

# Evaluating the Effectiveness of Non-Invasive Ventilation in Obesity Hypoventilation Syndrome: A Retrospective Study on Clinical Outcomes

<sup>1</sup>Hoda A. Khoutan, <sup>2</sup>Wafa M. Al-Malack, <sup>3</sup>Nahlah A. Albaalharith,  
<sup>4</sup>Eman M. Alanizi, <sup>5</sup>Abdullah G. Alshubaili, <sup>6</sup>Aishah R. Alanazi,  
<sup>7</sup>Abdulaziz S. Alaws

Respiratory Therapist  
Health affairs at the ministry of National Guard

## Abstract

**Background:** Obesity hypoventilation syndrome (OHS) is characterized by impaired ventilation leading to hypercapnia and disrupted sleep. Non-invasive ventilation (NIV) is commonly used to manage OHS, but its effectiveness in reducing hypercapnia and improving sleep quality requires further evaluation.

**Objective:** This study aimed to assess the impact of NIV on hypercapnia and sleep quality in patients with OHS.

**Methods:** We conducted a retrospective analysis of 50 OHS patients treated with NIV over a 6-month period. Clinical outcomes were measured through arterial blood gas analyses and polysomnography before and after NIV therapy. Data on PaCO<sub>2</sub> levels, sleep efficiency, apnea-hypopnea index (AHI), and hypopnea index were collected and analyzed.

**Results:** NIV significantly reduced mean PaCO<sub>2</sub> levels by 10.2 mmHg ( $p < 0.01$ ). Improvements in sleep quality were observed, with sleep efficiency increasing by 8.3%, and AHI and hypopnea index decreasing by 37.2% and 37.4%, respectively.

**Conclusion:** NIV effectively decreases hypercapnia and enhances sleep quality in patients with OHS. These findings support the use of NIV as a beneficial intervention in managing OHS.

**Keywords:** Non-invasive ventilation, obesity hypoventilation syndrome, hypercapnia, sleep quality, arterial blood gas, polysomnography.

## Introduction

Obesity hypoventilation syndrome (OHS), also known as Pickwickian syndrome, is a serious respiratory condition characterized by excessive weight leading to impaired ventilation and subsequent respiratory failure during sleep. Patients with OHS typically present with daytime somnolence, obesity, and hypoventilation, which can result in elevated arterial carbon dioxide levels (hypercapnia) and decreased oxygen saturation (Al Dabal and BaHammam, 2009).

Non-invasive ventilation (NIV) has emerged as a critical intervention in managing OHS, providing a means to improve ventilation without the need for invasive procedures. NIV assists in alleviating hypoventilation by delivering positive pressure to the airways, thereby reducing the work of breathing and enhancing gas exchange. This modality has been associated with improvements in both hypercapnia and sleep quality in patients with OHS (Masa et al., 2016).

Several studies have demonstrated the benefits of NIV in managing OHS, including reductions in hypercapnia and improvements in sleep-disordered breathing. For instance, a study by Masa et al. (2016) reported significant decreases in daytime hypercapnia and improvements in sleep architecture among OHS patients treated with NIV. Similarly, research by Heinemann et al. (2007) highlighted that NIV can improve oxygenation and overall quality of life in patients with OHS.

Despite these advancements, there remains a need for comprehensive data on long-term clinical outcomes of NIV in OHS, particularly in real-world settings. This study aims to address this gap by conducting a retrospective analysis to evaluate the effectiveness of NIV in improving clinical outcomes such as reduction in hypercapnia and enhancement of sleep quality in patients with OHS.

## Literature Review

### Obesity Hypoventilation Syndrome and Non-Invasive Ventilation

Obesity hypoventilation syndrome (OHS) is a complex disorder where excessive body weight impairs respiratory function, leading to hypoventilation and resultant hypercapnia, particularly during sleep. This syndrome is characterized by elevated carbon dioxide levels (PaCO<sub>2</sub>) and decreased oxygen levels (PaO<sub>2</sub>) due to inadequate ventilation. Research has shown that OHS significantly impacts patients' quality of life, leading to daytime sleepiness, reduced cognitive function, and an increased risk of cardiovascular events (Al Dabal and BaHamman, 2009).

Non-invasive ventilation (NIV) has become a cornerstone in the management of OHS. NIV, which includes techniques such as bilevel positive airway pressure (BiPAP) and continuous positive airway pressure (CPAP), helps alleviate hypoventilation by providing positive pressure to maintain airway patency and support breathing (Masa et al., 2016). The efficacy of NIV in managing OHS has been widely documented, with studies highlighting its role in improving hypercapnia and sleep quality.

### Effectiveness of NIV in Reducing Hypercapnia

A substantial body of research indicates that NIV is effective in reducing hypercapnia in OHS patients. A retrospective study by Heinemann et al. (2007) demonstrated that patients with OHS who were treated with NIV experienced a significant reduction in daytime PaCO<sub>2</sub> levels and improvements in arterial blood gases. The study also found that NIV therapy led to enhanced ventilatory control and decreased nocturnal hypoventilation, contributing to overall better respiratory function.

Further supporting these findings, a meta-analysis by Masa et al. (2016) synthesized data from multiple studies and confirmed that NIV reduces hypercapnia and improves oxygenation in OHS patients. The analysis revealed that NIV not only mitigates the physiological manifestations of OHS but also enhances patients' daytime alertness and overall quality of life.

### Impact of NIV on Sleep Quality

The impact of NIV on sleep quality in OHS patients has also been well-documented. Studies have shown that NIV can improve sleep architecture by reducing the frequency of apneas and hypopneas, thus enhancing overall sleep quality. For instance, a study by Masa et al. (2016) found that NIV led to significant improvements in sleep efficiency and reduction in sleep-disordered breathing events among patients with OHS. The study emphasized that improved sleep quality contributes to better daytime function and reduced daytime sleepiness.

Additionally, research by Ramírez-Molina et al. (2017) reported that NIV therapy was associated with improvements in sleep-related outcomes, including decreased sleep fragmentation and increased time spent in restorative sleep stages. The study highlighted that NIV's benefits extend beyond respiratory function, positively impacting patients' sleep health and overall well-being.

### Long-Term Outcomes of NIV in OHS

Despite the known benefits of NIV, there is a need for more comprehensive data on the long-term outcomes of this therapy in OHS patients. While short-term studies have demonstrated significant improvements in hypercapnia and sleep quality, research focusing on long-term efficacy and sustainability of NIV in managing OHS remains limited. The current study aims to fill this gap by providing a retrospective analysis of long-term clinical outcomes associated with NIV therapy in patients with OHS.

## Methodology

### Study Design

This retrospective cohort study assessed the effectiveness of non-invasive ventilation (NIV) in patients with obesity hypoventilation syndrome (OHS). The study utilized data from a single tertiary care hospital to evaluate clinical outcomes associated with NIV therapy, focusing on its impact on hypercapnia and sleep quality.

### Participants

The study included adult patients diagnosed with OHS who were treated with NIV. Inclusion criteria encompassed: (1) a clinical diagnosis of OHS, (2) initiation of NIV therapy, and (3) availability of pre- and post-treatment clinical data. Exclusion criteria included: (1) patients with conditions other than OHS that could affect NIV outcomes (e.g., significant obstructive lung disease), and (2) incomplete data records.

## Data Collection

Data were retrospectively collected from electronic health records. The following variables were extracted: demographic information (age, sex, BMI), baseline arterial blood gases (ABG) including PaCO<sub>2</sub> and PaO<sub>2</sub>, pre- and post-treatment sleep studies, and NIV settings.

## Outcomes Measured

1. **Reduction in Hypercapnia:** Changes in PaCO<sub>2</sub> levels from baseline to follow-up were measured. Hypercapnia reduction was assessed by comparing mean PaCO<sub>2</sub> levels before and after a minimum of 6 months of NIV therapy.
2. **Improvement in Sleep Quality:** Sleep studies performed before and after NIV initiation were reviewed to evaluate changes in sleep architecture. Outcomes included sleep efficiency, total sleep time, and frequency of apneas and hypopneas.

## Statistical Analysis

Descriptive statistics were used to summarize demographic and baseline characteristics. Paired t-tests were employed to compare pre- and post-treatment PaCO<sub>2</sub> levels. Changes in sleep quality parameters were analyzed using repeated measures ANOVA. Statistical significance was set at  $p < 0.05$ . All analyses were performed using SPSS version 26.0.

## Ethical Considerations

The study was approved by the ethics committee. Patient consent was not required for this retrospective analysis as it utilized de-identified data.

## Limitations

The study acknowledged limitations including the potential for selection bias, as it was conducted at a single institution, and the reliance on retrospective data, which may have limited the completeness and accuracy of recorded information.

## Findings

### Participant Demographics

A total of 100 patients with obesity hypoventilation syndrome (OHS) who received non-invasive ventilation (NIV) therapy between January 2018 and December 2022 were included in the study.

- Age: Mean age 54 ±8 years
- Gender: 60% male, 40% female

- BMI: Mean BMI 37.5  $\pm$ 5.6 kg/m<sup>2</sup>

Table 1: Baseline Characteristics of Participants

Characteristic	Value (Mean $\pm$ SD)
Age (years)	54 $\pm$ 8
Gender (Male)	60%
BMI (kg/m <sup>2</sup> )	37.5 $\pm$ 5.6

### Effectiveness of NIV on Hypercapnia

Table 2 presents the arterial blood gas (ABG) parameters before and after NIV therapy. There was a significant reduction in PaCO<sub>2</sub> levels, indicating improved control of hypercapnia.

Table 2: Changes in Arterial Blood Gas Parameters

Parameter	Baseline (Mean $\pm$ SD)	Post-Treatment (Mean $\pm$ SD)	p-value
PaCO <sub>2</sub> (mmHg)	55.3 $\pm$ 7.4	45.1 $\pm$ 8.1	< 0.01
PaO <sub>2</sub> (mmHg)	65.8 $\pm$ 9.2	68.4 $\pm$ 7.5	0.08

### Improvements in Sleep Quality

Table 3 shows the changes in sleep quality parameters. Significant improvements were noted in sleep efficiency and reductions in apneas and hypopneas.

Table 3: Sleep Quality Parameters Before and After NIV Therapy

Parameter	Baseline (Mean $\pm$ SD)	Post-Treatment (Mean $\pm$ SD)	p-value
Sleep Efficiency (%)	72.4 $\pm$ 10.3	80.7 $\pm$ 9.8	< 0.01
Apnea Index (events/hr)	14.5 $\pm$ 3.2	9.1 $\pm$ 2.8	< 0.01
Hypopnea Index (events/hr)	20.3 $\pm$ 4.5	12.7 $\pm$ 3.9	< 0.01

## Discussion

This study evaluated the effectiveness of non-invasive ventilation (NIV) in patients with obesity hypoventilation syndrome (OHS) by assessing its impact on hypercapnia and sleep quality. The results demonstrate that NIV significantly reduces hypercapnia and improves sleep quality in this patient population.

## Effectiveness on Hypercapnia

Our findings reveal a significant decrease in PaCO<sub>2</sub> levels following NIV therapy, with a mean reduction of 10.2 mmHg ( $p < 0.01$ ). This substantial decrease aligns with previous studies indicating that NIV effectively alleviates hypercapnia in OHS patients (Masa et al., 2016). The improvement in PaCO<sub>2</sub> levels suggests that NIV facilitates better ventilation and gas exchange, which is critical for patients with OHS who struggle with alveolar hypoventilation and resultant carbon dioxide retention.

## Improvements in Sleep Quality

The study also highlights significant improvements in sleep quality parameters. Sleep efficiency increased by 8.3%, and both the apnea index and hypopnea index decreased by 37.2% and 37.4%, respectively. These findings are consistent with the literature, which reports that NIV can lead to substantial improvements in sleep architecture and respiratory events in OHS patients (Ramírez-Molina et al., 2017). By reducing apneas and hypopneas, NIV helps restore normal sleep patterns and enhance overall sleep quality.

## Clinical Implications

The results underscore the importance of NIV in managing OHS, particularly in improving clinical outcomes related to hypercapnia and sleep disturbances. By mitigating the adverse effects of elevated PaCO<sub>2</sub> and reducing sleep-disordered breathing, NIV not only enhances daytime function and well-being but also contributes to better long-term health outcomes (Heinemann et al., 2007). These improvements can lead to decreased hospitalizations, reduced healthcare costs, and a better quality of life for patients.

## Limitations and Future Research

While the study provides valuable insights, it has limitations. The retrospective nature of the study may introduce selection bias and limit the generalizability of the findings. Additionally, the study did not assess long-term outcomes beyond 6 months, which would be valuable for understanding the sustained effects of NIV.

Future research should include larger, multi-center trials with longer follow-up periods to confirm these findings and explore the long-term benefits of NIV in OHS. Additionally, examining patient-reported outcomes and quality of life measures could provide a more comprehensive view of the impact of NIV.

## Conclusion

In summary, this study supports the use of NIV as an effective treatment for patients with obesity hypoventilation syndrome. NIV significantly improves both hypercapnia and sleep quality, highlighting its role in managing OHS. Continued research and clinical application of NIV are essential for optimizing patient outcomes and advancing treatment strategies for this challenging condition.

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