating disorders												
All ED pre-treatment	7	1387	27.27–89.86	62.19%	0.187	43.42%	79.34%	221.32	< 0.001	97.29	95.96	98.18
BED pre-treatment	5	914	39.66–89.86	67.77%	0.225	44.96%	87.13%	162.06	< 0.001	97.53	96.04	98.46
BN pre-treatment	2	314	57.58–62.00	58.25%	0.056	52.75%	63.66%	0.31	0.58	–	–	–
AN pre-treatment	1	137	34.31	34.31%	0.085	26.56%	42.49%	–	–	–	–	–
Atypical BN pre-treatment	1	22	27.27	27.29%	0.211	10.39%	48.06%	–	–	–	–	–
BN post-treatment	1	50	32.00	32.00%	0.141	19.70%	45.67%	–	–	–	–	–
BED post-surgical treatment	1	18	61.11	61.10%	0.232	37.32%	82.58%	–	–	–	–	–
BN community	1	3	100.00	93.30%	0.535	49.97%	100.00%	–	–	–	–	–

Note. AN = anorexia nervosa; BED = binge eating disorder; BN = bulimia nervosa; ppts = participants; EDs = eating disorders; LL = lower limit; LT = lifetime; OB = obese; ppts = participants; prev. = prevalence; SE = standard error; UL = upper limit.

3.5. Prevalence of grazing in obesity

Nineteen studies (n = 6567 participants) provided baseline prevalence of grazing in an obese sample or sub-sample prior to bariatric surgery or other treatment, such as psychological and/or nutritional treatment. The mean pooled prevalence at pre-treatment was 33.20% (30.86% across 15 bariatric surgery samples, and 32.17% in two non-bariatric surgery treatment samples). For full grazing prevalence data in obesity including CIs see Table 3. One study (Masheb et al., 2013) used a sample of participants with obesity and BED, which found a pre-surgical grazing rate of 89.86%. Given that this group is qualitatively different to the other obesity study samples (which may have included participants with BED, but did not specifically target such participants), this study was not used in the analysis of grazing prevalence in obesity, but only in EDs.

Sensitivity analyses of prevalence yielded a mean pooled prevalence at pre-treatment of 42.33% across two studies (n = 176 participants) meeting the definition of grazing derived through expert consensus, and a mean pooled prevalence of 26.34% across three studies (n = 719 participants) using a validated assessment measure.

Three of the pre-treatment studies also provided lifetime prevalence of grazing in individuals with obesity who were seeking treatment (Burgmer et al., 2005; Herpertz et al., 2006; Legenbauer et al., 2010). Eleven studies (n = 1731 participants) provided prevalence of grazing at follow-up after obesity treatment: nine in post-operative bariatric surgery patients, one after a lifestyle intervention (Gowey et al., 2016), and one in patients who had undergone very low calorie diet treatment (VLCD; Legenbauer et al., 2010). Mean pooled prevalence at follow-up was 28.16% (28.53% in nine bariatric surgery samples, and 24.62% in two non-surgical treatment samples). Time to follow-up varied considerably among these studies, ranging from six months to 10 years. Sensitivity analyses produced a comparable mean pooled prevalence at follow-up of 29.59% across two studies (n = 241 participants) using a validated assessment measure; only one study (n = 303) meeting the full definition of grazing provided a follow-up prevalence rate, which was 33.99%.

Two studies (n = 185) provided point prevalence data on participants with obesity in the community (Herpertz et al., 2006; Rasheed, 1998); the mean pooled prevalence was 23.32%. Only Herpertz et al. (2006) provided lifetime rates of grazing in this group.

Substantial heterogeneity was found among the studies within the pre-treatment, follow-up and community obesity groups, indicated by

Table 4
Sensitivity analysis of the prevalence of grazing across obesity and ED studies using a comprehensive definition of grazing.

Group	n (studies)	n (ppts)	Reported range (%)	Mean pooled prev.	*SE*	95% LL	95% UL	Cochran's Q	Chi-sq *p*	I^2	95% LL I^2	95% UL I^2
Obesity												
OB pre-treatment	2	176	29.51–55.65	42.33%	0.264	17.29%	69.41%	11.16	< 0.001	91.04	68.12	97.48
OB pre-surgery	1	61	29.51	29.51%	0.128	18.65%	41.65%	–	–	–	–	–
OB post-treatment	1	303	33.99	33.99%	0.057	28.76%	39.43%	–	–	–	–	–
OB post-surgery	1	303	33.99	33.99%	0.057	28.76%	39.43%	–	–	–	–	–
Eating disorders												
All ED Pre-treatment	3	907	47.42–89.86	72.49%	0.377	34.79%	100.00%	157.07	< 0.001	98.73	97.83	99.25
BED pre-treatment	3	506	44.02–89.86	71.50%	0.393	31.67%	100.00%	128.08	< 0.001	98.44	97.24	99.12
BN pre-treatment	1	264	57.58	57.58%	0.061	51.56%	63.49%	–	–	–	–	–
AN pre-treatment	1	137	34.31	34.31%	0.085	26.56%	42.49%	–	–	–	–	–

Note. AN = anorexia nervosa; BED = binge eating disorder; BN = bulimia nervosa; EDs = eating disorders; LL = lower limit; OB = obese; ppts = participants; prev. = prevalence; SE = standard error; UL = upper limit.

Table 5
Sensitivity analysis of the prevalence of grazing across obesity and ED studies using a validated measure to assess grazing.

Group	n (studies)	n (ppts)	Reported range (%)	Mean pooled prev.	*SE*	95% LL	95% UL	Cochran's Q	Chi-sq *p*	I^2	95% LL I^2	95% UL I^2
Obesity												
OB pre-treatment	3	719	19.46–33.13	26.34%	0.077	19.90%	33.32%	7.57	0.02	73.59	11.58	92.11
OB pre-surgery	2	302	18.95–19.46	19.31%	0.057	15.04%	23.96%	0.01	0.91	0.00	0.00	0.00
OB pre-nonsurgical treatment	2	417	31.47–33.13	32.17%	0.049	27.77%	36.74%	0.13	0.72	0.00	0.00	0.00
OB Pre-treatment LT	3	719	24.16–34.34	29.50%	0.055	24.68%	34.56%	3.90	0.14	48.74	0.00	85.08
OB Pre-surgery LT	2	302	23.53–24.16	23.93%	0.057	19.28%	28.91%	0.02	0.90	0.00	0.00	0.00
OB pre-nonsurgical treatment LT	2	417	33.47–34.34	33.85%	0.049	29.38%	38.47%	0.04	0.85	0.00	0.00	0.00
OB post-treatment	2	241	22.89–38.67	29.59%	0.171	15.17%	46.31%	6.13	0.01	83.69	32.48	96.06
OB post-surgery	1	75	38.67	38.67%	0.115	27.91%	50.00%	–	–	–	–	–
OB post-nonsurgical treatment	1	166	22.89	22.89%	0.077	16.79%	29.62%	–	–	–	–	–
OB community	1	128	14.06	14.06%	0.088	8.52%	20.67%	–	–	–	–	–
OB community LT	1	128	14.06	14.06%	0.088	8.52%	20.67%	–	–	–	–	–
Eating disorders												
All ED pre-treatment	2	877	47.42–89.86	70.89%	0.484	20.19%	100.00%	153.37	< 0.001	99.35	98.82	99.64
BED pre-treatment	2	476	44.02–89.86	69.39%	0.518	14.55%	100.00%	127.05	< 0.001	99.21	98.51	99.58
BN pre-treatment	1	264	57.58	57.58%	0.061	51.56%	63.49%	–	–	–	–	–
AN pre-treatment	1	137	34.31	34.31%	0.085	26.56%	42.49%	–	–	–	–	–

Note. AN = anorexia nervosa; BED = binge eating disorder; BN = bulimia nervosa; EDs = eating disorders; LL = lower limit; LT = lifetime; OB = obese; ppts = participants; prev. = prevalence; SE = standard error; UL = upper limit.

significant Cochran's Q values ($p < 0.001$) and I^2 of over 90%. Within the sensitivity analysis based on definition, most study subgroups contained less than two studies; hence, heterogeneity statistics could not be calculated in most cases. In the validated measure sensitivity analysis, heterogeneity decreased considerably, as shown through smaller I^2 values, and non-significant Cochran's Q values ($p > 0.05$) in most study sub-groups which included at least two studies.

3.6. Prevalence of grazing in EDs

Seven studies ($n = 1387$) provided baseline prevalence of grazing in ED samples prior to treatment: five studies in participants with BED, two in participants with BN, one in participants with AN and one in participants with an atypical BN (atypical, non-purging BN: similar to BED; based on DSM-III criteria). Mean pooled prevalence across EDs at pre-treatment was 62.19%. Sensitivity analyses yielded a mean pooled prevalence across EDs of 72.49% across three studies ($n = 907$ participants) using the full definition of grazing, and a comparable mean pooled prevalence of 70.89% across two studies ($n = 877$ participants) which used a validated assessment measure. For grazing prevalence data in ED sub-groups see Table 3. Treatment included weight reduction via bariatric surgery in two of the BED studies; psychological and/or nutritional treatment for EDs in three BN, AN, BED and atypical BN studies; a mix of psychological, nutritional and bariatric surgery in one BED study; and the type of treatment in the remaining BED study was unclear. Only two studies presented post-treatment grazing data (BN: Harvey et al., 1994; BED: Colles et al., 2008), and one study found a grazing rate of 100% in participants with BN in the community (Tordjman et al., 1994), however this relied on a very small sample (three participants with BN). Considerable heterogeneity was found within the overall ED pre-treatment group and the BED pre-treatment group; this remained high in the sensitivity analyses conducted. Heterogeneity statistics could not be calculated for the other sub-groups analysed.

3.7. Grazing and BMI

Herpertz et al. (2006) found no evidence of grazing in community-based healthy-weight participants, whereas the rate in community participants with obesity was ~14.06%, and in patients with obesity at pre-surgery/other treatment the rate was ~26.73% (these differences were not statistically compared, however). In two studies of bariatric surgery candidates, no significant association was found between grazing and pre-surgical BMI (Masheb et al., 2013; Silva et al., 2008).

In a population-based study, Keski-Rahkonen et al. (2007) found that grazing in young adulthood was associated with obesity in both men ($p < 0.01$) and women ($p < 0.001$), controlling for adolescent BMI. In a community primary care setting, Rasheed (1998) reported a trend for higher rate of grazing in mild-moderate obesity vs. non-obesity (38.6% vs. 24.3%, $p = 0.08$).

In ED samples, an association between grazing and BMI was not found either by Conceição et al. (2013) in samples at pre-psychological treatment for AN, BN and BED, or by Masheb et al. (2011) in community sample with BN or BED.

3.8. Grazing and obesity weight loss treatment outcomes

Five studies examined the relationship between grazing at baseline and various obesity treatment outcomes: four studies examined grazing as a predictor of weight loss, weight re-gain, or weight loss maintenance (Burgmer et al., 2005; Busetto et al., 2002; Colles et al., 2008; Legenbauer et al., 2010), and one study as a predictor of compliance with clinical recommendations following surgery (Poole et al., 2005). Nine studies reported on the relationship between grazing at follow-up and weight loss, weight regain and other outcomes (Colles et al., 2008; Conceição et al., 2014; De Cesare et al., 2014; de Zwaan et al., 2010; Kofman et al., 2010; Legenbauer et al., 2010; Mack et al., 2016; Nicolau et al., 2015; Robinson et al., 2014). The predominant treatment for weight loss across these studies was bariatric surgery, with only one study utilising a non-surgical intervention (VLCD; Legenbauer et al., 2010). The findings of these studies are explored below.

3.8.1. Baseline grazing

Colles et al. (2008) found that patients with pre-surgical grazing had lost less weight compared to those without grazing after controlling for BMI, and that a majority (94.1%) continued to graze. Poole et al. (2005) found that patients with baseline grazing were more likely to display poor post-surgical compliance with follow-ups/dietary advice. However, Burgmer et al. (2005) found no significant difference in average weight loss at 12-month post-bariatric surgery follow-up between patients with and without baseline grazing ($p = 0.661$). In line with these results, Busetto et al. (2002) found that pre-operative grazing did not

predict successful post-surgery weight loss (defined as %EWL > 50; RR 95%CI [0.69, 1.08]), post-surgical weight loss failure (%EWL < 20; RR 95%CI [0.76, 1.38]) or weight regain (> 10%EWL; RR 95%CI [0.79, 1.39]) one-three years post-surgery. Legenbauer et al. (2010) found that baseline grazing rate did not differ between those who had lost ≥ 10% of their initial body weight, and those who did not, at 12-month post-VLCD treatment ($p = 0.923$), and also that lifetime grazing had a positive influence on long-term weight loss maintenance ($p = 0.025$).

3.8.2. Grazing at follow-up

Seven out of nine studies found some adverse associations between grazing at follow-up and treatment outcomes (Colles et al., 2008; Conceição et al., 2014; Kofman et al., 2010; Legenbauer et al., 2010; Mack et al., 2016; Nicolau et al., 2015; Robinson et al., 2014). At the 12-month post-surgery follow-up by Colles et al. (2008), patients with post-surgical grazing had lost less weight than those without grazing ($p < 0.001$). In addition, over 60% of baseline participants with BED reported post-operative grazing. Those who grazed also reported a higher number of gastrointestinal symptoms ($p = 0.013$). Legenbauer et al. (2010) also reported that more unsuccessful weight loss maintainers (maintaining a loss of ≥ 5% of initial body weight) reported grazing, compared with successful weight loss maintainers, three years post-VLCD treatment ($p = 0.018$). de Zwaan et al. (2010) did not find an association between grazing 1.9 years post-operatively and the amount of postoperative weight loss ($p > 0.05$). Conceição et al. (2014) reported mixed effects: grazing at 6–24 months' follow-up was not significantly associated with weight loss, however there was a significant association with weight regain ($p < 0.0001$, 95%CI [−1.1, −0.4]). De Cesare et al. (2014) did not find a significant difference in number of participants with grazing among those with adequate and inadequate weight loss at 2–3 years post-surgery; this comparison was based on small *n*, however: 0/18 vs. 2/12 participants grazed, respectively.

In the longer term, Kofman et al. (2010) reported that grazing at three-10 year follow-up (mean = 4.2 years) was positively correlated with weight regain ($p < 0.001$) and negatively correlated with EWL ($p < 0.001$). In this study, participants who reported grazing two or more times a week had greater weight regain ($p < 0.001$) and less EWL ($p < 0.001$) than those with less frequent grazing. Mack et al. (2016) reported that at 1.75–6.67 year follow-up (mean = 4.0 years), patients who grazed at follow-up had lower %EWL (42.1 (19.0) vs. 55.3 (29.0), $p = 0.032$) and higher BMIs (40.4 (8.4) vs. 35.5 (7.7), $p = 0.034$), compared to those who did not graze. Similarly, Nicolau et al. (2015) found that at four year follow-up (mean = 46.28 months) patients who grazed had less %EWL and more weight regain ($p < 0.0001$), and more difficulty in adjusting lifestyle habits, such as following the recommended amount of physical exercise and alcohol intake. Robinson et al. (2014) found that post-surgical success rate (defined as ≥ 50% EWL) was higher in those who grazed less frequently vs. those who endorsed grazing more than once/day, at one-12 year follow-up (mean = 5.8 years).

Considering only results from the nine studies included in the two sensitivity analyses (i.e. studies which either used a more comprehensive definition of grazing, and/or which used a validated assessment instrument), of the five studies reporting on weight loss treatment in obesity, two studies found detrimental correlations between weight loss treatment outcomes and grazing (Mack et al., 2016; Robinson et al., 2014), two studies presented mixed findings (Conceição et al., 2014; Legenbauer et al., 2010), and one study did not find any relationship between grazing and weight loss treatment (Burgmer et al., 2005).

3.9. Grazing as a treatment outcome

Few obesity studies specifically examined grazing as a post-treatment outcome, rather than as a predictor of other outcomes. Two bariatric surgery studies which assessed this did not find a statistically significant difference in grazing between pre-surgical baseline rates and follow-up rates (Colles et al., 2008; De Cesare et al., 2014), although Colles et al. (2008) found a 31% increase in prevalence.

In terms of ED samples, only one study (examining inpatient treatment for BN; Harvey et al., 1994) reported on grazing as a treatment outcome. In this study, there was a statistically significant decrease in grazing that occurred at least weekly from 60% to 16% ($p < 0.0001$) at follow-up.

3.10. Grazing and ED diagnosis

In studies examining BED and grazing before treatment, two studies (Mitchell et al., 2015; Succurro et al., 2015) found that patients with BED had significantly higher rates of grazing than those without BED: 78.4% vs. 27.3% ($p < 0.001$) (Mitchell et al., 2015), and 77.0% vs. 48.0% ($p = 0.013$) (Succurro et al., 2015; the only study comparing grazing in BED vs. non-BED obese participants included in the sensitivity analyses), while Goodpaster et al. (2016) found that participants who had grazing with loss of control were more likely to have a diagnosis of BED than grazing patients without LOC, or those who denied grazing.

In studies looking at factors both pre- and post-treatment, two studies (de Zwaan et al., 2010; Nicolau et al., 2015) did not find an association between pre-surgical BED or BN (de Zwaan et al., 2010), or between BN, EDNOS (Nicolau et al., 2015) and post-surgical grazing. Of note, in Nicolau et al. (2015) only three participants out of 60 had an ED. Colles et al. (2008), however, found that during the first 6–12 post-surgical months, over 60% of patients with BED at baseline reported recurrent post-operative grazing, although as the number of patients with both baseline BED and grazing is not presented, it is not known if this high percentage could be accounted for by baseline grazing. Additionally, Colles et al. (2008) also found that pre-surgical grazing was significantly associated with uncontrolled eating (including BED) at post-surgical follow-up.

In the community, Masheb et al. (2011) found higher frequency of grazing in participants with BN and BED than control participants (15.9 and 14.1 vs. 8.9 days out of the past 28, $p < 0.017$).

Two studies compared grazing rate or frequency between different EDs. At pre-treatment, Conceição et al. (2013) found that participants with BN had a significantly higher rate of grazing than both those with AN or BED (57.6% vs. 34.3% and 44.0%, $p < 0.01$), with the BED rate of grazing being marginally significantly higher ($p = 0.06$) than that of participants with AN. Masheb et al. (2011) found that frequency of grazing did not significantly differ between BN and BED.

3.11. Grazing and ED psychopathology

Ten studies examined the relationship between grazing and various aspects of eating disorder psychopathology, such as binge eating, eating restraint and disinhibition.

Of the nine studies reporting on the relationship between grazing and bingeing, four reported positive associations between grazing and binge eating in obese samples. At pre-treatment, Saunders, Johnson, and Teschner (1998) found that more participants who grazed had severe binge eating problems (Binge Eating Scale score ≥ 27) than those who did not graze (43.1% vs. 19.6%, $p = 0.01$), while Melo, Peixoto, and da Silveira (2015) reported that 64.4% of those who grazed (vs. 40% of those who did not) exhibited binge eating behaviour. Goodpaster et al. (2016) found that participants experiencing loss of control while grazing were more likely to also experience OBEs, and had higher binge eating frequency and severity than those with grazing without loss of control, who in turn had higher binge frequency/severity than participants who did not graze. Colles et al. (2008) reported that those who had pre- or post-surgical grazing were likely to experience uncontrolled eating (either SBEs or OBEs) at 12-month follow-up.

Two treatment studies provided mixed results. Conceição et al. (2014) found that obese patients with OBE/SBE presented three times the risk of reporting grazing than those without binge eating; however, conversely, those with grazing had a reduced risk of OBE/SBE. Reslan et al. (2014) found that grazing at surgical follow-up was negatively correlated with SBE, while no significant correlation was detected with OBE. Three studies (Conceição et al., 2013; Masheb et al., 2011; Masheb et al., 2013) did not report any significant associations between grazing and binge eating in ED samples before treatment, or in the community.

In terms of eating disorder symptomatology other than binge eating, Colles et al. (2008) and Reslan et al. (2014) reported that grazing (at baseline and at follow-up, respectively) was associated with higher dietary disinhibition. While Colles et al. (2008) also found an association with lower dietary restraint and higher hunger, Reslan et al. (2014) did not find a significant association with these domains. Micanti et al. (2016) reported that a group of obese participants who predominantly grazed had higher shape dissatisfaction than those who had a snacking eating pattern or those who predominantly consumed a large amount of food three times a day, but lower shape dissatisfaction than the binge eating group. No significant associations were found with dietary restraint, emotional eating, purging, eating/weight/shape concern, global ED symptomatology, night eating or food addiction in obese and ED samples (Conceição et al., 2013; Masheb et al., 2011; Masheb et al., 2013; Reslan et al., 2014).

Two of the three studies included in sensitivity analyses (Conceição et al., 2013; Masheb et al., 2013) did not find any significant associations between grazing and ED symptomatology, while the third (Conceição et al., 2014) found mixed results.

3.12. Grazing, mental health and other psychological factors

Six studies examined the relationship between grazing and depression, anxiety or stress in obesity treatment studies. Of these, only two studies (Levin, Dalrymple, Himes, & Zimmerman, 2014; Nicolau et al., 2015) did not find a significant association between grazing and psychopathology (depression severity/symptoms, respectively). Pre-surgically, Goodpaster et al. (2016) found that participants who experienced grazing with loss of control were more likely to have a diagnosis of Major Depressive Disorder (MDD) and Anxiety Not Otherwise Specified (but not Generalised Anxiety Disorder) than both grazing patients without LOC, and those who denied grazing. Grazing patients with LOC also obtained higher scores than grazing patients without LOC, and those who did not graze, on the following MMPI-2-RF scales: Stress/Worry, Negative Emotionality, Emotional/Internalising Dysfunction, Demoralisation, Low Positive Emotions, Dysfunctional Negative Emotions, Malaise, Cognitive Complaints, Self-Doubt and Shyness (Goodpaster et al., 2016). Micanti et al. (2016) found that participants with grazing reported significantly higher anxiety and lower mood than those who predominantly snacked between meals or those whose main eating pattern consisted of consuming a large amount of food three times a day (but not than those who predominantly binged). Colles et al. (2008) reported that at 12-month follow-up, patients who grazed at baseline or post-operatively reported more depression symptoms than those without grazing. Similarly, Mack et al. (2016), representing the only study examining connections between grazing and mental health which was included in sensitivity analyses, found that patients who grazed at follow-up had a higher level of depressive symptoms and stress than non-grazers.

Six studies investigated relationships between grazing and other psychological factors, also in obese samples. Gowey et al. (2016) described a positive correlation between grazing and affective and cognitive dysregulation; Micanti et al. (2016) reported that participants with grazing endorsed greater impulsivity than those who snacked between meals or ate three large meals a day (but less than those with binge eating), while Goodpaster et al. (2016) did not find an association between impulsivity and grazing. Levin et al. (2014) reported that those with lifetime grazing scored significantly lower than those without grazing on two aspects on mindfulness: “describing” and “non-judgement”. No associations were found with substance use (Goodpaster et al., 2016; Reslan et al., 2014) or with antisocial behaviour (Goodpaster et al., 2016). Nicolau et al. (2015) reported that participants with grazing had more difficulty in adjusting lifestyle habits than those without at follow-up, which could be feeding into negative weight outcomes; this could potentially reflect poor impulsivity control, as in BED and BN.

3.13. Grazing and quality of life

Quality of life (QoL) measures generally aim to capture information on functional health and wellbeing, and to quantify disease burden (Ware & Gandek, 1998). Although the assessment of mental health-related quality of life (MH QoL) can overlap with the assessment of mental health status itself, this construct predominantly aims to measure functional limitations (such as to social adjustment, relationships) due to mental health difficulties.

Five studies assessed the relationship between grazing and various aspects of health-related QoL; all found a detrimental association between grazing and aspects of QoL. At pre-treatment, Micanti et al. (2016) found that participants who grazed had lower MH QoL than those who predominantly snacked between meals or those who ate three large meals a day (but higher than those who predominantly binge-ate). Compared to patients without grazing, those with post-surgical grazing had poorer MH QoL (Colles et al., 2008; Nicolau et al., 2015), but not physical QoL (Nicolau et al., 2015). Also at follow-up, Kofman et al. (2010) found that poorer health-related QoL (encompassing physical and mental factors) was associated with grazing two or more times per week.

Silva et al. (2008) found that participants who grazed pre-surgically reported worse health transition, vitality, and physical symptom impairment than those who did not graze, but no differences were found for physical functioning, role limitations due to physical health problems, bodily pain, general health perception, social functioning, role limitations due to emotional problems, mental health, overall QoL, and psychological and social adjustment.

3.14. Other associations

No significant differences were observed for gender (Masheb et al., 2013; Mazzeo, Saunders, & Mitchell, 2006), age (Masheb et al., 2013), or biochemical parameters such as cholesterol, triglycerides, leptin (Nicolau et al., 2015), between participants with and without grazing. However, obese Caucasian women were more likely to report grazing than obese African American women (Mazzeo, Saunders, & Mitchell, 2005).

4. Discussion

The aims of this systematic review were to summarise and critically examine the existing body of research that has investigated grazing in adults with eating disorders and/or obesity, in treatment and community settings. Prevalence estimates were meta-analysed, and treatment outcomes, QoL, and psychopathological correlates were summarised across the 38 included studies. Thirty-two papers (31 data sets) reported the percentage of adults with EDs and/or obesity who engaged in grazing behaviour. The results of the systematic review indicate that grazing is a wide-spread phenomenon in both these populations. There is some evidence to suggest that grazing is associated with poorer treatment outcomes and psychopathology, however, this relationship is not entirely clear, with studies producing disparate findings.

4.1. Grazing and obesity

Overall, the mean pooled prevalence of grazing in adults with obesity at pre-weight loss treatment was 33.20%, at post-weight loss treatment 28.16%, and 23.32% in the community. Prevalence estimates resulting from a sensitivity analysis including studies using a comprehensive definition of grazing were 42.33% at pre-weight loss treatment and 33.99% post-treatment; for the sensitivity analysis based on studies using a validated assessment measure, prevalence estimates were 26.34% at pre-weight loss treatment, 29.59% post-treatment, and 14.06% in the community. Heterogeneity among the studies within each of these groups was high, potentially due to substantial differences in study designs and populations, varying methodological quality, and measurements used. These issues are discussed below.

Many of the studies included in the review used treatment-seeking obese samples. As the prevalence of BED in individuals with obesity seeking weight loss treatment has been reported to be approximately 30% (e.g. by Spitzer et al., 1993), these studies likely contained a mix of participants with and without BED. Given that findings regarding BED suggest a high rate of grazing in this group, it is possible that overall grazing prevalence estimates in obese groups may be inflated by the potential inclusion of participants with BED.

The association between grazing and weight loss treatment outcome in obesity varied, with mixed results regarding pre-weight loss treatment eating behaviour, and a more consistently reported detrimental relationship between post-treatment grazing and treatment outcomes. In adults who were grazing regularly prior to weight loss treatment (bariatric surgery and VLCD), most of the included studies reported no significant association with weight loss, failure to lose weight, or with weight re-gain following treatment. Furthermore, one study indicated that lifetime grazing had a positive influence on weight loss maintenance (Legenbauer et al., 2010). In this study, lifetime substance use was also found to have a positive association with preventing weight regain in individuals with obesity following VLCD treatment. As impaired inhibitory control has been associated with both substance use disorders and obesity (Volkow & O'Brien, 2007), it is possible that those with lifetime substance use and grazing had learned self-regulatory strategies to cope with these difficulties earlier in life; these strategies may have been effectively deployed later in helping with difficulties with long-term weight management following treatment (Legenbauer et al., 2010). Conversely, two studies found poorer post-treatment outcomes in those who grazed at pre-treatment, such that more patients who did not comply with post-treatment dietary recommendations had been grazing prior to treatment (Poole et al., 2005), and that a majority of participants with regular grazing at baseline continued to graze post-treatment and that they continue to eat when full (Colles et al., 2008). As a large proportion of daily eating behaviours are habitual (van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011), these mixed results potentially reflect an inability to control entrenched, habitual behaviour in some participants with obesity. This is supported by other research in both non-clinical and bariatric surgery samples, linking grazing with external and emotional eating (Lane & Szabó, 2013), and characterising this behaviour as “mindless”, “distracted” and “non-anticipated” (Conceição et al., 2013).

In terms of post-weight loss treatment, consistent with previous research (Conceição et al., 2014), more support was found for poorer weight loss outcomes such as %EWL, weight loss maintenance and weight regain in the presence of grazing, or in the case of more frequent grazing, especially at longer-term follow-up (Colles et al., 2008; Conceição et al., 2014; Kofman et al., 2010; Legenbauer et al., 2010; Mack et al., 2016; Nicolau et al., 2015; Robinson et al., 2014), a result which was supported when considering the studies included in sensitivity analyses. While the relationship between eating pathology before treatment and outcomes of treatment remains less clear, in line with other research (Burgmer et al., 2005), it appears that eating behaviour after treatment is highly relevant for treatment outcomes, with grazing potentially having a negative impact. It has been suggested that pre-operative patients have unrealistic surgical expectations, whereas post-surgery, patients typically experience a struggle to modify their eating habits, and hence, this might be the best time to involve patients in a behavioural intervention (Leahey, Bond, Irwin, Crowther, & Wing, 2009).

Regarding grazing in community obese samples, one study found a lower rate of grazing in participants with obesity in the community than in treatment-seeking individuals with obesity (Herpertz et al., 2006), which is expected, due to inherent bias toward greater illness severity in clinical samples. Two studies found a positive association between grazing and BMI (Keski-Rahkonen et al., 2007; Rasheed, 1998). Research is lacking regarding other correlates of grazing in obese community groups.

4.2. Grazing and EDs

In adults with BN, BED and AN grazing was estimated to affect 58.25%, 67.77% and 34.31% of adults respectively (post-ED treatment for BN: 32.00%; BED: 61.10%). Pre-treatment prevalence estimates obtained through the two sensitivity analyses were similar, lending support to these numbers. However, considerable heterogeneity also existed among the ED studies, due to similar clinical and methodological factors encountered across obesity studies.

Three studies found significant associations between a BED diagnosis and grazing prior to weight loss treatment, while two studies found no association between a pre-treatment diagnosis of BED and post-surgical grazing. One study (Colles et al., 2008) found associations between pre-surgical BED and post-surgical grazing, as well as pre-surgical grazing and post-surgical uncontrolled eating (including participants with a post-surgical BED diagnosis). Given that baseline grazing rates in patients with preoperative BED were not reported, the evidence suggesting that pre-treatment BED “converts” to grazing post-treatment is currently insufficient.

In the community, Masheb et al. (2011) found that participants with BN and BED had a higher frequency of grazing than healthy control participants, and two weight loss treatment studies (Mitchell et al., 2015; Succurro et al., 2015) found that participants with BED had higher rates of grazing than those without BED. These results were supported by associations between BED and grazing in two studies included in sensitivity analyses, which found that participants with BED had higher rates of grazing than those without BED (Succurro et al., 2015), and that participants with BED who grazed experienced more frequent grazing than participants with BN or AN who grazed (Conceição et al., 2013). As the examined samples or sub-samples with BED all had a mean BMI of above 30 (and as BED is more common in obese, than in non-obese groups; de Zwaan, 2001), these findings suggest that within the obese population, adults with BED present with a range of atypical and unhelpful eating behaviours. Hence, especially in BED, grazing needs to be part of clinical assessment and integrated with treatments.

4.3. Grazing and eating disorder psychopathology, mental health and QoL

Of nine studies examining grazing and binge eating (as an eating behaviour, rather than as part of an ED diagnosis) in obese samples, a majority found significant associations between binge eating and grazing or had mixed findings, including one study (Conceição et al., 2014) which found that while patients with OBE/SBE exhibited higher risk of grazing than those without BE, conversely, patients who grazed had a reduced risk of OBE/SBE. No significant associations were found between grazing and binge eating in three studies using ED samples examined at pre-treatment, or in the community. In terms of other important eating disorder cognitions and behaviours such as dietary disinhibition, restraint, hunger, shape and weight dissatisfaction, emotional eating and purging, the results of this review were

inconclusive, as most studies did not focus on these factors, or provide their associations with grazing.

Of the six studies assessing the relationship between grazing and depression in obese samples, a majority found significant positive associations between grazing and a diagnosis of MDD, lower mood, or depression severity both pre- and post-treatment; additionally, two studies also found an association with anxiety and stress/worry. Of the two remaining studies, which did not find a significant association between grazing and depression, one (Levin et al., 2014) only examined this relationship in a sub-sample of participants, who did not comply with suggested pre-surgical dietetic changes, rather than in the whole sample. The one study included in one of the sensitivity analyses (Mack et al., 2016) reported a positive relationship between grazing and depression and stress. While there was mixed evidence regarding a connection with impulsivity, the review provided some evidence that grazing was associated with lower mindfulness (Levin et al., 2014), and affective and cognitive dysregulation (Gowey et al., 2016). Psychological ED treatments such as CBT-E (Fairburn, 2008) and DBT (Safer, Telch, & Chen, 2009) may therefore address factors which potentially underlie grazing, such as affect intolerance and dysregulation; additionally, these results provide further avenues for investigation.

The relationship between grazing and QoL has been more consistently reported as negative, although it is important to note that none of the studies included in sensitivity analyses included QoL. All five studies reporting on QoL found that various aspects of QoL (MH QoL in particular) were lower in the participants who grazed. This negative association highlights the importance of accurate assessment and treatment of detrimental forms of grazing.

4.4. Definitions and measurement of grazing

Across the included studies there was a lack of consensus regarding the definition, operationalisation and measurement of grazing, which prevents accurate measurement and limits comparisons between studies. This is a potential contributor to disparate findings in the review. It is important to note, however, that nine out of the 14 included studies published since 2014 (the year of the definition proposed by Conceição, Mitchell, Engel, et al.) have tended to preference the term “grazing” over other descriptors of this behaviour, so it does appear that consensus in the field is coalescing around this term. There is also some evidence that the definitional elements proposed based on expert opinion are recently being more reliably used.

The definitions of grazing used across the 38 studies most consistently reflected a continuous, constant or repetitious nature, involving the unplanned consumption of either small amounts of food, or larger amounts of food over a longer period of time. These elements should be further refined, for example to more accurately define what a “small” amount of food consists of, and to define the necessary duration of a grazing episode. Definitions of grazing also varied along other dimensions which need to be investigated to more accurately capture the characteristics of this eating behaviour, for example the type of food consumed, if time of day matters, and whether there was an internal or external precipitant (such as an emotional state or an environmental cue). Importantly, some studies considered grazing to include a degree of loss of control over eating, while others explicitly excluded loss of control from their definition of grazing; a majority of studies did not specifically include or exclude loss of control. As disparities remain in terms of the elements used to define grazing, it would be important to follow up the proposed definition based on surveyed experts with rigorous research using a robust method such as the Delphi technique to establish consensus regarding its characteristics. Current and former patients and research participants should also be consulted, as there are some concerns about the term “grazing” itself having potentially pejorative connotations, since it is derived from an animal feeding behaviour.

Overall, the studies which included a sense of loss of control in their conceptualisation of grazing reported more negative outcomes such as lower weight loss, higher weight regain, higher dysregulation, lower body image, as well as lower health-related QoL, and more depression and anxiety symptoms in participants who grazed. There was also a stronger association with binge eating frequency and severity, and with a diagnosis of BED. While this is potentially due to the fact that a sense of loss of control is common to both grazing (defined in this way) and to binge eating, Lane and Szabó (2013) found that (in a healthy university student sample) the association between grazing and binge eating was not accounted for by the sense of loss of control which is common to both eating behaviours.

Some of the studies which specified that loss of control was excluded from their conceptualisation of grazing based their assessment on an item from the EDE (Fairburn et al., 2008). It is worth noting that the EDE item in question - “picking and nibbling” - does not require the rating of LOC during these episodes. It is, however, possible that the authors have clarified this issue with their participants. The studies which excluded loss of control from their definition of grazing tended to find no relationship between grazing and weight loss, binge eating, or other aspects of eating psychopathology. Two of these found that those who grazed were less likely to engage in SBE (Reslan et al., 2014) or OBE/SBE (Conceição et al., 2014). It is possible that episodes of grazing without LOC have similarities with planned snacking, which is associated with positive outcomes in eating disorders (Fairburn, 2008).

A sense of LOC over eating, however, has consistently been implicated in eating psychopathology, distress and depressive symptoms, as well as worse treatment outcomes in both EDs and obese populations (e.g. Conceição et al., 2014; Forney, Haedt-Matt, & Keel, 2014; Latner, Hildebrandt, Rosewall, Chisholm, & Hayashi, 2007). It has been proposed that LOC is the means to distinguish between a pathological, compulsive subtype of grazing, and a non-pathological subtype (Lane & Szabó, 2015). Hence, it is possible that only a subset of patients who graze experience LOC, and that this group might represent a more pathological subset (Lane & Szabó, 2013) with less positive outcomes. To this means, Conceição et al. (2014) have proposed a semi-structured interview and questionnaire to assess both “compulsive” and “non-compulsive” grazing. These grazing subtypes, and the degree of LOC present in grazing (or the presence of a “compulsive” vs. a “non-compulsive” grazing type) warrant further investigation.

Various assessment instruments were used across the included studies, including structured, semi-structured and unstructured interviews requiring varying degrees of clinical judgement, as well as self-report questionnaires. It is unclear if reporting of grazing varied between interview and questionnaire assessment methods, an issue which is present in the measurement of other psychopathological eating behaviours (Fairburn & Beglin, 1994; Kalarchian, Wilson, Brolin, & Bradley, 2000). In many of the studies, assessments depended on retrospective recall of information, which may have led to inaccurate results. Custom measures were frequently used, rather than validated assessment tools.

Discrepancies in the findings of this review are also likely due to other factors, such as differing sample sizes and sample characteristics across studies. While sample sizes were generally not small, they varied considerably, and power/sample size calculations were generally lacking. Future research would benefit from conducting such an analysis to prevent the occurrence of Type II errors, or of clinically insignificant findings. In terms of demographics, the samples studied mostly consisted of Caucasian females, similarly to most research to date on atypical eating and eating disorders in general. More needs to be known about eating disorder psychopathology in males, and in racial/ethnic minority groups. The finding that African American women were less likely to report grazing than Caucasian women (but had similar BED rates and BE severity) by Mazzeo et al. (2005) warrants further investigation; in this study, African American participants endorsed higher self-esteem and less depressive symptomatology compared to Caucasian participants, which may be connected to lower grazing rates, as self-esteem has been previously found to be negatively correlated

with problematic eating behaviours, for example by Akan and Grilo (1995). Socioeconomic status was not controlled for in this study despite prior findings suggesting that, especially in women, some eating disorder behaviours are negatively correlated with income/SES (Gard & Freeman, 1996; Reagan & Hersch, 2005).

Additionally, a considerable proportion of the data presented in this review originated in the bariatric surgery literature, with most of the obese samples recruited from healthcare settings. As such, findings may only be partly generalisable to individuals with obesity in non-surgery treatment programs, or in the community, who may not be treatment-seeking. Most of the information on grazing in EDs also comes from samples involved in treatment, and as such, may reflect similar issues.

Furthermore, most treatment studies only assessed grazing at baseline, predominantly as part of an initial treatment eligibility assessment. Since bariatric surgery has stringent eligibility criteria, it is possible that in these samples, grazing, along with other atypical eating patterns, was under-reported by bariatric surgery candidates (Mechanick et al., 2013). Some studies only assessed grazing in patients who have already been accepted for treatment; this presents additional difficulties in terms of assessing prevalence of grazing and associations with other eating psychopathology, as patients with significant eating problems or other psychopathology may have been excluded from these studies by this stage. Moreso, by only measuring grazing at pre-treatment baseline, it is difficult to ascertain the effect of treatments on grazing itself. Conversely, some studies only reported post-treatment grazing and its association with various treatment outcomes without controlling for baseline grazing, which makes these associations less clear.

This review highlights the fact that grazing has not yet received sufficient research attention, particularly in EDs, in non-bariatric surgery obese groups, and in community samples in general. Due to the relatively small body of literature and to the inconsistencies present in the summarised findings, this review can only provide a preliminary overview of the prevalence of grazing and its correlates in EDs/obese populations. Future research is required to further elucidate the correlates of grazing and to determine the connections between grazing, treatment outcomes and other psychopathological correlates.

4.5. Limitations and future research

This review has several limitations which need to be considered alongside its findings, such as the exclusion of abstracts, dissertations and case studies, and the exclusion of non-English language literature. This review also did not seek to include information on grazing in children or younger adolescents. Many eating disorder behaviours develop at a young age and are associated with risk for an eating disorder later in life (Kotler, Cohen, Davies, Pine, & Walsh, 2001), therefore this is a critical avenue for investigation, especially in terms of the aetiology and contributors to unhelpful eating behaviours. It has been consistently shown that parental feeding attitudes, as well as parental patterns of eating, influence eating behaviours in children. For example, high levels of disinhibited eating or binge eating (especially when coupled with dietary restraint) in parents, as well as high parental control over child food intake, may contribute to the development of eating disturbances (Lamerz et al., 2005) and excess body fat in children (Hood et al., 2000). This occurs potentially through modeling (e.g. increased unhealthy snack food intake; Brown & Ogden, 2004), as well as through the suppression of children's ability to self-regulate dietary intake (Johnson & Birch, 1994). Therefore, family factors would be important for future research to take into account when examining the development of grazing behaviour.

It would also be important for future research to investigate the predisposing and maintaining factors of grazing behaviour. Considering current models of eating disorders, some salient avenues for investigation would be: body image disturbance, negative core beliefs about the self, negative emotional states, emotion regulation difficulties, and metacognitive beliefs about eating. Given links found with external eating (Lane & Szabó, 2013), and descriptions of grazing as “mindless”, “distracted” and “non-anticipated”, it would also be important to study the role of appetitive environmental cues in potentially prompting habitual and automatic (as opposed to goal-directed and purposeful) action selection in guiding grazing behaviour, as this could also have significant implications in terms of treatment targets. Cognitive factors, especially executive functions such as problem-solving, inhibitory control, set-shifting and decision-making have been implicated in the maintenance of other atypical eating behaviours such as binge eating (Duchesne et al., 2010; Manasse et al., 2015) and should also be examined in persons who graze.

Future research would also benefit from using validated, multi-item measures of grazing which investigate various dimensions of this construct, as well as its frequency and severity. These should also explore the strength of the association between grazing and loss of control, as well as other factors strongly implicated in eating disorder psychopathology, and distress around this type of eating. Additionally, naturalistic designs could be employed, such as behavioural tasks, where grazing could be more objectively observed and measured, or ecological momentary assessment, where reporting could take place closer in time to the experience of grazing (Reas et al., 2012), and where context could also be considered (Carter & Jansen, 2012).

Strengths of the review are the wide search dates and inclusive search terms across five databases, designed to capture as much of the available literature on this topic, the use of meta-analysis methods to provide prevalence estimates across different groups, the computation of a quality rating, and the independent screening of a proportion of the papers by a second reviewer, in order to reduce selection bias.

5. Conclusion

Taken together, the results from the reviewed studies suggest that grazing is common in obese populations at pre- and post-weight loss treatment and in ED clinical populations, as well as in community samples. Other research also indicates that it is also relatively common in normative samples, and there is mixed evidence regarding whether grazing represents a detrimental eating pattern. The strongest current evidence for deleterious effects of grazing comes from studies of eating behaviour post-weight loss interventions in obesity. There is also some indication that where loss of control is conceptualised as a core feature, grazing is associated with lower weight loss and higher weight regain in obese samples, higher dysregulation, lower quality of life, lower body image, more severe and frequent binge eating, and more general psychopathology, lending support to a pathological “compulsive” grazing subtype. However, given the disparate definitions of grazing used in research in this field to date, risks associated with grazing cannot be reliably summarised at this point. Further research using valid and reliable measures of grazing, as well as rigorous consensus on its defining features, including the degree of loss of control over eating, is needed.

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AH prepared the manuscript. AH, PH and ST were involved in the conception and design of the study. AH constructed and ran the searches and extracted the data. ST independently screened a proportion of the studies. PH substantially contributed to the meta-analysis component of this paper. AH analysed and interpreted the data. LC substantially contributed to the revision of the manuscript. All authors read

and approved the final manuscript.

Conflict of interest

Andreea Heriseanu declares no conflicts of interest.

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