Predictors of Severe Obstructive Sleep Apnea in Adolescents

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Introduction

Pediatric obstructive sleep apnea (OSA) is characterized by obstruction of the upper airway during sleep leading to inadequate ventilation (1). Children experience frequent hypopnea and apnea events during sleep leading to arousals, oxygen desaturation, and hypercapnia.

The association between overweight/obesity and OSA in adolescents remains poorly studied and unclear. Our research was conducted to establish the risk factors for severe OSA in adolescents aged 12-17.

The primary objective of our study was to determine the relationship between adiposity as measured by the BMI z-score and the AHI from overnight sleep studies. Our secondary objective was to determine the role of gender, age, ethnicity, tonsil size and birth term status, in predicting severe sleep apnea (AHI ≥10).

Methods

Electronic medical records of children who underwent polysomnography between 01/13 and 06/15 Children's Medical Center were examined.

Inclusion criteria were:
1) Age 12-17
2) Height, weight and polysomnography data available

Exclusion criteria were:
1) Significant comorbidities including genetic, neuromuscular or chromosomal abnormalities
2) Previous tonsillectomy and adenoidectomy

Demographic and polysomnogram measurements were recorded. Children were grouped into three age and sex-adjusted BMI percentile categories: normal-weight (5-85), overweight (85-95), and obese (95-100). A multilevel mixed effects regression model was used for analysis. Significance was set at $p \leq 0.05$.

Child undergoing polysomnography *(stock)*

Glossary of Terms
Apnea Hypopnea Index (AHI) – the number of complete (apnea) or partial (hypopnea) reductions in airflow per minute.
BMI Z-score - number of standard deviations above mean BMI for age and sex
Tonsil Size – 1-4 grading scale to describe the size of palatine tonsils with 1+ tonsils hidden behind palatoglossal arch and 4+ occupying > 75% of pharyngeal space.

Results

	All Patients n = 258	Normal-Wt n = 36	Overweight n = 53	Obese n = 169	P Value
Age –median	14.5	13.9	14.6	14.8	0.227
BMI – median	32.3	19.1	25.7	36.6	<0.001
Male - No (%)	139 (53.9%)	20 (14.4%)	28 (20.1%)	91 (65.5%)	0.968
Ethnicity – No (%)					
White	37 (14.3)	6 (16.7)	7 (18.9)	24 (64.9)	0.897
Black	79 (30.6)	12 (15.2)	19 (24.1)	48 (60.8)	0.549
Hispanic	137 (53.1)	16 (11.7)	25 (18.3)	96 (70.1)	0.251

Table 1 – Demographics of Study Population

258 patients were included in this study. There were no significant differences in age, gender, or ethnicity between the different weight categories (table 1). The BMI z-score and tonsil size were positively and independently correlated with increasing AHI. Holding BMI z-score constant and increasing tonsil size from 1+ to 4+ led to an average 23 point increase in the AHI. Male gender was not linearly associated with increasing AHI, however the odds ratio for severe OSA was 2x greater in males relative to females. Likewise, a one unit increase in the BMI z-score or tonsil size doubled the chance of severe OSA (table 2).

	Coefficient	P Value	Odds Ratio for AHI>=10
BMI Z-score	0.80	**0.002**	2.23
Tonsil Size	0.76	**<0.001**	2.13
Male Gender	0.80	**<0.016**	2.23

Table 2 – Odds Ratios for Severe OSA

Figure 1 demonstrates the relationship between AHI and BMI z-score in normal weight, overweight, and obese children. In obese children, increasing BMI z-score is strongly associated with increasing AHI; the relationship is less clear in normal weight and overweight children. Figure 2 shows that at any BMI z-score, increasing tonsil size leads to an increase in the AHI.
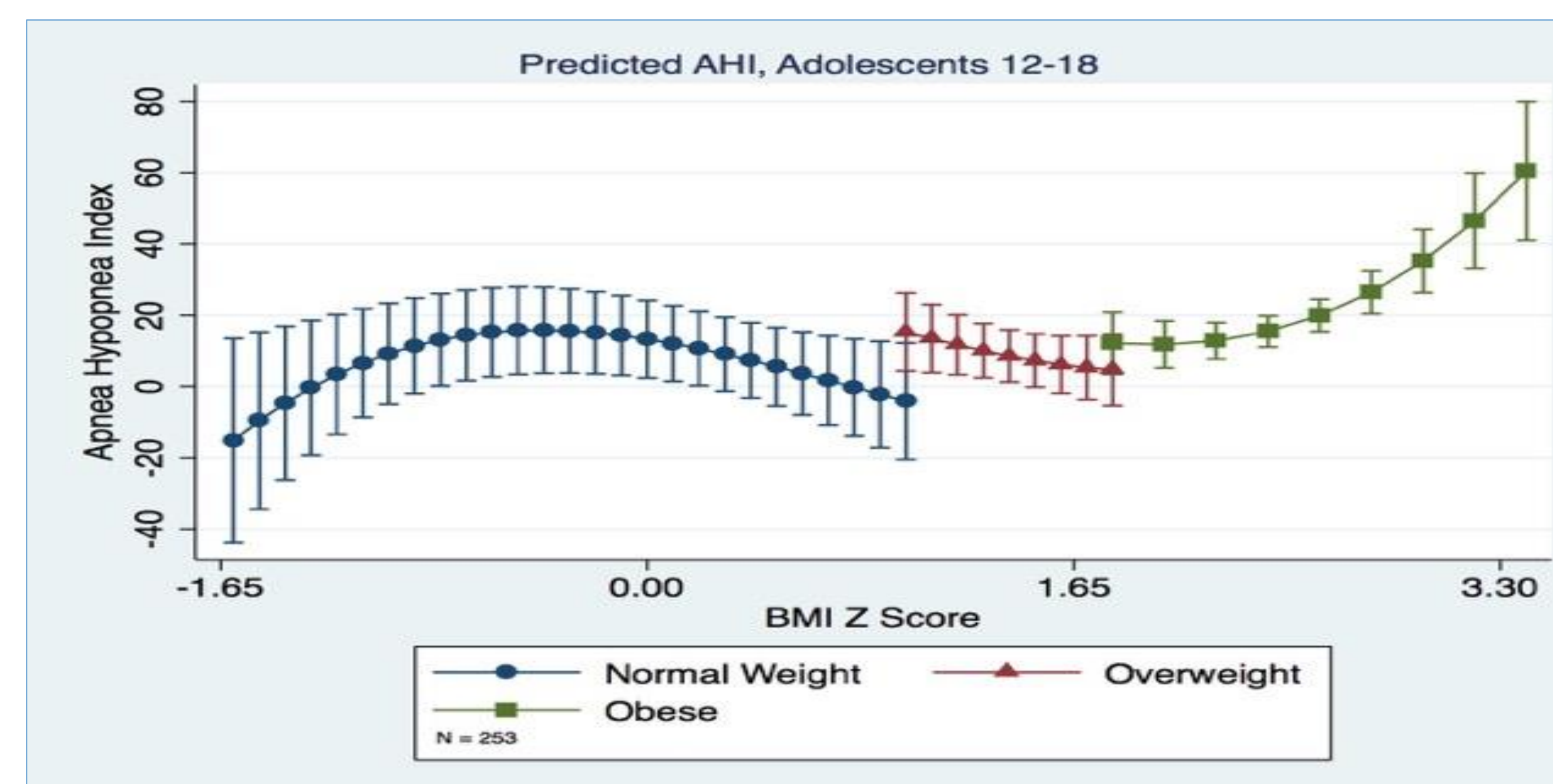

Figure 1 – Predicted AHI by Weight Category and BMI Z-score
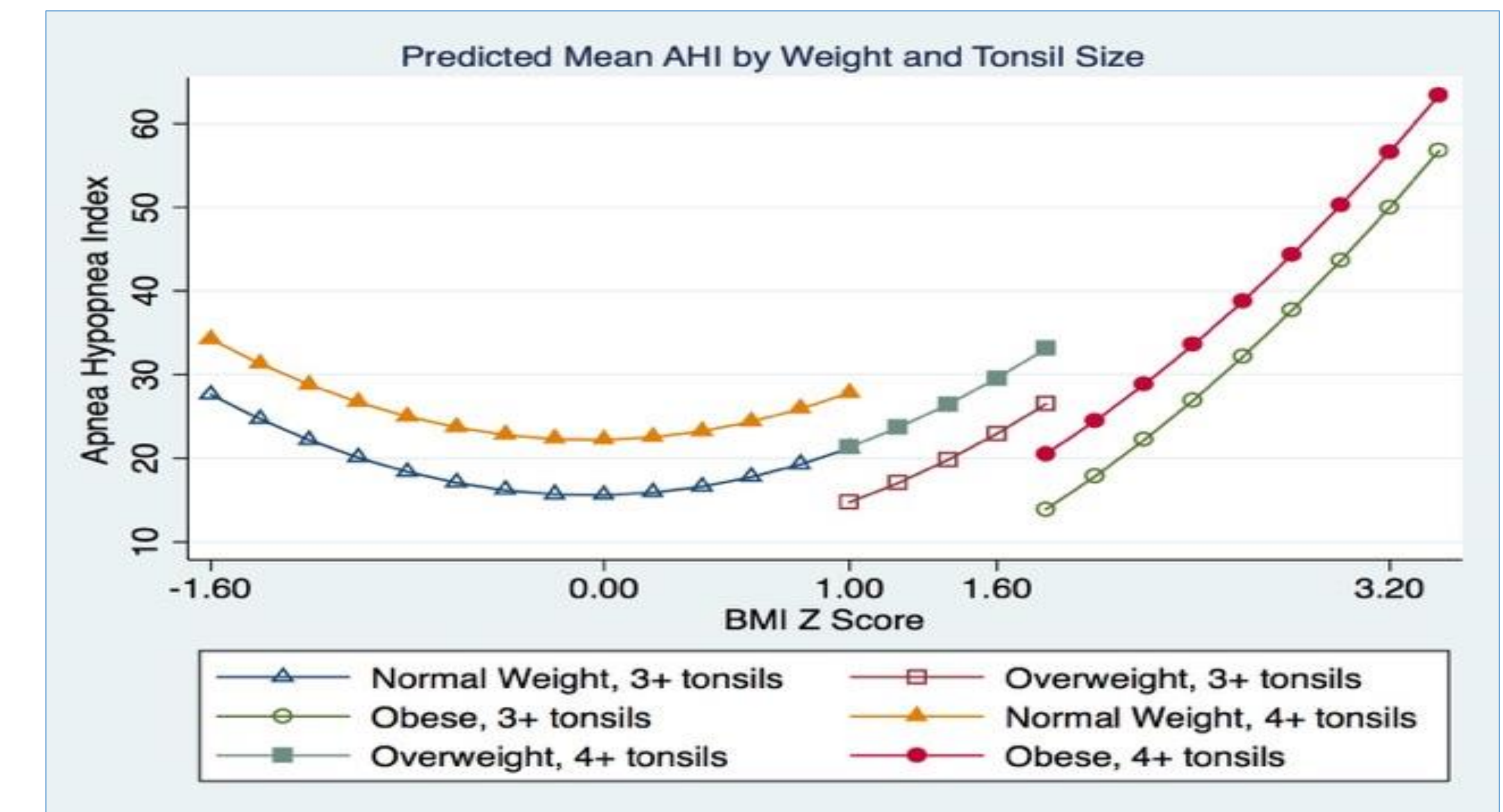
Results

Figure 2 – Predicted AHI by Weight Category and BMI Z-score Comparing 3+ and 4+ Tonsils

Conclusions

While research on risk factors for severe OSA in young children is relatively abundant, to our knowledge this is one of the first papers which has limited its study population to adolescents to more accurately assess risk factors in this group.

Our research has identified three strong risk factors for severe OSA: BMI z-score, tonsil size, and male gender. Each of these risk factors roughly doubles the risk of severe OSA in adolescents. These clear findings contrast with studies in younger children which have yielded conflicting reports on predictors of the AHI.[2-3] Additionally, our research shows that the relationship between BMI z-score and AHI is most pronounced in obese children, suggesting that there may be a critical mass of adiposity needed before major airway impingement begins.

This study has important clinical implications; a low threshold for PSG is needed in obese male adolescents with adenotonsillar hypertrophy. Earlier detection of severe OSA may allow for earlier treatment and reduction of the long term cardiovascular and quality of life complications associated with OSA.
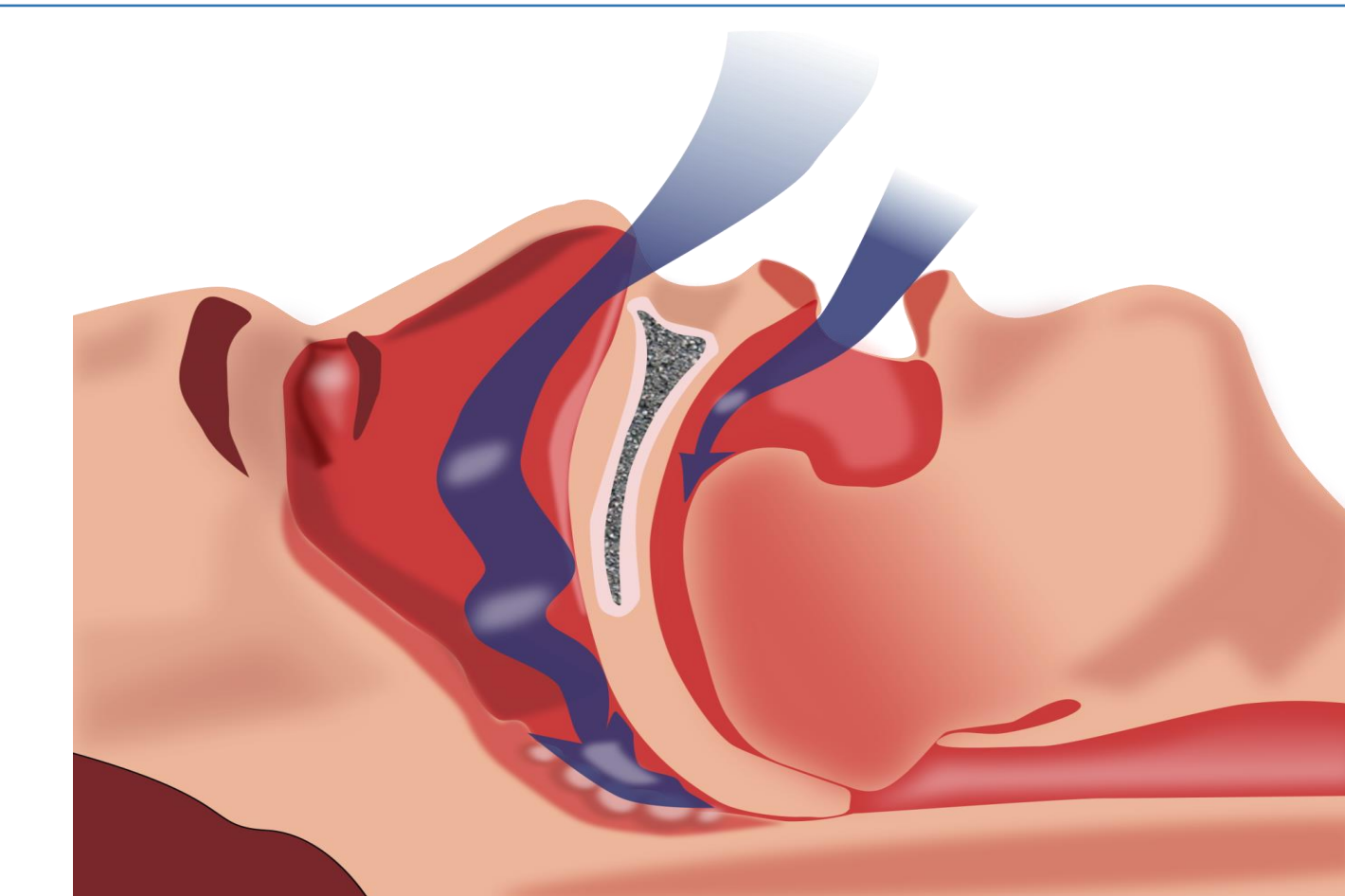
Airway obstruction by the tongue, tonsils, and pharyngeal fat all contribute to the pathogenesis of OSA

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