ASSESSMENT OF GROWTH IN CHILDREN FOLLOWING ADENOIDECTOMY AND OR TONSILLECTOMY FOR OBSTRUCTIVE SLEEP DISORDERED BREATHING AT KENYATTA NATIONAL HOSPITAL

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A Dissertation Submitted in Part Fulfillment for the Award of the Degree of Master of Medicine in Otorhinolaryngology, Head and Neck Surgery,

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STUDENT'S DECLARATION

I hereby certify that this dissertation is my original work and has not been submitted for any degree at any other institution.

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DEPARTMENTAL APPROVAL

This dissertation has been approved by the Otorhinolaryngology Head and Neck thematic unit Department of Surgery.

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OPERATIONAL DEFINITIONS

Adenoids– lymphoid tissues found in the nasopharynx, they may enlarge and causes obstruction in the paediatric age group from 7months to 7 years

Palatine Tonsils- Paired lymphoid tissue found on the lateral walls of the oropharynx.

Adenoidectomy - Surgical removal of the adenoid tissues.

Tonsillectomy – Surgical removal of the palatine tonsils.

Apnoea- Defined as a reduction in air flow by more than 90% for 10 seconds or 2 or more missed breaths. It can be central, obstructive or mixed. Obstructive apnoea is associated with increased respiratory effort.

Hypopnoea- Defined as reduction in inspiratory air flow by 30% leading to a reduction in oxygen saturation by at least 3-4% lasting for at least 10seconds.

Obstructive sleep apnoea- In paediatrics is defined as an apnoea hypopnoea index (AHI) of more than 1. That is, the sum total of apnoeas and hypopneas in one hour is more than 1. It can be mild AHI 1-5/hour, moderate AHI 5-10/hour or severe AHI>10/hour.

Primary snoring- Is defined as snoring with an apnoea hypopnoea index of less than 1/hour.

Upper airway resistance syndrome- This is defined as snoring with increased work of breathing and frequent arousals but no recognizable obstructive events or gas exchange abnormalities.

Respiratory disturbance index This is defined as the total of all apnoeas, hypopnoeas and respiratory effort related arousals (respiratory efforts other than apnoeas and hypopnoeas that lead to arousal) in one hour.

ABBREVIATIONS

AHI-	Apnoea hypopnoea index
ATH-	Adenotonsillar hypertrophy
BMI-	Body Mass Index
cm-	centimetres
ENT Clinic-	Ear, Nose and Throat Clinic
HAZ-	Height for age Z score
IGF-	Insulin like growth factor 1
IGFBP3-	Insulin like growth factor binding protein 3
KNH-	Kenyatta National Hospital
Kg-	Kilograms
m-	meters
OSA-	Obstructive sleep apnea
oSDB-	Obstructive sleep disordered breathing
PSQ-	Paediatric sleep questionnaire
SDB-	Sleep disordered breathing
SRBD-PSQ-	Sleep related breathing Disorder subscale Pediatric sleep questionnaire
SD-	Standard Deviation
WAZ-	Weight for age Z score
WHO-	World Health Organization

ABSTRACT

Background

Obstructive Sleep disordered breathing (oSDB) is a spectrum of disease that varies from simple snoring to obstructive sleep apnoea. It has many harmful effects in the paediatric age group including growth disturbances. The most common cause of oSDB in this group is adenotonsillar hypertrophy. Studies have shown increase in weight after adenoidectomy and or tonsillectomy for oSDB however clinicians routinely do not screen for growth disturbances in oSDB.

Broad objective To assess the rate of growth in children with obstructive Sleep disordered breathing after adenoidectomy and or tonsillectomy.

Research question Does adenoidectomy and or tonsillectomy in children with SDB lead to growth rate changes?

Study design and population Prospective case controlled study, 62 cases (40 males and 22 females) and 63 controls (34 males and 29 females) from the age of 2 to 5 years.

Study site Kenyatta National Hospital Ear Nose Throat (ENT) Clinic, ENT ward and well-baby clinic.

Study time and duration Eight months, starting April 2018.

Methodology Patients with obstructive sleep disordered breathing scheduled for adenoidectomy and or tonsillectomy and controls from the well-baby clinic were recruited using convenience sampling. After parental consent to participate in the study, they were subjected to the Sleep related breathing disordered paediatric subscale questionnaire (SRBD-PSQ). The children met the criteria for oSDB proceeded to have their heights in centimetres and weights in kilograms measured before adenoidectomy and or tonsillectomy. For the control group, those without oSDB proceeded to have their heights and weights measured. The heights and weight measurements were taken 3 months later for both groups. The data was analysed using SPSS version 21. Descriptive statistics was used to summarize age, weight and height measurements. Frequencies and percentages were used to summarize categorical data. Anthropometric indices were calculated using the WHO anthro software. The student's T-test was used to assess the difference in the means of weight for age, height for age and BMI for age Z scores between the study group and controls. The growth rate was then determined by

calculating a gradient representing the rate of change in anthropometric indices for each of the two groups of children. These gradients were used to determine the growth rate changes in children in the study group versus the controls.

Results Data from the study population and controls was analysed. Children with oSDB had statistically lower weight height and BMI Z scores when compared to controls (WAZ- 0.76 vs 0.14p value<0.001, HAZ -0.54 vs-0.08 p value 0.04, BMI z score -0.67 vs 0.25, p value 0.001). Three months after surgery, there was no statistical difference in the WAZ, HAZ and BMI Z scores of the study group and the controls. When divided into 18month age groups, the children in the younger age group had significantly larger changes in their Z scores. There was no significant difference in growth between the males and females. There was also no association between the quantity change in SRBD-PSQ score and the quantity change in WAZ, HAZ, and BMI Z score.

Conclusion Obstructive sleep disordered breathing had a negative impact on growth of affected children. Adenoidectomy and or tonsillectomy led to improvement in growth parameters as early as three months postoperatively.

1.0 CHAPTER ONE: BACKGROUND

1.1 Introduction

Obstructive sleep-disordered breathing (oSDB) is a clinical diagnosis characterized by obstructive abnormalities of the respiratory pattern or the adequacy of oxygenation/ventilation during sleep, which include snoring, mouth breathing, and pauses in breathing. oSDB encompasses a spectrum of obstructive disorders that increases in severity from primary snoring to obstructive sleep apnoea (OSA)[1]. The prevalence of oSDB varies between 4-13%[2,3]. The prevalence of OSA, the severest form of oSDB is between 1.2 -5.7%[1-3]. The commonest cause of oSDB in the paediatric age group is adenotonsillar hypertrophy[4,5] and adenotonsillectomy has been shown to lead to cure in 79-90% in children without comorbidities. [6-8]

Obstructive sleep disordered breathing has been thought to lead to substantial morbidities in the cardiovascular, nervous and metabolic systems. Children with oSDB have higher levels of hypertension, pulmonary artery hypertension and neurocognitive disturbances .[9,10]

Children with oSDB have also been shown to have lower growth measurements than normal controls[11]. Growth increases after adenotonsillectomy[11-13] and this has led the American academy of otolaryngology head and neck surgery to recommend assessment of comorbid conditions including growth retardation in children with sleep disordered breathing which could improve after adenotonsillectomy[1].

1.1.1Problem statement

Although it has been recommended that children with oSDB be assessed for growth retardation which could improve after adenotonsillectomy[1], it is not widely practiced[14]. We also have no local data that may be used to strengthen awareness of the effect of oSDB on growth in our environment. It is hence important to assess the children with oSDB in our environment and compare their growth to otherwise normal unaffected children in the same environment.

The well baby nursing team, nutritionists, paediatricians and otolaryngologist will benefit from the findings of this study as it may help guide their approach to a child growth retardation or oSDB.

1.2 Background

1.2.1 Obstructive sleep disordered breathing

Obstructive sleep-disordered breathing (oSDB) is a clinical diagnosis characterized by obstructive abnormalities of the respiratory pattern or the adequacy of oxygenation/ventilation during sleep, which include snoring, mouth breathing, and pauses in breathing. oSDB encompasses a spectrum of obstructive disorders that increases in severity from primary snoring to obstructive sleep apnoea (OSA)[1]. This definition has been enhanced to separate it from sleep disordered breathing which includes both oSDB and sleep disordered breathing from central causes[1,10].

The spectrum of oSDB encompasses primary snoring, upper airway resistance syndrome and OSA in increasing severity[10]. It is caused by narrowing of the air passages in the nose, nasopharynx, oropharynx or supraglottis. oSDB is more evident during the deep stages of sleep when the respiratory drive and pharyngeal muscle tone is reduced[4,15]. During inspiration, movement of air in the air passages creates a negative pressure effect that draws the surrounding tissues inwards. Narrowing of the air passages with enlarged adenoid tissue in the nasopharynx and or enlarged tonsillar tissue in the oropharynx worsens this situation [4,15,16]. The vibration of the tissues presents as snoring. If the tissues collapse inward completely, there is total cessation of breathing and it its observed as apnoea. With the build up of carbon dioxide and lack of oxygen to the brain due to the suspended respiration, the child moves to lighter stages of sleep or is aroused so that he may increase the pharyngeal muscle tone and hence open up the collapsed airway.

The gold standard test for diagnosing oSDB and its severity is the overnight polysomnography. However, it was not available at the time of the study. Other methods available to help in the diagnosis of oSDB include home polysomnography[18], pulse oximetry[19], use of biomarkers [20,21] and the use of questionnaires[22]. This study employed the use of a validated questionnaire; the sleep related breathing disordered questionnaire paediatric subscale SRDB-PSQ[22]. This was chosen as it was easily accessible, easy to administer and had been validated.

1.2.2 Sleep Related Breathing Disorder Subscale Paediatric Sleep Questionnaire (SRBD-PSQ)

The SRBD-PSQ is a validated questionnaire developed by Chevrin et al[22] (Appendix 2 Section 2) It is a questionnaire with 22 questions with high association to PSG readings. Responses to the questions asked can either be yes, no or don't know. A yes response is given a score of 1, a no response a score of 0 and don't know response is not scored. The total of all the yes responses, are divided by the sum of all the yes and no responses. Don't know responses are not included in the tabulation. Calculated values range from 0-1. Values equal or greater than 0.33 correlate with PSG diagnosis of OSA with a AHI> 5, with a sensitivity of 85% and a specificity of 87% [22].

1.3 Assessment of growth in children

Assessment of growth in children is vital as growth retardation can be detected early and intervention done before lifelong irreversible changes occur. In Kenya growth monitoring of children is done at the well-baby clinic up to 5 years of age. Data essential in assessment of growth include the child's age, weight and height. The data is used to derive growth indicators which include

1. Weight for age
2. Height for age
3. Weight for Height and Body mass index (BMI)

1.3.1 Weight for age

According to the World Health Organization (WHO), weight for age is a useful indicator for detecting children who are underweight. It however cannot be used to detect children who are overweight. The child's weight for age is compared to a median value derived from the WHO multicentre growth reference study group[23]. The standard deviation (SD) of the child's weight for age from the median value is used to determine if the child is underweight or severely underweight. A standard deviation between -2SD and -3SD is underweight. A score below -3SD is severely underweight (Table 1). The standard deviation is also regarded as the z score.[24]

1.3.2 Height for age

Height for age is a growth indicator used to detect stunting or abnormally tall children. The standard deviation of the child's height for age from the WHO median is used to determine the severity of stunting. -2 to -3 SD is interpreted as stunted growth (table 1). Values below -3 SD is severely stunted growth. Tallness is rarely a problem but values above +3SD is regarded as excessive tallness and the child should be screened for an endocrine disorder e.g. growth hormone tumor.[24]

1.3.3 Weight for Height and Body mass index (BMI).

Weight for height and BMI for age are growth indicators used to assess for wasting or obesity. Weight for height indicator is used in situations where it is difficult to establish the child's age. BMI for age gives the same growth indicator data but is used when the child's age is known. BMI is derived from dividing the child's weight in kilograms (Kgs) by the square of the child's height in metres (m), formula shown below;

$$\text{Child's weight (kg)}/\text{Child's height (m)}^2 = \text{BMI}(\text{Kg}/\text{m}^2).$$

The values of the weight for height or BMI for age are compared to the median values from the WHO, and the Z scores/ SD used to interpret. A Z score between -2 and -3 reflect wasting and below -3 reflects severe wasting. Z scores between +1 and +2 is reflective of a possible increased risk of being overweight. Values between +2 and +3 reflect overweight children and a Z score above +3 indicates obesity (table 1).[24]

In my study I opted to us the BMI for age as knowledge of the child's age was a prerequisite to be enrolled in the study.

Table 1: Interpretation of growth indicators

Z SCORE/ Standard Deviation	GROWTH INDICATOR: Weight for age	Height for age	BMI for age
ABOVE 3	Child may be Obese Assess better with BMI for	Excessive Tallness, rule out endocrine disorder	Obese
ABOVE 2	Age		Overweight
ABOVE 1			Possible risk of Overweight
O			
BELOW -1			
BELOW -2	Underweight	Stunted	Wasted
BELOW -3	Severely underweight	Severely stunted	Severely wasted

, Dark areas are Normal values

Courtesy of WHO training course on child growth assessment[23]

1.3.4 WHO Antho V3.2.2 Software

The children's weight for age, height for age and BMI for age Z scores were calculated using the WHO anthro V3.2.2 software. The software has fields for keying in the child's date of birth, weight and height. With the fields filled, the software calculated the child's Z score using the WHO median values. The software is a free to use software downloadable from the WHO website.[25]

1.4 Literature Review

1.4.1 Introduction

This section reviewed current literature on adenoidectomy and or tonsillectomy as a treatment for oSDB. It also reviewed literature on growth after surgery and the theories of how oSDB affects growth. The various methods of diagnosing oSDB in the paediatric population was also reviewed.

Literature for the current study was sourced from online sources including peer-reviewed articles. Databases used to search peer-reviewed articles include MEDLINE, Web of Science, Scopus, the Cochrane Library, Springer Link and Sage Journals. Google Scholar and Hinari was used to locate journal articles. Search terms (and their variations) used were: *adenotonsillar hypertrophy, sleep disordered breathing, obstructive sleep disordered breathing, obstructive sleep apnoea, adenoidectomy, tonsillectomy, adenotonsillectomy, growth, outcome* and *paediatric growth*. Mendeley was used to manage all references.

1.4.2 Adenoidectomy and or tonsillectomy as treatment for oSDB

The causes of oSDB in children include craniofacial anomalies, neuromuscular disorders and adenotonsillar hypertrophy. Adenotonsillar hypertrophy is the most common cause of oSDB in children [4,5]. This has led to adenotonsillectomy being the primary treatment for oSDB in children. Adenotonsillectomy has been shown to lead to improvement of oSDB in majority of the children. Marcus CL et al using data from the CHAT study[26] noted that 79% of children with OSA improved 7 months after adenotonsillectomy compared to 46% of children in the watchful waiting group[8]. Brietzke et al[7] noted 82.9% improvement in a systematic review of 14 studies. However other studies have reported lower rates[27,28]. One the factors for this is the definition of resolution of OSA. The heterogeneity of this was evident in the systematic review by Friedman et al[27]. In the study, adenotonsillectomy led to improvement of OSA in 66.1% of the studies reviewed when using the individual criteria of the studies. These criteria varied from AHI<5, AHI<1 or Respiratory disturbance index <5. However, when the AHI cut off of <1 was used, the rate of improvement reduced to 59.8%. Obesity has also been shown to result in poorer improvement after Adenotonsillectomy[6,28]. O'Brien et al noted OSA resolved in 71% of non-obese children verse 45% in obese children[28]. Other factors noted to influence resolution of oSDB include comorbid conditions (for example craniofacial anomalies, neuromascular disorders, underlying syndromes such as downs syndrome) and

age of the child. Mitchel et al[6] noted 71-90% improvement after excluding children with comorbidities and obesity

Majority of the studies done have focused on adenoidectomy and tonsillectomy as treatment for OSA. Domany et al[29] however noted that adenoidectomy led to the same resolution rates for OSA as adenoidectomy and tonsillectomy in children with tonsils Brodsky[30] grade 2 and below and in non-obese children. In our department adenoidectomy is done in children with oSDB with enlarged adenoids who do not have clinically enlarged tonsils of Brodsky[30] grade 3 or 4.

1.4.3 Growth in children with oSDB

Children with oSDB have been shown to have higher growth failure rates. Bonouk K et al [2] noted that growth failure rates of children with oSDB due to ATH was 18%. It increased to 21% in the under 6years of age. This was higher than the United States national average which was less than 5%. A recent study by Esteller E et al[31] in the Mediterranean region also found higher growth failure rate of 13.95% in oSDB children vs 5.81% of otherwise healthy controls. Lower growth measurements in children with oSDB have been found to significantly improve after adenotonsillectomy [11-13,32]. During this literature review, there was only one randomized control trial by Katz et al[32] that assessed growth after adenotonsillectomy. In the study, children with OSA were divided into either an early adenotonsillectomy group verses a watchful waiting group. The children in the early adenotonsillectomy group had a clinically higher than expected increase in their weight and BMI Z scores after 7 months. The American Academy of Otolaryngology head and neck surgery in their recent clinical practice guidelines recommend screening of co morbid conditions including growth failure in children with oSDB which could improve post operatively[1]. There has however been no meta-analysis of this done. A systematic review by Van et al[33] and Jeykumar et al[34] noted the challenges of performing a meta-analysis since data on growth from the different studies reviewed was presented differently. In the study by Van et al[33] growth in the studies analysed was either presented using growth percentiles or Z scores. In the studies analysed by Jeykumar et al[34], the results reviewed presented growth as either change in weight scores, BMI percentages or corrected weights. With this in mind a protocol for reporting outcomes may need to be adopted for all future studies to follow to enable eventual meta-analysis of the findings.

1.4.4 Obstructive Sleep Disordered Breathing and Growth

The cause of growth failure due to oSDB has not been established. Several theories have been put forward to try and explain this phenomenon. The theories focus on energy expenditure and growth hormone production. One theory is that there is increased energy expenditure in children with oSDB. Marcus et al[35] measured sleep energy expenditure in 14 Children undergoing adenotonsillectomy before and after surgery. Adenotonsillectomy was found to reduce the sleep energy expenditure significantly with no reduction in caloric intake thus leading to weight gain. It was postulated that the increased work of breathing due to obstruction of the airway in oSDB secondary to ATH led to higher energy demands. Postoperatively, there was a significant decline in the sleep energy expenditure in these children. However, a study by Bland et al[36] measuring total energy expenditure between children undergoing adenotonsillectomy and a control group before and after surgery, found there was no difference in total energy expenditure. It was postulated that though there was increased sleep energy expenditure in the adenotonsillectomy group before surgery, they would more likely compensate for it by having reduced energy expenditure during the day. Roemich et al[37] analysed motor activity in children before and after adenotonsillectomy. The findings were that before surgery, the children had higher motor activity scores leading to increased energy expenditure. The motor activity scores reduced after surgery. The study suggested that this could be the reason for the increased growth in these children

It has also been postulated that the cause of poor weight gain in children with oSDB is due to a reduction in growth hormone. Growth hormone is produced in the deeper stages of sleep (rapid eye movement sleep). This stage is characterized by hypotonia of pharyngeal muscles and reduced ventilatory drive. Children with oSDB develop hypopnoea and apnoea at this deep stages of sleep and are aroused so as to be able to increase the tone of their pharyngeal muscles[4]. This interrupts the production of growth hormone in these children as they spend very little time in deep sleep. Growth hormone stimulates production of insulin like growth factor 1 (IGF1) in the liver which functions as the main growth mediator and is transported bound to insulin like growth factor binding protein 3 (IGFBP3). Nieminen et al[38] showed reduced measurements of IGF1 and IGFBP3 levels in children with oSDB. In the study, children were divided into two groups, one undergoing adenotonsillectomy and the other managed medically. Six months after, there was significant increase in the IGF1and IGFBP3 values in the adenotonsillectomy group compared to the medically managed group. Similar findings were found by Yimaz et al [39].

1.4.5 Diagnosing obstructive sleep disordered breathing

The gold standard test for diagnosing obstructive sleep disordered breathing is an overnight polysomnography[2,10]. It was however not feasible to use it as it was not locally available at the time of the study. The demand of PSG also outstrips its supply in regions where it is available. This has led research into alternative methods of diagnosing oSDB[17]. Home PSG is one of the methods however it has not been proven to be efficacious in diagnosing oSDB in children aged 2-8 years[18]. Overnight pulse oximetry is another method. Traditionally done, it is not definitive in the diagnosis of OSA in children but when the McGill Oximetry score is used it reliably assesses OSAS and its severity[19]. We however did not have access to the overnight pulse oximetry during this study. Use of biomarkers to diagnose oSDB have been investigated, these include use of urine biomarkers such as gelsolin, perlecan[20] and elevated blood sugar level from blood[21] among others[17]. Associations have been made between the biomarkers and oSDB, however more studies need to be done to assess their utility in oSDB diagnosis.

The use of questionnaires has also been suggested as a way to diagnose OSA. The sleep related breathing disordered questionnaire Paediatric subscale questionnaire has been validated with a PSG AHI>5.[10,22]. As this was the available option at the time of the research, it was the method used to determine severe oSDB that correlated with OSA. Other questionnaires like the STOP, STOP-BANG[40] and Sleep Disordered Questionnaire 1[41] are adult questionnaires and have not been validated in children.

2.0 CHAPTER TWO: STUDY JUSTIFICATION

The impact of oSDB on growth is not well appreciated. Majority of paediatric oSDB in children without comorbidities is easily treatable by performing adenoidectomy and or tonsillectomy and hence these children would benefit from early association of oSDB with growth. This study sought to establish the association between oSDB and growth and ultimately raise the clinician's index of suspicion of oSDB as a cause of growth problems in the paediatric age group.

3.0 CHAPTER THREE: STUDY QUESTION AND OBJECTIVES

3.1 Study Question

Does adenoidectomy and or tonsillectomy in children with oSDB lead to growth rate changes?

3.2 Objectives

3.2.1 Broad objective

- To determine the rate of growth of children with obstructive sleep disordered breathing after adenoidectomy and or tonsillectomy

3.2.2 Specific objectives

1. To assess the rate of change in weight of the children with oSDB after adenoidectomy and or tonsillectomy and of the control group.
2. To assess the rate of change in height of the children with oSDB after adenoidectomy and or tonsillectomy and of the control group.
3. To assess the rate of change in BMI of the children with oSDB after adenoidectomy and or tonsillectomy and of the control group.
4. To compare the rate of changes in weight, height and BMI between the children with oSDB after adenoidectomy and or tonsillectomy and the control group.

4.0 CHAPTER FOUR: METHODOLOGY

4.1 Study type

This was a prospective case controlled study.

4.2 Study site

The study site was Kenyatta National Hospital ENT clinic, ENT ward and Well baby clinic

4.3 Sampling technique

The sampling technique used was convenience sampling.

4.4 Inclusion criteria for cases

The inclusion criteria for the cases was

1. Children from 2-5 years with obstructive sleep disordered breathing scheduled for adenoidectomy and or tonsillectomy.
2. Children whose parents consented to the study.

4.5 Inclusion criteria for the controls

The inclusion criteria for the controls was

1. Children 2-5 years of age attending well baby clinic
2. Children whose parents consented to the study

4.6 Exclusion criteria for cases and controls

The exclusion criteria for the cases and controls was

1. Children with ages less than 2 years or above 5 years.
2. Any syndromic child.
3. Any comorbidities e.g. pulmonary hypertension, congestive cardiac failure.
4. Children on nutritional supplementation.
5. Children undergoing adenoidectomy and or tonsillectomy for any reason other than sleep disordered breathing.
6. Children without a written consent.
7. Children whose parents opted out of the study.

4.7 Sample size calculation

Sample size was calculated using Rosner's formulae for detecting change in means for before and after measurements[42];

$$n = \frac{r(Z_\alpha + Z_\beta)^2}{(E/S(\Delta)\,)^2}$$

Where:

r = ratio of children with SDB: children without SDB set at 1:1

Z_α = 95% level of confidence represented by a standard normal deviate for α value of 0.05 = 1.96

Z_β = 80% power to detect the specified change in weight for age Z score between pre- and post-operative Z scores represented by a standard normal deviate for β value = 0.842

E = effect size, set at 0.5

$S(\Delta)$ = standard deviation of the change in weight for age Z score between pre- and post-operative Z scores estimated at 1.4 (This is as per the study by Smith DF et al where the change in weight for age Z scores for children with Obstructive sleep apnoea pre and post operatively was 0.26 and the calculated standard deviation of the Z score pre and post operatively was 1.4) [43]

$$n = \frac{1 \times (1.96 + 0.842)^2}{(0.5/1.4\,)^2}$$

n = 62 cases, 62 controls.

Add 15% to take care of those who drop out

62 + (62 x 10/100) = 9.3 Rounded up to 71.3

n = 72 cases and 72 controls (In the study, 73 cases and 73 controls were recruited, at 3 months 11 cases and 10 controls dropped out of the study and finally 62 cases and 63 controls were analysed)

4.8 Tools

The tools used in the study were,

1. SECA digital Weighing scale found at the well- baby clinic.
2. SCOREBOARD wooden Stadiometer board found at the well- baby clinic.
3. Formulated questionnaire with 3 sections. Section 1 captured biodata of the children, section 2 was the SRBD-PSQ Questionnaire and Section 3 captured the heights and weights (Appendix 2)

4.9 Procedure

4.9.1 Recruitment of the study group.

Children aged 2-5 years booked to undergo adenoidectomy and or adenotonsillectomy for obstructive sleep disordered breathing were recruited from the Kenyatta National Hospital (KNH) ENT clinic. Consent to join the study was sought. Those who consented had a history taken and a physical examination performed on admission. The children with comorbidities or on nutritional supplementation left the study at this point. Those without comorbidities or nutritional supplementation were subjected to the SRBD-PSQ questionnaire (Appendix 2 section 2 of the questionnaire). The children who had scores equal or greater than 0.33 proceeded with the study. Those with scores below the 0.33 exited the study. (Figure 1). More children were then recruited to compensate for the children who exited the study.

Those who proceeded with the study were weighed and had their height measured. At the beginning of weighing and taking of heights, the SECA weighing scale was reset to the 0kg mark, and the stadiometer weighing board was placed resting on a wall at right angles with the floor. Weighing was done first followed by height measurement.

Weight measurement

Weighing was done using the SECA digital weighing scale. The procedure of weighing was described to the parents. They were instructed to undress the child and leave them with minimal clothing such as their underclothes. Shoes, socks and ornaments were also removed. With the scale reset to the zero kg mark, the children stood on the scale unsupported and were encouraged to remain still until the final weight appeared. The weight was then recorded to the nearest 0.1kgs.

weighing scale was reset to the 0 kg mark, the mother then removed her shoes and stood on the weighing scale as her child was held by an assistant. Once the mother's weight appeared on the screen, the weighing scale was adjusted to reflect the 0kg reading. The mother was then handed the child to carry and the final weight appearing on the weighing scale screen was recorded to the nearest 0.1kgs

Height Measurement.

After weighing the child, the height was measured. The height measuring procedure was explained to the mother. With the child still undressed, the child stood on the baseboard of the stadiometer height board. The child was positioned so that the heel, calf, shoulder blades and occiput touched the vertical board. The mother assisted by ensuring the legs were straight and

by supporting the knees and the heels. The child's head was then adjusted so that a straight horizontal line drawn from the lower border of the eye socket to the ear canal was parallel to the baseboard. With the head supported in this position with one hand, the head board was pulled down until it compressed the child's hair or head. The height measurement was then recorded to the nearest 0.1cm

Three months after the operation, the weight and height measurements were taken in the same manner as described above and recorded in part 2 of section 3 of the questionnaire for the respective child.

4.9.2 Recruitment of the controls

The control group were recruited from the KNH well baby clinic. Consent to participate in the study was sought from parents of children from 2 to 5 years of age. Children whose parents consented then proceeded to have a past medical history taken and a physical examination performed. Children with co-morbid conditions or on nutritional supplementation were excluded. The children who met the criteria were subjected to the SRBD-PSQ questionnaire. Those with scores lower than the cut off (0.33) for sleep disordered breathing proceeded with the study. Those with SRBD-PSQ questionnaire scores above 0.33 exited the study and were referred to the KNH ENT clinic. (Figure 2).

Those who proceeded with the study were weighed and had their height measured following the same procedure as for the study group. Their weight was measured to the nearest 0.1kg and their height measured to the nearest 0.1cm. The measurements were recorded in the first section of Questionnaire 2(Appendix 2). Three months later, their weights and heights were measured again and recorded in the second section of the questionnaire.

The SRBD-PSQ questionnaire was administered by the primary researcher. The heights and weights were also taken by the primary researcher.

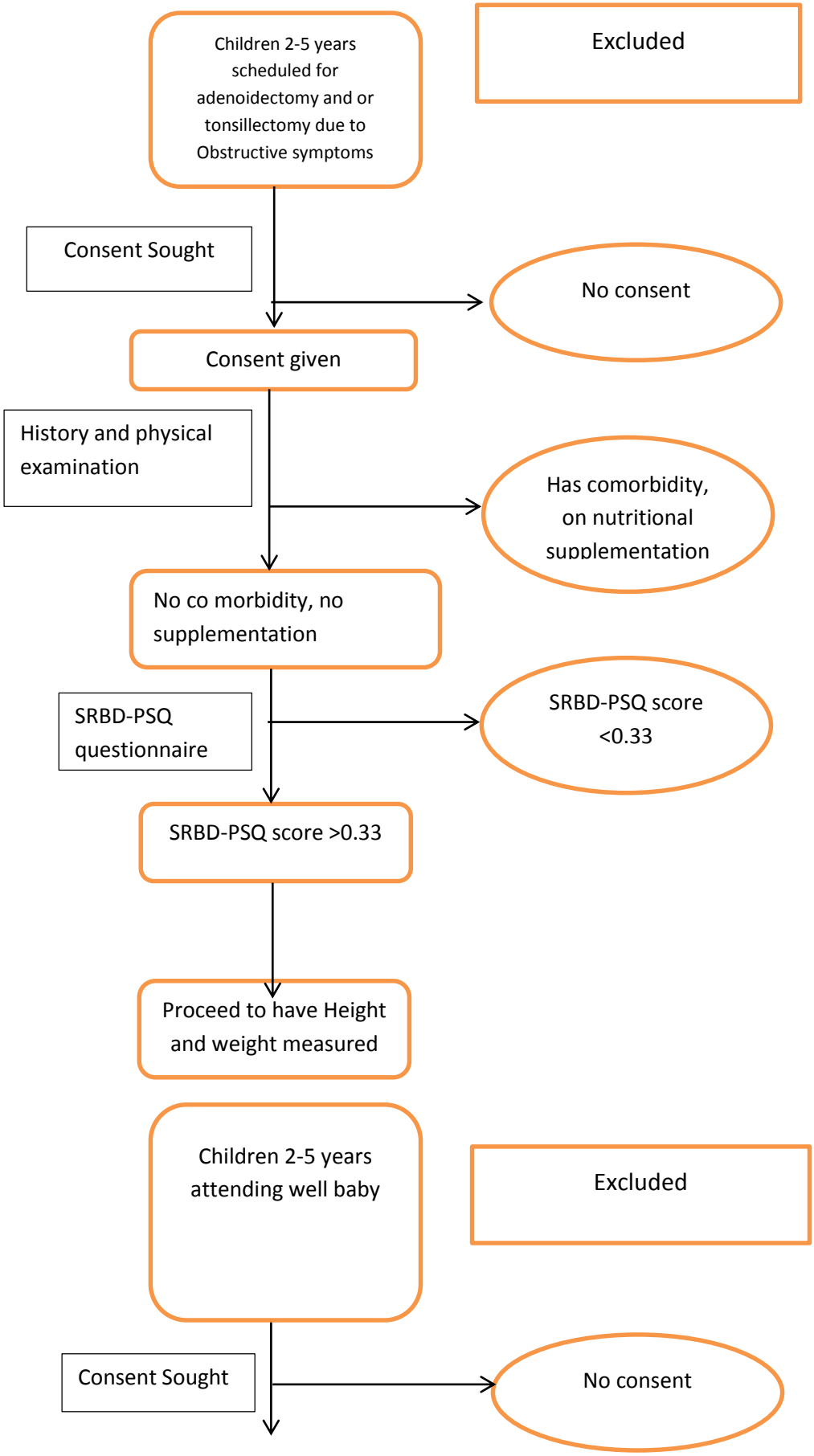

Figure 1: Flowchart of Procedure For Study Group

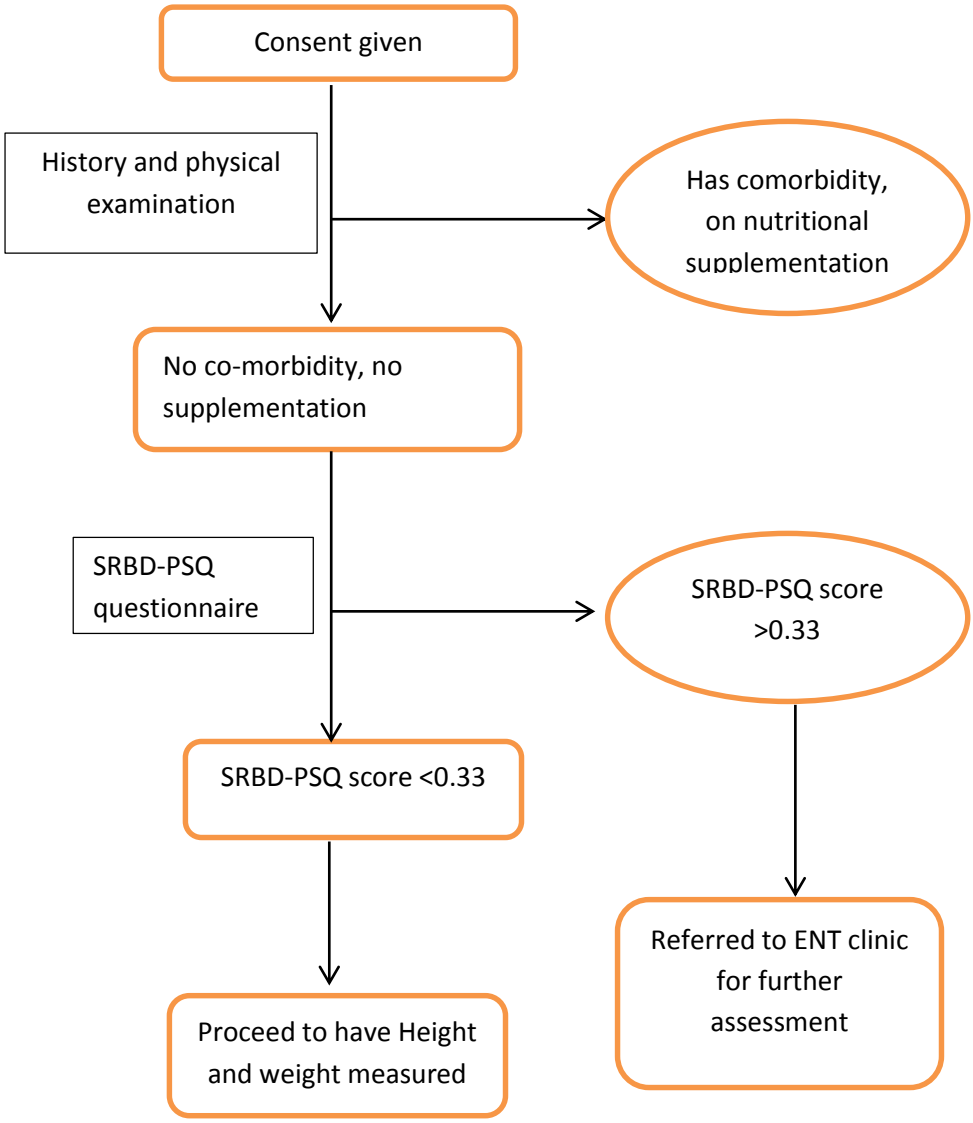

Figure 2: Flowchart of Procedure for Control Group

4.10 Data management

All data retrieved was handled with confidentiality. Participants were given codes that bore no relation to their names or contacts.

The principal researcher retrieved the data from the completed questionnaires and entered it into Microsoft Excel database. Data from the questionnaire was crossed checked against the database for any inconsistencies and data entry errors and appropriate corrections made.

4.11 Data analysis

Data analysis was conducted using IBM SPSS (version 21). Descriptive statistics including means and standard deviation/ Z scores was used to summarize sample characteristics measured using continuous variables e.g. age, weight, height. For categorical variables e.g. sex counts, frequencies were done and presented along with the percentages representing the different levels of the categorical variables. Each child's weight, height and age was inspected for accuracy and then used to calculate three anthropometric indices namely weight for age, height for age and BMI for age using the World Health Organization (WHO) standards. To assess the difference in weight for age between children with oSDB and the control group, the mean weight for age in the two groups was compared using the Student's T-test. Similar analysis was then conducted using height for age and BMI for age. The growth rate was then determined by calculating a gradient representing the rate of change in anthropometric indices for each of the two groups of children. These gradients were used to determine the growth rate changes in post adenoidectomy and or tonsillectomy children versus normal controls. The data is presented using tables, charts and text.

4.12 Study limitations

The SRBD-PSQ has been shown to have a sensitivity of 85% and a specificity of 87%. This means that it may not detect oSDB in 15% of the population and also misdiagnose oSDB in 13%. However, it was the best tool to use as polysomnography was not readily available. Also, although the SRBD-PSQ questionnaire has been validated in children from the ages of 2 years to 18 years, a hypothetical study limitation was that there were some questions which were difficult to evaluate in the younger age group. For example, a child of 2 years may not have been able to complain of early morning headaches even if he or she had them. The child subsequently would have scored lower than they actually should have.

The English version of the questionnaire Appendix 2 section 2 part 1 has been validated. However, there was no Swahili version of the questionnaire. Given that some patient's parents were more comfortable with Swahili, the questionnaire was translated to Swahili using a Swahili expert. The Swahili version was however not validated.

Given the 3 months interval of the study, some participants opted out of the study midway after completing the first section.

4.13 Quality Control

Quality control was a continuous process throughout the study to maximize validity and reliability of the findings of the study.

A pre-test of the structured questionnaires was carried out by clarifying grammar and language used so as to avoid bias and misinterpretation of the questions. The principal investigator carried out all the interviews and physical examinations.

The data collection tool was cross checked for completeness and any missing entries corrected. The quantitative and qualitative data collected was crosschecked for any inconsistencies and outliers rectified.

4.14 Ethical Considerations

Ethical approval was obtained from the KNH – UON ethics and research committee.

The parents/ guardians of the children recruited received full disclosure of the nature of study before any informed consent was taken. They were informed that participation in the study was voluntary.

Patients who declined to participate were not discriminated and received *the same* treatment as those who participated in the study.

Confidentiality was maintained. No extra cost was incurred by the participants for participating in the study. The questionnaire was filled and measurements carried out on the day of admission or on their routine well-baby or ENT clinic visit. Participants were not reimbursed for transport to and from clinic visits. There were no postulated conflicts of interest financial or otherwise in this study. This study was self-funded.

The results of the study will be disseminated through scientific presentations at conferences, and departmental academic meetings, through publications in peer reviewed scientific journals and even regular newspapers where necessary.

The primary researcher had no bias or conflict of interest to declare.

5.0 CHAPTER FIVE: RESULTS

The total number of children recruited at the beginning of the study was 146, 73 in the study group and 73 in the control group. At 3 months, 11 children in the study group and 10 children in the control group had dropped out of the study. There were 62 children in the study group, 40 males and 22 females, and 63 children in the control group, 34 males and 29 females (Figure 3 below). The children who dropped out of the study were not included in the data analysis.

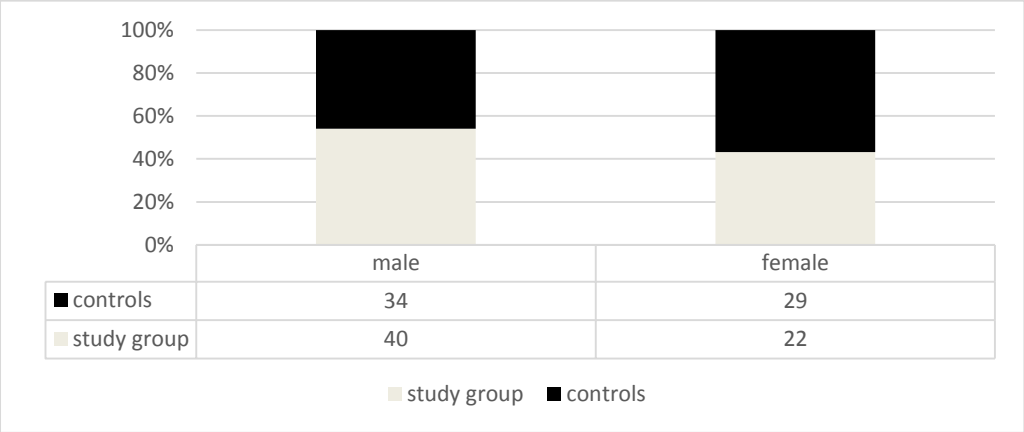

Figure 3: Distribution of male to females for the study group and controls.

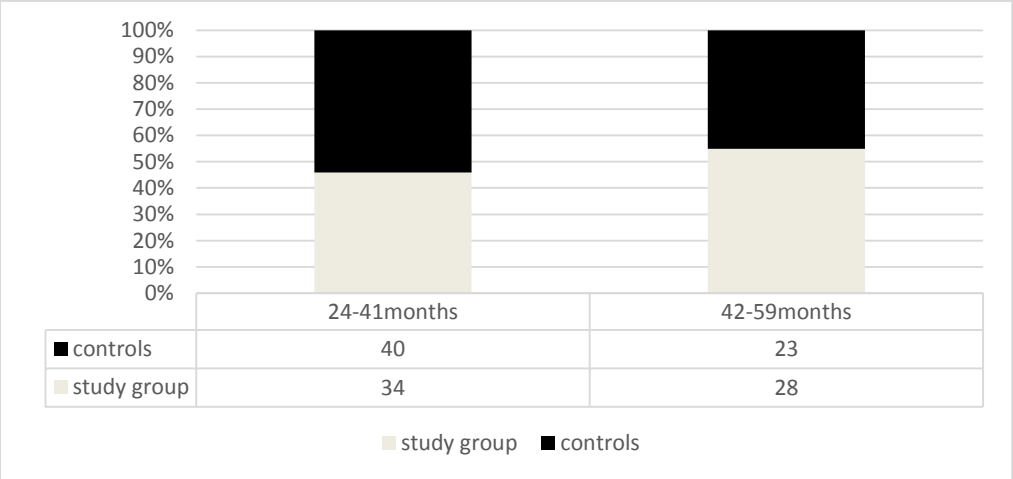

Figure 4: Figure of children in the study group and controls, grouped into the first 18 months and second 18 months groups

The average ages were 3.39years (0.9SD) for the cases and 3.15 years (1.1SD) for the controls. When divided into 18month interval groups, the number of study group children in the 24-

41month group was 34 vs 40 in the control group. Those in the 42- 59month group were 28 for the study group and 23 for the controls (Figure 4).

Table 2: Anthropometric values of the study group and controls at the beginning of the study

	Study group	**Controls**	**Difference (95%CI)**	**P Value***
	Mean (SD)	Mean (SD)		
Preoperative weight (kg)	13.74(2.43)	14.92(3.49)	1.18(0.12-2.23)	**0.031**
Preoperative WAZ score	-0.76(1.06)	0.16(1.32)	0.92(0.50-1.34)	**<0.001**
Preoperative height (cm)	96.24(7.64)	94.46(14.51)	-1.78(-5.84-2.27)	0.391
Preoperative HAZ score	-0.54(1.17)	-0.08(1.27)	0.46(0.03-0.89)	**0.04**
Preoperative BMI	14.77(1.62)	15.94(2.50)	1.17(0.44-1.91)	**0.002**
Preoperative BMI Z score	-0.67(1.29)	0.25(1.50)	0.92(0.43-1.41)	**<0.001**

*Two sample t-test

The weight, height and BMI Z scores for the children in the study group were significantly lower than those of the control group at the beginning of the study (Table 2).

Table 3: Anthropometric values of the Study group and controls at 3 months

	Study group	**Controls**	**Difference (95% CI)**	**P value***
	Mean (SD)	Mean (SD)		
Postoperative weight (kg)	15.30(2.50)	15.49(3.48)	0.19(-0.87-1.25)	0.723
Postoperative WAZ score	0.12(1.03)	0.48(1.25)	0.36(-0.04-0.76)	0.08
Postoperative height (cm)	98.71(7.47)	97.21(9.54)	-1.51(-4.52-1.51)	0.33
Postoperative HAZ score	0.11(1.18)	0.20(1.28)	0.09(-0.35-0.52)	0.688
Postoperative BMI	16.46(1.71)	16.41(2.23)	-0.04(-0.74-0.66)	0.909
Postoperative BMI Z score	0.65(1.15)	0.56(1.38)	-0.08(-0.53-0.36)	0.714

*Two sample t-test

Three months post operatively, the WAZ, HAZ and BMI Z score for the study group and control group increased and there was no statistical difference between the Z scores of the two groups (Table 4).

5.1 Assessment of the Change in Weight of the Children with oSDB after surgery and of the Control Group

The WAZ score at the beginning and at 3 months for the study group and control group are shown in table 4 and figure 5 below.

Table 4: Table of the weight Z scores for the study group and control group at 0 months and at 3 months.

Months	Mean WAZ		
	control group	study group	P Value
Month 0	0.16	-0.76	**<0.001**
Month 3	0.46	0.12	0.08

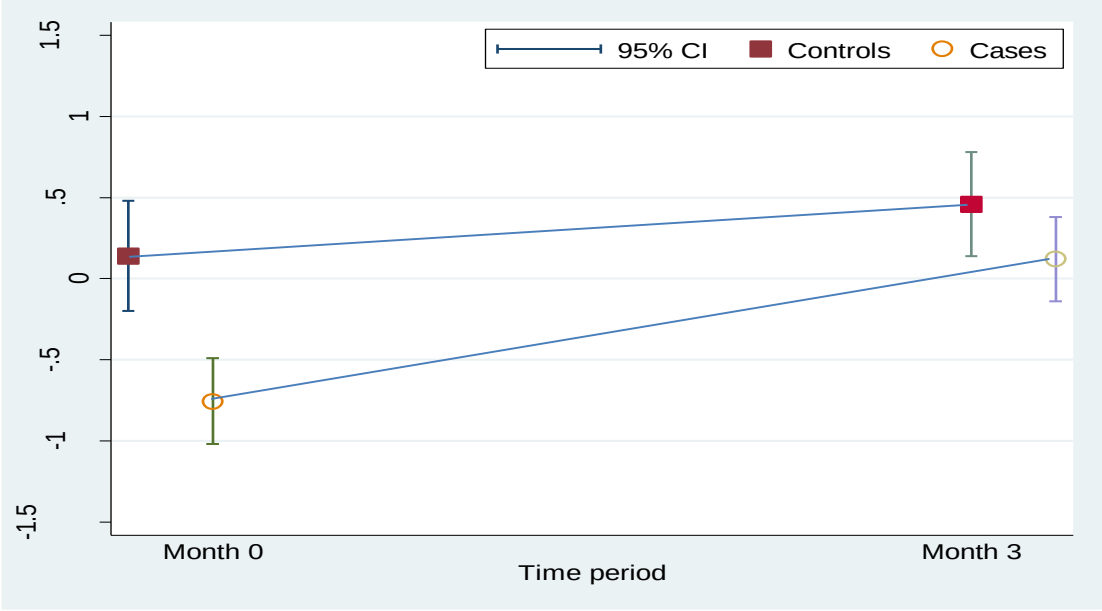

Figure 5: Change in weight of the children with oSDB 3 months after surgery and of the control group

At the beginning of the study, the WAZ for the study group was -0.76 vs 0.16 for the controls p value < 0.001. Three months after surgery the WAZ score for the study group changed from -0.76 to 0.12. The WAZ for the controls changed from 0.16 to 0.46. At 3 months there was no statistical difference between the Z scores of the study group when compared to the control group 0.12 vs 0.46 p value 0.08.

5.2 Assessment of the Change in Height of the Children with oSDB 3 months after Surgery and of the Control Group

The changes in HAZ after 3 months for the study group and the control group are shown in table 5 and figure 6 below.

Table 5 HAZ For the study group and the controls at 0 months and after 3 months

Months	Mean HAZ		
	Controls	Study group	P Value
Month 0	-0.08	-0.54	**0.004**
Month 3	0.20	0.11	0.688

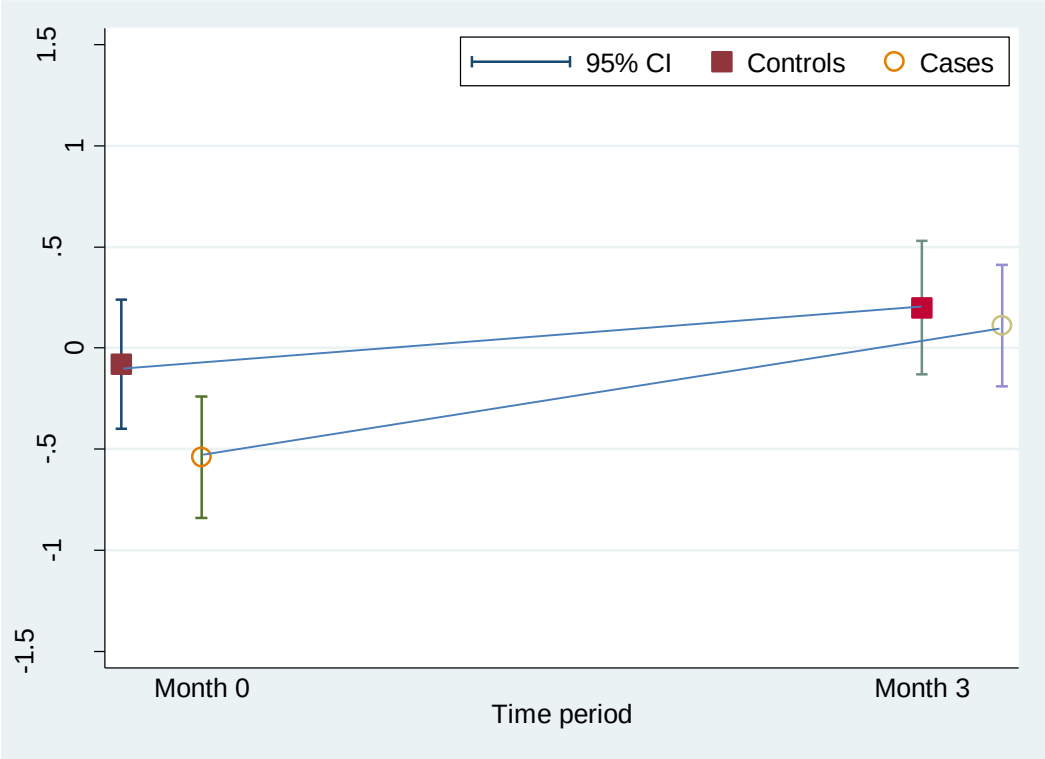

Figure 6: Change in height of the children with oSDB 3 months after surgery and of the control group

At the beginning of the study the study group had a lower HAZ than the controls (-0.54 vs -0.08 p value 0.004). Three months post operatively the HAZ for the study group increased to 0.11 while that for the controls increased to 0.20. At three months the difference of the HAZ for the study group and the controls was not statistically significant. (0.11 vs 0.20 p value 0.688).

5.3 Assessment the change in BMI for age in children with oSDB 3 months after surgery and of the control group

The changes in BMI Z score for the study group and for the control group are shown in table 6 and figure 7 below.

Table 6: BMI Z score for the study group and the controls at 0 months and after 3 months

		Mean BMI for age	
Month	Controls	Study group	P Value
Month 0	0.25	-0.67	**<0.001**
Month 3	0.56	0.65	0.714

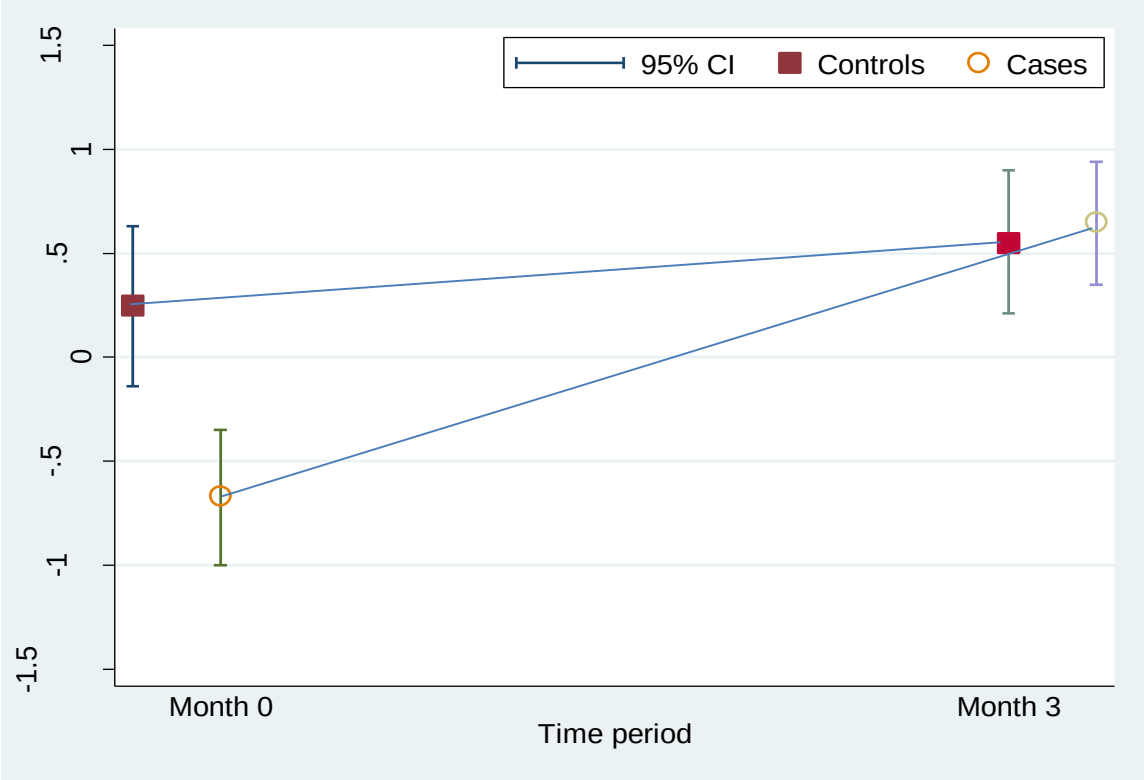

Figure 7: Change in BMI of the children with oSDB 3 months after Surgery and of the control group.

The BMI Z score for the study group preoperatively was significantly lower than that for the controls, (-0.67 vs 0.25 p value <0.001) however 3 months after surgery, the BMI Z score for the study group increased to 0.65 and that for the controls increased to 0.55. There was no statistically significant difference between the BMI Z score for the study group vs the controls (0.65 vs 0.56 p value 0.714)

5.4: Comparison of Changes in weight, height and BMI Z score between the children with oSDB 3 months after surgery and the control group

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Table 7: Assessment of change in weight, height and BMI Z scores between the study group and controls

	Study group			**Control**			**Difference (95%CI)**	**P Value***
	Mean			Mean				
	0 months	3 months	Change	0 months	3 months	Change		
Weight for age Z score	-0.76	0.12	0.88	0.14	0.46	0.32	0.56(0.42 - 0.67)	**p <0.001**
Height for age Z score	-0.54	0.11	0.65	-0.08	0.20	0.28	0.37(0.24 - 0.52)	**p <0.001**
BMI for age Z score	-0.67	0.65	1.32	0.25	0.55	0.30	1.02(0.77 - 1.21);	**p <0.001**
BMI	14.71	16.37	1.66	15.90	16.39	0.49	1.17(0.70 - 1.63)	**<0.001**

* T-test comparing mean change in controls to mean change in cases

The change in WAZ, HAZ and BMI Z scores between the study group and the controls was assessed (Table 7). There was significantly greater increase in weight height and BMI Z scores for the study group when compared to the controls after three months of follow up (WAZ, 0.88 vs 0.32 p value <0.001, HAZ 0.65 vs 0.28 p value <0.001, BMI Z score 1.32 vs 0.30 p value <0.001)

5.5: Comparison of change in oSDB score with change in HAZ, WAZ and BMI Z score

The mean SRBD-PSQ score for the study group at enrolment was 0.562 (SD 0.123) reducing to a mean score of 0.104 (SD 0.183) at 3 month follow up. The mean change in SRBD-PSQ score for the study group was -0.452 (SD 0.191). There was a weak negative correlation between change in oSDB score and changes in WAZ (Pearson's rho = -0.0411), HAZ (Pearson's rho = -0.0772) and BMI (Pearson's rho = -0.0713) in the study group.

Table 8: Comparison of change in oSDB score with change in HAZ, WAZ, and BMI Z score

	Change in SDB score
Change in oSDB score	1.0
Change in HAZ	-0.0772
Change in WAZ	-0.0411
Change in BMI	-0.0713

5.6: Assessment of the effect of age and sex on WAZ, HAZ and BMI Z scores

Table 9: Z scores at 0 months and at 3 months for 24-41month old study group and controls

	Study group Mean (SD)	**Controls** Mean (SD)	**Difference (95% CI)**	**P value***
Month 0				
Age, in years	2.74(0.44)	2.44(0.48)	-0.30(-0.51--0.10)	**0.005**
Preoperative weight (kg)	12.71(2.07)	13.38(2.49)	0.67(-0.37-1.71)	0.211
Preoperative WAZ score	-0.68(1.18)	0.22(1.41)	0.90(0.31-1.49)	**0.004**
Preoperative height (cm)	91.46(5.26)	88.30(14.17)	-3.16(-7.89-1.58)	0.197
Preoperative HAZ score	-0.58(1.22)	-0.06(1.30)	0.51(-0.06-1.09)	0.086
Preoperative BMI	15.14(1.71)	15.98(2.57)	0.83(-0.15-1.81)	0.101
Preoperative BMI Z score	-0.49(1.35)	0.28(1.47)	0.77(0.12-1.42)	**0.023**
Month 3				
Postoperative weight (kg)	14.36(2.31)	13.90(2.36)	-0.46(-1.53-0.61)	0.401
Postoperative WAZ score	0.34(1.14)	0.57(1.32)	0.23(-0.33-0.79)	0.428
Postoperative height (cm)	94.12(5.29)	91.91(6.24)	-2.21(-4.86-0.43)	0.106
Postoperative HAZ score	0.17(1.23)	0.25(1.31)	0.08(-0.51-0.66)	0.796
Postoperative BMI	17.12(1.81)	16.51(2.16)	-0.61(-1.51-0.30)	0.195
Postoperative BMI Z score	1.02(1.23)	0.62(1.34)	-0.41(-1.00-0.18)	0.179

Table 10: Z scores at 0 months and at 3 months for 42-59 month old study group and controls

	Study group Mean (SD)	Controls Mean (SD)	**Difference (95% CI)**	**P value***
Month 0				
Age, in years	4.17(0.56)	4.39(0.61)	0.22(-0.11-0.55)	0.193
Preoperative weight (kg)	15.00(2.26)	17.60(3.40)	2.60(0.98-4.22)	**0.003**
Preoperative WAZ score	-0.85(0.91)	0.06(1.18)	0.91(0.32-1.50)	**0.004**
Preoperative height (cm)	102.05(5.86)	105.17(6.97)	3.12(-0.47-6.70)	0.095
Preoperative HAZ score	-0.49(1.13)	-0.11(1.24)	0.37(-0.28-1.03)	0.271
Preoperative BMI	14.32(1.40)	15.89(2.43)	1.57(0.45-2.69)	**0.01**
Preoperative BMI Z score	-0.90(1.19)	0.20(1.57)	1.09(0.31-1.87)	**0.009**
Month 3				
Postoperative weight (kg)	16.42(2.28)	18.24(3.43)	1.81(0.18-3.45)	**0.036**
Postoperative WAZ score	-0.15(0.83)	0.33(1.11)	0.48(-0.07-1.03)	0.096
Postoperative height (cm)	104.29(5.75)	106.20(7.11)	1.90(-1.70-5.51)	0.306
Postoperative HAZ score	0.04(1.14)	0.12(1.26)	0.08(-0.58-0.75)	0.809
Postoperative BMI	15.65(1.18)	16.25(2.39)	0.60(-0.48-1.67)	0.285
Postoperative BMI Z score	0.18(0.85)	0.47(1.47)	0.28(-0.39-0.96)	0.418

The WAZ, HAZ and BMI Z scores for the 24- 41month age group and 42- 59month age group are presented in the tables 9 and 10 respectively. The children in the younger age group (both study group and controls) had a greater change in the WAZ, HAZ and BMI Z score when compared to the control group.

Using linear regression modelling, the effect of age, sex and surgery on change in WAZ, HAZ and BMI Z score was assessed (table 11, table 12 and table 13 respectively).

Table 11: Linear regression analysis of change in WAZ adjusted for surgery, patient sex and age.

	Coefficient.	Std. Err.	T	P value	95% CI	
Surgery (2 = Study group)	0.57	0.06	10.14	**<0.001**	0.46	0.68
Sex (2 = Female)	-0.03	0.06	-0.56	0.58	-0.14	0.08
Age (2 = 41-59 months)	-0.20	0.06	-3.44	**0.001**	-0.31	-0.08
Constant	0.63	0.12	5.37	**<0.001**	0.40	0.87

On linear regression analysis, surgery and age positively correlated to change in WAZ whereas sex did not. The change in WAZ between month 0 and month 3 was higher by a mean Z score of 0.57 in the study group compared to control ($p < 0.001$) after adjusting for effect of sex ($p = 0.58$) and age ($p = 0.001$). There was no statistical difference in the change in WAZ when the males were compared to the females (p value 0.58). The change in mean WAZ score was lower by a mean of 0.2 Z scores in children above 41 months when compared to those below 41 months ($P<0.001$). Children in the younger age group gained significantly more WAZ than the older children (Table 11).

Table 12: Linear regression analysis of change in HAZ adjusted for surgery, patient sex and age

	Coefficient.	Std. Err.	T	P value	95% CI	
Surgery (2 = Study group)	0.35	0.07	5.11	**<0.001**	0.22	0.49
Sex (2 = Female)	-0.06	0.07	-0.92	0.358	-0.20	0.07
Age (2 = 41-59 months)	-0.17	0.07	-2.38	**0.019**	-0.30	-0.03
Constant	0.62	0.15	4.27	**<0.001**	0.33	0.91

On linear regression analysis, surgery and age positively correlated to change in HAZ whereas sex did not. The change in HAZ between month 0 and month 3 was higher by a mean Z score of 0.35 in the study group compared to control ($p < 0.001$) after adjusting for effect of sex ($p = 0.358$) and age ($p < 0.001$). The change in mean WAZ score was lower by a mean of 0.17 Z scores in children above 41 months compared to those below 41 months. P value 0.019. Male or female sex did not affect the change in HAZ Z score p= 0.0358 (Table 12).

Table 13: Linear regression analysis of Change in BMI for age Z score adjusted for surgery, patient sex and age

	Coefficient.	Std. Err.	T	P value	95% CI	
Surgery (2 = Study group)	1.02	0.11	9.65	**<0.001**	0.81	1.23
Sex (2 = Female)	-0.16	0.11	-1.45	0.151	-0.37	0.06
Age (2 = 41-59 months)	-0.24	0.11	-2.26	**0.025**	-0.45	-0.03
Constant	0.86	0.22	3.92	**<0.001**	0.43	1.30

On linear regression analysis, surgery and age positively correlated to change in BMI Z score whereas sex did not. The change in BMI Z score between month 0 and month 3 was higher by a mean Z score of 1.02 in study group compared to control ($p < 0.001$) after adjusting for effect of sex ($p = 0.151$) and age ($p = 0.0$). The change in mean BMI Z score was lower by a mean of 0.24 Z scores in children above 41 months compared to those below 41 months P value 0.025. There was no statistically significant change in BMI Z score between the males and the females (p value 0.151).

6.0 CHAPTER SIX: DISCUSSION AND CONCLUSION

6.1 Discussion

At the beginning of the study children with obstructive sleep disordered breathing were found to have significantly lower weight height and BMI Z scores when compared to controls. This could be attributed to the fact that children with oSDB have been found to have lower growth hormone levels[38]. This is because the children with oSDB spend less time in the deeper stages of sleep, a time when growth hormone is produced. Children with oSDB have also been found to have higher energy expenditures due to the increased work of breathing[35]. The findings in this study are similar to Selimoglu et al's[11] study where growth of 29 children with obstructive adenotonsillar disease was compared with 20 controls. The weight and height z scores were significantly lower in the cases when compared to controls (-0.47 vs 0.07 p value < 0.05 and -0.27 vs 0.49 p value < 0.05 respectively). Zhang et al[13] compared twins, one with and other without oSDB also found reduced weight and height measurements for the children with oSDB at the onset of the study. The study by Lewis et al[44] however did not find a difference in weight height and BMIs of the cases and controls in the different categories at the beginning of his study. The study was however composed of children with both obstructive sleep disordered breathing 80.7% and recurrent tonsillitis 19.3%.

In this study both the study group and controls had an increase in weight height and BMI Z scores after 3 months. Taking into consideration that the growth Z scores for the controls also increased, the change in the Z scores for the study group was assessed for significance. There was a greater increase of the Z scores in the study group. Initially, the growth Z scores were statistically lower in the study group but after 3 months there was no statistical difference in the Z scores between the study group and controls. This increase has been termed as catch up growth by some authors[45]. This has been thought to be due to increased growth hormone production once the oSDB symptoms have been corrected[38]. There is also a reduction in the work of breathing[35].

Multiple studies done assessing the effect of adenoidectomy and or tonsillectomy on growth of children have had varying results. The follow up period, whether or not there was a control group and the constitution of the control group also varied. This influences comparability of the studies. This study followed the children for 3 months and found statistically significant increase in weight height and BMI Z scores in the study group when compared to the controls. The weight and height measurements for both the study group and controls were taken at the

beginning and after 3 months. The control group constituted children attending well baby clinic. Selimoglu et al[11] found significant weight and height increase 6 months post operatively (weight Z score from -0.47 to -0.19 p value <0.005, height Z score from -0.27 to 0.20 p value <0.005). The study however only measured the control group at the beginning of the study. Nacholon et al[12] in Israel also found significant increase in weight and BMI Z scores 4 to 6 months after surgery (weight Z score from -1.29 to -0.19 p value <0.001, and BMI Z score from -0.45 to 0.36 p value 0.007), the height Z score increased but it was not statistically significant, (from -1.18 to -0.49 p value 0.223). The study however did not have a control group. Katz et al.[32] compared early adenotonsillectomy vs watchful waiting. There was a significantly faster increase in weight and BMI Z scores 7 months later in the adenotonsillectomy group when compared to the watchful waiting group. The height increase was however not statistically significant. Al Adulla[46] et al in Bahrain however did not find a difference in BMI percentile scores between cases and controls. The study assessed growth in children undergoing tonsillectomy but did not limit the inclusion criteria to those with only obstructive sleep disordered breathing. The control group in the study also constituted children with other conditions other than oSDB or chronic recurrent tonsillitis attending their ENT clinic.

The effect of age and sex on growth changes following surgery was assessed using linear logistics regression. The children were divided into two 18month age groups. The children in the younger age group (both study group and controls) had a greater increase in growth Z scores when compared to the older group. This could be attributed to a plateauing of growth at around 3 years of age as noted in the study by Karlberg J et al[47] and Rogol AD et al[48]. The reason for the plateau was however not found. Using logistics regression modelling, Adenoidectomy and or tonsillectomy led to a greater increase in weight height and BMI Z scores of the younger children when the effect of age and sex was adjusted. The study by Smith et al[41] had a similar conclusion. In assessing factors determining growth post adenotonsillectomy, age was the only factor that had a correlation with increase in weight height and BMI Z scores. Children less than 6 years had a larger increase in BMI Z score than those above 6 years of age (BMI Z score, <6 years 0.55 to 0.98 vs > 6 years 1.37 to 1.47). The study however did not have a control group. Sex of the children did not have an influence on the growth after surgery in this study similar to the study by Smith et al[42].

Determination of oSDB in this study was done using the Sleep disordered breathing paediatric subscale questionnaire developed by Chevrin et al[30]. It is a validated tool that was co related to PSG findings. It was used given the lack of PSG during the study period. When assessed, the quantity change in SRDB-PSQ score had no co relation with the quantity change in WAZ, HAZ, and BMI Z scores.

In this study 11 children had adenoidectomy performed while 51 had adenotonsillectomy done. Adenoidectomy was done in the children with tonsils graded as Brodsky[30] grade 1 or 2. Adenotonsillectomy was done in children with grade 3 or 4 tonsillar hypertrophy. As the objective of this study was to assess the growth in the children post adenoidectomy and or tonsillectomy, all the children in the study group were grouped together. Further studies may need to be done to assess if there is a growth advantage of performing adenoidectomy verses adenotonsillectomy for children with oSDB.

6.2 Conclusion

Obstructive sleep disordered breathing had a negative impact on the growth of the affected children evidenced by the lower WAZ, HAZ and BMI Z scores. Adenoidectomy and or tonsillectomy as a treatment for paediatric obstructive sleep disordered breathing had an added advantage of improvement in growth parameters as early as 3 months postoperatively.

Take home message

Children with oSDB have lower growth parameters than otherwise healthy controls.
Adenoidectomy and or tonsillectomy leads to catch up growth in children with oSDB without comorbidities.

6.3. Recommendations

Clinicians should be aware, among others, of the negative effects of oSDB on growth of the affected children.

The findings in this study are important to the well baby nursing team, nutritionists and paediatricians who may be the first contact of a child with growth retardation secondary to oSDB. It is also important to the otolaryngologist who should screen for growth retardation in this children.

Study results will be disseminated through continuous medical education platforms in the ENT, paediatric and well baby clinics, the results may also be disseminated to the general group of doctors in the fields of general practice, paediatrics and otolaryngology through society meetings and also through publication.

Limitations of the study included the 3 month follow up duration. As such there were children who exited the study both in the study group and control group.

Further studies in our set up are needed to assess how adenoidectomy and or tonsillectomy affects the growth of children in the different anthropometric categories (that is underweight, normal weight overweight and obese). This is because although increase in weight is beneficial to the child who is underweight or severely underweight, it is deleterious to the child who is overweight or obese.

Further studies may also be needed to assess if there are growth rate differences between children who undergo adenoidectomy verses adenotonsillectomy for oSDB.

STUDY PERIOD

Mid-November to January 2018	6weeks	Study proposal writing and presentation
Mid-January – Mid-March 2018	2months	Ethics
Mid-March2018- Mid February 2019	6months	Data collection
Mid-February 2019- March 2019	5 weeks	Data analysis and writing of paper
April 2019		Presentation of results

BUDGET

Stationary	10,000
Miscellaneous	10,000
Statistician	45,000
Total	65,000

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APPENDICES

Appendix I (a): Consent Form (English)

CONSENT EXPLANATION

General patient information

I am a resident doctor in ENT Head and Neck Surgical Unit. I would like to seek consent from you to participate in a study aimed at assessing the growth changes in children who have their tonsils and adenoids removed because of sleeping and breathing difficulties

How you will participate

1. I will ask you questions regarding your child's medical condition and they will be focused on the sleeping, breathing and behavior.
2. I will carry out a complete examination.
3. I will then take the weight and height of your child today and three months after.
4. There will be no monetary benefits for participating in the study and it will be on a purely voluntary basis.
5. You will not incur any extra financial costs as the measurements shall be taken on admission or during the child's routine well-baby or ENT clinic visit. There shall be no reimbursement for transport costs or time spent.
6. Confidentiality will be maintained at all times.
7. You have the right to withdraw from the study at any time without any penalty.

The study doesn't affect you in anyway negatively and there are no hidden dangers in your participation.

What will I do with the information I get?

The information I get may not be of immediate benefit to you. If an immediate benefit is found, it shall be communicated to you. Results of this study shall improve our understanding of the relationship between sleep disordered breathing and growth, and hence improve management.

Like all scientific information I will seek to share our findings with other people undertaking similar studies therefore we may publish our findings in scientific journals or present them in scientific meetings.

If there is need of you discussing this matter with family/friend you are free to do so and I will be ready to answer any questions.

If you are satisfied with the explanation and willing to participate then please sign the consent form given.

CONSENT FORM

Consent by patient

I ……. hereby give consent for my child to be included in this study on "Assessment of growth changes in children following adenoidectomy and tonsillectomy for sleep disordered breathing."

The nature of the study has been explained to me by Dr……

Date……Signed……

I Dr…….. confirm that I have explained to the patient the nature of the study.

Date……..Signed…….

1.Principal Investigator

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The Chairman KNH-UON Ethics and Research Committee,

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Tel.2726300 Ext.44355

Appendix I (b): Consent Form (Swahili)

KIAMBATISHO ; FOMU YA MAELEZO KUHUSU IDHINI YA MGONJWA

Kushiriki katika utafiti huu ni kwa hiari yako. Lengo letu ya kufanya utafiti huu ni kutuwezesha kutathmini jinsi oparesheni ya kutoa findo inavyo athiri ukuaji wa watoto wanao shida ya kupuma wakati wanapo lala katika Hospitali Kuu ya Kenyatta.

JINSI UTAKAVYOSHIRIKI

1. Nitakuuliza maswali kuhusu afya ya mtoto wako na italenga maswala ya masikio, mapua, mdomo na koo.
2. Nitapima mwili wa mtoto wako.
3. Nitapima uzani na urefu wa mtoto wako.
4. Hakuna zawadi ambayo utakayopewa Kushiriki ni kwa hiari yako.
5. **Hakuna malipo ambayo utahitajika kulipia zaidi kwa kushiriki kwa utafiti huu. Vipimo vyote vitafanywa wakati mtoto anapolazwa au siku ya kliniki ya kawaida.**
6. kila kitu utakacho niambia itakuwa faraghani**.**
7. Niko tayari kujibu maswali yoyote.

Kushiriki au kutoshiriki kwa utafiti huu haitakuathiri vibaya.

Matokeo ya utafiti huu pengine haita kufaidi binafsi. Ikiwa faida ya kibinafsi itapatikana, utaelezwa. Matokeo itatupa maarifa ambayo itaboresha utabibu wa ugonjwa hii siku zijazo.

Kuna uwezekano wa kuchapisha matokeo ya utafiti huu katika majarida ya kisayansi au kuwekwa katika mikutano ya kisayansi.

Kama umeridhika na maelezo, na uko tayari kushiriki, tafadhali weka sahihi yako kwenye fomu ya idhini.

KIAMBATISHO; KIBALI CHA UTAFITI

Mimi Bi / Bwana……..nimekubali kushiriki katika utafiti huu baada ya kuelezwa na Daktari……..

Sahihi yangu ni thibitisho ya kwamba nimeelewa umuhimu wa utafiti huu na kwamba habari yoyote nitakayotoa itawekwa faraghani.

Pia nathibitisha ya kwamba sijapewa au kuahidiwa pesa au chochote kile ili nishiriki kwenye utafiti huu.

Sahihi…….Tarehe……
……..

Ikiwa una swali ama ungetaka kupata maelezo zaidi kuhusu utafiti huu, wasiliana nami

Daktari Samuel Ndemo Okerosi,

mwanafunzi wa upasuaji wa masikio, mapua na koo,

Chuo kikuu cha Nairobi,

Anwani 58914-00200,Nairobi

Simu 0716399437

Barua pepe: snokerosi@gmail.com

Wasimamizi

Daktari John Ayugi

Daktari wa upasuaji wa Masikio,mapua na koo

Idara ya upasuaji,kitengo cha upasuaji waMasikio,Mapua na Koo

Barua pepe; johnayugi@gmail.com

Nambari ya simu; 0722883041

Anwani 2134-00100 Nairobi.

Daktari Joseph K. Kamau

Daktari wa upasuaji wa Masikio,mapua na koo

Hosipitali Kuu ya Kenyatta

Barua pepe; jkkabeu@gmail.com

Nambari ya simu; 0722784170

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Mwenyekiti

KNH/UON Ethical and Research Committee

Hosipitali kuu ya Kenyatta,Simu 2726300-9 Ext.44355

Appendix II: Questionnaire

Section 1; Biodata

DATE_____/_____/_____

Patient study ID_____ Date of Birth____/_____/_____

SEX; Male/Female

GROUP; Surgery: Adenoidectomy/ Tonsillectomy/ Both

Control

Section 2: Pediatric Sleep Questionnaire: Sleep-Disordered Breathing Subscale*

2.1 ENGLISH VERSION

Please answer these questions regarding the behavior of your child during sleep and wakefulness. The questions apply to how your child acts in general during the past month, not necessarily during the past few days since these may not have been typical if your child has not been well. You should circle the correct response or print your answers neatly in the space provided. A "Y" means "yes," "N" means "no," and "DK" means "don't know."

1. WHILE SLEEPING, DOES YOUR CHILD:

Snore more than half the time?……. ……Y N DK

Always snore? ……...Y N DK

Snore loudly? ……Y N DK

Have "heavy" or loud breathing? …….…… Y N DK

Have trouble breathing, or struggle to breathe? …….…… ..Y N DK

2. HAVE YOU EVER SEEN YOUR CHILD STOP BREATHING DURING

THE NIGHT? ……Y N DK

3. DOES YOUR CHILD:

Tend to breathe through the mouth during the day?……Y N DK

Have a dry mouth on waking up in the morning? ……...Y N DK

Occasionally wet the bed? ……...Y N DK

4. DOES YOUR CHILD:

Wake up feeling unrefreshed in the morning? ……. Y N DK

Have a problem with sleepiness during the day? …….…….…...Y N DK

5. HAS A TEACHER OR OTHER SUPERVISOR COMMENTED THAT YOUR

CHILD APPEARS SLEEPY DURING THE DAY? ……Y N DK

6. IS IT HARD TO WAKE YOUR CHILD UP IN THE MORNING? ……Y N DK

7. DOES YOUR CHILD WAKE UP WITH HEADACHES IN THE MORNING? Y N DK

8. DID YOUR CHILD STOP GROWING AT A NORMAL RATE AT

ANY TIME SINCE BIRTH? ……. Y N DK

9. IS YOUR CHILD OVERWEIGHT? ……. Y N DK

10. THIS CHILD OFTEN:

Does not seem to listen when spoken to directly. ……**....** Y N DK

Has difficulty organizing tasks and activities. …….……**....** Y N DK

Is easily distracted by extraneous stimuli. …….……...Y N DK

Fidgets with hands or feet or squirms in seat. …….....Y N DK

Is "on the go" or often acts as if "driven by a motor". ……. Y N DK

Interrupts or intrudes on others (e.g., butts into conversations or games). ……Y N DK

Thank You!

Total Yes/Total Yes and No =_____

SWAHILI TRANSLATION

Tafadhali jibu maswali haya kuhusu mwenendo wa mtoto wako wakati anapolala na wakati akiwa ameamka. Maswali ni kuhusu mwenendo wa mtoto wako kwa muda wa mwezi moja na sio siku chache zilizopita. Waweza kuweka alama katika jibu sahihi. Please answer these questions regarding the behavior of your child during sleep and wakefulness. Alama ya "Y" yamaanisha "ndio," "N" yamaanisha "hapana" na "DK" yamaanisha "kutojua."

1. WAKATI MTOTO WAKO AMELALA;

Hukoroma Zaidi ya nusu ya wakati?……. ……Y N DK

Hukoroma kila wakati? …….Y N DK

Hukoroma kwa sauti ya juu? ……Y N DK

Hupumua kwa nguvu au hupumua kwa sauti ya juu?
……..…… ……..Y N DK

Huwa na matatizo ya kupumua au hupambana kupumua? ……Y N DK

2. UMEWAHI ONA MTOTO WAKO AKISITA KUPUMUWA WAKATI WA USIKU?
……Y N DK

3. MTOTO WAKO:

Huwa na shida ya kupumwa kupitia mdomo wakati wa mchana?……Y N DK

Hukauka mdomo wakati anapoamka asubuhi? ……..**.....**Y N DK

Hukojoa kitandani mara kwa mara? ……..Y N DK

4. MTOTO WAKO:

Huamka asubuhi akiwa mchovu? ……Y N DK

Huwa na shida ya kusinzia wakati wa mchana? …….……..**.....**Y N DK

5. MWALIMU AU MSMAMIZI WA MTOTO WAKO ANEWAHI KUELEZA KUWA MTOTO WAKO HUONEKA KAMA ANAUSINGIZI WAKATI WA MCHANA?
……Y N DK

6. HUWA NI VIGUMU KUAMSHA MTOTO WAKO ASUBUHI? ……..Y N DK

7. MTOTO WAKO HUWA ANAAMKA NA KICHWA KIKIMUMA ASUBUHI?.Y N DK

8. MTOTO WAKO ALIWACHA KUKUA VYEMA WAKATI WOWOTE TANGU AZALIWE? ……Y N DK

9. MTOTO WAKO AMEPITISHA UZANI INAYOMFAA?……..Y N DK

10. MTOTO WAKATI MWINGI THIS CHILD OFTEN:

Haonekani kusikiliza wakati anapoongeleshwa . …….....Y N DK

Huwa na shida ya kupanga mafikira zake na kazi zake. …….……...Y N DK

Hupurukuswa rahisi na kichocheo kisicho cha maana ……...Y N DK

Hukosa utulivu wa mikono au miguu au hukosa utulivu akiwa ameketi?.....Y N DK

Hatulii au hua na mwenendo kama anaendeshwa na mashine?…….Y N DK

Hukatiza au huingilia kati shughuli ya wenzake (mfano huingilia kati ya mazungumzo au michezo ya wengine) . ……..…Y N DK

Asante!

Jumla Ndio/ jumla ndio na Hapana =_____

Section 3; Anthropometric Measurements Questionnaire

PART 1

Date_____

Weight_____(Kg)

Height_____ (cm)

BMI_____(Kg/m^2)

PART 2 (To be filed 3 months after part 1 is completed)

Date_____

Weight_____(Kg)

Height_____ (cm)

BMI_____(Kg/m^2)

Appendix III: KNH Ethical Approval Letter

UNIVERSITY OF NAIROBI
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Ref: KNH-ERC/A/87

5th March, 2018

Dr. Samuel Ndemo Okerosi
Reg.No.H58/74450/2014
Dept.of Surgery
School of Medicine
College of Health Sciences
University of Nairobi

Dear Dr. Okerosi

RESEARCH PROPOSAL – ASSESSMENT OF GROWTH IN CHILDREN FOLLOWING ADENOIDECTOMY AND TONSILLECTOMY FOR SLEEP DISORDERED BREATHING IN KENYATTA NATIONAL HOSPITAL (P28/01/2018)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH- UoN ERC) has reviewed and **approved** your above revised proposal. The approval period is from 5th March 2018 – 4th March 2019.

This approval is subject to compliance with the following requirements:

a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH- UoN ERC within 72 hours.
e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (*Attach a comprehensive progress report to support the renewal*).
f) Submission of an *executive summary* report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/ or plagiarism.

For more details consult the KNH- UoN ERC website **http://www.erc.uonbi.ac.ke**

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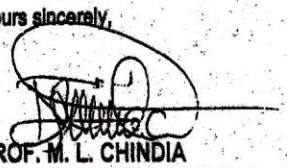
Yours sincerely,



PROF. M. L. CHINDIA
SECRETARY, KNH-UoN ERC

c.c. The Principal, College of Health Sciences, UoN
The Deputy Director, CS, KNH
The Chairperson, KNH-UON ERC
The Assistant Director, Health Information, KNH
The Dean, School of Medicine, UoN
The Chair, Dept. of Surgery, UoN
Supervisors: Dr. John Ayugi, Dr. Joseph K. Kamau

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ASSESSMENT OF GROWTH IN CHILDREN FOLLOWING ADENOIDECTOMY AND OR TONSILECTOMY FOR OBSTRUCTIVE SLEEP DISORDERED BREATHING AT KENYATTA NATIONAL HOSPITAL by Dr. Samuel Ndemo Okerosi

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