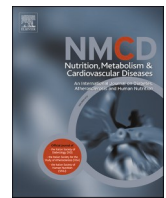





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Night eating syndrome in liver transplant recipients with diabetes or excess-weight: a cross-sectional study

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ABSTRACT

Background and aims: Night Eating Syndrome (NES) is a disordered eating pattern characterized by evening hyperphagia and nocturnal eating episodes. While NES has been extensively studied in obese and psychiatric populations, its presence in liver transplant (LT) recipients remains unexplored. Hence, we aimed to assess NES prevalence in a real-life cohort of LT recipients with type 2 diabetes and/or overweight or obesity.

Methods and results: The Night Eating Questionnaire (NEQ) was administered to 101 LT recipients attending a nutritional-metabolic outpatient clinic, and clinical data were collected. Inclusion criteria were age >18 years, liver transplantation, and presence of type 2 diabetes and/or BMI >25 kg/m². Patients with recent psychiatric diagnoses or unstable psychotropic medication were excluded.

NES was identified in 5 % of participants. Obesity was significantly associated with nocturnal awakenings unrelated to urination ($p = 0.008$). NES symptoms such as insomnia, evening eating urges, and depressive mood were also reported by a substantial subset of patients.

Conclusions: NES is present among LT recipients and appears more prevalent in those with obesity and disrupted sleep patterns. Given the metabolic and psychological vulnerability of this population, NES may represent an under recognized barrier to optimal post-transplant care. These findings support incorporating psycho-nutritional screening tools in transplant follow-up protocols.

1. Introduction

Despite advancements in medicine, liver transplantation remains the only definitive therapeutic option for patients with acute or chronic end-stage liver disease and hepatocellular carcinoma. Post-transplant survival has significantly improved over the years, currently reaching 96 % at 1 year and 52 % at 20 years. Between 1988 and 2000, there were significant improvements in survival rates for liver transplant recipients. However, in the following decades, these outcomes have remained relatively stable. This stability indicates that, despite ongoing advancements in immunosuppressive therapy and post-operative care,

improvements in patient survival beyond the first year after transplantation have been modest. Liver transplant recipients experience cardiovascular, infectious, and oncological events more frequently than the general population, and these complications continue to be the leading causes of late mortality among these patients [1].

Cardiovascular diseases and cancer are now the leading causes of long-term mortality in liver transplant recipients [2,3], with key modifiable risk factors including diabetes, hypertension, obesity and dyslipidemia, conditions whose incidence increases after transplantation [4]. Evidence suggests that these risk factors can be significantly reduced through weight loss, particularly via Mediterranean dietary patterns [5,

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6].

However, there is no clear consensus on how to promote sustainable weight loss in transplant recipients, nor on how to support long-term lifestyle changes. Canadian guidelines emphasize the need for a holistic approach, including an understanding of patients' psychosocial context and their relationship with food [7]. This is relevant given the known link between restrictive diets and eating disorders (EDs). Although no single study has demonstrated a direct causal link, restrictive eating is associated with a higher risk of ED onset, particularly when combined with psychological and sociocultural vulnerability [8,9].

Eating behavior disturbances have been previously observed in liver transplant recipients [10]. Notably, individuals engaging in restrictive eating for weight control show a higher prevalence of Night Eating Syndrome (NES) [11]. NES is a disorder of circadian-delayed food intake that behaviorally manifests as evening hyperphagia (EH) (>25 % of total daily food intake after dinner) and/or nocturnal food ingestion (NI) (>2/week), with preserved circadian sleep patterns [12,13].

The prevalence of NES has been reported to be 1–1.5 % in the general population compared to the reported 6–16 % observed in patients undergoing weight reduction programs [14,15]. It has not yet been clarified whether NES leads to weight gain or if excess weight causes nocturnal awakenings followed by eating.

NES has been associated with obesity, mood disorders, sleep disturbances, and metabolic complications, including type 2 diabetes [16].

This study aims to explore the prevalence of NES in liver transplant patients with diabetes and/or overweight or obesity, and to analyze NES-related symptom distribution with a focus on its psycho-behavioral and metabolic implications.

2. Methods

2.1. Study population

This was a cross-sectional study which included consecutive patients evaluated in the Clinical Nutrition and Metabolism Unit, IRCCS AOUBO, in Bologna (Italy), from January 2021 to December 2023.

The inclusion criteria were: age >18 years, having undergone a liver transplant, and suffering from type 2 diabetes mellitus and/or overweight or obesity (BMI>25). The exclusion criteria were having a diagnosed psychiatric disorder (according to the DSM-5) within the 12 months prior to enrollment and/or taking psychotropic drugs that had not been at a stable dose in the 6 months preceding the enrollment visit.

Information about participants' age, sex, marital status, education, occupation were collected. Height and body weight were measured. The height and weight were recorded while the participants were wearing light clothing with their shoes removed. Body mass index (BMI) was calculated as the weight in kilograms divided by the height in meters squared. For BMI classification, a BMI of less than 25 kg/m² was considered normal weight, a BMI between 25 and 29.9 kg/m² was classified as overweight, and obesity was defined as a BMI of ≥30 kg/m².

The revised version of the Night Eating Questionnaire (NEQ) was administered to all participants [13]. Created by Kelly C. Allison and collaborators in 2008, the NEQ is a self-reported Likert scale tool aimed at evaluating the occurrence and frequency of night eating patterns. The key behaviors assessed by the NEQ include evening hyperphagia, nighttime awakenings accompanied by food consumption, morning anorexia, difficulty falling asleep, and mood disruptions [17].

In addition to applying the specified criteria for questionnaire scoring, we separately collected data for exploratory purposes from responses to the following questions: 9, 11, 12, and 17.

All data was collected simultaneously on the day of enrollment.

This study was approved by the ethics committee of the Area Vasta Emilia Centro (reference code 301/2021/Oss/AOUBO). Written consent from enrolled patients was obtained. This research was conducted in accordance with the Declaration of Helsinki.

2.2. Statistical analyses

Continuous variables are presented as mean and standard deviation, while categorical variables are expressed as counts and percentages. Comparisons between categorical variables were performed using the chi-square test or Fisher's exact test, as appropriate.

The statistical analyses were performed using STATA 18, considering two-tailed P-values < 0.05 statistically significant.

3. Results

A total of 104 patients were enrolled in the study; however, complete questionnaires were available for only 101 patients (31 females, 70 males), and thus, 101 patients were included in the analysis.

The participants had a mean age of 61.7 years (SD 8.4), were predominantly male (69.3 %), and most were long-standing type 2 diabetes mellitus patients (81.2 %, mean duration 10.1 years, SD 7.6). The mean BMI indicated overweight (29.7; SD 5.8). Details regarding marital status and occupation can be found in Table 1. The results of the NED questionnaire revealed that NES was present in 5 % of patients. Table 2 provides data on the total NED score and specific items.

No significant associations were observed between NES diagnosis and BMI category, marital status, or occupational status. This may be due in part to the limited sample size and demographic homogeneity (predominantly male, older, retired individuals). In addition, no significant differences were observed in sex distribution or diabetes duration between participants with and without night awakenings without the need to use the bathroom. Specifically, the proportion of males (69.7 % vs 66.7 %, $p = 0.833$) and females (30.3 % vs 33.3 %) was comparable between groups. Similarly, diabetes duration did not differ significantly (10.27 ± 7.41 vs 8.89 ± 9.85 years, $p = 0.628$). On the other hand, age was significantly higher in individuals reporting night awakenings without need to use the bathroom (66.33 ± 9.86 vs 61.02 ± 8.06 years, $p = 0.040$), indicating that older age may be associated with this behavior.

Among patients who woke up at night without needing to use the bathroom, obesity was more prevalent than overweight ($p < 0.01$) and, to a lesser extent, normal weight ($p = 0.09$) (Table 3).

In particular, responses to NEQ items related to mood, difficulty falling asleep, and nocturnal cravings highlighted a subset of patients with potential psychological vulnerability. These symptoms were not exclusive to those meeting the full NES diagnostic threshold, suggesting

Table 1
Patient's characteristics, N = 101.

Variables	Mean (standard deviation) or Number (%)
Age (years)	61.7 (8.4)
Weight (kg)	83.6 (19.2)
BMI (kg/m ²)	29.7 (5.8)
Sex	
Female	31 (30.7 %)
Male	70 (81.2 %)
LT duration (years)	8.5 (8.2)
Diabetes	82 (81.2 %)
Diabetes years (N = 82)	10.1 (7.6)
Occupation	
Housewife	8.0 (8.2 %)
Workman	5.0 (5.2 %)
Employee	12.0 (12.4 %)
Self-employed	8.0 (8.2 %)
Unemployed	7.0 (7.2 %)
Retired	57.0 (58.8 %)
Marital status	
Unmarried/Single/Divorced	17.0 (17.5 %)
Married/Cohabiting	77.0 (79.4 %)
Widowed	3.0 (3.1 %)

BMI: Body Mass Index; LT: Liver Transplantation.

Table 2
NED results, N = 101.

Item		Number (%) or Mean (standard deviation)
NEDQ diagnostic for NES	yes	5.0 (5.0 %)
	no	96 (95 %)
Question 9	yes	12.0 (11.9 %)
	no	89.0 (88.1 %)
Question 11	yes	95.0 (94.1 %)
	no	6.0 (5.9 %)
Question 11a		7.3 (5.8)
Question 11b		6.4 (5.2)
Question 12		5.6 (4.7)
Question 17	yes	25.0 (24.8 %)
	no	76.0 (75.2 %)
Number of times per week they wake up without using the bathroom	0	89 (88.1 %)
	1	3 (3.0 %)
	2 or more	9 (9.0 %)

NEDQ: Night Eating Diagnostic Questionnaire; NES: Night Eating Syndrome; Q9: On most days, do you have a strong urge to eat between dinner and sleep onset and/or during the night? Q11: Do you have trouble staying asleep at night? 11a. If YES, how many times each week? 11b. If YES, how many times each week do you get out of bed during these awakenings? Q12: How many times each week do you awake from sleep during the night to use the bathroom? Q17: Have you been feeling depressed or down nearly every day? Q19: Are you currently dieting to lose weight?.

Table 3
Patient's characteristics based on night awakenings. NEDQ and BMI results.

		Night awakenings without need to use the bathroom		Total	P-value
		No	Yes		
Total population N (%)		89 (88.1)	12 (11.9)	101 (100)	
NEDQ Result N (%)	Negative	84 (94.4)	12 (100.0)	96 (95.0)	0.52
	Positive	5 (5.6)	0 (0.0)	5 (5.0)	
BMI (kg/m²)		29.1 ± 5.7	34.1 ± 4.7	29.7 ± 5.8	0.005
BMI classes N (%)	normal weight	18 (20.2)	1 (8.3)	19 (18.8)	0.012
	overweight	37 (41.6)	1 (8.3)	38 (37.6)	
	obesity	34 (38.2)	10 (83.3)	44 (43.6)	

BMI: Body Mass Index; NEDQ: Night Eating Diagnostic Questionnaire.

the presence of clinically relevant subthreshold night eating behavior.

4. Discussion

This study represents one of the first investigations into the prevalence of NES among liver transplant recipients with diabetes and/or excess weight. Our findings suggest that NES may act as a marker of residual psychological distress and circadian dysregulation — two underappreciated yet clinically relevant dimensions in the post-transplant context. While NES has been extensively studied in general and bariatric populations, its presence in transplant recipients remains underexplored — despite the high prevalence of metabolic and psychological vulnerabilities in this group [18].

Our findings emerge from a real-life clinical cohort, and although the prevalence of NES was relatively low (5 %), it exceeded that reported in

the general population (1–1.5 %) and aligned with previously documented ranges in populations with obesity (6–16 %) [14,15]. These results are consistent with the notion that NES is more common in individuals with disrupted circadian regulation, emotional dysregulation, and metabolic impairment — features frequently encountered in the post-transplant setting. To note that, extracting data from the questionnaire, we observed that older age was associated with a statistically significance higher frequency of night awakenings without the need to use the bathroom, suggesting a potential correlation with altered circadian regulation.

From a clinical standpoint, several considerations make the transplant population particularly susceptible to night eating behaviors. Firstly, a large proportion of transplant recipients follow strict nutritional plans both before and after surgery. These regimens, while clinically necessary, may promote restrictive eating patterns that have been associated with disordered eating behaviors in the general population [8]. Secondly, considering that metabolic dysfunction-associated steatohepatitis (MASH) is the main cause of liver cirrhosis, it is becoming more common for liver transplant recipients to have a history of previous attempts of diet-induced weight loss attempts or exposure to stigmatizing narratives around food and body image [19].

Moreover, prior research by our group has shown a higher prevalence of binge eating disorder (BED) in patients with steatotic liver disease [20]. These overlapping patterns support the hypothesis that liver transplant recipients represent a psychologically vulnerable group, particularly in terms of appetite regulation, self-perception, and body-related distress. This is especially important considering the high frequency of depressive symptoms and anxiety in these patients, as previously described in both liver disease and transplant literature [21, 22].

While we did not observe a strong association between NES and gender or marital status, it is important to recognize the limits of our sample distribution — dominated by older, male, retired individuals, which reflects the epidemiology of liver transplantation but limits generalizability. Interestingly, we did find that obesity was significantly associated with nighttime awakenings unrelated to the need to use the bathroom. This finding, while exploratory, reinforces the possibility of sleep fragmentation due to neuroendocrine dysregulation, emotional eating, or residual metabolic disturbance.

This supports the idea that NES may not always emerge as a fully developed syndrome but rather exist on a spectrum of disordered behaviors influenced by emotional and neuroendocrine imbalances.

NES is no longer viewed as a simple behavioral quirk but rather as a condition with implications for metabolic health, mental well-being, and sleep architecture. It is also increasingly recognized in the DSM-5 framework and shares several characteristics with other eating disorders, such as binge eating and emotional eating, although with a distinct chronobiological pattern. Studies have shown associations between NES and mood disturbances, insomnia, and anxiety symptoms [10,23]. Our study is in line with this literature, suggesting that nighttime eating behaviors may serve as a maladaptive emotional regulation strategy in a subgroup of post-transplant patients.

From a psycho-nutritional perspective, NES deserves attention not only for its potential metabolic consequences but also as a marker of post-transplant quality of life. The absence of a validated clinical pathway to address NES in liver transplant care highlights the need for integrated models that include nutritional education, behavioral counseling, and psychiatric evaluation when appropriate. Cognitive behavioral therapy, selective serotonin reuptake inhibitors, and bright light therapy have shown efficacy in treating NES in the general population and may warrant exploration in this unique patient group [24].

Given the potential implications for both metabolic control and quality of life, future clinical protocols could benefit from the routine integration of NES screening — such as the NEQ — within the first 6–12 months post-transplantation, as part of standard psycho-nutritional assessments.

This study has several limitations. Its cross-sectional design prevents inference of causality, and the absence of a control group limits direct comparison with non-transplanted populations. Given the low prevalence of NES in the sample (only 5 participants), the absence of significant associations with BMI, occupational status, or marital status should be interpreted with caution. Another important limitation is the potential underreporting of NES symptoms, possibly due to stigma or limited insight, which may have led to an underestimation of its true prevalence. Nevertheless, the study's strengths include the use of a validated questionnaire, a real-world clinical cohort, and the identification of clinically relevant patterns that can inform future research.

5. Conclusion

This study is among the first to explore NES in liver transplant recipients with metabolic comorbidities, highlighting its presence even in a medically supervised, post-transplant population. Although the overall prevalence of NES was low, its occurrence was disproportionately higher among individuals with obesity and nighttime awakenings, underlining the interplay between metabolic, behavioral, and psychological factors. Our findings suggest that NES may act as a marker of residual psychological distress and circadian dysregulation in this group, often masked by a focus on clinical stability and graft survival. The incorporation of NES screening tools, such as the NEQ, into nutritional or psychological assessments may provide valuable insights into patient vulnerability and quality of life after transplantation. Addressing NES in this population requires an integrated psycho-nutritional approach that recognizes the emotional and behavioral dimensions of post-transplant care.

Given the increasing metabolic complexity of transplanted patients, the clinical relevance of NES is expected to grow, making early identification and tailored intervention essential.

Future research should explore longitudinal outcomes and therapeutic interventions tailored to NES in transplant recipients. NES may not only reflect a disordered eating pattern, but also a broader unmet need in the continuum of post-transplant survivorship care.

Statements

CRediT authorship contribution statement: Michele Stecchi: Conceptualization, Writing - Original Draft. Maria Giuseppina Albanese: Data Curation, Writing - Original Draft. Elena Nardi: Formal analysis. Giulia Simonetti: Data Curation, Writing - Review & Editing. Chiara Baldo: Data Curation. Miriana Sciatta: Data Curation. Giovanni Vitale: Conceptualization, Writing - Review & Editing. Paolo Pianta: Writing - Review & Editing. Matteo Ravaioli: Writing - Review & Editing. Matteo Cescon: Writing - Review & Editing. Maria Cristina Morelli: Writing - Review & Editing. Lucia Brodosi: Conceptualization, Writing - Original Draft.

Data sharing

Data can be found at the following link: <https://zenodo.org/records/15624774>.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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