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A Review of the Relationship between Night Eating Syndrome and Body Mass Index

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Abstract

Purpose of the review—To review literature on night eating syndrome (NES) and body mass index (BMI; kg/m^2) published in the last five years.

Recent Findings—Since December, 2013, 11 studies examined the association between NES and BMI. Five of these studies reported a positive relationship, five showed no relationship, and one produced mixed findings. Emotional eating and age were moderators. Twelve studies examined whether there was a difference in BMI between those with and without NES with only five of these finding differences. A primary weakness of the recent literature base is that it is almost entirely cross-sectional.

Summary—Recent findings regarding the relationship between NES and BMI are mixed. Future research should examine the relationship between these variables longitudinally and continue to examine moderating variables that explain why some individuals manifest excess weight with NES and others do not.

Keywords

Night eating syndrome; Nocturnal eating; Night eating questionnaire; Obesity; Overweight; Body mass index

Introduction

In 2012, Gallant, Lundgren, and Drapeau reviewed studies examining the relationship between night eating syndrome (NES) and obesity [1]. Their review highlighted that the prevalence of NES was higher in samples with overweight and obesity seeking weight loss treatment or bariatric surgery, as compared to general community samples. However, they found conflictual evidence when examining the relationship between body weight and NES, with nine studies showing a significant positive relationship and thirteen studies showing no significant association. They hypothesized that the conflictual findings may have been due to variance in how NES was measured, whether a measurement tool yielded a continuous NES score or dichotomous outcome, or differences in sample characteristics. They also implied

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that unmeasured moderating variables (e.g., genetic factors, exercise, dietary restraint, energy intake, sleep difficulties, other mental health difficulties) might have influenced the relationship between NES and body mass index (BMI, kg/m^2) in various samples, resulting in mixed results. Since the 2012 review, the DSM-5 was published (May, 2013) and for the first time NES was captured in this new iteration of the DSM under the Other Specified Feeding or Eating Disorders diagnosis (307.59, F50.8) [2]. The purpose of this paper was to review studies examining the relationship between NES and BMI that were published since the 2012 review, especially in light of increased recognition and research on this disorder due to its presence in the DSM-5.

Method

PubMed, ScienceDirect, Embase, Web of Science, and Academic Search Complete were searched to find articles published from December 2013 through December 2018 on this topic, using the term “obesity” in combination with the phrases “night eating,” “nocturnal eating,” “night eating syndrome,” and “night eating questionnaire” respectively. These searches yielded a total of 493 titles, which were screened. The abstracts of article titles that seemed relevant were read. Peer-reviewed articles were included that examined the relationship between NES and BMI and were written in English. Twenty-eight full articles were reviewed, and five were excluded. Two articles were excluded because NES was assessed, but weight and height were not measured [3, 4]. One was excluded because weight was measured but the relationship between NES and BMI was not reported [5]. One was excluded because it used the same sample as another article included herein and the data were redundant [6]. Lastly, a review article was excluded because it did not report on the variables of interest [7]. A total of 23 articles are reviewed here.

Results

Description of the Selected Studies (Table 1)

The studies had sample sizes ranging from 54 to 2459 subjects. The mean age of the participants ranged from 18.7 to 63.8 years of age, and the mean BMI ranged from 22.4 to 35.6 kg/m^2. The prevalence of NES in these samples typically ranged from 0.3 to 9.4%. However, much higher prevalence values were reported in the following samples: a sample of adults recruited from internet advertisements and adults seeking weight loss treatment (41.8%) [8], mental health patients in a general outpatient setting (22.4%) [9•], mental health outpatients with depression (21.3%) [10•], mental health outpatients with eating disorders and a control group (22%) [11••], and adults with restless leg syndrome (17%) [12•]. The proportion of females in these samples ranged from 40.5 to 100%. Multiple studies did not report on race, but for those that did, 28 to 100% of the samples were Caucasian.

Four studies examined only college students [13–16], four examined mixed samples comprised of college students and others (e.g., community members, college faculty and staff) [17••, 18–20], five examined only adults [21••, 22••, 23–25], and one examined a sample of adolescents and adults [26]. One examined a mixed sample of community members and individuals seeking weight loss treatment [8], one examined patients with

bipolar disorder [27•], one examined outpatients with depression [10•], one study examined outpatients with a variety of mental health difficulties [9•], and one examined mental health outpatients with eating disorders and controls [11••]. Two examined sleep medicine patients undergoing polysomnography [28•, 29•], one examined patients with restless leg syndrome [12•], and one examined patients with type 2 diabetes [30•].

All studies used cross-sectional data except for one that examined 2-year longitudinal data [21••]. Six of the 17 studies were conducted in the United States.

Assessment of Night Eating Syndrome

Some studies used only one method to assess night eating, while others used both a screening questionnaire and a criteria set to classify participants into different diagnostic categories. Seventeen studies used the Night Eating Questionnaire (NEQ) to measure NES [31]. Five studies used the NES diagnostic criteria developed by Allison and colleagues in 2010 to diagnose NES, and one used the diagnostic criteria developed by Birketvedt and colleagues in 1999 [32, 33]. Two studies diagnosed NES using the Night Eating Diagnostic Questionnaire (NEDQ) [34], which is a diagnostic self-report measure created by Drs. Allan Geliebter and Marci Gluck based on the diagnostic criteria developed in 2010. One study diagnosed NES using the Night Eating History and Inventory (NESHI) [34], which is a semi-structured interview that includes the NEQ.

Assessment of Body Mass

Weight and height were self-reported by participants in 14 samples, measured by research or medical personnel in eight samples, and retrieved from medical charts in two samples. Two studies featured two samples each whose weight and height were measured using different methods. Weight and height were used by researchers to calculate BMI, using the formula weight in kilograms/(height in meters)^2

Relationship between Night Eating Syndrome and Body Mass Index (Table 2)

Eleven studies examined the association between NES and BMI. Five of these reported that there was a significant relationship between NES and BMI [17••, 20, 22••, 23, 25], five showed no significant relationship [13,14, 21••, 24, 30•], and one produced mixed findings [18]. Of those that found a significant relationship, all correlations were in the positive direction and none found a negative relationship. Overall correlational values were small to moderate with Pearson *r*s ranging from .13 to .29.

One of these studies was longitudinal [21••], one study had a unique sample type [30•], and two studies investigated moderators of the relationship between NES and BMI [17••, 22••], which made their findings important contributions to the literature. One study examined the ability of NES scores to predict BMI change across time in adults and found no significant relationship between baseline NES scores and percent BMI change across two years [21••]. Another study investigated BMI and NES in a sample of patients with Type 2 diabetes and found no significant relationship between these variables in their sample [30•].

Moderators—Age was found to moderate the relationship between NES and BMI in a U shaped relationship in one study [22••]. There was a significant positive association between these two variables in individuals between the ages of 31 and 60 years, but this association was not present in younger (21 to 30 years of age) and older (61 years of age and older) adults. Another research team found that there was a significant relationship between NES and BMI in a sample of community adults (mean age of 44.5 years), but there was no significant association between these variables in a sample of college students (mean age of 18.7 years) [18]. Although age was not explored as a moderator in this study, age may help explain these different findings.

Emotional eating was also found to moderate the relationship between NES and BMI [17••]. This study showed that there was a significant positive predictive relationship between night eating and BMI when individuals had a high emotional eating score (one standard deviation above the mean score), but there was no significant relationship between these variables in individuals with a low emotional eating score (one standard deviation below the mean score).

Difference in Body Mass Index in those with and without Night Eating Syndrome

Twelve studies examined differences in BMI between those with and without NES. Five of these studies revealed a significant difference, with those with NES showing higher BMIs than those without NES [10•, 12•, 18•, 26, 29•]. Seven studies showed no significant difference between the groups [7, 9•, 11••, 14, 15, 18•, 27•]. Two of the studies provided effect sizes that were large, showing higher BMI in those with NES as compared to those without, with Cohen's d values of .85 [29•] and .88 [26].

Six studies examined differences in BMI in those with and without NES in unique samples. Three of these studies investigated differences in BMI based on NES status in medical patients [12•, 28•, 29•] and three studies examined differences in BMI based on NES status in patients with mental health conditions [9•, 10•, 27•], which made their findings important contributions to the literature. One research team examined BMI in patients with restless leg syndrome and found that patients with NES had higher BMIs than those without NES [12•]. Two additional studies investigated BMI differences in sleep medicine patients with and without NES [28•, 29•]. One found no significant difference in BMI by NES status [28•], but the other found that patients with NES had higher BMIs than patients without NES [29•]. Another study investigated differences in BMI among outpatients with depression and found that those with comorbid NES had higher BMIs that those without NES [10•]. Two other studies, one in patients with bipolar disorder, and one in a general mental health outpatient clinic, found no group differences in BMI by NES status [9•, 27•]. Lastly, one research team investigated differences in BMI in patients with NES, bulimia nervosa, bulimia nervosa with NES, and controls and found no group differences in BMI [11••].

Discussion

Overall, findings from literature published from December 2013 through 2018 regarding the relationship between NES and BMI are mixed. The same conclusion was reached in the 2012 review of the literature on this topic [1]. Part of the previous mixed findings included

strong associations of higher BMI with NES, such as that found in the Swedish Twin Register STAGE cohort, with the odds of having NES being 2.5 times higher in men and 2.8 time higher in women with obesity than men and women with normal weight [35]. In the 2012 review on NES and BMI, the prevalence of NES was higher in samples with overweight and obesity seeking weight loss treatment or bariatric surgery as compared to general community samples [1]. Also, in a study examining NES in outpatient psychiatric patients published in 2006, those with NES were five times more likely to have obesity than patients without NES [36]. The current review indicated that the prevalence of NES was notably higher in a mixed sample of community members and adults seeking weight loss treatment, a sample of mixed mental health outpatients, mental health outpatients with eating disorders, a sample of outpatients with depression, and a sample of adults with restless leg syndrome as compared to samples of college students and community members [8, 9•, 10•, 11••, 12•], but only two of these studies reported that the BMI of those with NES was higher than for those without NES [10•, 12•]. Having mental health conditions and certain medical problems appears to contribute to an increased risk for also having NES. While the direction of the relationship is consistent for studies that do find a significant association, with BMI being higher in those with NES, just as many studies did not find any relationship between these in the various samples.

Given the mixed findings, it is likely that unmeasured or currently unknown moderators influence the relationship between NES and BMI, such that some individuals gain weight with regular night-eating and others do not. Two studies from the current review revealed that age and emotional eating were moderators of the relationship between NES and BMI, with individuals between the ages of 31 and 60 years and individuals with high emotional eating demonstrating a significant relationship between these variables, but individuals of younger and older ages and individuals with low emotional eating showing no such relationship [17••, 22••]. Thus, age and emotional eating status may explain the presence or absence of a significant relationship between NES and BMI across the studies herein, even if researchers did not examine whether these variables were moderators. Earlier epidemiological studies of NES reported no association between nighttime eating and BMI while controlling for age, but they did not present separate moderator analyses for the effect of age on BMI on those with and without late night eating [37]. It may be that the effects of nighttime eating on weight are gradual and cumulative, so they may not be present in young adulthood. Additionally, age of onset of fully diagnosable NES is typically in the late 20s/early 30s [38]. This is in contrast to late night eating that may be tied to social eating in late adolescence and young adulthood that could be captured as NES in studies that only use brief screening instruments, also suggesting that the relationship between NES and BMI may not manifest itself until later. In late adulthood, night eating also seems to subside [37], and other metabolic processes associated with aging may influence weight more than nighttime eating at that stage.

Gallant et al. hypothesized that the presence of genes that predispose individuals to overweight/obesity as well as a person's level of physical activity, daytime dietary restraint and energy intake, severity of sleep difficulties, and comorbid psychopathology may influence the relationship between NES and BMI [1]. However, most of these moderators were not explored in the studies in this review. Given the notably high NES prevalence in the

samples of patients with diagnosed mental health difficulties and patients with restless leg syndrome, severity of comorbid mental health difficulties and sleep disturbances in those with NES may be important moderators of the relationship between NES and BMI. Compensatory behaviors for nighttime eating through excessive exercise or purposeful daytime restriction is likely another mechanism that moderates weight control among a subsample or persons with NES that was not described in the studies reviewed here. Studies of persons with NES with weights in the normal weight range have shown elevated exercise and dietary restriction more similar to behaviors observed in eating disorders such as bulimia nervosa or anorexia nervosa [39, 40].

Although socioeconomic status (SES) factors were measured in some of the studies reviewed here, it was not tested as a moderator of the relationship between NES and BMI. Lower access to healthy foods, financial resources to purchase healthy foods, nutrition education, and preference for and purchasing of calorically dense foods among those with lower SES may influence what foods are eaten in the evening and during the night. What foods are eaten in the evening and during the night and the quantity of these foods may serve as independent moderators of the relationship between NES and BMI. The number of calories ingested and the effects of particular foods on hunger and satiety hormones may partially determine whether NES results in weight gain and elevated BMI. Different age ranges, body weight variability, and other differences in sample characteristics may also partially explain the mixed findings.

Another possibility is that the mixed findings are related to the use of different measurement methods, such as using the NEQ [31] that produces a continuous score or using the NEDQ [34] or diagnostic criteria proposed by Allison et al. in 2010 [32], which yield categorical results. To be diagnosed with NES, the NEDQ and the criteria by Allison and colleagues in 2010 require that an individual have biweekly nocturnal eating episodes or evening hyperphagia (consumption of 25% or more of one’s daily calories after dinner), at least three of the following symptoms (lack of desire to eat or breakfast skipping at least four times per week, strong urge to eat after dinner or during the night, insomnia at least four nights per week, holding the belief that one must eat in order to fall or stay asleep, depressed mood), either distress or impairment in functioning, and presence of nocturnal ingestions and/or evening hyperphagia for at least the past three months. The NEDQ and criteria by Allison and colleagues in 2010 also require that the night eating is not better explained by substance use disorder, medical disorders (e.g., sleep-related eating disorder), medication, or other factors.

In contrast, the NEQ uses the cutoff scores, typically 25 or above for a more relaxed criteria or 30 or above for a stricter criteria, as indicators of possible NES [31]. However, individuals can provide a wide array of different responses on these items to yield a score of 25 or 30, corresponding to highly distinct night eating symptom profiles. Also, an individual does not need to have significant evening hyperphagia or nocturnal ingestions to score a 25 on the NES. Additionally, if an individual has had nocturnal ingestions and scores a 30 or above, he/she might not exhibit this behavior twice per week. Furthermore, the NEQ does not capture certain additional symptoms that often come with night eating (e.g., lack of desire to eat or breakfast skipping in the morning), does not require medical rule-outs, and does not

require distress or impairment. Therefore, some individuals classified as likely having NES with the NEQ would not meet criteria for NES based on the diagnostic criteria aforementioned. Thus, the studies reviewed herein that use the NEQ to look at the relationship between NES and BMI or differences in BMI by NES status, may be including a greater number of individuals in the NES group that have greater symptom variability and some with sub-clinical night eating syndrome. Whereas, studies reviewed herein that use the NEDQ or the diagnostic criteria proposed by Allison et al. in 2010 are likely examining the relationship between night eating and BMI in a smaller group of individuals that have less symptom variability and who have clinically significant night eating syndrome [32, 34]. However, it does not appear that the statistical significance of group differences in BMI by NES diagnosis differed by whether the NEDQ or Allison et al.'s criteria versus the NEQ cutoff scores were used to classify someone as having NES.

Strengths and Limitations

Strengths—There was a good variety of sample types in the studies reviewed, including medical patients, patients with mental health conditions, adult samples, college student samples, and samples from several countries. Many studies included both males and females. All of these factors increase the external validity of the literature base. It is also a strength that some studies examined correlations between the continuous variables of NES and BMI and others examined BMI across individuals with and without a diagnosis of NES.

Limitations—Only one study conducted since December, 2013 was longitudinal [21••], and it showed that baseline NEQ score was not linearly related to BMI percent change across two-years. Given the sparse longitudinal data available in the last five years, we cannot make any causal interpretations regarding NES and BMI. Previously, Gluck and colleagues [41] reported that individuals who ate between 23:00 h and 05:00 h during an inpatient study gained significantly more weight after 3.4 years (5.6 kg gain) than individuals who did not eat during those hours during the inpatient study (1.7 kg gain). Further, women in the Danish MONICA study who endorsed nighttime eating gained 5.2 kg more over 6 years than women without night eating, but this pattern was not observed among men [42]. Another limitation of the current literature base is that 15 of the 22 studies (68%) did not collect or report information on the racial composition of their samples, which makes it difficult to determine how the studies' findings generalize to particular racial groups.

Implications

Future research should examine the relationship of NES and BMI longitudinally and continue to explore which variables moderate this relationship, such that some individuals manifest excess weight with NES and others do not. Currently, age and emotional eating have been identified as moderators of this relationship [17••, 22••]. Possible moderators that could be investigated include: calories and types of foods eaten during the late evening and nocturnal ingestions, SES, daytime exercise, daytime dietary restraint, presence and severity of certain sleep disorders and mental health problems, and genetic risk factors for overweight, eating disorders, and sleep disorders.

Conclusions

Recent findings regarding the relationship between NES and BMI are mixed, as were earlier findings on this topic [1]. This could be due to differences in the measurement of NES, lack of inclusion and analysis of potential moderators, differences in sample characteristics, or lack of longitudinal monitoring of the relationship between these variables. Having mental health conditions including certain eating disorders, restless leg syndrome, and overweight status appears to relate to an increased risk for having NES. All of the studies that found a significant relationship showed a positive association between the variables. Future research should investigate the relationship between NES and BMI longitudinally, analyzing important moderators, especially in samples with increased prevalence of NES.

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Table 1

Information on studies conducted from December 2013 through 2018 examining night eating syndrome and weight

Reference	Location	Sample size	Type of Sample	Mean age (years)	Mean BMI (kg/m^2)	Height & Weight Measurement	Prevalence of NES	Sex	Race
Aloi et al., 2017 (13)	Italy	444	College students	21.4 (±2.3)	22.4(±4.1)	Self-reported	1.2%	73.6% female	NR
Antelmi et al., 2014 (12)•)	Italy	120	Adult patients with RLS	63.8 (±11.5)	26.6(±4)	Self-reported	17%	69.2% female	NR
de Zwaan et al., 2014 (26)	Germany	2459	Representative national sample of teens and adults	48.1(±19)	NES: 28.4 (±6.8) No NES: 25.1(±3.7)	Self-reported	1.1%	51.1% female	NR
Gallant et al., 2014 (23)	Canada	615 (of 1630 full cohort)	Adults	Female: 40.3 (±5.1) Male: 42.5 (±5.9)	Female: 28.8 (±6.2) Male: 30.3 (±5.0)	Researcher measured	Female: 0.5% Male: 0.3% (in full cohort)	50.4% female	100% Caucasian
Gallant et al., 2015 (21)••)	Canada	388	Adults	41.2(±5.7)	29.6(±5.7)	Researcher measured	NR	59.0% female	100% Caucasian
Geliebter et al., 2016 (28)•)	New York, USA	84	Adult patients undergoing a PSG	43.2(±13.3)	Females: 35.3(±13.4) Males: 33.0(±11.1)	Medical chart	6% met full NES criteria 30% met sub-threshold NES criteria	40.5% female	NR
He et al., 2018 (14)	China	1237	College students	19.96 (±1.36)	20.78 (±2.71)	Self-reported	NR	54.2% female	84.2% Han
Hood et al., 2014 (30)•)	Chicago, USA	194	Adult patients with Type 2 diabetes	58.4(±13.0)	35.6 (±8.3)	Medical chart	7%	70.1% female	28% Caucasian
Kim et al., 2016 (24)	South Korea	404 (of 3617 full sample)	Adult nurses	<29 years = 68.6% 30–39 years = 29.5% ≥40 years = 2%	Mean BMI NR BMI <18 = 64.6% BMI 18.5–23 =16.3% BMI ≥23 = 19.1%	Self-reported	5.7% (in full sample)	100% female	NR
Kucukgoncu et al., 2014 (10)•)	Turkey	155	Adult mental health outpatients with depression	35.80 (±8.78)	NES: 28.89(±6.50) No-NES: 26.20(±5.31)	Researcher measured	21.3%	80.6% female	NR
Latzer et al., 2014 (8)	Israel	141	Adults from the community and adults seeking treatment for weight loss	Full NES: 39.94 (±13.26) Subthreshold-NES: 41.74 (±14.47)	Full NES: 29.88 (±8.11) Subthreshold NES: 28.69 (±6.93)	Self-reported	41.84%	71.6% female	NR

Reference	Location	Sample size	Type of Sample	Mean age (years)	Mean BMI (kg/m^2)	Height & Weight Measurement	Prevalence of NES	Sex	Race
				Other EDs 49.00(±10.41) Control: 41.64(±11.44)	Other EDs: 30.41 (±4.31) Control: 25.14(±5.17)				
Melo et al., 2018 (27)•)	Brazil	120 (80 BD patients, 40 controls)	Adult patients with bipolar disorder recruited from four "institutions"	BD patients: 42.3 (±12.7)	All BD patients: 29.4 (±4.8) BD with NES: 30.4(±4.0) BD without NES:29.3 (±4.9)	Measured by "qualified professional"	8.8% in BD patients 0% in control group	BD patients with and without NES: 61.3% female	NR
Meule et al., 2014 (22)••)	Germany	2317	Representative national adult sample	51.45(±16.97)	25.35(±3.83)	Self-reported	NR	53.7% female	NR
Meule et al., 2014 (17)••)	Germany	729	Primarily college students (91% of sample)	23.55 (±3.89)	22.59(±4.24)	Self-reported	>30 NEQ score: 0.3% >25 NEQ score: 1.2%	77.0% female	NR
Nolan & Geliebter, 2016 (18)	New York, USA	393 analyzed (of 498 full sample)	College students (64.6%) and community members (35.4%)	Students: 18.7(±0.1 SEM) Community: 44.5(±0.9 SEM)	Students: 24.5(±0.3 SEM) Community: 27.1(±0.4 SEM)	Researcher measured (students) Self-reported (community)	>30 NEQ score: Students: 0%, Community 4.1% >25 NEQ score: Students: 2%, Community: 8.2%	Students: 63.1% female Community: 59% female	NR
Nolan & Geliebter, 2017 (19)	New York, USA	722	College students (41.2%) and community members (58.8%)	Students: 18.7(±0.1 SEM) Community: 42.9(±0.6 SEM)	Students: 24.5(±0.3 SEM) Community: 28.0(±0.3 SEM)	Researcher measured (students) Self-reported (community)	Met full criteria for NES on NEDQ= Students: 2.4% Community: 9.4% Met subthreshold criteria for NES on NEDQ= Students: 18.1% Community: 16.7%	Students: 63.1% female Community: 55.8% female	Students: 83.6% Cauca-sian Com-munity: 78.2% Caucas-ian
Olejniczak et al., 2018 (25)	Poland	611	Adults	22.7(SD NR)	Mean BMI NR Normal weight (BMI 18.5–24.9): 79.1% Overweight (BMI 25–29.9): 11.1% Obese (BMI ≥30): 2.8%	Self-reported	≥30 NES score: 0.7% ≥25 NES score: 1.3%	100% female	NR
Runfola et al., 2014 (15)	10 locations in USA	1636	College students	20.9(±1.7)	23.3(±3.4)	Self-reported	Met full diagnostic criteria: 4.2% ≥30 NES score: 0.5% ≥25 NES score: 2.5%	59.5% female	74.2% Caucasian
Saraçlı et al, 2015 (9)•)	Turkey	433	Mixed mental health outpatients	37.75(±12.02)	27.4(±5.4)	Psychiatrist measured	Met full diagnostic criteria: 22.4%	70.7% female	NR

Reference	Location	Sample size	Type of Sample	Mean age (years)	Mean BMI (kg/m^2)	Height & Weight Measurement	Prevalence of NES	Sex	Race
							≥30 NES score: 9% ≥25 NES score: 19.4%		
Tu et al., 2018 (11)••)	Taiwan	167	Mental health outpatients with eating disorders and internet referrals both with and without eating disorders	NES only patients: 27.7(±8.0) BED patients: 26.1(±7.3) BN with NES patients: 28.6(±6.2) Control: 26.6(±7.6)	NES only patients: 23(±7.1) BED patients: 21.2(±3.1) BN with NES patients: 22.4(±3.1) Control: 22.1(±4.5)	Self-reported	22% of full sample, 27% of portion of sample with EDs	91.6% female	NR
Yahia et al., 2017 (16)	Michigan,USA	413	College students	20.6(±1.68)	23.96(±3.60)	Re-searcher measured	Met full diagnostic criteria on NEDQ: 1.2%	78.2% female	91.2% Cauca-sian
Yeh & Brown, 2014 (20)	Australia	330	College students (48.4% of sample), university personnel, and their friends and colleagues	27.42 (±10.36)	26.08(±8.55)	Self-reported	≥25 NES score: 9%	67.6% female	NR
Vinai et al., 2015 (29)•)	Italy	54 used in analysis (60 full sample)	Adult patients who engaged in a NI during a PSG and met criteria for NES and matched control patients	44.3 (±10.90) [those with nocturnal ingestions] 45.8 (±11.27) [matched controls]	26.3(±3.88) [those with nocturnal ingestions] 23.1(±3.63) [matched controls]	Self-reported	NR	50% female	NR

BMI Body mass index; *NES* Night eating syndrome; *NR* Not reported; *RLS* Restless Leg Syndrome; *PSG* Polysomnography; *EDs* Eating Disorders; *SD* Standard deviation; *SEM* Standard error of the mean; *BD* Bipolar Disorder; *NEQ* Night Eating Questionnaire; *NEDQ* Night Eating Diagnostic Questionnaire; *BED* Binge eating Disorder; *BN* Bulimia Nervosa; *NI* nocturnal ingestion.

Table 2a

Correlational findings on the relationship between night eating syndrome and body mass index

Reference	Study Type & Measure of NES	Mean(±SD) NES Score for Total Sample (Unless labeled as SEM)	Relationship between variables	Summary of findings
Aloi et al., 2017 (13)	Cross-sectional Psychometric Evaluation; I-NEQ (Italian version)	Women: 9.24 (±5.2) Men: 8.32 (±4.3)	$r = .070$, $p = .092$	No significant relationship between NES and BMI.
Gallant et al., 2014 (23)	Cross-sectional data from a longitudinal study; NEQ (French version)	Women: 10.7 (±4.6) Men: 10.9 (±4.9)	Women: $r = 0.29$, $p < 0.001$ Men: $r = 0.12$, $p = 0.04$	Significant positive relationship between NES and BMI. Stronger relationship in women.
Gallant et al., 2015 (21)••	Longitudinal; NEQ (French version)	10.7(±4.5)	NEQ and BMI percent change (linear mixed model): β(s.e.) = 0.07, $p = 0.93$	NEQ score at baseline was not linearly related to BMI percent change two-years later
He et al., 2018 (14)	Cross-sectional Psychometric Evaluation; Simplified Chinese NEQ (SC-NEQ)	Total sample: 13.18(±4.56)	$r = -0.01$, p = ns	No significant relationship between NES and BMI.
Hood et al., 2014 (30)•	Cross-sectional; NEQ (English version)	14.03(±6.31)	$r = -0.05$, p = ns	No significant relationship between NES and BMI.
Kim et al., 2016 (24)	Cross-sectional; 1999 NES Diagnostic Criteria (33)	N/A	$r_s = 0.04$, p = ns	No significant relationship between NES and BMI.
Meule et al., 2014a (22)••	Cross-sectional; NEQ (German version)	9.17 to 9.72 (± 4.26 to 5.14) [varied by age group]	$r = .13$, $p < .001$ Interaction of age group X NEQ scores when predicting BMI: $F(5, 2305) = 3.93$, $p = .001$, $R^2_{change} = .01$, $f^2 = .01$	Significant relationship between NES and BMI, moderated by age. NES and BMI were positively correlated in those between 31 and 60 years of age, but not significantly correlated in older or younger individuals.
Meule et al., 2014b (17)••	Cross-sectional; NEQ (German version)	11.58(±4.41)	$r = .18$, $p < .001$ $\beta = .11$, $p < .01$ Association between NEQ and BMI when emotional eating scores were high = $\beta = .20$, $t_{(720)} = 4.27$, $p < .05$. Association between NEQ and BMI when emotional eating scores were low = $\beta = .03$, $t_{(725)} = 0.60$, p = ns.	Relationship between NES and BMI was moderated by emotional eating. NES and BMI were positively correlated in participants with high emotional eating (+1 SD from the mean), but not in participants with low emotional eating (−1 SD from the mean).
Nolan & Geliebter, 2016 (18)	Cross-sectional; NEQ (English version)	College: 13.6 (±0.3 SEM) Community: 14.3 (±0.5 SEM)	College: $r = .02$, p = ns Community: $r = .19$, $p < .001$	Significant positive relationship between NES and BMI for community participants, but not for college students.
Olejniczak et al., 2018 (25)	Cross-sectional; NEQ (Polish version)	12.4(±4.72)	Association between NEQ and BMI $\beta = .09$, $t = 2.3$, $p = .022$.	NEQ score was a significant predictor of BMI, demonstrating a positive relationship.
Yeh & Brown, 2014 (20)	Cross-sectional; NEQ (English version)	14.60(±6.87)	$r = .21$, $p < .01$	Significant positive relationship between NES and BMI.

NES Night eating syndrome; *SD* Standard deviation; *BMI* Body mass index; *NEQ* Night Eating Questionnaire; *SEM* Standard error of the mean.

Table 2b.

Group differences in BMI by NES diagnosis

Reference	Study Type & Measure of NES	Mean NES Score for Total Sample (±SD)	Group differences	Summary of findings
Antelmi et al., 2014 (12)•)	Cross-sectional; 2010 NES Diagnostic Criteria (32)	N/A	Mann-Whitney *U* test $p = .037$	BMI was significantly higher in RLS patients with NES than those without
de Zwaan et al., 2014 (26)	Cross-sectional; NEQ (German version)	NR	Student's $t = -2.531(26,362)$, $p = .018$ Cohen's d = 0.88	BMI was significantly higher for those with NES than those without.
Geliebter et al., 2016 (28)•)	Cross-sectional; NEDQ	Women: 12(SD NR) Men: 18(SD NR) (full and sub-threshold NES)	$F(1,82) = 2.2$, $p = .14$	BMI did not differ between those without NES and those with some degree of NES (full or sub-threshold)
Kucukgoncu et al., 2014 (10)•)	Cross-sectional; NEQ (Turkish version) and 2010 NES Diagnostic Criteria (32)	No-NES: 18.62 (±4.61) NES: 30.15(±5.07)	$t = 2.459$, $p < .05$	BMI was significantly higher in those with NES than those without NES
Latzer et al., 2014 (8)	Cross-sectional Psychometric Evaluation; NEQ (Hebrew version)	21.3(±9.03)	NR	There were no significant differences in BMI across the group with NES, the group with a partial diagnosis of NES, the group with other EDs, and the control group
Melo et al., 2018 (27)•)	Cross-sectional; NEQ (Brazilian Portuguese version)	NR	Student's *t*-test $p = .57$	There were no significant differences in BMI between patients with BD and NES and patients with BD without NES
Nolan & Geliebter, 2017 (19)	Cross-sectional; NEQ (English version) and NEDQ	Students: 13.6(±0.3 SEM) Community: 15.6(±0.3 SEM)	No main effect of NEDQ on BMI $F(3, 705) = 2.01$, $p = 0.111$, partial $\omega^2 = .004$ No significant interaction of group and NEDQ on BMI $F(3, 705) = 0.34$, $p = .794$, partial $\omega^2 = -0.0003$	There was no main effect of NEDQ on BMI. There was no interaction between group and NEDQ on BMI. However, those who met full criteria for NES had a significantly higher BMI than the moderate, mild, and no NES categories.
Runfola et al., 2014 (15)	Cross-sectional; NEQ (English version) and 2010 NES Diagnostic Criteria (32)	NR	Mann-Whitney $U = 49396$ $z = -.26$ $p = .80$	There was no significant difference in BMI in those with and without NES.
Saraçlı et al, 2015 (9)•)	Cross-sectional; NEQ (Turkish version) and 2010 NES Diagnostic Criteria (32)	18(±7.7)	Student's *t*-test $p = .216$	There was no significant difference in BMI in those with and without NES.
Tu et al., 2018 (11)••)	Cross-sectional; NEQ (Chinese version) and NESHI	NES only patients: 31.3(±8.6) BN patients: 19.3(±6.6) BN with NES patients: 26.5(±8.3) Control: 11.7(±5.6)	Student's *t*-test $p = .482$	There were no significant differences in BMI among those with NES only, BN only, BN with NES, and controls.

Reference	Study Type & Measure of NES	Mean NES Score for Total Sample (±SD)	Group differences	Summary of findings
Yahia et al., 2017 (16)	Cross-sectional; NEDQ	N/A	Females: Student's *t*-test $p = .126$ Males: Student's *t*-test $p = .101$	There was no significant difference in BMI in those with and without NES.
Vinai et al., 2015 (29)•)	Cross-sectional; 2010 NES Diagnostic Criteria (32)	N/A	Student's $t = 3.128$, $p < .003$ Cohen's d = 0.853	BMI was significantly higher in those with NES than those without NES

NES Night eating syndrome; *SD* Standard deviation; *BMI* Body mass index; *RLS* Restless leg syndrome; *NEQ* Night Eating Questionnaire; *NR* Not reported; *NEDQ* Night Eating Diagnostic Questionnaire; *SEM* Standard error of the mean; *NESHI* Night Eating History and Inventory; *BN* Bulimia Nervosa.