A comprehensive study of Clinical and Psychological factors in Snoring and Obstructive Sleep Apnoea

Balakrishnan D. BSc, MBBS, MS (ENT), DLO

Guide and Supervisor: Prof. Dr. B. S. Virudhagiri nathan PhD, DSc.

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Declaration

I hereby declare that this thesis ‘A Comprehensive Study of the Clinical and Psychological factors in snoring and Obstructive Sleep Apnoea’ submitted by me to the Tamilnadu Dr. MGR Medical University, for the degree of Doctor of Philosophy, is a record of the research work done by me. I also declare that this thesis has not formed the basis for the award to the candidate of any degree, diploma, associateship, fellowship or a similar title.

(D. Balakrishnan)
Candidate
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A comprehensive study of Clinical and Psychological factors in Snoring and Obstructive Sleep Apnoea

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Chapter I: Introduction

Preamble:

In recent decades, awareness of sleep apnoea syndromes has increased both in the public mind and among medical professionals. As a result, more patients demand treatment of sleep disorders. However, the health care delivery system is unable to meet this demand. The inadequacies mainly relate to lack of infrastructure and lack of skilled manpower. When great advances have been made in the medical field, provision of such facilities may appear to be simple. But, we are hampered by lack of information regarding the size of the problem. We do not know the actual prevalence of sleep disordered breathing. Another significant inadequacy relates to the absence of a comprehensive algorithm for approaching a patient with suspect OSA. The skill sets required for this algorithm are spread widely amongst various specialists, namely pulmonologists, neurologists, critical care specialists, internal medicine specialists and otolaryngologists. Supporting staff in the pulmonary, sleep and imaging laboratories must be developed. The willingness of the health insurance to assume the reimbursement of expenses will play an important role in this development. This study is an effort in meeting the first of these inadequacies namely, defining the magnitude of the burden of this disease.

Sleep - description, function and its implications:

Sleep is a state of unconsciousness, from which a person can be aroused, albeit with some difficulty. It is a complex neurological state, with its primary function of providing rest and restoring the body's energy levels. The importance of sleep could be seen from the fact that people spend about one-third of their lifespan in sleep. It is essential for life; it is difficult to enumerate its functions. It is stated that sleep is essential for restoration and recovery. Energy conservation is one function that is proposed for sleep. Sleep may help to discharge emotions through dreaming. Memory consolidation, brain growth and repair are the other functions proposed for sleep (1). Restorative functions including immunity build up are also attributed to sleep.
**Types and stages of sleep:**
Normal human sleep is divided into non-rapid eye movement (NREM) and rapid eye movement (REM) sleep, based on the presence of rapid eye movements. Discovery of REM sleep in 1953 by Aserinsky and Kleitman (2) revolutionised the understanding of sleep.

A person starts his sleep with NREM sleep. Within the NREM phase, four stages of NREM are discernible. These stages are named I, II, III and IV, representing successively deeper stages of sleep. The first cycle of REM sleep may appear after 30 to 90 minutes of NREM sleep. The REM sleep is characterised by a profound loss of tone of muscles (except eye, middle ear and respiratory muscles). The other features of this phase are muscle twitches, respiratory changes, increased heart rate and increased coronary blood flow. Dreaming is believed to occur during REM sleep only.

Fig I (1). Stages of sleep.

The NREM and REM phases of sleep alternate with each other. In the newborn, the cycling is very frequent (polycyclic). The sleep pattern changes as the child grows and the cycling becomes less frequent (monocyclic). In adult, the alterations occur about 4-5 times during a night of normal sleep. The first REM period may be less than 10 minutes in duration, while the last one may exceed 60 minutes. Awakening after a full night’s sleep is usually from REM sleep.
Normal duration of sleep: In newborns, the total sleep duration can be 14 to 16 hours, in a day of 24 hours. It is common to observe that pre-school children sleep between 11-13 hours a night and school-aged children between 10-11 hours of sleep a night. Teenagers also, are found to stretch their sleep hours to eleven, sometimes. In adults, sleep of 7 to 8.5 hours is considered fully restorative, although there is a wide variation among individuals. In the elderly people, and in some cultures, total sleep is often divided into a mid-afternoon nap of about one hour, and an overnight sleep for the remaining period.

The procedure of staging of sleep:

Traditionally, three primary measures are used to assess the different stages of sleep. These physiological measures are electro encephalogram (EEG), electro myogram (EMG) and electro oculogram (EOG).

The most important parameter required for sleep analysis is EEG. The different EEG waves found during sleep and wakefulness could be classified on the basis of their frequency and amplitude as delta (< 4 Hz, 150-250 μV), theta (4 - 8 Hz, 100-200 μV), alpha (8-13 Hz, 50 -100 μV), and beta (>13 Hz, < 50 μV).

During NREM sleep the EEG shows increasing voltage and decreasing frequency, as the sleep progresses from stage I to IV. These stages represent successively deeper stages of sleep. The deeper stages of sleep are found predominantly during the first one-third of a night’s sleep. The muscles are progressively relaxed during the deeper stages of sleep. Though the muscle activity is reduced, the sleeper makes postural adjustments after about every 20 minutes. During NREM sleep the heart rate and blood pressure decline, but the gastrointestinal motility and parasympathetic activity increases.

As mentioned earlier, NREM sleep alternates with REM sleep. The REM sleep is also called “paradoxical sleep”, as the EEG during this phase becomes desynchronised (i.e. low voltage fast activity), similar to the wakeful stage. The eyeballs show rolling movement with superimposed bursts of rapid eye movements (REM) during this phase of sleep.
During the awake stage, the EEG alternates between beta and alpha activity. Alpha activity is observed when the subject is relaxed and the eyes are closed. Beta activity appears when the subject is alert with eyes open and scanning the visual environment. The amount of visual scanning would be reflected in the EOG. The EMG may be high or moderate, depending on the degree of muscle tension.

The alpha activity suddenly decreases as the person enters the stage I of NREM sleep. The EEG consists mostly of low voltage, mixed frequency activity, with much of it in 3-7 Hz range. The EOG activity is mostly absent, but slow rolling eye movements would be present. The EMG is moderate to low during this period. As the person enters stage II, from stage I, sleep spindles (12-14 Hz sinusoidal waves) appear against the background of low voltage, mixed frequency EEG. Eye movements (EOG) are rare, and EMG is low to moderate during stage II. During stage III, delta waves appear in the EEG, but the EOG continue to remain as before. The EMG may also continue to remain as before, or show slight reduction as the sleep progress from stage II to stage III and IV. There is a quantitative increase in delta waves during stage IV, so that they come to dominate the EEG tracing. The EOG continues as before during this stage.

Rapid eye movement sleep is marked by the reverting of EEG to a low voltage, mixed frequency pattern, similar to that of awake alert stage. Bursts of prominent rapid eye movements appear in the EOG. The EMG is virtually absent, but small muscle twitches may occur against a background of low level of activity. The REM sleep is also associated with penile erection and testosterone release.

Though REM sleep is associated with dreaming, some mental activity is also associated with NREM sleep. But, they are less vivid and not accompanied by full dream narrative. Dreams are usually visual, but the congenitally blind have auditory dreams.

**Neural Control of Sleep:**

Sleep was considered as a passive process till the 1950's. but, now it is established that sleep is an active rhythmic neural process. The ascending
reticular activating system of the brainstem keeps the cortex and rest of the brain tonically active during wakefulness. Sleep is actively produced by the preoptic and other basal forebrain areas.

Study of changes in the activity of the basal forebrain sleep regulating areas in conscious rats, by employing functional magnetic resonance imaging (fMRI), helped to localise the critical area for the maintenance of slow wave sleep at the medial preoptic area (3). Regularly occurring periods of eye Motility and concomitant phenomena during sleep. Selective neuronal lesion of the basal forebrain has shown that the areas around the medial preoptic area play a major role in sleep initiation (4,5). The thalamo cortical loop is important for EEG slow waves of alpha frequency. Interaction of the brainstem areas, namely the pedunculo-pontine and lateral dorsal tegmental area, with the dorsal raphae nucleus and locus coeruleus, is important for REM sleep generation.

Circadian sleep rhythm is one of the several intrinsic body rhythms modulated by the supra chiasmatic nucleus of the hypothalamus, and the pineal gland. They set the body clock to approximately 25 hours, but environmental signals (like light exposure) and activity schedule entrain it to a 24-hour cycle. So, light is called a “zeitgeber” a German word meaning ‘time giver’, because it sets the circadian clock to a 24-hour rhythm. Thus, the inherent circadian rhythm continuously interacts with the external environment. Sleep-wake cycle can continue even without external clues, but then the cycle length assumes a periodicity of 25 hours or more.

Sleep disorders:

It is essential to spend sufficient period of time in sleep. Persistent and repeated interruption of sleep or sleep deprivation affects the health of an individual. Other than sleep deprivation, there are other types of alterations in the quality, quantity and pattern of sleep. All the alterations are collectively called sleep disorders. Sleep disorders cover a wide variety of diseases. Though there are more than 100 identified sleep/wake disorders, most sleep complaints can be categorised into five, namely, hypersomnia, insomnia, circadian rhythm disorders, parasomnias, and sleep disorders associated with mental, neurological, and other medical disorders. According to the National Institutes of Health, the prevalence of sleep disorders in USA is approximately 15 % of the population.
Though a clear-cut statistical data is not available about sleep disorders in India, the percentage of people suffering from it is not likely to be grossly different (1).

**Sleep apnoea and its types:**

A cessation of breathing is called apnoea. An apnoea occurring sleep is aptly termed sleep apnoea. An apnoea is defined conventionally as cessation of breathing for >10 seconds or for the duration of two breaths. But, like most other definitions in this field, this is purely arbitrary.

As early as 1966, Gastaut et al (6,7) described three types of sleep apnoea:

1. Obstructive, in which air flow ceases but movement of the chest wall (rib cage and abdomen) persists, implying respiratory effort in the face of a closed upper airway
2. Central, in which both flow and movement cease, apparently because of cessation of the drive to breathe
3. Mixed, a combination of the previous two patterns with features suggesting initially a central and then an obstructive event. It later became clear that mixed apnoeas are essentially obstructive, with the respiratory efforts remaining undetected during the early part of the particular episode.

Obstructive sleep apnoea is the most common type, occurring in 5-20% of adult men. Central apnoea syndrome is much less common than obstructive syndrome. The diagnosis of sleep apnoea syndrome is made by performing polysomnography.

Obstructive sleep apnoea is characterized by recurring episodes of upper airway obstruction during sleep. This condition is usually associated with loud snoring and arousals, resulting in marked sleep fragmentation. Increased daytime sleepiness is an important symptom. The recurrent hypoxaemia and hypercapnia may lead to both pulmonary and systemic hypertension, cardiac arrhythmias and decreased survival.

Central apnoea is seen in infants with an immature respiratory control system, while in adults it may occur with cerebrovascular or neuromuscular
disease. In patients with advanced heart disease and low cardiac output, the respiration becomes alternately shallow and deep. This type of periodic breathing is more commonly called Cheyne Stokes respiration, after the two physicians who first described it, John Cheyne (1777-1836) and William Stokes (1804-1878). The waxing and waning pattern of such Cheyne-Stokes breathing tends to be exaggerated during sleep and this may lead to a label of central apnoea.

Fig. I (2). The physiological parameters of different types of apnoea

The genesis of OSA and the factors underlying the same:

Fig. I (3). Dilators of pharynx

The obstruction to the airway (air flow) can be due to a structural narrowing in the upper airway like nasal block or an enlarged adenoids, enlarged tonsils, large tongue. Or, it can be due to passive collapse of the pharyngeal walls. The pharynx is a very compliant floppy structure which responds readily to dilating and compressing forces. During inspiration, several small muscles (pharyngeal dilators) contract synchronously with the main inspiratory muscles with the effect of supporting the wall of the pharynx and countering the tendency to narrow which results from the sub
atmospheric intra pharyngeal pressure. During sleep, the tone of these pharyngeal dilators is relatively suppressed. The result is a greater tendency for the upper airway to narrow during inspiration (8).

Why obstructive apnoeas develop in some individuals and not in all is determined largely by the initial size of the pharynx, with any structural features which reduce its static dimensions predisposing to more severe narrowing or closure during sleep. The most common of these contributory factors are obesity (with excess adipose tissue increasing the load against which the pharyngeal dilator muscles have to act), enlargement of the tonsils and the relative position of the upper and lower jaws. In relation to the latter, even a mild degree of retro gnathia is associated with a more vertically oriented mandible and an intrinsically smaller pharynx. Combinations of these factors may interact in individuals, increasing the likelihood or severity of OSAS. Sometimes a familial tendency to develop sleep apnoea is recognized, probably due in part to hereditability of the bony structure of the face (9).

Whatever might be the cause, during the airway obstruction, hypoxemia and hypercapnia develop, which cause a progressive increase in the drive of the medullary respiratory centres. At this point, the sufferer may wake, partially or completely. This awakening restores the tone of the pharyngeal muscles, and terminates the apnoea. The blood gas levels return to normal after a few noisy breaths. The patient, relieved of obstruction, goes back to quiet sleep. With this second sleep onset, the obstruction gradually returns with even louder snoring until the apnoea recurs with complete silence again. This cycling of recurrent loud snoring and arousal with consequent alterations in the oxygen and carbon dioxide concentrations persists throughout the night, grossly disturbing both cardiorespiratory physiology and sleep. The worst disturbances usually occur during rapid-eye-movement sleep, a particularly vulnerable period.

Lugaresi of Italy and his team (10) did pioneering research in defining the actual mechanism of airway obstruction. They did a series of cine radio graphic studies in heavy snorers. Initially, they found that the airway obstruction was usually caused by a ball valve mechanism at the level of the oro pharynx. With further studies, they found additional mechanisms in different types of apnoeas.
In heavy snorers, they (10) found that the intra thoracic pressures frequently reached a nadir of 50 cm of H₂O. This led to a lowering of the entire laryngo tracheo bronchial complex, with a consequent lengthening and narrowing of the oropharyngeal tract. An isthmus is thus formed, wherein, the airflow became faster and the inspiratory collapse due to the venture effect becomes more pronounced, favouring further narrowing, until total obstruction is reached. This phenomenon occurs during sleep and not while he is awake because only during sleep, the oropharyngeal muscles relax and become hypotonic.

This narrowing of the upper respiratory tract caused by the stretching of the oro pharynx might explain why the obstruction always occurs in the oro pharynx irrespective of the site of anatomical stenosis. This is because the oropharyngeal walls are the only soft and elastic segment of the entire upper airway.

In a patient with mixed apnoea, they found that, at the time of diaphragmatic arrest, the intra thoracic pressures dipped even upto 100-150 cm H₂O. This great dip caused the epiglottis to fall back and completely block the airway during the subsequent inspiratory effort.

Fig. I (4). Site of narrowing in patients with OSA.

Starling resistor theory and flow limitation phenomenon: In patients with snoring and obstructive hypopnea, partial collapse of upper airways occurs during inspiration. It has been suggested that this can be explained by the Starling resistor theory, which predicts that the flow increases with negative intra luminal driving pressure only up to a critical value ($P_{\text{crit}}$). Above this critical value, greater collapse occurs and there is no further increase in flow despite a greater inspiratory effort. The occurrence of
complete closure of airway, during sleep of labored inspiratory effort is
generally ascribed to this phenomenon, aptly termed as flow limitation (11).

**Polysomnography:**

The gold standard for investigating sleep apnoea is polygraphic monitoring
of parameters of sleep and respiration. This is called polysomnography (PSG). It is usually conducted in a hospital or in a sleep clinic, with the
patient sleeping over night. PSG monitoring includes electro encephalo
graphy, nasal air flow, respiratory movements of chest and abdomen, pulse
oximetry, muscle tone, and eye movement. The raw data obtained by the
above monitors on a time scale, throughout the entire night is analysed and
several indices are derived. For a long time, interpretation, comparison of
different studies and meta analysis, in this nascent field, had been
hampered by the lack of standardized terminology. Hence, in 1996, the
American Academy of Sleep Medicine published a manual for scoring of the
SDB terminology (12).

**Standardized definitions of SDB indices - AASM 1996 (12).**

**Obstructive apnea:** An obstructive apnea is scored when there is a > 90%
drop in the signal amplitude of airflow for >90% of the entire event,
compared with the pre-event baseline amplitude, and the event lasts for at
least two breaths (or the duration of two baseline breaths) with continued
inspiratory effort throughout the entire period of decreased airflow. The
duration of the apnea is measured from the end of the last normal breath
to the beginning of the first breath that achieves the prevent baseline
inspiratory excursion.

**Mixed apnea:** An event is scored as a mixed apnea if the airflow signal
meets duration and amplitude criteria for obstructive apnea, and the event
is associated with an absent inspiratory effort in the initial portion of the
effort, followed by respiratory effort before the end of the event.

**Central apnea:** A central apnea is scored if the respiratory event is
associated with absent inspiratory effort throughout the duration of the
event and one of the following is present: (1) the event lasts .20 seconds or
(2) the event lasts at least two missed breaths (or the duration of two
baseline breaths) and is associated with an arousal, an awakening, or a > 3% desaturation.

Hypopnea: An event may be scored as a hypopnea if there is a >50% drop in airflow signal amplitude compared with the preevent baseline amplitude for at least 90% of the duration of the event. In addition, the event must last at least two missed breaths (or a duration of two baseline breaths) and should be associated with an arousal, awakening, or a >3% desaturation.

Respiratory effort-related arousal: A respiratory effort-related arousal can be scored when an event is accompanied by snoring, noisy breathing, increase in PETCO2/PtcCO2, or visual evidence of increased work of breathing, and the event lasts at least two breath cycles (or the duration of two baseline breaths) if one of the following is present: (1) a discernable reduction in amplitude of the nasal air pressure sensor that is less than 50% in comparison to the baseline level with a flattening of the nasal pressure waveform or (2) there is a progressive increase in inspiratory effort during the event on an esophageal pressure sensor tracing.

Hypoventilation: Sleep-related hypoventilation may be scored when .25% of the total sleep time (TST) is spent with a CO2 .50 mm Hg, measured by PtcCO2 and/or PETCO2 sensors.

Apnea index: Number of obstructive and/or central apneic events per hour of sleep. Obstructive apnea index: Number of obstructive apneic events per hour of sleep. Hypopnea index: Number of hypopneas per hour of sleep.

Apnea-hypopnea index (AHI): The summation of apnea index and hypopnea index.

Obstructive AHI: The summation of obstructive apneic events and hypopneic events per hour of sleep.

Upper airway resistance syndrome: A respiratory disorder of sleep associated with snoring, causing excessive daytime sleepiness due to arousals and sleep fragmentation.
The practical utility of PSG in OSA:

OSAS was first defined in terms of the apnoea index (AI), i.e. the average frequency of apnoeas per hour of sleep; one popular definition was an AI >5. With the passage of time, it has become clear that such a simple arbitrary definition is a gross oversimplification and of little practical use. Firstly, many asymptomatic and apparently healthy subjects in the community have an AI >5. Secondly, it became apparent that the full-blown syndrome with all the typical symptoms could also be seen in patients with periodic hypopnoea rather than complete apnoea. This led to the concept of the apnoea-hypopnoea index (AHI), a measurement which remains in general use. The distribution of AHI in the general population is continuous rather than bimodal. American Sleep Disorders Association (ASDA) classifies Sleep related obstructive breathing events (apnoea, hypopnoea, and respiratory effort related arousals) as

- Mild: 5–15 events/hour of sleep
- Moderate: 15–30 events/hour of sleep
- Severe: >30 events/hour of sleep

PSG has been validated in adults with clearly defined criteria for diagnosing SDB. Thus, in adults, PSG is well established as the gold standard. One of the reasons why PSG is not as widely used as might be expected is resistance on the part of insurance companies (in the US) to reimburse for these investigations. It is expensive, requires a night stay, intrusive and not available in all places. One valid medical reason is that it does not predict morbidity. Slowly it is becoming a routine for suspect OSA patients to undergo PSG.

PSG in children and alternate modalities:

The clinical practice guidelines of the American Academy of Pediatrics (AAP 2002) state 'if a history of nightly snoring is elicited, a more detailed history regarding labored breathing during sleep, observed apnea, restless sleep, diaphoresis, enuresis, cyanosis, excessive daytime sleepiness, and behavior or learning problems (including attention-deficit/hyperactivity disorder) should be obtained'. History and physical examination are useful to screen patients and determine which patients need additional
investigation for OSAS' (13). Thus, it is evident that PSG has a role in the management of children with sleep breathing disorders.

However, the opinion of AAP is not shared universally. There are several dissenting opinions. The strongest of these opinions is set out in a letter to the editor of the journal, Pediatrics, by Jon Matthew Farber, a general practitioner practicing in Virginia US. It may be recalled that Pediatrics is the official journal of the American Academy of Pediatrics and it is the very same journal which published the original recommendations of AAP, just in its previous issue. In his letter, Farber states that the guidelines appear to be poorly thought out. “Although it is important to alert the pediatricians to the existence of this condition, the ramifications of following these guidelines do not appear to have been given adequate consideration. According to the AAP report, primary snoring can be seen in up to 12% of pre school-aged children. Furthermore, there is no way to rule out OSAS in these children without doing PSG. The unmistakable conclusion, therefore, is that up to 12% pre shool-aged children should be undergoing PSG. An obvious consequence of following the guidelines will be a markedly increased demand for their use” (14). A careful reading of his views indicates that he is loathe to subject children to an investigation, which might be unnecessary, scarce and expensive. In no unmistakable terms, he demands that the recommendations must be withdrawn, because they go beyond the available evidence.

Several researchers have expressed concern about the prohibitive costs and the unavailability of PSG. Serda et al in 2006 state that 'nevertheless, this is a costly and labor-intensive technique that is uncomfortable for the patient and not available in all centers (15). Furthermore, protracted waiting lists for performing this study result in diagnosis and treatment delays for patients with important symptoms of OSA.

PSG is a painless study and should be well tolerated by most preschool age children without sedation. But, many sleep centers do not perform PSGs in children less than 6 years of age. The role of PSG, in children remains controversial. In part, the controversy relates to the lack of standardized criteria for interpreting and diagnosing the severity of the SDB in children. Furthermore, there is little evidence that PSG can predict adverse clinical outcomes for individual children and, therefore, many question its usefulness.
Therefore, it has become necessary to develop new strategies aiming to prioritize or reduce the number of polysomnography tests without loss of diagnostic accuracy (15, 16). Several other authors also concur with this view. However, the current consensus view is that polysomnography should follow if screening studies in suspected children do not support OSAS (16).

Alternate modalities for diagnosing OSA in children have been developed, including videotaping or audiotaping at home, simple pulse oxymetry alone at nights and daytime nap studies. The AAP does accept the use of audiovisual taping and pulse oximetry recording as screening studies for OSAS (13). In fact, complicated and expensive recording equipment may not be necessary to confirm the diagnosis; simple observation during a period of sleep will show the recurrent cycling of snoring and apnoea. In milder cases, poor sleep in hospital may make it a little less obvious and longer periods of observation on more than one night may be necessary. A tape recording made at home of the snoring and apnoea may be diagnostic when the history is inadequate.

Unfortunately, none of these abbreviated modalities have been validated for OSA. In these instances, the tools appear to be specific but not sensitive for OSA. Portable or simplified monitors (such as SNAP) have been developed to clinically diagnose SDB because they are easy to use, in the home setting (where the child is relaxed and comfortable), and inexpensive compared with PSG. However, these monitors too have not been validated for diagnosing OSA in children. Where the future will take us in terms of newer modalities for diagnosing SDB in children remains unclear at this time.

If PSGs are not widely used for children, then how do clinicians identify those at risk for SDB?

For the most part, the diagnosis is based on clinical signs and symptoms that suggest SDB and the otolaryngologist’s judgment. Clinical evaluation of a child with suspected SDB requires a meticulous history taking and physical examination. The history must include questions regarding the sleep environment, sleep history, snoring frequency, daytime manifestations of SDB, medication, past medical and surgical histories, and a family history of snoring, OSA, obesity, and treatments for OSA. Snoring
itself is insufficient to diagnose OSA as mentioned above; however, its presence requires that we enquire about episodes of apnea and desaturation (cyanosis) during sleep and restless sleep. Other signs and symptoms referable to SDB and OSA in children include enuresis, nightmares, hyperactivity disorder, and behavior disorders. Again, none of these signs alone is diagnostic of OSA. A history of poor academic performance in school and decreased activity level may be suggestive of OSA. Finally, a full review that focuses on craniofacial, chromosomal, and neuromuscular disorders may also suggest OSA.

However, a recent systematic review demonstrated that, in spite of the high quality of the evidence, history, and/or physical examination (in the absence of laboratory tests) were inadequate to diagnose OSA when compared with PSG (17). Clinicians, if they are to make presumptive diagnoses of OSA without PSGs, must now rely on their clinical judgment to complement the history and/or physical examination. The prevailing ground reality is that most children, who present for T&A surgery, have not had a PSG preoperatively (18).

**Sleepiness associated with the OSA:**

Excessive Daytime Sleepiness (EDS) is defined as sleepiness that occurs in a situation when an individual would usually be expected to be awake and alert. EDS has a negative impact in tasks which require alertness like driving, learning etc. Clues toward recognizing childhood daytime sleepiness may be sleeping longer hours than expected for age, daytime naps beyond normal for age, being sleepy when other children of the same age are active and alert, and sleeping more than previously.

Sleep fragmentation and sleep deprivation results in uncontrollable sleepiness during the succeeding waketime. EDS has a negative impact in tasks which require alertness like driving, learning etc. Undiagnosed and untreated EDS may cause not only misery to the sufferer, but may also cause socio-economic consequences. Several road traffic accidents are attributed to the driver sleeping behind the wheels(19).

Sleepiness is considered to be the major cause of increased traffic accidents in patients with obstructive sleep apnoea syndrome. Patients with OSAS exhibited much longer reaction times than controls, leading to a
lengthening of the vehicle’s stopping distance of 8.8 m at 40 km.h(-1) and to twice the number of collisions(19). Major disasters, such as Bhopal and Challenger are also partly attributed to impaired executive functions caused by sleepiness (1).

American Sleep Disorders Association (ASDA) classifies Excessive Daytime sleepiness into three categories.

- **Mild**: unwanted sleepiness or involuntary sleep episodes occur during activities that require little attention
- **Moderate**: unwanted sleepiness or involuntary sleep episodes occur during activities that require some attention
- **Severe**: unwanted sleepiness or involuntary sleep episodes occur during activities that require active attention

Causes of EDS are arbitrarily divided into 3 categories: insufficient nighttime sleep, fragmented nighttime sleep, and increased drive of sleep. A detailed history along with examination of the upper airway is crucial in evaluating patients with EDS. Appropriate screening tools such as sleep logs, sleepiness scales, and sleep questionnaires further help in identifying and quantifying the degree of sleepiness. Several standard scales are now available viz. Berlin questionnaire, Epworth Sleepiness Scale, Karolinska Sleepiness Scale, Stanford Sleep Scale. All the above mentioned instruments have withstood scientific scrutiny and have been validated. They are utilized globally and serve an excellent purpose. However, some are easy to administer and save the valuable time of the harried medical practitioners. Such questionnaires are of special relevance to our country where the initial screening of sleepiness can be made using a questionnaire and then the patients can be subjected to PSG, when appropriate, for confirmation and assessment of severity.

However, the most common cause of EDS is not OSA, but volitional or forced sleep deprivation, which occurs due to work related, academic and social pressures. Additionally, this issue is further compounded by the fact that not all OSAs are followed by EDS.

Assessment of sleepiness itself presents difficulties and is usually self-reported rather than objective (see below). Thus neither the consequences nor the proximate cause of OSAS are measurable with the desirable
precision. However, such a situation is not unusual in medicine; a precise quantitative definition of asthma has eluded numerous experts over a much longer period than applies to sleep apnoea. At present, several questionnaires have been developed to subjectively assess the severity of EDS viz. Stanford Sleepiness Scale, Epworth sleepiness Scale, Karolinska Sleepiness Scale, Berlin Questionnaire, OSA 18 etc. all of these have been validated to have discriminant functions. Some e.g. OSA 18 have been validated for evaluative functions also.

A well designed study by Netzer et al in 1999 showed that a simple self administered patient questionnaire is an excellent way of identifying patients who are at high risk for sleep apnea and who might benefit from sleep testing for that condition (20). Other studies also have borne out the same conclusion (21).

Studies of patients attending sleep clinics have shown correlations between AHI and the severity of daytime sleepiness, but the relationship is not close. This lack of strength in the association is hardly surprising because, in everyday life, there are several other common causes (shift work, examinations, travel etc) which can fragment sleep and lead to sleepiness on the next day. Thus, both episodic sleep apnoea (and hypopnoea) and daytime sleepiness are common, some subjects will inevitably have both without necessarily a cause-and-effect relationship. In order to find out whether such a relationship does exist, various studies have examined whether other EEG and PSG parameters relate better to daytime sleepiness. But, none has been shown to correlate better with sleepiness than the rather crude AHI.

Snoring is a cardinal symptom of SDB:

Snoring is a cardinal symptom of obstructive sleep apnoea (OSA) syndrome and a frequent finding in otherwise healthy subjects. Snoring is produced by vibrations and partial obstruction in the oropharynx. It is characterized by audible, high frequency oscillations of the soft palate, pharyngeal walls, epiglottis and tongue, occluding and opening a narrowed pharyngeal airway. During sleep there is a progressive reduction in all muscle activity, which results in the tongue relaxing and the airway narrowing. This reduction in pharyngeal dimension is a universal phenomenon, but the degree of narrowing varies considerably between individuals. When the pharyngeal
passage narrows down, the speed of airflow increases (Bernoulli’s Theorem), producing a relative vacuum. This vacuum sucks the walls closer together and increases the airways resistance. This increase in airflow and the turbulence caused by the same can cause vibration of the soft tissues, which results in the sound of snoring. In some cases it can be associated with structural abnormalities. 

Primary snoring, defined as snoring without altered sleep architecture, alveolar ventilation, or oxygenation, is considered to be a clinically benign condition or as a social nuisance. This condition has plagued the bedrooms for several centuries. It may even disrupt the harmony of marital life and affect intimate relationships. Despite the long standing awareness of snoring and the havoc it causes, it was firmly believed that snoring was nothing but a social nuisance. The solutions for snoring ranged from the rare radical one as exemplified by J.W. Hardin, the infamous gun fighter from Texas, who shot and killed a loud snorer sleeping in the next room, to the more frequent submissive solutions like moving to a different place to sleep. For several centuries, therapeutic attempts were clearly devoted to improving the suffering of the bed partner. Even today, ear muffs are touted as ‘snore cure’.

**Assessment of snoring:**

One problem which impedes studying snoring in a systematic fashion is the lack of standardized and agreed upon techniques for quantification of snoring, such as has been done for sleep apnea. Snoring is first and foremost a subjective perception by a listener. There is no general agreement on how snoring should be assessed. Neither are there any standard measurements of snoring in the sleep laboratory. In addition, other qualities of snoring, apart from the loudness of snoring, such as its frequency, may contribute to the annoyance caused by snoring. Therefore, in most studies reliance is placed on subjective assessment.

Assessment of snoring by self-report is potentially limited because persons naturally are unaware of their behavior during sleep. Many clinicians recommend that spouses should be routinely queried concerning the sleep-related symptoms of their partners. The overall agreement between self report and spouse report has been found to be generally high. Furthermore, patients who report that they snore habitually do seem to
snore objectively (29). However, the results of the questionnaires may be misleading in part.

But, is snoring really a benign condition? Several eminent researchers have expressed their reservations over this issue.

A population based study lasting ten years, by Lindberg and his co workers, found that snoring with related daytime sleepiness was associated with an increased risk of occupational accidents (30). Similarly, several research workers have identified loud snoring and habitual snoring as markers of cardiovascular diseases. Increased QT interval which is well known to induce cardiac arrhythmias, occurs in OSA patients. This study shows that QT dispersion is increased also in simple snoring patients without apnea and that QT interval decreases after surgical interventions uvulopalatopharyngoplasty, laser assisted uvulopalatoplasty, and cautery assisted uvulopalatoplasty (31). But several confounding factors prevent us from deriving a cause and effect relationship.

Snoring had also been associated with adverse cardiovascular consequences such as hypertension. Franklin and others in 2000, studied 502 pregnant women in Sweden and found that snoring is common in pregnancy. 23 percent of the women reported snoring every night, during the last week of pregnancy, compared to only four percent before becoming pregnant. According to their study (32), snoring is a sign of pregnancy-induced hypertension. Hypertension developed in fourteen percent of snoring women, compared with six percent of nonsnorers (p < 0.01). Preeclampsia occurred in ten percent of snorers, compared with four percent of non snorers (p < 0.05). They also concluded that snoring indicates a risk of growth retardation of the foetus.

Snoring is considered to indicate several other medical conditions also. The sleep fragmentation and repetitive hypoxemia associated with OSA contribute to the primary symptoms of the disorder: excessive daytime sleepiness (33), neurocognitive impairment (34, 35), and increased risk for motor vehicle accidents (36).

In a series of 200 patients with OSA, Guilleminault (37) reported snoring in 100% of cases, although the degree of snoring varied. He states that snorers without obstructive sleep apnea syndrome may be at a risk of
Lerman, drawing upon his own and other studies, expresses a doubt that "Loud snoring without recurrent apnoea and symptoms is probably a \"forme fruste\" that may precede development of the full syndrome\(18\)."

Because of the above facts, snoring should not be dismissed as an innocuous social nuisance. Presence of snoring must alert us to look for other features of SDB. The 2002 clinical practice guidelines of the American Academy of Pediatrics \(13\) recommend that 'screening for snoring should be part of routine health care visits ... if a history of nightly snoring is elicited, a more detailed history regarding labored breathing during sleep, observed apnea, restless sleep, diaphoresis, enuresis, cyanosis, excessive daytime sleepiness, and behavior or learning problems including ADHD should be obtained'.

In spite of the omnicient awareness, it is surprising that studies on snoring per se are sparse. Even the burden of the disease on the community i.e. the prevalence is not known. This unfortunate state is probably due to widely held perception that snoring is benign. For some reason, snoring in oriental culture is supposed to indicate deep and comfortable sleep, leading thereby to under diagnosis and under reporting of sleep apnoea syndromes \(39\).

However, several estimates about the community prevalence are available. In a well designed country wide telephonic survey Ohayon found that the community prevalence is as high as 40% of the UK population, rising to more than 50% in middle aged males. \(40\). The effects of snoring on other family members make the total number affected by this problem far greater \(22\). Partinen states that habitual snoring i.e. snoring that is present on most nights, is a common condition affecting 9-35% of the general adult population, and its prevalence increases up to the age of 60-65 years and decreases slightly thereafter \(41\). Barthel states that snoring affects up to 60% of the adult population \(42\). Xu et al in 2006 \(43\), estimate that the prevalence of obstructive sleep apnea is approximately 2% in children, but primary snoring to be more common, ranging from 3 to 12%. \(Xu\ 2006\). As can be seen above, these estimates span a very wide range and do not allow us to draw any conclusion.

A recent systematic review demonstrated that, in spite of the high quality of the evidence, history, and/or physical examination (in the absence of
laboratory tests) were inadequate to diagnose OSA when compared with PSG. To improve the diagnostic predictability of clinical findings for OSA, a questionnaire of the signs and symptoms was developed. However, the questionnaire was subsequently invalidated. Clinicians must now rely on clinical judgment and objective laboratory tests to complement the history and/or physical examination if they are to make presumptive diagnoses of OSA without PSGs.

The spectrum of SDB:

Sleep disordered breathing is a continuum of sleep-related disturbances in breathing that is characterized by the severity of the upper airway obstruction.

Snoring is a common accompaniment of sleep disordered breathing. When snoring is not accompanied by alveolar hypoventilation, it is called Primary Snoring (PS).
It is the mildest form of SDB and it does not manifest breathing pauses; neither does it show any hypoxia. Primary snoring appears to be benign. When snoring is persistent and manifests frequently, it is called habitual snoring. Habitual snoring in adults is a distressing social problem (44).

When the partial obstruction of PS progresses to a total blockade of the airway, the condition gets the name of OSA. When OSA is accompanied by EDS, it is termed obstructive sleep apnoea syndrome (OSAS).

In 1972, Guilleminault and others described a new syndrome (45), the upper airway resistance syndrome (UARS). Working with snoring children, he found that a sub population had to make increased efforts at breathing; but, never worsened to a stage of apnoea. In these children, oesophageal balloon monitoring confirmed that the intra thoracic pressures (Pes) were indeed highly negative. Considering that these children manifested EDS and some behavioural impairments, a distinct clinical identity was formed by Guilleminault. However, recently, doubts have been raised by some others that it is only an earlier stage of OSA (46).

The exact place of other sleep disorders viz. Restless Legs syndrome (RLS), Periodic Limb Movement Disorder (PMLD), Insomnia and Hyper
somnolence (Narcolepsy), in the spectrum is as yet ill defined. However, they have distinct clinical features and may merit a separate distinction.

<table>
<thead>
<tr>
<th>PS</th>
<th>UARS (in Children)</th>
<th>OH</th>
<th>OSA</th>
<th>OSAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snoring not associated with daytime symptoms</td>
<td>Increased UAR sufficient to cause symptoms like EDS</td>
<td>Increased UAR sufficient to cause increased Pa CO2 or decreased SaO2</td>
<td>Upper airway obstruction leading to manifest apnoea</td>
<td>Same as OSA with daytime somnolence (EDS)</td>
</tr>
</tbody>
</table>

Figure I (5). SDB is a continuous spectrum. As the upper airway resistance increases, the severity of the signs and symptoms increases from primary snoring to OSAS.

**Symptoms of SDB patients:**

The symptoms of SDB include loud snoring, witnessed pauses in breathing, gasping to breathe when asleep. In the approach to a snoring patient, it is important to distinguish between PS and OSA. The efforts in this direction must start from the stage of history taking. The AAP in its 2006 clinical practice guidelines underscores this point by recommending that ‘if a history of nightly snoring is elicited, a more detailed history regarding labored breathing during sleep, observed apnea, restless sleep, diaphoresis, enuresis, cyanosis, excessive daytime sleepiness, and behavior or learning problems (including attention-deficit/hyperactivity disorder) should be obtained. Symptom of dry mouth on awakening indicates snoring and OSA Arie 2006.

History and physical examination are useful to screen patients and determine which patients need additional investigation for OSAS’. Schechter 2002. However, it is well established that clinical history alone can not distinguish PS from OSA Carroll 1995.

**Clinical examination of Snoring and OSA**

Obstructive sleep apnea (OSA) and snoring are common medical conditions that often present to the otolaryngologist for evaluation and treatment.
The otolaryngologist uniquely has the ability to diagnose and manage many disorders of the upper airway.

The physical examination is often superficially unremarkable in patients with snoring and OSA, except for the common findings of obesity and systemic hypertension. A focused examination of the upper airway, however, will usually reveal evidence of craniofacial soft tissue and skeletal abnormalities that predispose to upper airway narrowing. Enlarged tonsils are readily apparent. Nasal obstruction can be identified by speculum examination, but more detailed otorhinolaryngological assessment may be required to identify specific anatomical abnormalities such as a deviated nasal septum, nasal polyposis, enlarged adenoids, and upper airway tumours.

Various simple measurements such as increased neck circumference, decreased thyro-mental distance, steep thyro-mental plane, and high Mallampati oropharyngeal score reflect regional neck adiposity, mandibular deficiency, and crowding of the posterior oropharynx that may contribute to upper airway obstruction during sleep. A short and fat neck in patients with sleep apnea, both men and women, is a very characteristic sign of this disease. However, the population with OSA is a heterogeneous group, and patients with OSA may not have all of these physical features.

Table I (1). Anatomical causes of snoring and sleep apnoea.

<table>
<thead>
<tr>
<th>Physical causes which can cause Snoring and/or OSA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat deposits around the neck - double chin</td>
</tr>
<tr>
<td>A large tongue, which falls back, obstructing the airway</td>
</tr>
<tr>
<td>Obstruction at the same place, but due to Retrognathia or Micrognathia</td>
</tr>
<tr>
<td>Small or collapsing nostrils</td>
</tr>
<tr>
<td>Deviated septum</td>
</tr>
<tr>
<td>Nasal congestion and catarrh</td>
</tr>
<tr>
<td>Enlarged nasal turbinates and nasal polyps</td>
</tr>
<tr>
<td>Large soft palate</td>
</tr>
<tr>
<td>Elongated uvula</td>
</tr>
<tr>
<td>Oedema of the uvula due to GERD</td>
</tr>
</tbody>
</table>

Table I (2). Clinical features of snoring and sleep apnoea
Common signs and symptoms associated with OSA

<table>
<thead>
<tr>
<th>Nocturnal signs and symptoms</th>
<th>Daytime signs and symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drooling</td>
<td>Excessive sleepiness</td>
</tr>
<tr>
<td>Xerostomia</td>
<td>Xerostomia</td>
</tr>
<tr>
<td>Sleep restlessness</td>
<td>Morning headaches</td>
</tr>
<tr>
<td>Witnessed apneas</td>
<td>Non restorative sleep</td>
</tr>
<tr>
<td>Choking or gasping</td>
<td>Dry mouth on waking up</td>
</tr>
<tr>
<td>Diaphoresis</td>
<td>GERD</td>
</tr>
<tr>
<td></td>
<td>Impaired concentration</td>
</tr>
<tr>
<td></td>
<td>Depression</td>
</tr>
<tr>
<td></td>
<td>Decreased libido</td>
</tr>
<tr>
<td></td>
<td>Impotence</td>
</tr>
<tr>
<td></td>
<td>Irritability</td>
</tr>
</tbody>
</table>

The treatment of OSA and Snoring:

In the early years, after initial recognition of OSAS, the only effective treatment available was tracheostomy. A tracheostomy completely bypasses the segment of the upper airway and completely abolishes the obstruction to breathing. This is the gold standard of treatment. But, it has many obvious disadvantages. With great strides in medical technology, resort to tracheostomy is done only if all else fail.

A select number of interventions are available for patients with SDB. These may be categorized into life style changes, medical, surgical and mechanical equipment.

Life style changes:

- Weight loss
- Avoidance of alcohol and sedatives
- Smoking cessation
- Sleep posture - avoidance of supine sleep position

Drug therapy:

- Relief of nasal obstruction
- Modafinil for residual hypersomnolence
- Progesterone - a respiratory stimulant
• Protriptoline - a nonsedating antidepressant
• Supplemental oxygen in selected patients

**Mechanical equipment:**

• Intra oral devices (tongue retaining devices, Mandibular advancement devices)
• Continuous positive airway pressure (CPAP)
• Bi level postitive airway pressure (BiPAP)

**Available surgical procedures:**

• Adenotonsillectomy: curative in children and selected adults.
• Uvulopalatopharyngoplasty (UPPP): for obstruction confined to the velopharynx.
• Laser assisted uvulopalatoplasty (LAUP) : not indicated for OSAHS.
• Other palatal procedures: not indicated for OSAHS.
• Tongue advancement procedures
• Maxillomandibular advancement: should be restricted to specialised centres.
• Tongue base surgery: possible role for temperature controlled radiofrequency tissue ablation in mild to moderate OSAHS.
• Tracheostomy: emergency management of severe OSAHS, when nasal CPAP therapy is not an option

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**Principles of Surgical treatment for snoring and OSA**

• For specific anatomical obstructing lesions, surgery is the treatment of choice (e.g. adenotonsillectomy).
• Preoperative mapping of the locus of upper airway obstruction is essential.
• The invasive nature of surgical treatment dictates a phased approach progressing from less to more radical procedures
• Irreversibility of surgery dictates that the treatment goal is cure or efficacy equivalent to nasal CPAP therapy.
• Objective assessment of the severity of OSAHS before and after surgery is essential.
• Long term follow up is strongly recommended because of the high rates of treatment failure.
Now, let us consider each of the above in detail.

Weight loss:

This is the first form of the treatment regimen for patients with mild to moderate symptoms. Meyer 1990 Obesity, particularly regional neck obesity is a major risk factors for OSA.

Weight loss directly leads to a reduction in the tissue volume in the upper airway and thus, less airway resistance. Additionally, the decreased load on the chest wall and abdomen results in an improvement of respiratory muscular efficiency. Reduction in body Changes in body weight are frequently associated with pronounced improvements in AHI, oxygenation, sleep architecture, blood pressure and daytime alertness.

A variety of options are available for weight reduction e.g. cognitive behavioral therapy, very low calorie diets, anorexiant drugs, and bariatric surgery. They lead to weight reductions ranging from 5% to 50%. In general, bariatric surgery resulted in more impressive weight reduction than medical treatment. Following bariatric surgery, some deaths had been reported.

However, not all patients who have snoring and OSA are obese. About two thirds of patients with OSA are obese (>120% ideal body weight). However, the relationship between the degree of obesity and the severity of OSA is non-linear, making it difficult to prescribe precise weight reduction goals for individual patients. Further, there is a great degree of recidivism. Of the patients who attempted weight loss, 95% regained all or more of their weight within two years Ryan 2005. Faced with these uncertainties about the role of weight reduction and its long term efficacy in the treatment of OSA, what advice should the clinician give?

Certainly, all obese patients with OSA should be informed that obesity is likely to be a major contributory factor to their sleep disordered breathing. They should be counselled to lose weight if possible, regardless of what other treatments are undertaken. Weight reduction and other lifestyle adjustments may be the appropriate primary treatment strategy for patients with mild OSA who are not sleepy and have no serious co-morbidities.
An aggressive approach to weight reduction using very low calorie diets or bariatric surgery may be appropriate for some morbidly obese patients with severe OSA, particularly if undertaken as part of a comprehensive treatment programme. This approach may also be justified for patients with severe OSA who cannot tolerate nasal CPAP therapy and are unsuitable for tracheostomy. Weight reduction may lower the effective nasal CPAP pressure required to control OSA and thereby potentially improve compliance. Some patients are motivated by the prospect that significant weight reduction may allow them eventually to be free of nasal CPAP therapy.

Finally, the potentially favourable impact of weight reduction on co-morbid conditions such as hypertension, heart failure, respiratory failure, insulin resistance and dyslipidaemia, and their interactions with OSAHS, should be impressed upon the patient.

Sleep posture:

A lateral decubitus posture reduces the tendency for airway collapse. The collapsibility of the upper airway during sleep in patients with OSA, as measured by the critical closing pressure (Pcrit), is lower in the lateral than in the supine sleep position. In a retrospective study of 574 patients with OSA, Oksenberg and colleagues found that 56% had positional apnoea as defined by a supine AHI ≥2 times higher than lateral AHI. These patients were younger, less obese, had less severe OSA, and were less sleepy. Obese patients are less likely to show a reduction in AHI in the lateral position than in the supine sleep position. The effect on systemic blood pressure of promoting the lateral sleep position for one month was studied in thirteen patients with OSA, six of whom were hypertensive. Mean 24 hour, awake and sleeping blood pressure fell significantly (systolic/diastolic 6.4/2.9, 6.6/3.3, 6.5/2.7 mm Hg, respectively). The reduction in systolic blood pressure was greater in the hypertensive patients than in those who were normo tensive. Jocik and co-workers compared nasal CPAP with positional treatment in thirteen patients. Although AHI was lower and minimum oxygen was higher with nasal CPAP, when compared with the values with positional treatment, there was no difference between the two treatments in the main outcome measures of sleep architecture, daytime sleepiness, psychometric test performance, mood, and quality of life. Taken together, these data suggest that
promoting the lateral sleep position is a worthwhile goal that may be applicable to the majority of patients with OSA. Various devices that incorporate a soft ball or sock attached to the back of the pyjamas have been tried. While this technique is effective in the short term, its practicality and efficacy in the long term have not been tested.

Reduction in clenching, apnea index, and hypopnea index also occurs after assuming a lateral decubitus. As already mentioned, individuals whose weight was closer to normal benefitted more from a change in sleep posture than the obese patients. Positional treatment should be considered for patients with mild OSA and as an adjunctive measure for patients receiving other treatment such as nasal CPAP or an oral appliance. Ryan

Avoidance of alcohol and other respiratory depressants:

Alcohol selectively suppresses upper airway dilator muscle activity while leaving the diaphragm virtually unaffected. This effect increases inspiratory resistance during wakefulness and sleep and predisposes to obstructive sleep apnoea. Alcohol increases the frequency of apnoeas and hypopnoeas during sleep in normal subjects and patients with OSA, even in low doses. At higher doses, the duration of apnoeas and the severity of associated hypoxaemia are increased. Similar effects may be seen with other respiratory depressants such as benzodiazepines, narcotics, and barbiturates. Arousal responses to hypercapnia and hypoxia may also be blunted by respiratory depressants. Patients with OSA should therefore be counselled to avoid alcohol and sedative-hypnotic medications. Where such medications cannot be easily discontinued, nasal CPAP therapy should be recommended to control the OSA. Patients who are unwilling to avoid alcohol completely should be advised not to drink within 3–4 hours of retiring to bed. Ryan

Smoking cessation:

Cigarette smoking is a risk factor for snoring and OSAHS. Data from 811 adults enrolled in the University of Wisconsin Sleep Cohort Study were analysed using logistic regression with control for potential confounders. Compared with never smokers, current smokers had a significantly greater risk of sleep disordered breathing (odds ratio 4.44), with heavy smokers (≥40 cigarettes/day) being at the greatest risk. Former smokers were not at
increased risk. The mechanism of this interaction is unclear but may relate to increased upstream inspiratory upper airway resistance as a consequence of nasal mucosal inflammation. Patients with OSAHS who are current cigarette smokers should be counselled to quit. They should also be warned about the potential for weight gain associated with quitting cigarette smoking. (Ryan)

Sleep hygiene:

Sleep deprivation reduces ventilatory responses to hypoxia and hypercapnia and selectively decreases upper airway muscle activity in normal subjects. Sleep deprivation increases the number of apnoeas in snorers and patients with mild OSA. Short term sleep fragmentation does not appear to affect ventilatory responses to hypercapnia but does increase upper airway collapsibility to a greater extent than sleep deprivation. Thus, sleep fragmentation and sleep deprivation as a consequence of poor sleep hygiene could exacerbate OSA. Measures to improve sleep hygiene should be advocated, including avoidance of caffeine and other stimulants, a regular sleep-wake schedule, environmental measures to promote a comfortable undisturbed sleep, and avoidance of daytime napping. Ryan

Drug therapy:

The limitations of existing treatments for OSA have led to continued interest in drug therapy as a potential alternative approach. A wide variety of pharmacological agents have been tested.

The mechanisms of actions of these drugs include increased ventilatory drive (medroxyprogesterone, acetazolamide, theophylline, doxapram, naloxone, nicotine, carbon dioxide); suppression of REM sleep (protriptyline, clonidine, selective serotonin reuptake inhibitors); decreased sympathetic tone and baroreceptor activity (metoprolol, alazapril); stabilisation of ventilation (sabeluzole); and selective activation of upper airway dilator muscles (strychnine, paroxetine, trazodone and L-tryptophan). Many of these agents are limited by poor patient tolerance and their use is not supported by randomised controlled trials.

The response to drug therapy is less than optimal. Progesterone is used for its respiratory stimulant effect. Less than 50% of patients respond to this
medicine. It is expensive, and produces feminizing side effects. Protriptoline is a non-sedating antidepressant. It can reduce symptoms of daytime sleepiness and nocturnal apneas, and this reduction of symptoms seems to be related to the reduction of REM sleep. The important side effects are urinary retention and anticholinergic effects. Supplemental oxygen by cannula or by mask during sleep produces conflicting results. It is found to relieve bradycardia, cardiac dysrhythmias, pulmonary hypertension, and congestive heart failure. However, it may prolong obstructive apneas by removing the major stimulus (hypoxemia) for their termination. Ryan

In a randomised, double blind, placebo controlled, crossover study in 10 men with OSA, four of whom were hypercapnic, Cook et al found that medroxyprogesterone 150 mg/day had no effect on AHI or total sleep time. Whyte et al compared acetazolamide, protriptyline and placebo in eight men and two women with OSA (AHI >15/hour) using a randomised, double blind, crossover design (47). Acetazolamide 250 mg qid for 14 days reduced the AHI (p<0.03) but not the frequency of arousals or subjective daytime sleepiness. Long term use was limited by intolerable side effects, particularly parasthaesiae. Mulloy and co-workers studied the effect of theophylline in 12 men with OSAHS in a randomised, double blind, placebo controlled, crossover study. The AHI decreased from a mean of 49 / hour (sd = 9) to 40 / hour (sd = 9). (p = 0.02). But, total sleep time, sleep efficiency and sleep architecture deteriorated. Randomised, blinded, placebo controlled, crossover studies of aminophylline, buspirone, sabeluzole and clonidine have failed to demonstrate any benefit of these agents in OSAHS. In summary, the currently available evidence does not support the use of pharmacological agents exclusively, in the treatment of OSAHS. Modanafil is prescribed to combat the daytime hypersomnia. Two recent randomised, double blind, placebo controlled trials of modafinil in patients with OSA who had residual sleepiness despite nasal CPAP therapy showed significant improvement in alertness and subjective and objective daytime sleepiness, suggesting that this agent may have a role as adjunctive symptomatic therapy.

In a study, spread over Twenty-two centers in the United States, in a sample of one hundred and twenty five patients with moderate to severe OSA, receiving CPAP therapy, Schwartz et al found that Modafinil remained effective and well tolerated as an adjunct therapy for residual
daytime sleepiness even after 12 weeks of daily dosing in patients with OSA (48).

Roth et al, in a more recent study (49), found that Modafinil is well tolerated in the treatment of excessive sleepiness associated with disorders of sleep and wakefulness and does not affect cardiovascular or sleep parameters.

The future development of new pharmacological approaches to OSAHS awaits a greater understanding of the central neuronal mechanisms and the various neurotransmitters involved in the modulation of motor output to the upper airway muscles. This is currently an area of active research.

**Supplemental oxygen:**

Supplemental oxygen is an accepted treatment for patients with chronic lung disease who have significant arterial oxygen desaturation during sleep. Arterial oxygen desaturation is a common pathophysiological consequence of OSA that may contribute to the development of complications such as pulmonary hypertension, cardiac dysrhythmias, and cognitive impairment. Relief of hypoxaemia is therefore an important outcome measure of successful treatment of sleep disordered breathing. Supplemental oxygen improves overall oxygenation during sleep in patients with OSA but increases apnoea duration while reducing apnoea frequency only slightly. Daytime sleepiness is not reduced. In most instances supplemental oxygen is insufficient as sole therapy for OSA. Occasionally, patients with co-morbid medical conditions such as chronic heart or lung disease who have significant oxygen desaturation in association with otherwise mild asymptomatic sleep disordered breathing can be considered for supplemental oxygen alone. In these patients consideration should also be given to a trial of nasal CPAP therapy. Oxygen is also indicated as adjunctive therapy for patients using positive airway pressure devices for OSAHS who have persistent arterial oxygen desaturation at the highest tolerated pressures.

**CPAP:**

The treatment of OSAS was revolutionized by the introduction of nasal CPAP by Sullivan of Australia. The principle is very simple: splinting of the airway by the application of positive pressure via the nose and mouth. Such
splinting prevents the airway from collapsing, consequently snoring is suppressed, sleep quality is normalized and daytime symptoms are alleviated.

Several commercial models are available. Basic design is the same in all machines. Positive pressure is applied to the nasopharynx by a tight fitting mask attached to a blower. The pressure required to overcome the hypopnoeas and apnoeas varies between individuals. Even within an individual, it may vary depending upon several factors like posture, sleep stage and recent alcohol consumption. In most centres a simple 'titration' study is performed over a single night with the therapeutic pressure determined as that which overcomes 90% or 95% of sleep-related events. A variant of nasal CPAP uses an airflow device that inserts into the nostrils and eliminates the external nasal appliance. It significantly decreased the number of desaturations per hour of sleep. It is not as effective as nasal CPAP.

The disadvantages are (i) it is uncomfortable and inconvenient - Not surprisingly, many patients do not wish to be encumbered with an inconvenient and somewhat unaesthetic form of treatment which may be lifelong, (ii) the airway mucosa may dry up (iii) failure of the compressor unit, such as occlusion of the exhaust line could cause hyperinflation of the lungs.

Some modern CPAP machines respond rapidly to the state of the upper airway and adjust the pressure automatically (auto-CPAP). This may allow a slight reduction in the average nocturnal pressure and improve compliance in some individuals, particularly those requiring higher pressures. Auto CPAP machines are expensive; they are not necessary for many patients.

CPAP machine must used continuously and for adequate duration each night. The main reason for the failure is inadequate usage. However, the minimum period required to alleviate symptoms is not known and probably varies in a complex way between individuals and, indeed, within individuals. Many patients, especially those with more severe symptoms who therefore perceive the greatest benefit, use the treatment comfortably all night and every night (i.e. averaging 6 or 7 h per night). Others may derive benefit from more limited use. Overall, about 70% of symptomatic patients use CPAP effectively and
sufficiently. There is no doubt that many thousands of lives have been transformed, marriages saved, jobs preserved and (probably) road accidents prevented by this treatment.

**Miscellaneous devices and aids:**

Various interventions have been tested to explore the pathophysiological mechanisms of upper airway obstruction during sleep in OSAHS. Some pilot studies have been reported, but none of these interventions has been evaluated by large scale controlled trials. They include neck collars, nasal valve dilators, pharyngeal lubricant, electrical stimulation of upper airway dilator muscles, transtracheal air insufflation, and even atrial pacing. Although modest efficacy has been claimed for some of these approaches, their widespread use is likely to be limited by discomfort, impracticality, or the potential for serious complications. Even a naso pharyngeal airway had been tried. A tube, placed beyond the site of clinical obstruction within the nasal cavity, can yield a positive gain. But the problems engendered are correct placement, chronic irritation, pain and a possible development of redundant tissue that may occlude the naso pharyngeal tube.

A recent report of the Clinical Practice Review Committee of the American Academy of Sleep Medicine (12) noted that the paucity and limited quality of scientific data on non-prescription treatments for OSAHS resulted in insufficient information upon which to base standards of practice recommendations.

**Intra Oral devices:**

There are several mechanical devices in the market. Table All these devices work on the principle of keeping the airway open by mechanical means. All are constructed with the goal of positioning the tongue and mandible in a forward position, to minimize the possibility of oropharyngeal obstruction. The benefits are variable.

Tongue retaining devices (TRD) are made of soft polymer that envelope the tongue and and restrain it from falling backwards. They can be kept in position for up to 4 hours per night. They are often removed after this time due to discomfort or loss of suction. They lead to fewer and shorter apneic episodes, deeper sleep, and increased duration of REM sleep. A
better response from the TRD accrues for patients who previously revealed improved apneic indexes as a result of changes in sleep posture.

Mandibular Advancement device (MAD): these keep the mandible in a forward position. The anterior position of the mandible is thought to increase the tone of the genioglossus muscle, thus decreasing the possibility of tongue collapse during sleep. There should not be any other nasal block; otherwise, this device will be ineffective. Several innovative designs have been evolved, for better comfort and for patient compliance e.g. Equalizer airway device®, Thornton Adjustable Positioner II (TAP II)®. These orthotic devices are constructed of vinyl resins which by sensing the tone of the muscles adjust the position of mandible appropriately. Favorable responses, namely, reduction in the number of snores per hour and loudness have been reported. They also reduce apnoic episodes (50).

Fig. I (6). Nasal and oral devices to reduce snoring.

List of intra oral devices (Sleep Breath. 2007; 11(1): 1-22)
The equalizer
The silencer
TAP
TOPS
SNOAR
Herbst
Jasper Jumper
PM positioner
Tongue locking apparatus
Adjustable soft plate lifter
Z training appliance
Relief of nasal obstruction:

Chronic nasal obstruction is a common complaint among patients with OSA and can compromise its management. Nasal obstruction due to anatomical abnormalities or nasal mucosal congestion can increase upstream inspiratory resistance, promoting more negative intra luminal pressure in the pharynx and predisposing to pharyngeal occlusion during sleep. Nasal obstruction has been shown to increase the number of apnoeas and hypopnoeas and to cause sleep fragmentation. However, treatment of nasal obstruction with decongestants or surgery does not appear to improve OSA. The reasons for this lack of efficacy are unclear.

Series et al observed an improvement in OSA following nasal surgery in a subgroup of patients who did not have cephalometric abnormalities commonly found in OSA such as an inferiorly positioned hyoid bone and a narrow oro pharyngeal antero posterior dimension (51). This suggests that the failure of measures that relieve nasal obstruction to reduce OSA may be related to the persistence of anatomical abnormalities in the pharynx. Nevertheless, the absence of improvement in OSA following treatment of nasal obstruction in unselected patients should not deter consideration of this treatment option. In a separate article, Series again stresses the usefulness and importance of a pre operative cephalogram, because it can alert the surgeon about the presence of an airway bony abnormality so that he can give a cautious prognosis to the patient.

In selected patients, specific abnormalities such as a grossly deviated nasal septum or nasal polyposis may warrant referral to an oto rhino laryngologist.
for consideration of surgical treatment options. Furthermore, severe nasal mucosal congestion may impede nasal CPAP therapy or oral appliance therapy and should be addressed to enhance the efficacy of these treatments. Measures to relieve nasal congestion include nasal corticosteroids, oral non-sedating antihistamines and various surgical procedures such as cauterisation of the nasal turbinates, polypectomy, submucosal resection, turbinectomy and nasal septoplasty.

**Tonsillectomy and Adenoidectomy:**

Tonsillectomy and adenoidectomy (T&A) is the standard first-line treatment for childhood OSAS, resulting in a cure in the majority of patients. Suen 1995 Many will be adequately treated with adenotonsillectomy. In otherwise healthy children with adenotonsillar hypertrophy, polysomnographic resolution occurs in 75% to 100% after adenotonsillectomy. Marcus et al in 1994 measured the Pcrit values i.e. the critical nasal pressure at which the upper airway collapses, in three OSAS children. He found that Pcrit declined after adenotonsillectomy and adenoidectomy. Such laboratory improvements are reflected in subjective clinical improvement also. Generally, obese children have less satisfactory results.

Potential complications of adenotonsillectomy include haemorrhage, anesthetic complications and immediate postoperative pain. In addition, patients with OSAS may develop respiratory complications, such as worsening of OSAS or pulmonary edema, in the immediate postoperative period. Death in the immediate post operative period, attributable to respiratory complications has been reported in patients with severe OSAS. High-risk patients should be hospitalized overnight after surgery and monitored continuously with pulse oximetry.

In adults, adenotonsillar enlargement is occasionally the major cause of OSAHS. Verse and associates studied nine patients prospectively who underwent tonsillectomy as the sole treatment for OSAHS. Eight had a good response as measured by a reduction in AHI of >50% or to <20/hour postoperatively.

Inflammation of the tonsils and adenoids with subsequent obstructive hypertrophy is one of the most ancient and common paediatric problems.
Attempts at surgical treatment for tonsils have been documented throughout the past two thousand years (53). The frequency of adenotonsillectomy increased rapidly in the early part of the last century as the “focus of infection” theory attributed “rheumatism” and other systemic disorders to diseased tonsils and adenoids. Broad-scale surgery was performed on entire populations of school children. With the spontaneous decline of acute rheumatic fever in Western countries, introduction of antibiotics, and the falling incidence of chronic tonsillitis and its complications, surgery became less frequent, but is still the major ambulatory surgical procedure among children in the USA (53).

The reasons for the chronic recurrent course of an otherwise benign disease are poorly understood, purulent processes persist during asymptomatic periods of adenotonsillitis. Most bacteria involved in this process are covered by a thick inflammatory infiltrate, are deeply invading, or are located within macrophages. These bacteria were shielded either by inflammatory infiltrates that covered them or by lymphatic tissue that surrounded them, or were incorporated into macrophages and thus were not accessible for microbial diagnosis by swab. This shielding of bacterial biofilms could also be shown by electron microscopy, which may be responsible for the poor efficiency of antibiotics that leads to surgery (54).

Uvulectomy:

Ariyasu et al in 1995 did uvullectomy by snare in an office setting in 28 patients (55). Seventeen of them were followed up. The patients rated the benefit as somewhat beneficial, (a mean score 3.2 on a scale of 10, with 10 representing no snoring) 28 patients

Uvula palato pharyngo plasty (UPPP):

UPPP is a procedure that attempts to enlarge the retropalatal airway by excising the tonsils along with portions of the anterior and posterior tonsillar pillars and the free margin of the soft palate including the uvula, while preserving the function of the proximal palatal musculature. Uvulopalatopharyngoplasty (UPPP) which was first described by Ikematsu in 1952 (56) is the most common surgical intervention for the treatment of OSAHS. After Fujita et al reported (57-59) the improvement in
obstructive sleep apnea patients undergoing UPPP, this procedure has
became widely used for the treatment of apnea and snoring.

A meta-analysis of 37 papers published between 1966 and 1995 was
performed by Sher and associates (60). UPPP resulted in significant
reductions in the severity of OSAHS as measured by a decrease in the
respiratory disturbance index (RDI) of 38% weighted average (range -72%
to +12%). A higher baseline severity of OSAHS was associated with less
improvement after UPPP. A good response to UPPP, as defined by a 50%
decrease in RDI and a postoperative apnoea index of <10 and RDI <20, was
obtained in 41% of patients. Even among patients who were obstructed
exclusively at the level of the velopharynx, only 52% had a good response.
Some degree of velopharyngeal insufficiency may occur post operatively, in
up to 40% of patients. Postoperative upper airway obstruction has been
reported in 10% of patients and deaths have occurred. Velopharyngeal
stenosis has also been reported and may explain worsening OSAHS in some
patients following UPPP.

The reasons for the overall poor success rate of UPPP are unclear. The 95%
failure rate among patients with upper airway obstruction caudal to the
velopharynx suggests that persistent obstruction at this level is
responsible; but only 50% of patients with exclusively velopharyngeal
obstruction obtain a good response.

Surgical results of UPPP or uvulopalatal flap are considerably successful
for simple snoring. In contrast to simple snoring, OSAHS can not be
treated as successfully as snoring by the operations involving the soft
palate and pharynx. Obstruction at other sites not addressed by UPPP in
the upper airway (especially base of the tongue) may be the cause of the
poor response. Detecting collapsed or obstructed segments in the upper
airway is necessary in order to predict the success of the surgical
procedures for OSAHS.

In the technique described by Fujita (57), the patient undergoes a
tonsillectomy, which is followed by a partial removal of the soft palate,
uvula, and pharyngeal arches figure. Finally, the mucosal edges are
approximated with sutures. The procedure is performed under general
anesthesia. The intended effect is to lessen snoring by allowing more room
for airflow and by reducing vibratory tissue.
Early results indicated that UPPP was 75 to 100% effective in eliminating or significantly reducing snoring. This was most encouraging, but as these patients were followed, it became apparent that the long-term success rates were not as good, ranging from 46 to 73%. Kotecha et al (52) specifically addressed this change in patient satisfaction and found that 13% of patients who had “successful” outcomes within the first postoperative year subsequently developed a recurrence of their snoring. The reasons for this decline in efficacy are not entirely known. The decrease in long-term success rates might represent a true increase in the incidence of snoring, or it might merely be a reflection of inexact measurements. Unfortunately, there is no standard way to measure the intensity of a patient’s snoring. Nearly all researchers rely on the subjective assessment of the patient’s bed partner, and they use one of several scales to quantify the intensity of snoring. Attempts to objectively quantify intensity have met with only limited success). For now, snoring is “in the ears of the beholder,” because its capacity to irritate involves more than just decibels.

Another problem is that there is little agreement on what constitutes a successful outcome. Some authors define success as “improved to absent snoring,” while others call it “absent or markedly reduced snoring.” Using the former definition will interject bias into a study toward a better outcome, as is evident in the literature. Until these issues are resolved, it will remain difficult to quantify the true outcome of UPPP or any other snoring procedure.

Nonetheless, in the largest long-term UPPP study (61), by Hudgel et al conducted in 1988, only 46% of patients said that they had stopped snoring or that their snoring was markedly improved (i.e., their bed partner was infrequently awakened. There is little doubt that many UPPP patients do not obtain adequate relief of their snoring. In addition to relieving snoring, UPPP alleviates EDS. In one long-term study of 51 patients who initially complained of EDS, 73% later said that their EDS had been completely or markedly alleviated.

The most serious perioperative complication was a 2 to 11% incidence of postoperative airway obstruction that resulted in an approximately 1% perioperative mortality. One group reported a 5% incidence of difficult
intubation, but they correlated that incidence to the severity of OSAS. Postoperative bleeding serious enough to require a return to the operating room occurred in 2 to 5% of cases. Clinical experience indicates that UPPP is often complicated by severe postoperative pain. The most common long-term complications are velopharyngeal incompetence (VPI) and palatal dryness. Temporary postoperative VPI occurs in most patients, and studies have reported that 10 to 24% of patients continued to complain of intermittent nasopharyngeal regurgitation 1 year after surgery. In the same studies, up to 31% of patients complained of persistent palatal dryness. Less frequent long-term complications include nasopharyngeal stenosis, long-term voice changes, and a partial loss of taste. In addition to all its limitations, UPPP is expensive.

**Fig I (7). Uvulo pharyngo plasty and Laser assisted uvulo plasty**

**Laser assisted uvulo palato plasty (LAUP):**

Laser assisted uvulopalatoplasty (LAUP) is a modification of the UPPP procedure that results in a less radical resection of palatal tissue. A carbon dioxide laser is employed to vaporise the uvula and free margin of the soft palate. LAUP is performed as a one stage or multi stage procedure under local anaesthetic in the surgeon's office. Originally introduced for the treatment of snoring, LAUP increasingly gained popularity in the treatment of patients with OSAHS. Roughly half of the patients were satisfied with the LAUP treatment. The long term results of LAUP have not been defined.
but there are some data to suggest that short term improvements are not maintained over time. Adverse effects include postoperative pain, velopharyngeal insufficiency, dysphagia, and a sensation of dry throat. The development of postoperative upper airway oedema and narrowing has raised concerns about the advisability of performing LAUP as an outpatient procedure for OSAHS. Practice parameters issued by the Standards of Practice Committee of the American Academy of Sleep Medicine advise that LAUP is not recommended for the treatment of sleep related breathing disorders.

**Other palatal procedures:**

Various other procedures designed to stiffen or ablate palatal tissue have been described including laser palatoplasty, using a Nd YAG laser, cautery assisted palatal stiffening operation (CAPSO), and radiofrequency ablation. These procedures are intended for the treatment of snoring and are not indicated for the treatment of OSAHS.

Fig I (8). Cautery assisted stiffening operation and radio frequency stiffening.
Maxillary, mandibular and hyoid advancement:

The limited efficacy of UPPP prompted the development of surgical procedures directed at relieving upper airway compromise distal to the velopharynx in the retroglossal oropharynx and hypopharynx. These procedures—which include inferior sagittal mandibular osteotomy with genioglossus advancement, hyoid myotomy and hyothyroidopexy; total subapical mandibular osteotomy; bilateral sagittal split mandibular osteotomy; and Le Fort I maxillary osteotomy—are performed in various combinations and are designed to advance the ventral wall of the pharynx. Maxillary advancement appears to facilitate a greater degree of mandibular advancement and, in addition, may increase the calibre of the velopharynx. Coordination of care between surgeon and orthodontist is important to ensure satisfactory dental occlusion postoperatively. It is generally accepted that the choice of surgical intervention should be based on the location of upper airway compromise as determined by such procedures as lateral cephalometry and fibreoptic nasopharyngoscopy. A staged surgical approach has been advocated to avoid the more invasive and complex procedures where possible, but there is not general agreement on the necessity of this strategy.

Fujita used fibreoptic endoscopy and lateral cephalometry were used to classify the sites of upper airway compromise into type I (retropalatal), type II (retro palatal and retrolingual), and type III (retrolingual) obstruction, respectively. Different combinations of surgical approaches are indicated for the different types. In a prospective study of 34 consecutive patients, the most commonly performed procedure was uvulopalatopharyngoplasty (UPPP) combined with radiofrequency tongue base reduction. All patients achieved reduction in apnea hypopnea index and improvement in clinical symptoms (62).

Li et al reported (63) the results of a two phase surgical approach in 306 patients. Stage I procedures included UPPP for retropalatal narrowing and inferior sagittal mandibular osteotomy with genioglossus advancement and hyoid myotomy and suspension for retroglossal obstruction.

Patients who failed to respond adequately to stage I procedures, as determined by polysomnography at least 6 months postoperatively, were offered the stage II procedure consisting of maxillomandibular
advancement. Other groups have employed maxillomandibular and hyoid advancement as the primary surgical approach. Interpretation and comparison of the results of these studies is problematic because of considerable heterogeneity within and between studies in the patient selection criteria, previous or concomitant surgical procedures, polysomnographic techniques, confounding variables such as postoperative weight loss, and definitions of a good response.

Good response rates to stage I surgical procedures ranged between 23% and 67%. Stage II procedures yielded good response rates of 75-100% whether as primary treatment or following stage I surgery. The more recent results suggest that the staged approach may not be warranted, with some investigators advocating that maxillomandibular advancement be performed as the primary surgical treatment. It remains unclear which patients are most suitable for this treatment approach. Limited long term follow up data suggest that good response rates of 80% are sustained up to 2 years postoperatively.

Complications of stage I surgery include anaesthesia of the lower lip in most patients, tooth injury, wound infection, and upper airway obstruction in the early postoperative period. Anaesthesia of the cheek, lower lip and chin are also common after stage II procedures. Velopharyngeal insufficiency occurs commonly in those who have had a previous UPPP. Speech difficulties are relatively common and a change in facial appearance is to be anticipated. Convalescence after maxillo mandibular advancement is difficult and the average time off work is ten weeks.

**Tongue base surgery**

Various procedures have been developed to remove excess lingual tissue and increase the calibre of the retrolingual oropharynx. These include glossoplasty, laser midline glossectomy, radiofrequency tissue ablation, lingual plasty and tongue base suspension. These are sometimes incorporated into the stage I surgery outlined above (64). In a prospective study of 34 consecutive patients by Friedman, Darius, Vidyasagar et al (65), the most commonly performed procedure was uvulopalatopharyngoplasty (UPPP) combined with radiofrequency tongue base reduction. All patients achieved reduction in apnea hypopnea index and improvement in clinical symptoms.
Woodson and colleagues recently reported a randomised controlled trial comparing temperature controlled radiofrequency tissue ablation (TCRFTA) of the tongue and soft palate with sham placebo surgery and nasal CPAP therapy in patients with mild to moderate OSA. Effects sizes were small to moderate but felt to be clinically important. Compared with baseline, TCRFTA improved reaction time, disease specific quality of life, and subjective sleepiness. CPAP improved quality of life and sleepiness. There were no differences in outcomes between TCRFTA and CPAP. Compared with sham surgery, TCRFTA increased airway volume, reduced apnoea severity, and improved quality of life. The investigators concluded that TCRFTA and CPAP produce comparable improvements in quality of life in patients with mild to moderate OSAHS.

Tracheostomy

Tracheostomy is the only surgical procedure that is consistently effective in relieving OSAHS. It provides an airway below the level of the obstruction, often results in immediate relief of symptoms. Life threatening findings such as severe somnolence (drowsiness) and notable cardiac dysrhythmias can have remarkable improvement in symptoms. Polysomnography revealed apnea indices within normal limits and total disappearance of cardiac arrhythmias. Additional benefits include resolution of chronic hypercapnic respiratory failure and cor pulmonale, and improvements in systemic hypertension and cardiac dysrhythmias. Central apnoeas, probably caused by unstable control of breathing, may persist after tracheostomy, but eventually resolve within 6 months. The major drawbacks of tracheostomy are the cosmetic effect and its associated psychosocial morbidity.
Chapter II

Review of literature on snoring and sleep apnoea

Ancient literature
Early scientific literature
Global studies of Prevalence at the global level
Indian studies of Prevalence
Clinical methods
Questionnaires and other tools

Ancient historical notes:

Sleep disorders are not new diseases. They have existed since ancient times. It is remarkable to note that a field as important as this has developed only since the last four decades. However, it is equally remarkable that our ancients had crystal concepts about this field.

In the hoary past of ancient India, the Upanishads and Vedas reveal remarkable concepts about sleep and wakefulness (66). Katha Upanishad compares the human body to a chariot, where 'Jeeva athma' (self) is the owner, intellect is the driver, 'indriyas' (senses) are the horses and 'manas' is the bridle. Three ordinary states of existence are mentioned as Jagrata (wakeful state), Swapna (dreaming state) and Susupti (deeply asleep). These three states are caused by corresponding dispositions of mana. They are analysed in great detail in Mandukya Upanishad and in Brhadaranyaka Upanishad. Later day saints like Gaud Padarcharya and Adi Sankaracharya also have given detailed commentaries on these original vedic texts.
Table II(1). Vedantic analysis of the three states of consciousness.

<table>
<thead>
<tr>
<th>State</th>
<th>Part which is active</th>
<th>Part which is withdrawn</th>
<th>Part which is dominant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Awake ‘Jagrata’</td>
<td>Intellect &amp; senses</td>
<td>None</td>
<td>Intellect</td>
</tr>
<tr>
<td></td>
<td>Manas</td>
<td>Ahamkara</td>
<td></td>
</tr>
<tr>
<td>Dreaming ‘Svapna’</td>
<td>Manas</td>
<td>Intellect &amp; senses</td>
<td>Manas</td>
</tr>
<tr>
<td></td>
<td>Ahamkara</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep sleep ‘Susupti’</td>
<td>Ahamkara</td>
<td>Intellect &amp; senses</td>
<td>Ahamkara</td>
</tr>
<tr>
<td></td>
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</table>

A fourth state, called ‘turiya’, is also discerned by our sages. This is an extraordinary state, which can be attained by a yogi through practice of meditation. In later day scriptures, this state is also termed ‘Siddhi’.

Such philosophies are found in Greek and Roman history also. Theories about the function of sleep and dreaming have been with us since the beginning of recorded history. A lot of information about snoring in the ancient world could be gained by reading the article ‘Schnarchen in der Antike’ written by Albert Esser (1885-1972), who was a Professor of History of Medicine in Dusseldorf, Germany and published in Germany’s leading journal for history of medicine, Sudhoffs Archiv fur Geschichte der Medizin und Naturwissenschaften, in 1941. An English translation by Kerstin Jacob had been published in the journal 'Sleep and Breathing' in 2002, under the title 'Snoring in the ancient world'. Esser enumerates several ancient Greek and Roman writings and concludes that they considered that snoring to be a proof of sleep. In addition, they were also aware that the sounds similar to snoring can be produced during wakefulness due to obstruction to breathing.

Empedocles (c. 490–430 BC), described sleep as occurring from a moderate cooling of heat in the blood, with death being the result of a total cooling. A similar ‘cooling’ hypothesis for sleep was also ascribed to Parmenides. Leucippus, the first ‘atomist’ and the teacher of Democritus, described
sleep as something that happened to the body, and not the soul, and which occurred when ‘the excretion of fine textured atoms exceeds the accretion of psychic warmth’ (67).

The ancients also had fairly clear concepts about obstructive sleep apnoea also. Descriptions of conditions, remarkably similar to Pickwickian syndrome have existed for several years. Dionysius of Heracleia (born 360 BC) was described by Athenaeus as “an unusually fat man, always sleepy, difficult to arouse and had problems breathing during sleep, so that his physicians prescribed fine needles, long enough that they thrust through his ribs and belly when he happened to fall into a very deep sleep”.

Early scientific literature:

Relatively recently, in 1899, writing in the prestigious British Medical Journal, Hill makes an observation (68, 18) that ‘the stupid-lazy child, who frequently suffers from headaches at school, breathes through his mouth instead of his nose, snores and is restless at night, and wakes up with a dry mouth in the morning, is well-worthy of the solicitous attention of the school medical officer’.

And the most well known historical account is by Charles Dickens, who in 1935, caricatured (69) Little Fat Joe, who falls asleep behind the wheels (reins) of his horse drawn coach. Burwell et al in 1956 coined the term Pickwickian syndrome after the somnolent boy Joe from the Pickwick Papers (70). Of course, it is the graphic narration by Charles Dickens, in the Pickwick Papers, which excels every other description till today. However, his interest was purely literary.

Before the 1960s there were occasional reports in the medical literature of cases which in retrospect were probably OSAS, but it was not until 1966 that obstructive sleep apnoea was clearly documented. The sleep apnoea syndrome was described independently by two European research groups in 1965. Gastaut et al (71) in France and Jung and Kuhlo in Germany, both reported their findings of the Pickwickian syndrome of sleep apnoea (72).

In 1966, Gastaut, Tassinari and Duron (73) performed clinical sleep investigations in a large series of patients. They described the sleep apnoea syndrome in obese and non obese patients and also showed a
correlation with cardiovascular diseases and identified snoring and hypersomnolence as diagnostic indicators.

The earliest scientific definition and foundation for obstructive sleep were laid by Guilleminault et al in 1973, through his classic paper (74) in the prestigious journal, Science, titled ‘Insomnia with sleep apnea: a new syndrome’. It was he who defined apnoea by the duration and type and also introduced the concept of Apnoea Index. Much later Gould et al documented the relationship between daytime somnolence and nocturnal sleep fragmentations caused by OSA (75).

Literature on prevalence:

Understanding the prevalence of a disease i.e. the proportion of a population with the condition, is critical to anticipate the health care needs and allocating appropriate resources. In addition, comparisons of prevalences by demographic factors may yield etiological clues and identify sub groups at particularly high risk for targeted case finding. (76).

Snoring is a common complaint, the prevalence of which has been documented to be anything from 24% to 50% of males (77). It is quite surprising that such a common conditions as snoring and sleep apnoea have received a belated attention. The reason for this could be the public perception that snoring is a benign condition. The prevalence of OSAS is not well established in many countries and only a few studies have been performed in large, non-selected populations, chiefly in the USA. These studies, namely Young et al 1993, Young et al 1997, Young Shahar et al 2002, Netzer et al 2003, are considered to be the landmark studies (78,8).

Various studies as given below, have reported community prevalences of habitual snoring in adults to be about 11-15%. About 30-50% of adult habitual snorers (Cirignotta 1996) are estimated to have the sleep apnoea/hypopnoea syndrome (SAHS), which is estimated to occur in 2-4% of the general population (Lavie 1983).

In Warsaw, Poland, Plywaczewski et al studied 676 subjects (356 males and 320 females) in Warsaw (mean age 56.6. +/- 8.2 years, range 41 - 72 years). There were 284 (42%) habitual snorers, 221 (32.7%) moderate snorers and 171 (25.3%) non-snorers. The prevalence of habitual snoring
was significantly higher in males than females (48 and 35.3%, respectively. EDS was found in 109 subjects (16.1%). It was more frequent in males (78 subjects: 21.9%) than in females (31 subjects: 9.7%). In the group as a whole the ESS score was within the normal range, 6.4 ± 3.9 points. Scores for the ESS were higher in males when compared with females (7.1 ± 4 and 5.5 ± 3.5, respectively). In neither sex was there any difference in the ESS score across the age groups (79).

Gradually, it came to be recognized that snoring is not a benign condition. It may not only presage OSA, but also may endanger health of an individual by itself.

The classical study by Young and his co workers in 1993, places the prevalence of obstructive sleep apnea at 4% in men and 2% in women. They studied the prevalence of snoring and sleep apnoea (1993 Wisconsin study) in a random sample of 1,255 employed people 30-60 yr old and found that 9% of women and 24% of men met minimal criteria for OSAH, and when results were extrapolated to the general population, it was estimated that 2% of women and 4% of men had OSAH syndrome. This landmark study was quickly followed by several other studies. In the last three decades, increased access to reliable monitoring equipment like EEG, pulse oxymeters, etc., had spurred several studies around the world (80).

In 2002, the same pioneering group of Young and others studied 5615 subjects aged 40–98 years (mean age 63.5 ± 10.7 years) as part of their Sleep heart Health Study. In that study, SDB (AHI ≥ 15) was diagnosed in 18% of subjects (25% of males and 11% of females). They found that habitual snoring was an important risk factor for SDB along with obesity, Waist hip ratio and a greater neck circumference (76).

An undercurrent in all the studies, done in various parts of the world, including in non whites, is a similarly high prevalence of snoring and sleep apnoea. An appropriate interpretation of the literature depends critically on whether the population is a community sample or is drawn from the highly selected symptomatic individuals who attend sleep clinics. However, lack of standard terminology and a well founded recognition of ethnic differences of morphological, cultural and sociological features, precludes any worthwhile extrapolation of data from one part to other parts of the world (8).
Even with all these studies, taken into reckoning, there is a paucity of data characterizing the epidemiology of OSA in populations other than middle-aged or older white men, and few studies have focused on young adults, women, or patients of African or Asian descent (78). Of course, in the few studies that have been done, the ethnic differences are markedly seen.

In community studies in the USA the prevalence of OSA in the black population is at least as high as in the white population after controlling for obesity (8). In individuals of Chinese and other Far Eastern origin, BMI appears to be relatively less important and variations in craniofacial bony structure more relevant. Consequently, in these countries many individuals have severe OSAS with relatively normal or only mildly increased, body weight. Similarly, in Polynesian men in New Zealand, variations in the craniofacial skeleton have a major contributory effect and may interact with obesity.

Ng et al investigated in 1988, the prevalence of snoring and symptoms of sleep breathing-related disorders in the multi-ethnic population of Singapore (3 million people, comprising 75% Chinese, 15% Malay and 7% Indian). The sample consisted of 2298 adults aged 20–74 yrs, with approximately equal numbers of Chinese, Malay and Indian and in each 10 yr age group. A questionnaire was used to record symptoms of snoring and breathing disturbances during sleep. The prevalence of snoring was found to be 6.8% (95% CI was 5.3–8.3). Marked ethnic differences in snoring and sleep breathing-related disorders were observed in Chinese, Malays and Indians in this study. The prevalences were Chinese, 6.2% (4.4–8.1); Malay, 8.1% (6.1-10.2) and Indian, 10.9% (8.5-13.4). The ethnic differences in sleep breathing symptoms paralleled the differences in body mass index, neck circumference and hypertension.

Ip et al. (2001) assessed SDB in middle-aged 1542 Chinese men in the age range 30– 60 years. 784 persons responded. Full PSG was performed in 150 respondents. OSAS (AHI ≥ 5, ≥ 10 or ≥ 15 and excessive daytime sleepiness) was confirmed in 4.1, 3.2 and 3.1%, respectively. Independent predictors of SDB were BMI, habitual snoring, time taken to fall asleep and age. Chinese males were younger (mean age 41 years), had normal body weight (BMI 23.9 kg m). And the percentage of habitual snores was smaller.
(23%) when compared with our data (respectively, 57 ± 8.2 years, 28.5 ± 4.3 kg m)², 48% of habitual snorers (81).

Three years later, Ip et al. (2004) published the results of SDB prevalence in 1532 Chinese women aged 30–60 years. 854 persons returned the questionnaires. Full PSG was performed in 106 respondents. SDB (AHI ≥ 5) and OSAS (AHI ≥ 5 and EDS) were found in 3.7 and 2.1%, respectively. The authors described a 12-fold increase of SDB prevalence from the fourth and sixth decades of life. BMI and age were identified as significant independent predictors of SDB. Chinese females were younger, thin and only 15% of them were classified as habitual snorers. These factors explain the lower incidence of SDB in the aforementioned group (82).

Kim et al. (2004) performed polysomnography in 457 Korean males and females randomly allocated from an initial cohort of 5020 participants between 40 and 69 years. The prevalence of SDB (AHI ≥ 5) was 27% in males and 16% in females (results similar to our data). The incidence of OSAS (AHI ≥ 5 and EDS) was 4.5% in males and 3.2% in females (lower than in our subjects). BMI, sex and hypertension were associated with the risk of SDB in a middle-aged Korean population. Smaller BMI, younger age, lower occurrence of habitual snoring (21.9% in males and 12.5% in females) and ethnic factors may explain the differences between the Korean and Polish studies (83).

In a questionnaire survey of 111 young medical students in Pakistan (M: F=2:3, age range 18-23 years), Pasha and Khan, the frequency of snoring was 27% in males and 12% in females, with males admitting to snoring more nights in the week than the females. 92% of both males and females graded their snoring as being softer than the sound of talking. 15% of the males and 38% of the females said they snored in every body position. Percentages of male and female snorers exhibiting symptoms of sleep apnea were very similar, with choking arousals at 6% and 5% respectively. These results are similar to studies done on the adult population with snoring more common and louder among the males (84).

Habitual snorers also were known to often experience the effects of chronic sleep disruption, manifesting as excessive daytime somnolence, automatic behaviour and cognitive and affective impairment (85).
The studies by Ip et al (81, 82) among the Chinese men and women indicate that OSA may occur with a similar prevalence in a cohort of non obese subjects, as the mean BMI for this study cohort was only 23.9 kg/m².

The actual figures of OSA around the world have been around 4% in men and 2% in the women. However, depending on the methods employed, several biases had crept in. For instance, in a community study by Olson and others conducted a study of the prevalence of sleep-disordered breathing in subjects derived from a random sample of the population, in the New South Wales in Australia. A total of 2,202 subjects 35 to 69 yr of age were requested to take part in the study. Of them, only 441 accepted. A majority of the persons responding happened to be snorers (368 snorers and 73 non snorers). Thus, the sample was biased in favor of snorers. Fifty-six percent of the subjects were men. Each subject answered a questionnaire concerning their sleep symptoms, general health, and habits such as alcohol consumption, and they underwent monitoring to ascertain the presence of sleep disordered breathing (86).

Of the 441 subjects 79 (17.9%) had SDB. Thus, the prevalence of SDB in this population sample was therefore estimated by the authors to be at least 3.6% (79 of 2,204). The minimum prevalence in men was 5.7%, and in women it was 1.2%. In this study, the independent predictors of SDB among snorers were age and neck circumference.

The authors noted that 289 of the total 368 snorers had RDI less than 15. Logistic regression identified only male sex as an independent predictor of snoring without SDB. Body mass index and alcohol consumption were not significant predictors of snoring, in that study. Six non snorers were found to have SDB. However, in the interpretation of this sample, it should be kept in mind that the sample is a biased one with more number of snorers. With this reservation in mind, it should be noted that a majority of snorers had SDB also.
Natural history of snoring:

The natural history of had been studied only a few researchers. Three independent research teams seized rare opportunities afforded by longitudinal studies for general health, to study the natural history of snoring.

As part of their uniquely longitudinal Busselton Health study in Melbourne, Australia, Matthew and his colleagues found that out of 967 adults, aged 25 to 74 years, who reported no snoring in 1981, thirteen percent (13%) had become habitual snorers in 1994 - 95. By logistic regression, this study confirmed male gender, obesity, and weight gain as key determinants of habitual snoring, and also indicated that development of asthma and taking up smoking also play a role. They recommended lifestyle preventive strategies like maintaining a healthy weight and not smoking in order to reduce the risk of sleep-disordered breathing and its sequelae.(87, 88).

In 1989-90, a survey of the prevalence of snoring and related symptoms in 782 children aged 4-5 years, was carried out, in Oxford, England, by Ali et al (89). Two years later, in 1992, the same group of children was studied to gather information on the natural history of snoring and the related behaviour problems. A total of 507/782 (64.8%) completed questionnaires were received. Comparison of the responses with the 1989-90 survey showed the overall prevalence of habitual snoring did not change between the two surveys (12.1% in 1989-90 v 11.4% in 1992).

Lindberg et al also showed in a questionnaire based epidemiology study in 2668 men that over 10 years snoring increased from 15% to 20% and that weight gain was an important predictor of this increased prevalence (90).

Epidemiological studies in the general population detect many subjects with periods of apnoea during sleep but no symptoms. Despite the growing awareness about the harmful effects of OSA, Young, Bluestein and Fin in 1997, estimated that 93% of women and 82% of men with moderate to severe OSA remain undiagnosed. (91)
Prevalence studies in India

In hospital based study of 658 male subjects, who had come for a regular health check to a hospital, in 1999-2000, Udwadia and colleagues (92) found a prevalence of 19.5 % of OSAS. Multiple stepwise logistic regression analysis determined that BMI, neck circumference and history of diabetes mellitus as the principal covariates of SDB. The presence of snoring, nocturnal choking, unrefreshing sleep, recurrent awakenings from sleep, daytime hyper somnolence and daytime fatigue were each statistically significant for identifying patients with OSA. This higher prevalence is striking and may have major public health implications in our developing country.

In the year 2000, twenty patients attending the sleep disorders unit at the Neurology department of the All India Institute of Medical Sciences, New Delhi were studied by Pradeep Kumar et al in 2000 () with questionnaires, Epworth Sleepiness Scale (ESS), anthropometry, ENT examination, chest x rays and biochemical tests. Forty of their relatives formed age and gender matched controls. This study group found that patients with OSA had significantly higher BMI and hypertension and were more likely to have road accidents.

In a hospital based study in 2001, Hyderabad, Kaul et al (94) reported that out of a total 12,000 neurology patients seen in two years, 60 had primary sleep disturbances. All of them underwent PSG studies. Eight patients i.e. 13 % had sleep apnoea. Of these eight patients, five had obstructive sleep apnoea, three had mixed sleep apnoea and none had pure central apnoea syndrome. Three fourth of the eight patients were middle aged males and had obesity (mean weight 82 Kg). All of them had excessive daytime sleepiness and had snoring. The symptom severity was found to correspond directly with duration of symptoms as well as obesity.

In 2006, Bhatia et al studied 300 obese (BMI >25 Kg per m²) males and females, attending a slimming clinic and found that 49 persons (16%) had habitual snoring. Age, gender, nocturia, presence of arthritis, smoking and family history of snoring were risk factors for snoring (95).

A community based study was done by Balakrishnan et al, in 2003, in the metropolitan city of Chennai (96). Visitors of all ages to a medical
exhibition constituted the study population. Of a total of 1133 recruited to
the study, 58 were excluded from the study because they were less than
two years of age. Each of them filled a simple questionnaire with assistance
from the study team. Physical parameters like age, height and weight were
recorded. Their economic levels were defined using simple criteria. The
over all prevalence of snoring was 19.5 %. Across the age groups, the male
gender and affluence had a positive association with snoring. The BMI
increased the snoring prevalence only in the adults. A history of sore
throat was positively associated with snoring in children less than 12 years
of age only. This survey broadly indicates the profile of snorers in this part
of the country.

In another study done in Delhi recently by Vijayan et al (97), out of about
15,000 people screened, a good 14 per cent were found to be “regular
snorers” — people snoring for a minimum three to five nights a week.
Among snorers, 4.4 per cent men and 2.5 per cent women in urban Delhi
were found to be suffering from OSA. In rural Delhi, prevalence of OSA
was found to be higher: 6.6 per cent among men and 4 per cent among
women. Persons having obesity, hypertension, diabetes and old age were
more likely to snore. The most vulnerable age group, however, is those in
the bracket of 41-60 years. In urban Delhi, for example, 18 percent of
people in this age group were found to be snoring. A good 21 per cent of
male snorers and 11 per cent of female snorers in the same age group also
suffer from excessive daytime sleepiness in rural Delhi. In urban Delhi, the
numbers are much lower: 11 per cent men and 7 per cent women were found
to be afflicted with snoring and daytime drowsiness. The study is yet to be
published and was funded by the Department of Science and Technology,
Government of India. It recommended that snoring be considered a
“serious public health concern” in Delhi.

Thus, in India, many studies done, so far, have focused on specific groups
and community studies are very few. Hence, there is a need for data from
the general population. Such data will be of use in diagnosis and
management of SDB.
Snoring in children

Lerman in 2006 (18) found that Snoring occurs in children with a prevalence between 3% and 20%. Primary snoring is regarded as a benign condition. It resolves in 50% of children over time, although in a minority, about 10%, it progresses to OSA.

In a longitudinal study, Ali et al (89) noted that half of the children who snored at 4-5 years of age stopped snoring by 7 years without intervention. Children who snored exhibited more hyperactivity, daytime somnolence, and restless sleep than those who did not.

We now know that snoring occurs far more commonly in children than previously appreciated. Although, if snoring occurs in isolation, it is not likely to be of clinical significance. On the other hand, snoring that is complicated by clinical manifestations, such as poor school performance, cognitive impairment, and behavior problems, may signify a forme fruste of OSA that may continue to adulthood. In both cases, T&A appears to be salutory for children who snore and exhibit clinical manifestations of increased airway resistance. The prevalence of UARS in children is unknown. The demography of UARS in adults points to a preponderance in women versus men, snoring at night, and frequent and repeated micro arousals from sleep. These patients have neither obstructive breathing nor nighttime hemoglobin desaturation. In the past, children who snored and exhibited manifestations of cardiovascular or neurobehavioral changes were diagnosed with OSA, and very few were diagnosed with UARS. This trend appears to be changing.

The prevalence of OSA in children is approximately 1-3% in all age groups. Of the three types of sleep apnea, obstructive is the most common type, comprising 85% of the apneas, with the remainder being central, 10%, and mixed, 5%, in origin. The prevalence of OSA is said to be increasing, perhaps as a result of a decrease in the number of T&A surgeries performed in the past decade as well as the increased survival of children with congenital malformations that are associated with OSA. The peak prevalence of OSA in children occurs in those 3-6 years of age. At this age, children have the greatest amount of lymphoid tissue in their upper airways relative to the dimensions of the airways. The degree of collapsibility of their upper airway may also be increased. Children with
craniofacial anomalies (associated with maxillary and mandibular hypoplasia, macro glossia), hypotonia, and a variety of other disorders (cerebral palsy and post-pharyngeal flap) are at risk for upper airway collapse because of narrow upper airway passages or poor muscle tone in the upper airway. These findings decrease the dimensions of the patent upper airway in children and increase the propensity for OSA.

Several salient differences between the features in children and adults are noteworthy. Gender prevalence is equal; failure to thrive is the most common complaint; and excessive daytime somnolence is uncommon in children with OSA. BMI, in the studies done so far, does not show much significance. But, recently, a trend of increasing prevalence of snoring is seen. Obesity, which is a growing epidemic in childhood afflicting 16% of children today, may be responsible for the increasing prevalence of children with OSA.

Snoring and OSA are also common in children with neuromuscular disorders, including Down syndrome, achondroplasia, Arnold-Chiari, and myelomeningocele. The combination of lymphoid accumulation in a small hypopharynx, defects in the upper airway anatomy, loss of airway muscle tone, and control combined with sleep disturbances place the child at high risk for OSA.

In 1989-90 a survey of the prevalence of snoring and related symptoms in 782 children aged 4-5 years, was carried out, in Oxford, England, by Ali et al (89). Two years later, in 1992, the same children were studied to gather information on the natural history of snoring and the related behaviour problems. A total of 507/782 (64.8%) completed questionnaires were received. Comparison of the responses with the 1989-90 survey showed the overall prevalence of habitual snoring did not change between the two surveys (12.1% in 1989-90 v 11.4% in 1992).

Primary Snoring affects up to 12% young children. In contrast, SDB with associated apneas or hypopneas i.e. manifest OSA affects only 1 - 3% of children and is called OSAS. (98). Because, OSAS and PS can not be distinguished without PSG, the broader term SDB is more relevant to every day practice (99).
Urschitz et al (101-103) found that habitual snoring was significantly associated with hyperactive (odds ratio 2.4) and inattentive behavior (odds ratio 4.0). Neuropsychological deficits may be more common among children with obstructive sleep apnoea but that does not prove how many of these deficits are caused by sleep apnoea. Muscular hypotonia and dyscoordination are common among children with neuropsychiatric disabilities, and can cause snoring and obstructive sleep apnoea. Also, Reimer in 2005 (103) remarks about both snoring and neuropsychological deficits existing together; but he specifically says that coexistence does not mean a cause and effect relationship.

Most, but not all, of the episodes of OSA in children occur during REM sleep. During this period, upper airway and intercostal muscle tone is reduced. With this loss of tone, airway collapse is exaggerated and airway obstruction can occur. During these episodes of airway obstruction, micro arousals from sleep occur frequently. Despite this, however, the proportion of REM sleep in children with OSA is unchanged compared with that in children without OSA. Whether these micro arousals terminate the obstruction in children as they do in adults remains controversial.11 Furthermore, whether these micro arousals are responsible for the altered neurobehavioral or cognitive activity also remains controversial. Recent radiographic studies have shed new light on the sites of airway obstruction in SDB.

The sites of increased airway resistance and airway obstruction in OSA include antero-posterior opposition of the tongue to the pharyngeal wall, posterior displacement of the soft palate by the tongue against the posterior pharyngeal wall, and opposition of the lateral pharyngeal walls. Together, these changes close the pharynx in a circular pattern, thereby increasing upper airway resistance. Cross-sectional CT scans of the head and neck of children with and without OSA show thickening and elongation of the soft palate, hypertrophy of the retropharyngeal wall, glossoptosis, and encroachment of the insertion of the tongue onto the epiglottis.

In a very elegant MRI study using subtraction imaging, Schwab et al. (104, 105) compared and contrasted the retro palatal and retro glottic dimensions in obese adults (BMI 32.5 kg/m2) with and without OSA. The findings corroborate many of those reported previously with CT scanning and extend some of the previous observations with additional detail. For
example, the retro palatal dimensions in the adult with OSA are narrowed by approximately 80% and lengthened when compared with the non-OSA adult. Similarly, the retro glottic dimensions with OSA are narrowed superiorly and extended rostrally compared with the non-OSA adult.

The sizes of the tongue, soft palate, and lateral pharyngeal walls are larger in the OSA adult compared with the non-OSA adult. These MRI findings validate the severity of the upper airway narrowing that occurs in patients with OSA and that leads to the pathological changes in the cardio respiratory and neurobehavioral systems.

Much of the airway obstruction described above is compounded by lymphoid hypertrophy, which often occurs in preschool age children who have repeat throat infections. Tonsillar and adenoidal hypertrophy may become so severe that the tonsils appear as a single mass behind the soft palate. Gozal remarks that sleep Disordered Breathing caused by enlarged tonsils or adenoids is common in early childhood (106, 107).

The enlargement of adenoids can not be easily ascertained during clinical examination. Hence, resort is often made to radiology. A lateral view of skull with soft tissue exposure parameters is done and the encroachment of the adenoids is visualised. Xu et al (108), in a 2006 study, analysed the upper airway narrowing due to adenoidal hypertrophy, simply as a binary variable, using Adenoid Nasopharyngeal Ratio of 0.5 as the cut-off point. For the sake of reliability and reproducibility, the radiologist categorized adenoid enlargement with adenoidal-nasopharyngeal ratio (ANR) < 0.5 as normal or mild and adenoid enlargement with ANR > 0.5 as moderately or severely enlarged adenoid. They found a good correlation between the size of the adenoids and the upper airway obstruction found by poly somnography.

Bitar used a much simpler method. A lateral nasopharyngeal X-ray was taken in the erect position, with the mouth closed and the palatal airway was evaluated. The obstruction was considered mild if < 50% of the palatal airway was obstructed, moderate if more than 50% was obstructed, but with still well delineated air column and severe when the air column was thin or absent. Bitar had also devised a clinical scale to record the size of the adenoids, as seen in the operating table. The degree of obstruction was assessed using a laryngeal mirror, intra-operatively, following a 3-grade
scale. The scale relied on dividing the posterior choanae into three thirds: less than 50%, 50–75% and more than 75% obstructed. This scale had been used by others also and is called the Bitar scale (109).

Reversibility of the impairments after intervention:

Guilleminault et al. investigated 25 children who snored heavily and who also suffered from daytime somnolence and lethargy. Neither night time hemoglobin desaturation nor OSA was present. After these children underwent T&A, their daytime sleepiness and lethargy either disappeared or were attenuated (110).

Gozal noted that first grade students who performed poorly in school were more likely to snore at night and exhibit episodic hypoxemia at night. He also noted that T&A significantly improved their performance in school (106, 107). However, this is a reversible complication as weight loss attenuates or eliminates the symptoms of OSA in the morbidly obese.

Questionnaires:

Several patients have difficulty in articulating their clinical history. One way of getting comprehensive history in a short time is to employ questionnaires. Questionnaire sets have been devised for ascertaining the presence of snoring, OSA, and co morbid features. Several validated questionnaire instruments are already available and have, indeed, been found to have good reliability.

Early questionnaire on EDS by Lavie:

Lavie conducted two studies (111, 112) on industrial workers in Israel, in the eighties. The study population consisted of 1502 workers (84% males and 16% females). 18.5 percent admitted to snoring. 16.4 % of the workers had the habit of taking regular afternoon naps. But, a striking feature was that 15% reported involuntary somnolence under various conditions. Of these workers, 3.5% reported snoozing during work breaks and 2.6% admitted that they had to stop work working for a short nap. At that period, the Epworth Sleepiness Scale had not yet been formulated; however, Lavie had devised a scale of his own with strikingly similar questions with closed responses of never, seldom, many times and always. His study showed that
many workers had a tendency to fall asleep in passive and less demanding activities: watching TV (30.6%), traveling (16.9%), reading (14.5%), at movies and plays (5%), and during lectures (3.4%) and while visiting friends (1.1%). A total of 119 workers (103 males and 16 females) reported falling asleep 'always' or 'many times' in at least two of the above six activities. Of these 119 persons, 35 reported a more severe form: 33 males and 2 females reported falling asleep in at least three activities. From this study, it was evident that the prevalence of snoring, sleep apnoea and excessive daytime sleepiness were quite high in the shift workers.

Table II (2). The responses of 1502 workers in the study by Lavie 1981, to the question 'Do you sleep while doing any of the following?'

<table>
<thead>
<tr>
<th>Item</th>
<th>Percentage of workers, responding</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Never &amp; seldom</td>
</tr>
<tr>
<td>1. Watching TV</td>
<td>69.4</td>
</tr>
<tr>
<td>2. Traveling</td>
<td>83.1</td>
</tr>
<tr>
<td>3. Reading</td>
<td>85.5</td>
</tr>
<tr>
<td>4. Movies and plays</td>
<td>95</td>
</tr>
<tr>
<td>5. Lectures</td>
<td>96.6</td>
</tr>
<tr>
<td>6. Visiting friends</td>
<td>98.9</td>
</tr>
</tbody>
</table>

Brouilette SNQ questionnaire: One of the earliest one was designed by Brouilette in 1984 (113). In that questionnaire devised by him in 1984, only three questions were asked. (a) How often would you say your child has difficulty breathing when he or she is sleeping? 0 = never; 1 = occasionally; 2 = frequently; 3 = constantly, (b) Does your child stop breathing, when he or she is asleep? 0 = no, 1 = yes, (c) How often would you say your child snores? 0=never, 1 occasionally, 2 = frequently, 3 = constantly.

The answers to the above questions were then used to calculate the OSA score according to the equation described by Brouillette et al (1984) as follows: OSA score= 1.42 (a) + 1.41 (b) + 0.71 (c) - 3.73.
Table II (3). The initial Snore questionnaire devised by Brouilette in 1984

Please put a tick mark inside the correct box

<table>
<thead>
<tr>
<th>S No</th>
<th>Item</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>How often would you say your child has difficulty breathing when he or she is sleeping?</td>
<td>Never⁰, Occasionally¹, Frequently², Constantly³</td>
</tr>
<tr>
<td>b</td>
<td>Does your child stop breathing, when he or she is asleep? (0 = no, 1 = yes).</td>
<td>No, Yes</td>
</tr>
<tr>
<td>c</td>
<td>How often would you say your child snores?</td>
<td>Never⁰, Occasionally¹, Frequently², Constantly³</td>
</tr>
</tbody>
</table>

Total Clinical OSA score = 1.42(a) + 1.41(b) + 0.71(c) - 3.73.

This tool was found to be very useful. Subsequently, several researchers, including Brouilette himself made several additions and improvements to the original. In our interventional study, the latest improved Rosenfeld and Suratt version of 2006 is used.

The advantage of employing an already validated instrument is obvious. However, while employing any one of them, a singular difficulty is experienced by every scholar. This difficulty stems from the lack of agreed definitions for the snoring (OSA) parameters. Because the definitions are not universally agreed upon, comparison of different studies is not possible.

**Calgary SAQLI**: This tool was devised by Flemons and his colleagues (114), based in Calgary in Canada. It has 35 questions organized into four domains: daily functioning, social interactions, emotional functioning, and symptoms. A fifth domain, treatment-related symptoms, can be added for
clinical intervention trials to record the possible negative impacts of treatment.

**Berlin Questionnaire:** Using a similarly simple questionnaire (Berlin questionnaire), Netzer demonstrated that questionnaires could be effective. Briefly, the Berlin questionnaire is divided into three sections. In section 1, respondents are asked whether they snore. Those who respond affirmatively are asked how loud the snoring is, how often it occurs, and whether their snoring bothers other people. Respondents are also asked whether anyone has ever noticed the cessation of breathing during sleep. In section 2, respondents are asked how often they feel tired or fatigued after sleep, how often they feel tired, fatigued, or not up to par during wake time, and whether they ever fall asleep driving a car. In section 3, respondents are asked about a personal history of hypertension, as well as their height, weight, age, and sex. Body mass index (BMI) is calculated from the information in section 3. A section is considered positive if there are two affirmative answers in either section 1 or 2, or one affirmative response in section 3. Individuals who have positive scores in two of the three sections are considered to be at risk for OSA (115). The Berlin questionnaire was used in this sleep in America study in 2005 telephonic poll and was found to be useful in risk stratification.

**A Single Question as a Sleepiness Screening Tool:** Very recently, in 2008, in a sample of 303 subjects of 18-78 years of age, with a variety of sleep disorders, Zallek, tested the effectiveness of a single question:

‘Please measure your sleepiness on a typical day: (0 = none, 10 is highest).’

According to the author, Dr. Zallek, the single question had significant correlation with the ESS in all subject groups and was able to distinguish between “subjectively sleepy” and “subjectively not sleepy” groups. Hence, even a single question could be an effective screening tool, in a busy practice (116).
Chapter III.

The aims of this study

The aims of this study are three fold:

1. To study the prevalence of snoring and sleep apnoea in the general population.
2. Comparison of clinical and psychological profiles of children suffering from snoring and sleep apnoea with non-obstructed children.
3. Study of the changes in the above profiles, after therapeutic intervention i.e. adenotonsillectomy.

The American Thoracic Society, in a dedicated workshop in 1999, indicated several specific areas requiring additional research (117) as follows:

- Accurate prevalence data.
- Identification of risk factors of complications resulting from OSAS, including the relationship of OSAS severity to specific outcomes.
- Development and evaluation of low-cost, high-sensitivity, and high-specificity screening methods for OSAS.
- Delineation of the natural history of treated and untreated PS and OSAS.
- Assessment of long-term efficacy of adenotonsillectomy, CPAP, and other OSAS treatments.

Seven years later, in 2006, several of the above issues still remained unaddressed, either fully or partially in several regions of the world. This prompted the American Academy of Pediatrics to endorse the same research goals once again and to reiterate their importance. This study is a humble attempt to fill the lacunae existing in our country.
Chapter IV.
The Plan and Scope of this study

The entire study was done in two parts

Part I. Study of the prevalence of snoring
Part II. Interventional study of children with adeno tonsillar enlargement, before and after surgical therapy.

Part I. Study of the prevalence:

The community prevalence of snoring was ascertained among different sample populations namely, the general public, students, industrial workers and children, by survey techniques, over a period of five years from 2003 to 2008.

a) Pedex survey: This is the first survey of this study. In this survey, the prevalence of snoring in the general community was ascertained. All the available and consenting visitors to a medical exhibition in the city of Chennai were studied. A simple questionnaire was administered. The questions related primarily to the presence, frequency and intensity of snoring. Basic demographic data also was recorded. A research assistant and the author were present to make sure the questionnaire was completed correctly and answer any questions the respondents might have. A total of 1133 persons of all ages and differing socio economic status constituted this sample population.

(b) Street survey: In an effort to make the sample more broad based, a novel method was employed in this second phase of the study. Trained personnel interviewed people at busy streets sequentially and randomly, without any selection bias and recorded the answers in a standard survey format. Out of expediency, this format consisted of very few questions. The questions were short, but very relevant. The questions looked at the prevalence of self reported snoring with quick references to gender, age group, build and precipitating factors namely, good food, alcohol and general tiredness due to overwork. A pilot survey (n = 102) was initially done to ascertain the feasibility and the same was followed up with a main
survey. This sample comprised of 937 subjects of all ages and socio economic status.

(c) Household survey: As a follow up to the above surveys, all the available and consenting inhabitants of a housing colony in Chennai were studied. All the households belonged to middle socio economic group. Children aged less than two years were excluded. All the other age groups were represented in this survey. No other selection was done. Each person was screened by questionnaires and was then examined clinically. A total of 405 persons were studied in this part of the study.

(d) Special population of Industrial workers: Employees of all categories, in a factory, were screened for snoring by a questionnaire. These employees had shift duties. The survey looked at the prevalence of self reported snoring with quick references to age group, BMI, and precipitating factors namely, good food, alcohol, overwork and general tiredness. The number of subjects was 602.

(e) Special population of young adults: The young adult is known to have a need for more hours of sleep. However, precisely during this age, academic and social pressures increasingly encroach upon his sleeping time. This encroachment on sleep results in daytime sleepiness and impaired cognitive abilities and impacts the learning processes. Hence, this special population was targeted and studied with questionnaires and by clinical examination. This sample consisted of 198 medical and nursing students aged 17 to 22 years.

The above surveys focused on different populations, including common persons encountered on the streets, factories, schools and residential households. All the socio economic classes, namely upper, middle, and lower were included. In each setting, a sequential sample was taken, by including all the persons available. Only a few in each group did not volunteer. The most common reason for refusal was that they were too busy to complete the questionnaire. The definition of snoring was a general one of noise produced while sleeping. For the specific and limited purpose of estimating the prevalence of snoring, all the samples were collated. By this methodology, we hoped to get a broad ranging and representative sample. Additionally, in each sample, associations of other variables were analysed in a focused manner.
2. Interventional Study of children with adeno tonsillar enlargement, before and after therapeutic intervention i.e. adeno tonsillectomy:

This part of the study focused on the future citizens. Children attending the ENT out patient clinic with suspected adeno tonsillar enlargement were sequentially enrolled into the study, without any selection, regardless whether they snored or not. 196 children entered the study. A detailed history was taken. Clinical examination, cephalometry, a disease specific quality of life survey (OSA 18) and assessment of behaviour and learning were done.

Based on the snoring questionnaire (SNQ), they were stratified into non snoring, occasionally snoring and habitually snoring groups. The differences between the three groups, in the pre operative period (at the stage unchanged by operation) were studied by statistical analysis. The specific purpose of this analysis is to ascertain whether any significant differences exist between children who snore and those who do not. Additionally, clinical examination findings were also studied similarly.

Behaviour and learning ability of children have a great impact on the general community. At present, it is not clear whether all snoring children are at risk of having impaired performance and whether there are clinical indicators that predict a higher risk for certain sub group of children. If such a prediction were possible from historical, clinical and psychological variables, either individually or in combinations, it will help to caution the parents accordingly and to avoid unnecessary intervention in patients who are not at risk for adverse outcomes (16).

The same sample of children was stratified into (a) predominantly infectious group (81) and (b) predominantly obstructed group (115), based on clinical criteria, namely, the temporal sequences like the onset of snoring and number of infective episodes.

125 children of the sample had adeno tonsillectomy. Some children underwent the surgery because of obstructive features (68) and the others had the surgery for infective indications (57). In these 125 children, the clinical examination and OSA 18 QOL survey were repeated post operatively. The differences between the pre operative scores and
post operative scores were critically analysed by statistical methods. 71 children, who did not get operated, formed the control group. Data of the variables in this group were used to assess the significance of any change.

The goals of this analysis were to ascertain whether there was a change after therapeutic intervention, whether these changes could be predicted pre operatively and more specifically, whether any failure of resolution of snoring i.e. unsuccessful outcome could be predicted by simple variables before hand. Such information will be of immense help to the clinician to counsel the parents regarding what could be expected realistically from surgery.

3. Summary of the plan:

The important condition of upper airway obstruction and snoring has not been studied well, so far, in this part of the world. This study attempted to fill this gap in knowledge. Resources like history, clinical examination, morphometry and cephalometry methods were employed. The prevalence and the clinical profile of the condition in the Indian context were assessed in this study.
Flow Chart – Prevalence studies

1. Pedex Survey
   Persons visiting a health expo (1075)
   Gender, Age group, SES, BMI, presence of snoring, precipitating factors

2. Street Survey
   Persons at traffic intersections interviewed (937)
   Same as above

3. Special population of industrial workers having shift duty (602)
   Same as above

4. Households survey
   All inmates of a housing colony (405)
   Same as above
   + clinical examination

5. Special population of students
   Young adults in college (198)
   Same as above
   + clinical examination

Statistical analysis of all the variables for associations with snoring
Flow Chart 2 - Interventional study

Children with adeno tonsillar enlargement, attending ENT OP (196)

Children stratified clinically, into
Predominantly Infective group (115)
Predominantly Obstructive group (81)

Again, stratified by SNQ, into
Frequent snorers (158)
Occasional snorers (33)
Non snorers (5)

All the children undergo
History taking
Anthropometry
Clinical examination
Cephalometry
Laboratory tests
OSA 18 (both before and after T&A)
General learning assessment

On clinical merits, children undergo adeno tonsillectomy (125)

Statistical analysis
Comparison between the groups
for associations of all the parameters individually and in various combinations
Chapter V. Part One
Study of the prevalence of snoring

The study of the prevalence of snoring and other features of sleep disordered breathing was done by a series of surveys with wide ranging bases, namely Pedex survey, Street survey, Households survey, Adolescent Students survey and Adult industrial workers survey. (Flow chart 1 & 2)

A. Patients and methods:

Patients and methods of Pedex survey:

This is the first survey of this study. In this survey, the prevalence of snoring in the general community was ascertained. All the available and consenting visitors to a medical exhibition were studied. Children aged less than 2 years were excluded. A simple questionnaire, which recorded contact data, socio economic status, associated diseases, personal habits and snoring status, was administered to each subject cf. appendix.

Associated diseases: Presence of diabetes, hypertension and/or hypothyroidism, and if present, duration of the illness were ascertained by relevant queries. The number of episodes of cold or sore throat in the last one year was ascertained; the significance of each episode was judged by the need to go to a doctor for the same. Similarly, the number of episodes of ear pain was recorded. A positive response to the question "Has a doctor ever told you that you had nose / dust allergy?" is taken as indicative of allergic rhinitis. Wheeze was defined as a positive response to the question "Have you ever had wheezing or tightness in the chest?"

Personal habits: Smoking was categorized as never, ex-smoker, light (one packet of ten or less cigarettes or beedis per day), or heavy (eleven and more per day). Alcohol consumption was assessed via 7-day recall regarding the amount of alcohol consumed and was categorized as nondrinker, ex-drinker, light (< 140 g/wk i.e. one quarter per week), or heavy (> 140 g/wk).

Additional questions related to the presence, frequency, loudness of snoring. A single direct question asked whether the person regularly felt sleepy during the daytime. Each person had a clinical examination and the findings were recorded in a standard format of a study sheet.
A total of 1133 persons were administered the survey. Of these, 58 children below the age of two years were excluded from the analysis. Thus, 1175 persons constituted this sample.

Patients and methods of Street survey:

In an effort to make the prevalence a little more broad-based, a second community survey was conducted in a novel way. Trained personnel interviewed persons at busy streets consecutively, as and when they presented i.e. randomly, without any selection bias and recorded the answers in a standard survey format. A pilot survey and a main survey were conducted. The pilot street survey (n = 102) was done in order to ascertain the feasibility and then was followed by a main survey. The interview was conducted with a short and crisp questionnaire, which was filled up by the interviewer. Out of expediency, each person was asked just four questions: 1. Do you snore? 2. If yes, how many times in a week? 3. Do other people complain about your snoring? If the answer was yes, it was recorded as 'loud'. 4. If yes, what makes the snoring worse - tiredness, good food, alcohol. All that the interviewer had to do was to put a tick mark against the relevant item. In addition, the interviewer recorded his / her observation regarding the gender, the vehicle the person was travelling in, age group and build. A total of 937 persons of all ages and both genders constituted the sample for this portion of the study. (Appendix 2: Street survey study sheet).

Patients and methods of Households survey:

Subsequent to the above surveys, the inhabitants of an entire housing colony in Chennai were studied. All the available and consenting persons in the entire 158 households were included in the study. Children aged less than two years were excluded. All the other age groups were represented in this survey. No other selection was done. A total of 398 were included in this study. In addition to the questionnaire, each person had a clinical examination. (Appendix 3: Households study sheet).

Patients and methods of Students survey:

One of the important problems engendered by snoring and sleep apnoea is learning impairment. Hence, this part of the survey had a focus on young adult students. All the third year medical students in a medical college
(Chengalpattu Medical College) and the entire student population of the nursing school attached to the same college formed the sample.

Each student filled up a questionnaire, listing basic demographic details and past medical history. Each one specifically completed the Berlin and ESS questionnaire. All the students were assessed for weight, height, body mass index (BMI = Kg/m²), neck circumference at the level of the cricothyroid membrane, chest circumferences, waist circumference at the level of the umbilicus and maximal hip circumference. Upper body obesity was assessed by calculation of the waist hip ratio and waist height ratio. The neck circumferences were adjusted for height, by rendering them as neck/height ratios. After the above, each student had a clinical ENT examination, focusing on the upper airway features. All the results were entered in a standard study sheet. 198 students, aged 17-22 years of both genders formed this sample. (Appendix 4: Students survey study sheet)

Patients and methods of Adult industrial workers survey:

This part of the study focused on industrial workers. All the employees on shift duty in a large industrial establishment formed the subjects of this study. The subjects had their heights and weights measured. Then, each one of them filled up a questionnaire. The questions pertained to the presence of snoring, its frequency and any precipitating factors, if present. It was essentially modeled after a previous study by another researcher, Montgomery Downs in 2005. The format was kept simple and minimal. Six hundred and two employees of all ages formed this sample. (Appendix 5. Industrial Employees’ Study sheet)

Tools adopted in this Part One of the study:

(a) Archana Wealth Index Scale: For assessing the socio economic status, the classical Kuppusami (KUP) scale was found to be lengthy and difficult to administer. A Wealth Index Scale (WIS) devised and validated by Archana Patel et al, in the Indian context, was found to be quick and also, had been found to have good agreement with KUP. This Archana WIS is an eight item ownership scale, yielding the following five SES levels (118).

<table>
<thead>
<tr>
<th>Low</th>
<th>Upper Low</th>
<th>Low Middle</th>
<th>Upper Middle</th>
<th>Upper</th>
</tr>
</thead>
</table>

The following eight items are considered as indicators of wealth: electricity, radio, television, bicycle, Scooter or motor cycle, land
ownership, car and refrigerator. Based on information specifically collected from a wide cross section of the community by the authors (Patel A et al), the eight items are distinguished into essential, non essential and useful items. The single essential item (E) is electricity. Radio, bicycle, television, scooter and land are considered by general public as useful (U) items. Car and refrigerator are considered as non essential (NE) items. The WIS was constructed based on the above perceptual information.

The WIS is calculated as follows: A person is considered as 'Low income group' if they did not have electricity (E), 'Upper Low income group' if they had electricity and two or less number of U items but no NE, 'low middle income group' less than 2 U but no NE, "Low Middle" if they had electricity and more than 2 U and no NE, 'Upper Middle income group' if they had electricity, more than 2 U and I NE, 'Upper income group' if they had all E, all U and all NE.

(b) Berlin Questionnaire: Berlin questionnaire for snoring and sleep disorders: The Berlin Questionnaire provides a means of identifying patients who are likely to have sleep apnea. This instrument provides a means of identifying and stratifying persons at risk for sleep apnoea (Table V-1). This strategy was shown to be useful in sleep clinic and community surveys.

c) Epworth Sleepiness Scale (ESS): The Epworth Sleepiness Scale is used to determine the level of daytime sleepiness. This is a simple self administered questionnaire which is shown to provide a measurement of the subject’s general level of daytime sleepiness. The questions rate the chance of that they will doze off or fall asleep when in eight common situations, in a scale of four levels (0 = would never doze or sleep, 1 = slight chance of dozing or sleeping, 2 = moderate chance of dozing or sleeping, 3 = high chance of dozing or sleeping). This scale was devised by the Epworth Hospital (Australia) group (119) and had been adapted worldwide. (Table V-2 and appendix 6). The ESS is used to determine the level of daytime sleepiness. Scores 10 and more are considered significant.
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
<th>Categorization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has your weight changed recently (in the last 6 months)?</td>
<td>Increased</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Decreased</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No change</td>
<td></td>
</tr>
<tr>
<td>Do you snore?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not know</td>
<td></td>
</tr>
<tr>
<td>Snoring loudness</td>
<td>Loud as breathing</td>
<td>Soft</td>
</tr>
<tr>
<td></td>
<td>Loud as talking</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Louder than talking</td>
<td>Loud</td>
</tr>
<tr>
<td></td>
<td>Very loud</td>
<td></td>
</tr>
<tr>
<td>Snoring frequency</td>
<td>Almost every day</td>
<td>Frequent</td>
</tr>
<tr>
<td></td>
<td>3 to 4 times per wk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per wk</td>
<td>Occasional</td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per mo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Never or almost never</td>
<td>Non snorer</td>
</tr>
<tr>
<td>Does your snoring bother other people?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>How often have your breathing pauses been noticed?</td>
<td>Almost every day</td>
<td>Significant apnoeic pauses</td>
</tr>
<tr>
<td></td>
<td>3 to 4 times per wk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per wk</td>
<td>Insignificant or never</td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per mo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Never or almost never</td>
<td></td>
</tr>
<tr>
<td>Are you tired after sleeping?</td>
<td>Almost every day</td>
<td>Significant EDS</td>
</tr>
<tr>
<td></td>
<td>3 to 4 times per wk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per wk</td>
<td>Insignificant or No EDS</td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per mo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Never or almost never</td>
<td></td>
</tr>
<tr>
<td>Are you tired during wake time?</td>
<td>Almost every day</td>
<td>Significant EDS</td>
</tr>
<tr>
<td></td>
<td>3 to 4 times per wk</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per wk</td>
<td>Insignificant or No EDS</td>
</tr>
<tr>
<td></td>
<td>1 to 2 times per mo</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Never or almost never</td>
<td></td>
</tr>
<tr>
<td>Have you ever fallen asleep while driving?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Do you have high blood pressure?</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Do not know</td>
<td></td>
</tr>
</tbody>
</table>
Table V (2). Epworth sleepiness Scale

How likely are you to doze off or fall asleep in the following situations, in contrast to just feeling tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you. Put a tick mark in the correct box.

<table>
<thead>
<tr>
<th>Situation</th>
<th>No chance 0</th>
<th>Slight chance 1</th>
<th>Moderate chance 2</th>
<th>High chance 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sitting and reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Watching TV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting inactive in a public place (e.g a theater or a meeting)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>As a passenger in a car for an hour without a break</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lying down to rest in the afternoon when circumstances permit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting and talking to someone</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sitting quietly after a lunch without alcohol</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>In a car, while stopped for a few minutes in traffic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Score 9 and less is normal. 10 – 17 sleepy. 18 & more highly significant EDS

Procedures adopted in this Part One of the study:

A general examination and a specific ENT examination were done in the following uniform manner, wherever applicable. Special emphasis was given to the dimensions of the upper airway and the pharynx.

(a) Anthropometric data: Anthropometric indexes such as BMI and WC relate to important health outcomes, are easy and relatively inexpensive to measure, and are easy to monitor over time by either the individuals themselves or their health care providers. For anthropometry to be of maximum value the measurements must be well standardized. In this study, care was taken to follow standard procedures. The weight was measured to the nearest 0.1 kg by a digital weighing scale using load cell technology.
manufactured by Cibi Giritronics, Chennai, with the subject lightly dressed and barefoot. Standing height to the nearest 0.5 cm was recorded, by a stadiometer. From the height and weight, the body mass index was calculated. (BMI = Kg / height in m²). The waist circumference was measured at the midpoint between the lowest rib and the iliac crest (the highest point of the ilium), as per the WHO growth standards guidelines, Singapore consultations revision for Asia 2002). Systolic and diastolic blood pressures were measured using mercury manometers, in the right arm, with the patient comfortably sitting. A person with an average BP >140/90 mmHg or on antihypertensive drugs at the time of the study was classified as hypertensive.

(b) Morphometry: This included circumference measurements of the neck circumference at the level of the cricoid, chest on inspiration and expiration, waist and the hip. The cricometrical space as described by Tsai et al in 2003 was recorded. The patient is seated in the 'mirror position'. A thin ruler is used to connect the cricoid cartilage to the inner mentum. The cricometrical line is bisected and the perpendicular distance to the skin of the neck is measured (120). Additionally, clinical photographs of frontal and lateral views of face and neck with the subject in the head neutral position (mirror position).

Fig. V (1). Crico mental space of Tsai

(c) Clinical examination: Across the entire study, the clinical examination was done and recorded in a study sheet with a standardized format. The findings and their interpretations are given below. The findings and their significance are given in the table V (3).

Resting lip posture was assessed for each subject while they were relaxed and seated. If the lips were contacting each other, it was recorded as 'lips closed' and if the lips appeared separated, it was recorded as 'lips parted'.
If the upper frontal teeth protrude (overjet) by more than 5 mm it is recorded as ‘teeth protruded’. The presence of these two features is considered to indicate mouth breathing.

Pharyngeal airway dimensions: The palatine tonsils were clinically graded on a standardized scale as recommended by Brodsky (121). Tonsils graded 3 and 4 were considered enlarged in this study. The vertical component of pharyngeal airway encroachment was assessed by the Mallampatti score. With the patient sitting relaxed, the tongue is protruded without making any efforts at phonation. Structures of the oro pharynx, which are visible are noted. The lateral encroachment of the pharyngeal airway was measured by a pharyngeal grading scale of Tsai (120). This system is based on the intersection of the palato pharyngeal arch horizontally on the tongue (Figures V. 2-4).

Statistical methods employed in this study:

The data was entered in a computer and was analysed with the aid of SPSS ver. 15. The descriptive statistics employed mean, median, standard deviation, standard error of the mean and percentages. The significances of different associations were tested with p values with chi square and by Student’s t tests. As and when required, ANOVA was utilised.

Table V (3). Clinical features recorded in the study sheet and the clinical conditions indicated by them.

<table>
<thead>
<tr>
<th>Clinical conditions</th>
<th>Evidenced by the following features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth Breathing</td>
<td>Lips parted</td>
</tr>
<tr>
<td></td>
<td>Teeth protruding in</td>
</tr>
<tr>
<td>Nasal allergy</td>
<td>Nasal concha enlarged,</td>
</tr>
<tr>
<td></td>
<td>Ant nasal discharge serous and minimal, post nasal discharge serous/ mucoid</td>
</tr>
<tr>
<td>Nasal infection / sinusitis</td>
<td>Nasal conchae enlarged,</td>
</tr>
<tr>
<td></td>
<td>Ant nasal discharge significant &amp; thick, Post nasal discharge purulent</td>
</tr>
<tr>
<td>GERD</td>
<td>Uvula elongated</td>
</tr>
<tr>
<td></td>
<td>Uvula oedematous</td>
</tr>
<tr>
<td>CSOM</td>
<td>Ear, any side,</td>
</tr>
<tr>
<td></td>
<td>Dry CP</td>
</tr>
<tr>
<td></td>
<td>CP with discharge</td>
</tr>
<tr>
<td>Secretory otitis media</td>
<td>Ear, any side, Retracted</td>
</tr>
</tbody>
</table>
Figure : V (2) Fedex survey

Figure : V (3) Filling up the questionnaire
Figure : V (4) Morphometry
Figure: V (5) Weight & morphometry neck
Figure: V (6) Excessive Daytime Sleepiness
Fig. V (2). The grading of the tonsils sizes, as recommended by Brodsky

<table>
<thead>
<tr>
<th>Tonsils Brodsky grade</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fully inside</td>
<td>just outside (25 % airway obstruction)</td>
<td>readily seen, (25 - 50 % obstruction)</td>
<td>midway (50 - 75 % obstruction)</td>
<td>&gt; 75 % obstruction</td>
</tr>
</tbody>
</table>

Fig V (3). The Mallampatti oropharyngeal scale

<table>
<thead>
<tr>
<th>Mallampatti Scale: Vertical extent of airway</th>
<th>I soft palate, faucæ, uvula, pillars seen</th>
<th>II soft palate, faucæ, uvula seen</th>
<th>III soft palate, base of uvula seen</th>
<th>IV soft palate not visible at all</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical extent of airway</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modified Mallampatti (Samsoon and Young 1987)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig V (4). The Tsai pharyngeal grading scale

<table>
<thead>
<tr>
<th>Pharyngeal grade: Horizontal extent of airway Tsai ph grading classes</th>
<th>I Posterior arch at edge of tongue</th>
<th>II arch intersects at 25% or more of tongue diameter</th>
<th>III arch intersects at 50% or more of tongue diameter</th>
<th>IV arch intersects at 75% or more of tongue diameter</th>
</tr>
</thead>
</table>
B. Results of the Pedex survey

a) Demographic profile of the sample: The total sample of 1075 individuals consisted of 431 children, 117 adolescents, 469 adults and 58 elders. Considering their economic levels were considered, the total sample consisted of 263 affluent, 601 middle income and 211 economically weaker individuals.

b) Prevalence of snoring: The total frequency of snorers in the entire survey population of 1075 was 210, amounting to 19.5 % (95% CI = 17.13 to 21.87).

c) Age group and snoring: the prevalence within the individual age groups was then calculated: 12 percent of the children and the adolescents snored. The adults showed a higher prevalence of 24 percent; the elder group had an even higher prevalence with nearly one half reporting snoring (Table 1). This positive association of snoring with increasing age was found to be significant (p = 0.001).

Table V (4). Distribution of snorers by age groups, in the Pedex study

<table>
<thead>
<tr>
<th>Age Groups</th>
<th>n</th>
<th>Total snorers</th>
<th>%age of Total snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child</td>
<td>431</td>
<td>56</td>
<td>13</td>
</tr>
<tr>
<td>Adolescent</td>
<td>117</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Adult</td>
<td>469</td>
<td>114</td>
<td>24.3</td>
</tr>
<tr>
<td>Elderly</td>
<td>58</td>
<td>26</td>
<td>44.8</td>
</tr>
<tr>
<td>Total</td>
<td>1075</td>
<td>210</td>
<td>19.5</td>
</tr>
</tbody>
</table>

d) Gender and snoring: the percentage of snorers was found to be higher in the males than in the females - 24.4 % in males vs. 13 % of females. This higher prevalence among the males was further analysed with reference to age groups. The male predominance was found to significant only in the adult category. Such a higher prevalence in the male gender was not present in the sub groups of children, adolescents and the elders.
Table V (5). Gender wise distribution of snorers by gender within the age groups in Pedex survey

<table>
<thead>
<tr>
<th>Age Groups (Total snorers within the age group)</th>
<th>Gender</th>
<th>n</th>
<th>Snorers</th>
<th>%age of snorers within the respective gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child (56)</td>
<td>Male</td>
<td>238</td>
<td>34</td>
<td>14.3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>193</td>
<td>22</td>
<td>11.4</td>
</tr>
<tr>
<td>Adolescents (14)</td>
<td>Male</td>
<td>70</td>
<td>9</td>
<td>12.9</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>47</td>
<td>5</td>
<td>10.6</td>
</tr>
<tr>
<td>Adult (114)</td>
<td>Male</td>
<td>259</td>
<td>84</td>
<td>32.4</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>210</td>
<td>30</td>
<td>14.3</td>
</tr>
<tr>
<td>Elderly (26)</td>
<td>Male</td>
<td>44</td>
<td>22</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>14</td>
<td>4</td>
<td>28.6</td>
</tr>
</tbody>
</table>

e) Frequency of snoring: Out of the 210 snorers in this Pedex survey, 175 persons (16.3 %) snored occasionally and 35 (3.3 %) snored frequently.

f) Body Mass Index and Snoring: The prevalence of snoring within each age group was analysed in relation to the BMI (Table V-5). The prevalence of snoring in children and in adolescents was found to be independent of BMI. In contrast, the adult age group showed a significant increase in snoring with increasing BMI (p = 0.01). In the elder group, though the percentages of snorers were high, statistical significance was not evident because of the small numbers.
Table V (6). Age wise distribution of snorers in relation to their BMI

<table>
<thead>
<tr>
<th>Age group</th>
<th>Child</th>
<th>Adolescent</th>
<th>Adult</th>
<th>Elder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>Snores</td>
<td>snorers</td>
<td>%</td>
<td>snorers</td>
</tr>
<tr>
<td>BMI &lt;20</td>
<td>375</td>
<td>48</td>
<td>12.8</td>
<td>81</td>
</tr>
<tr>
<td>20 -25</td>
<td>46</td>
<td>7</td>
<td>15.2</td>
<td>29</td>
</tr>
<tr>
<td>26 -29</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
<td>7</td>
</tr>
<tr>
<td>&gt;30</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total for each age group</td>
<td>431</td>
<td>56</td>
<td>12.9</td>
<td>117</td>
</tr>
<tr>
<td>p value</td>
<td>0.958</td>
<td>0.912</td>
<td>0.01</td>
<td>0.837</td>
</tr>
</tbody>
</table>

Table V (7). Prevalence of snoring by the Economic status, in the Pedex survey

<table>
<thead>
<tr>
<th>Economic status</th>
<th>Total number</th>
<th>Snorers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaker section</td>
<td>211</td>
<td>25</td>
<td>11.8</td>
</tr>
<tr>
<td>Middle income</td>
<td>601</td>
<td>127</td>
<td>21.1</td>
</tr>
<tr>
<td>Affluent</td>
<td>263</td>
<td>58</td>
<td>22.1</td>
</tr>
<tr>
<td>p value</td>
<td></td>
<td>0.008</td>
<td></td>
</tr>
</tbody>
</table>

g) Socio economic status and Snoring: The prevalence of snoring was found to increase positively with increasing affluence (Table 3) ($\chi^2 = 7.034$, $p = 0.008$).

Table V (7). Prevalence of snoring by the Economic status, in the Pedex survey

h) Snoring in relation to history of sore throat: Among the children, 169 did not have any sore throat in the eight months since the last school vacation; only 12 had snoring (7.1 %). In contrast, in children having a history of sore throat ($n = 269$), 44 had snoring (16.7%). This positive association of snoring and sore throat was statistically significant ($p = 0.01$). This type of association was not evident in the Adolescent and in the Adult subgroups. The elders i.e. those aged 46 years and above
showed a highly significant association. As the number was relatively small, inferences can not be considered. In summary, there is a significant association between sore throat and snoring in children.

Table V (8). Association of snoring with sore throat - age group wise distribution

<table>
<thead>
<tr>
<th>Age group</th>
<th>Child (n=431)</th>
<th>Adolescent (n=117)</th>
<th>Adult (n=469)</th>
<th>Elder (n=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Snore rs</td>
<td>%</td>
<td>Total</td>
</tr>
<tr>
<td>h/o Sore throat absent</td>
<td>169</td>
<td>12</td>
<td>7.1</td>
<td>50</td>
</tr>
<tr>
<td>present</td>
<td>262</td>
<td>44</td>
<td>16.8</td>
<td>67</td>
</tr>
<tr>
<td>p value</td>
<td>.003</td>
<td>.571</td>
<td>.049</td>
<td>.001</td>
</tr>
</tbody>
</table>

i) Awareness about the possible effects of snoring: Regardless of the presence or the absence of snoring, all the individuals were asked whether they would like to be mailed any further literature regarding snoring. 81.4% of snorers and 52.3% of non snorers replied in the affirmative i.e. nearly a fifth of the snorers did not feel the necessity to know more about their snoring problem. This may be taken to indicate a lack of awareness about the possible associated effects of snoring.

Table V (9). Community awareness about snoring and sleep apnoea (persons interested in getting more information about snoring in the Pedex survey)

<table>
<thead>
<tr>
<th>Single Question: Would you like to have further information (pamphlets and information sheets) regarding snoring and sleep apnoea?</th>
<th>Number</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects who said ‘yes’ within the total sample (1075)</td>
<td>624</td>
<td>58</td>
</tr>
<tr>
<td>Subjects who said ‘yes’ within Snorers</td>
<td>171</td>
<td>81.4</td>
</tr>
<tr>
<td>Subjects who said ‘yes’ within non snorers</td>
<td>453</td>
<td>52.3</td>
</tr>
</tbody>
</table>
Summary of the Pedex survey results:

In this Pedex survey, with a sample size of 1075 persons of all ages and economic background, the total prevalence of snoring was 19.5 %. The percentage of snorers was found to be 24.4 % in males vs. 13 % of females (higher in the males). Among the age groups, with increasing age, the prevalence of snoring increased – children: 12 %, adults: 24 %. The prevalence of snoring in children and in adolescents was found to be independent of BMI. In contrast, the adult age group showed a significant increase in snoring with increasing BMI. The prevalence of snoring was found to increase positively with increasing affluence. Children with sore throat had a significant tendency to have snoring. In the general community, awareness of the condition exists. However, many persons (snorers and non snorers alike) are not interested in getting more information.

C. Results of the Street survey

A total of 937 persons constituted the sample for this unit of the study. 582 (62.1%) were males. 355 (37.9 %) were females. Their ages, build and socio economic status were distributed widely. Their detailed description is given in table.

Table V (10). Description of the Street survey sample (937), by age

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total number of subjects in this age group (%)</th>
<th>Male (%)</th>
<th>Female (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;12 yrs</td>
<td>139 (14.8)</td>
<td>102 (10.9)</td>
<td>37 (3.9)</td>
</tr>
<tr>
<td>13 - 18</td>
<td>75 (8)</td>
<td>75 (8)</td>
<td>0</td>
</tr>
<tr>
<td>19 - 29</td>
<td>244 (26)</td>
<td>118 (12.6)</td>
<td>126 (13.4)</td>
</tr>
<tr>
<td>30 - 59</td>
<td>404 (43.1)</td>
<td>248 (26.5)</td>
<td>156 (16.6)</td>
</tr>
<tr>
<td>60 &amp; above</td>
<td>75 (8)</td>
<td>39 (4.2)</td>
<td>36 (3.8)</td>
</tr>
</tbody>
</table>
Table V (11). Description of the Street survey sample, by build.

<table>
<thead>
<tr>
<th>Build</th>
<th>Total number</th>
<th>Male (%)</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lean</td>
<td>354</td>
<td>266 (75)</td>
<td>88 (25)</td>
</tr>
<tr>
<td>Moderate</td>
<td>507</td>
<td>316 (62)</td>
<td>191 (38)</td>
</tr>
<tr>
<td>Large</td>
<td>76</td>
<td>0 (-)</td>
<td>76 (100)</td>
</tr>
</tbody>
</table>

Table V (12). Description of the Street survey sample by SES.

<table>
<thead>
<tr>
<th>Socio Economic Status</th>
<th>Total number in this category</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income</td>
<td>364</td>
<td>250 (69%)</td>
<td>114 (31%)</td>
<td>364 (100%)</td>
</tr>
<tr>
<td>Middle income</td>
<td>301</td>
<td>213 (71%)</td>
<td>88 (29%)</td>
<td>301 (100%)</td>
</tr>
<tr>
<td>High income</td>
<td>272</td>
<td>119 (44%)</td>
<td>153 (56%)</td>
<td>272 (100%)</td>
</tr>
</tbody>
</table>

Prevalence of snoring: Out of the total sample of 937 persons, 198 (21.1%) were found to be snorers. Among the 198 snorers, 103 (11%) were males and 95 (10.1%) were females.

The snorers were categorized into occasional and frequent, based on their snoring frequency. Those who snored more than three nights in a week were considered frequent snorers. Those who snored less nights were the occasional snorers. There were a total of 186 (94%) occasional snorers and 12 (6%) frequent snorers. Among the occasional snorers, 51 percent were males and 49 per cent were females. There was no difference statistically. Among the frequent snorers, 52 percent were males and 48 per cent were females i.e. males had a significantly higher prevalence.
Table V (13). **Presence** of snoring, by gender, in the Street survey sample.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of persons within the entire sample of 937</strong></td>
<td>582</td>
<td>355</td>
<td>937</td>
</tr>
<tr>
<td><strong>Number of snorers</strong></td>
<td>103</td>
<td>95</td>
<td>198</td>
</tr>
<tr>
<td><strong>Non snorers</strong></td>
<td>479</td>
<td>260</td>
<td>799</td>
</tr>
</tbody>
</table>

value <0.001

Table V (14). **Presence** of snoring by Socio economic status in the street survey.

<table>
<thead>
<tr>
<th>Socio Economic Status</th>
<th>Snorers</th>
<th>Non Snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low income n 364</td>
<td>93</td>
<td>271</td>
</tr>
<tr>
<td>Middle income n 301</td>
<td>4</td>
<td>297</td>
</tr>
<tr>
<td>High income n 272</td>
<td>101</td>
<td>171</td>
</tr>
</tbody>
</table>

p value <0.001

Table V (15). **Frequency** of snoring by age groups among the total 198 snorers, in the street survey sample.

<table>
<thead>
<tr>
<th>Age</th>
<th>Occ. snorers in this age group (%)</th>
<th>Freq. Snorers in this age group (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 - 59</td>
<td>157 (39%)</td>
<td>9 (2%)</td>
</tr>
<tr>
<td>60 and Above</td>
<td>29 (39%)</td>
<td>3 (4%)</td>
</tr>
<tr>
<td>Total</td>
<td>186 (94%)</td>
<td>12 (6%)</td>
</tr>
</tbody>
</table>

p value 0.39 (not significant)
Table V (16). **Frequency** of snoring by gender in the street survey sample.

<table>
<thead>
<tr>
<th>Category</th>
<th>Males</th>
<th>Females</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occasional snorers</td>
<td>94</td>
<td>92</td>
<td>186</td>
</tr>
<tr>
<td>(47.5)</td>
<td>(46.5)</td>
<td>(94%)</td>
<td></td>
</tr>
<tr>
<td>Frequent snorers</td>
<td>9</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>(4.5)</td>
<td>(1.5)</td>
<td>(6%)</td>
<td></td>
</tr>
<tr>
<td>Total snorers</td>
<td>103</td>
<td>95</td>
<td>198</td>
</tr>
<tr>
<td>(52%)</td>
<td>(48%)</td>
<td>(100%)</td>
<td></td>
</tr>
</tbody>
</table>

p value 0.1 (not significant)

Table V (17. **Frequency** of snoring by age groups and gender, among the total 198 snorers

<table>
<thead>
<tr>
<th>Gender</th>
<th>30-59 yrs (248)</th>
<th>&gt;=60 yrs (39)</th>
<th>30-59 yrs (156)</th>
<th>&gt;=60 yrs (36)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>102</td>
<td>1</td>
<td>64</td>
<td>31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>females</td>
<td>106</td>
<td>38</td>
<td>92</td>
<td>5</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

**Snoring and age groups:**

In the 30-59 age group, out of the total 248 males, 102 persons snored occasionally and an additional 9 persons (3.6%) snored frequently. Among the 156 female subjects in the same age group, 64 persons (41%) snored occasionally and no female in this age group (in this sample) snored frequently.

Among the males in the age group 60 years and above (n = 39), one person snored occasionally and none snored frequently. In the same age group, out of the 36 females, 28 persons (78%) snored occasionally, and an additional 3 persons (8%) snored frequently. Among the 39 males in this age group, there was only one snorer and he reported occasional snoring.
Loudness of snoring: Among the total 198 snorers, 162 persons snored softly and 36 snored loudly. When the gender wise distribution is considered, Among the 103 total male snorers, 70 snored softly and 33 snored loudly. Among the 95 total female snorers, 92 snored softly and only 3 snored loudly. The percentages of this data are given in table. The p value was <0.001. It is evident that females tend to snore softly.

Factors worsening the snoring: The snorers in this survey implicated the following factors as worsening their snoring: tiredness (67%), good food (35%) and alcohol 36%.

Table V (18). Loudness of snore in the street survey by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Soft snorers%</th>
<th>Loud snorers%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>68</td>
<td>32</td>
</tr>
<tr>
<td>Female</td>
<td>97</td>
<td>3</td>
</tr>
</tbody>
</table>

Table V (19). Factors which worsen snoring among the snorers in the Street survey

<table>
<thead>
<tr>
<th>Factors which worsen snoring</th>
<th>Number of persons among the snorers, who implicated this factor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
</tr>
<tr>
<td>Tiredness</td>
<td>68</td>
</tr>
<tr>
<td>Good food</td>
<td>69</td>
</tr>
<tr>
<td>Alcohol</td>
<td>70</td>
</tr>
</tbody>
</table>

Discussion of the results of the street survey: On analysing the prevalence of the self reported snoring, it was found that no one below the age of 30 years (male and female) reported snoring, even though they constituted 43.8 percent of the sample. This is in contradiction with similar surveys and our own surveys. This method of getting subjects from the streets is commonly adopted in opinion surveys and in election predictions. This method had even been employed by Davey in 2002 (77), to estimate the prevalence data for snoring itself. With the experience gained in this
survey, we find that this method of obtaining the prevalence data is not yielding correct data.

A relatively comfortable environment, where the patient has the time, inclination and willingness to think and answer (not one where the subject awaits the change of signals or for the arrival of the next bus) would be appropriate.

**Summary of the results of the Street survey:**

In the novel street survey with a sample size of 937 persons of all ages, gender and build, the overall prevalence of snoring was 21.1% (males 11% and females 10.1%). In this sample, the self reported prevalence and the frequency of snoring showed no significant difference between the genders. This is at variance to the conventional belief that more males snored more frequently. However, it was seen that females tend to snore less loudly than males. The method of obtaining sample subjects from the streets is found by this study to yield less appropriate data.
D. Results of Households survey

A total of 398 persons (222 males and 176 females) were included in this study. All the persons belonged to middle income category of the Patel Wealth Index Scale. Their ages and BMI covered a wide range. The number of snorers in this sample population was 171 (43%). 26.4 percent were males and 16.6 per cent were females.

Table V (20). Description of the Households study sample (age)

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 12 yr</td>
<td>59 (52%)</td>
<td>55 (48%)</td>
<td>114</td>
</tr>
<tr>
<td>13-18</td>
<td>33 (52%)</td>
<td>31 (48%)</td>
<td>64</td>
</tr>
<tr>
<td>19-29</td>
<td>15 (31%)</td>
<td>34 (69%)</td>
<td>49</td>
</tr>
<tr>
<td>30-44</td>
<td>81 (62%)</td>
<td>50 (38%)</td>
<td>131</td>
</tr>
<tr>
<td>45-59</td>
<td>31 (84%)</td>
<td>6 (16%)</td>
<td>37</td>
</tr>
<tr>
<td>60 &amp; above</td>
<td>3 (-)</td>
<td>0 (-)</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>222 (56%)</td>
<td>176 (44%)</td>
<td>398</td>
</tr>
</tbody>
</table>

Table V (21). Description of the Households study sample (BMI)

<table>
<thead>
<tr>
<th>BMI Category WHO 2002 Singapore rev. for Asia</th>
<th>Description of category</th>
<th>Males</th>
<th>Females</th>
<th>Total (% of n 398)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>&lt;14.9</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Underweight</td>
<td>15-18.4</td>
<td>79</td>
<td>74</td>
<td>153 (38%)</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-22.9</td>
<td>67</td>
<td>50</td>
<td>117 (29%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>23-27.5</td>
<td>39</td>
<td>32</td>
<td>71 (18%)</td>
</tr>
<tr>
<td>Obese</td>
<td>27.6-40</td>
<td>37</td>
<td>20</td>
<td>57 (14%)</td>
</tr>
<tr>
<td>Morbidly obese</td>
<td>&gt;40</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Table V (22). Description of the Households study sample (SES)

<table>
<thead>
<tr>
<th>Socio Economic Status category</th>
<th>Males</th>
<th>Females</th>
<th>Total (% of n 398)</th>
</tr>
</thead>
<tbody>
<tr>
<td>low income</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Upper Low income</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lower middle income</td>
<td>152</td>
<td>106</td>
<td>258 (65 %)</td>
</tr>
<tr>
<td>Upper middle income</td>
<td>70</td>
<td>70</td>
<td>140 (35%)</td>
</tr>
<tr>
<td>High income</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table V (23). Prevalence of snoring in the sample population (398) in the households survey

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of persons within the entire sample</td>
<td>222</td>
<td>176</td>
<td>398</td>
</tr>
<tr>
<td>Number of snorers</td>
<td>105</td>
<td>66</td>
<td>171</td>
</tr>
<tr>
<td>Number of non snorers</td>
<td>117</td>
<td>110</td>
<td>227</td>
</tr>
</tbody>
</table>

p value 0.049 (significant)

Prevalance of snoring is found be more in the males. The difference between genders is found be statistically significant at p value of 0.049. When analysed further among the different age groups, this male predilection was found to persist in the 30-44 and 45-59 age groups only.
When the snoring is further stratified into occasional and frequent snoring, within the age groups and gender, there were more number of frequent snorers among the male population. Among the female population, the occasional snorers were present in more numbers among within each age groups.

Table V (24). Prevalence of snoring in age groups by gender in the Households study

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Number of male snorers in this age group (%)</th>
<th>Number of female snorers in this age group (%)</th>
<th>Number of snorers of both genders in this age group (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 yr and less (114)</td>
<td>22 (56%)</td>
<td>17 (44%)</td>
<td>39 (34.2%)</td>
</tr>
<tr>
<td>13-18 (64)</td>
<td>15 (58%)</td>
<td>11 (42%)</td>
<td>26 (40%)</td>
</tr>
<tr>
<td>19-29 (49)</td>
<td>8 (44%)</td>
<td>10 (56%)</td>
<td>18 (36.7%)</td>
</tr>
<tr>
<td>30-44 (131)</td>
<td>43 (63%)</td>
<td>25 (37%)</td>
<td>68 (51.9%)</td>
</tr>
<tr>
<td>45-59 (37)</td>
<td>15 (83%)</td>
<td>3 (17%)</td>
<td>18 (48.6 %)</td>
</tr>
<tr>
<td>60 and more (3)</td>
<td>2 (100%)</td>
<td>0 -</td>
<td>2 (67 %)</td>
</tr>
</tbody>
</table>
Table V (25). Number of Male frequent and occasional snorers within the different age groups in the households survey subjects.

<table>
<thead>
<tr>
<th>Males</th>
<th>Snoring frequency</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non snorer</td>
<td>Occasional snorer</td>
<td>Frequent snorer</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;=12 yrs</td>
<td>37</td>
<td>17</td>
<td>5</td>
<td>59</td>
</tr>
<tr>
<td>%</td>
<td>62.7%</td>
<td>28.8%</td>
<td>8.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>13-18 yrs</td>
<td>18</td>
<td>8</td>
<td>7</td>
<td>33</td>
</tr>
<tr>
<td>%</td>
<td>54.5%</td>
<td>24.2%</td>
<td>21.2%</td>
<td>100.0%</td>
</tr>
<tr>
<td>19-29 yrs</td>
<td>7</td>
<td>4</td>
<td>4</td>
<td>15</td>
</tr>
<tr>
<td>%</td>
<td>46.7%</td>
<td>26.7%</td>
<td>26.7%</td>
<td>100.0%</td>
</tr>
<tr>
<td>30-44 yrs</td>
<td>38</td>
<td>28</td>
<td>15</td>
<td>81</td>
</tr>
<tr>
<td>%</td>
<td>46.9%</td>
<td>34.6%</td>
<td>18.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>45 - 59</td>
<td>16</td>
<td>6</td>
<td>9</td>
<td>31</td>
</tr>
<tr>
<td>%</td>
<td>51.6%</td>
<td>19.4%</td>
<td>29.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>60 &amp; above</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>%</td>
<td>33.3%</td>
<td>33.3%</td>
<td>33.3%</td>
<td>100.0%</td>
</tr>
<tr>
<td>Total</td>
<td>117</td>
<td>64</td>
<td>41</td>
<td>222</td>
</tr>
<tr>
<td>%</td>
<td>52.7%</td>
<td>28.8%</td>
<td>18.5%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table V (26). Number of Female frequent and occasional snorers within the different age groups in the households survey subjects.

<table>
<thead>
<tr>
<th>Females</th>
<th>Snoring frequency</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non snorer</td>
<td>Occasional snorer</td>
<td>Frequent snorer</td>
<td>Total</td>
</tr>
<tr>
<td>&lt;=12 yrs</td>
<td>38</td>
<td>14</td>
<td>3</td>
<td>55</td>
</tr>
<tr>
<td>%</td>
<td>69.1%</td>
<td>25.5%</td>
<td>5.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>13-18 yrs</td>
<td>20</td>
<td>7</td>
<td>4</td>
<td>31</td>
</tr>
<tr>
<td>%</td>
<td>64.5%</td>
<td>22.6%</td>
<td>12.9%</td>
<td>100.0%</td>
</tr>
<tr>
<td>19-29 yrs</td>
<td>24</td>
<td>3</td>
<td>7</td>
<td>34</td>
</tr>
<tr>
<td>%</td>
<td>70.6%</td>
<td>8.8%</td>
<td>20.6%</td>
<td>100.0%</td>
</tr>
<tr>
<td>30-44 yrs</td>
<td>25</td>
<td>22</td>
<td>3</td>
<td>50</td>
</tr>
<tr>
<td>%</td>
<td>50.0%</td>
<td>44.0%</td>
<td>6.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td>45 – 59</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td>%</td>
<td>50.0%</td>
<td>16.7%</td>
<td>33.3%</td>
<td>100.0%</td>
</tr>
<tr>
<td>60 &amp; above</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>110</td>
<td>47</td>
<td>19</td>
<td>176</td>
</tr>
<tr>
<td>%</td>
<td>62.5%</td>
<td>26.7%</td>
<td>10.8%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table V (27). Number of loud snorers in the households study, total and, by gender (% age of the loud snorers within the snorer groups)

<table>
<thead>
<tr>
<th>Category</th>
<th>Total number of loud snorers (M&amp;F)</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occ. Snorer</td>
<td>63 (57%)</td>
<td>37 (33%)</td>
<td>26 (24%)</td>
</tr>
<tr>
<td>Freq. snorer</td>
<td>55 (92%)</td>
<td>37 (62%)</td>
<td>18 (30%)</td>
</tr>
<tr>
<td>Total</td>
<td>118 (69%)</td>
<td>74 (43%)</td>
<td>44 (26%)</td>
</tr>
</tbody>
</table>

Table V (28). Presence of Excessive Daytime Sleepiness among non snorers and snorers in the households survey (number of persons)

<table>
<thead>
<tr>
<th></th>
<th>EDS absent</th>
<th>EDS present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non snorers</td>
<td>138</td>
<td>89 (39%)</td>
</tr>
<tr>
<td>Snorers occ + freq</td>
<td>106</td>
<td>65 (38%)</td>
</tr>
<tr>
<td></td>
<td>244</td>
<td>154</td>
</tr>
</tbody>
</table>

p value 0.81 (not significant)

Table V (30). Presence of Excessive Daytime Sleepiness among non snorers and snorers in the households survey percentages alone given in this table.

<table>
<thead>
<tr>
<th></th>
<th>EDS absent</th>
<th>EDS present</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non snorers</td>
<td>60.8</td>
<td>39.2</td>
</tr>
<tr>
<td>Snorers Occ + Freq</td>
<td>62.0</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>61.3</td>
<td>38.7</td>
</tr>
</tbody>
</table>

Test for significance of the difference in EDS between the snorers and non snorers: p = 0.81 i.e. excessive sleepiness does not have any increased presence in snorers; it occurs independent of snoring.
Table V (31). Pharyngeal airway dimensions found by clinical examination in the entire sample of Households study - enumeration of the number of persons in each category. (percentages of the number of persons having each grade within the clinical category)

<table>
<thead>
<tr>
<th>Clinical category</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonsil Brodsky Grading (100%)</td>
<td>398</td>
<td>18</td>
<td>191</td>
<td>132</td>
<td>57</td>
</tr>
<tr>
<td>Vertical Dimensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mallampatti oro pharyngeal score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 (0.8)</td>
<td>3</td>
<td>304</td>
<td>91</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Horizontal dimensions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tsai pharyngeal Grading (100%)</td>
<td>398</td>
<td>2</td>
<td>286</td>
<td>110</td>
<td>0</td>
</tr>
<tr>
<td>0 (0.5)</td>
<td></td>
<td>286</td>
<td>110</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table V (32). Percentages of different types of snorers within each tonsil size

<table>
<thead>
<tr>
<th>Tonsil size Brodsky</th>
<th>Non snorer</th>
<th>Total snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>77.8</td>
<td>22.2</td>
<td>5.6</td>
<td>16.7</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>67</td>
<td>33</td>
<td>19.9</td>
<td>13.1</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>53.8</td>
<td>46.2</td>
<td>29.5</td>
<td>16.7</td>
<td>100</td>
</tr>
<tr>
<td>3</td>
<td>24.6</td>
<td>75.4</td>
<td>57.9</td>
<td>17.5</td>
<td>100</td>
</tr>
<tr>
<td>4 No subjects had this grade of enlargement</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

p value of the differences in the tonsil size between non snorers and all snorers is <0.001.
Table V (33). Percentages of different types of snorers within each Mallampatti score in the households study

<table>
<thead>
<tr>
<th>Mallampatti score of vertical pharyngeal dimensions</th>
<th>Non snorer</th>
<th>Total snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (n only 2 in this score)</td>
<td>100</td>
<td>0</td>
<td></td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>62.6</td>
<td>37.4</td>
<td>31.1</td>
<td>6.3</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>41.8</td>
<td>58.2</td>
<td>20.0</td>
<td>38.2</td>
<td></td>
</tr>
<tr>
<td>3 (No subjects)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 (No subjects)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

p value of the differences in the Mallampatti score between non snorers and all snorers is 0.002

Table V (34). Percentages of different types of snorers within each Tsai grading score

<table>
<thead>
<tr>
<th>Tsai pharyngeal grading score of horizontal pharyngeal dimensions</th>
<th>Non snorer</th>
<th>All snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>63.5</td>
<td>36.5</td>
<td>25.3</td>
<td>11.3</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>35.2</td>
<td>64.8</td>
<td>37.4</td>
<td>27.5</td>
<td>100</td>
</tr>
<tr>
<td>3 (No subjects)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 (No subjects)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

p value of the differences in the Tsai grading score between non snorers and all snorers is <0.001

Community awareness about the possible effects of snoring: Regardless of the presence or the absence of snoring, all the individuals were asked
whether they would like to be mailed any further literature regarding snoring. Only 43\% of snorers and an equal percentage of non snores wanted additional information on snoring and sleep apnoea. It should be noted that a majority (57\%) of snorers themselves were not worried and did not feel the necessity to know more about their snoring problem. This may be taken to indicate a lack of awareness about the possible associated effects of snoring.

Table V (35). Response of the household study sample to the Q. would you like to have further information (pamphlets and information sheets) regarding snoring and sleep apnoea

<table>
<thead>
<tr>
<th></th>
<th>Info not reqd.</th>
<th>Info reqd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non snorers</td>
<td>82 (57%)</td>
<td>62 (43%)</td>
</tr>
<tr>
<td>Snorers</td>
<td>145 (57%)</td>
<td>109 (43%)</td>
</tr>
</tbody>
</table>

p value 0.978 not significant

Summary of the households survey: A total of 398 persons, all the inhabitants of an entire housing colony in Chennai, formed the sample. In addition to the questionnaire, each person had a clinical examination.

The overall prevalence of snoring in this sample was found to be quite high at 43 percent (26.4\% males and 16.6\% females). Among the total of 114 children below the age of 12 years, 34\% were snorers. Out of the male snorers, 18.5 \% snored frequently. Oropharyngeal indicators like tonsil size and Mallampatti had significantly higher scores in this sample.
E. Results of the Students survey - special population of young adults:

1. Description of the sample: One hundred and ninety eight students (26 males and 172 females) formed this sample. Their ages ranged from 18 to 25 years with a mean of 20.6 years. Two third of them (63%) belonged to the middle class.

Their BMI ranged from 13.7 to 30.6 with a mean of 19.7. Their profile is given in table no V. None of them had any diabetes or hypertension. Two girls had goiter with hypothyroidism since two years and were under adequate thyroxine therapy.

2. Prevalence of snoring by gender, by age: Among this sample, fifteen persons (6 males and 9 females) snored. By percentage, the total snorers constituted 7.6% of the sample (3% males 4.6% females). Among the snorers, 13 persons (5 males and 8 females), snored occasionally, while two females snored frequently.

Table V (36). Description of the Student survey sample (age and BMI)

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>26</td>
<td>21.6</td>
<td>1.2</td>
<td>20</td>
<td>24</td>
</tr>
<tr>
<td>Female</td>
<td>172</td>
<td>20.4</td>
<td>1.6</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>20.6</td>
<td>1.6</td>
<td>18</td>
<td>25</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>26</td>
<td>20.8</td>
<td>3.1</td>
<td>15.8</td>
<td>29.8</td>
</tr>
<tr>
<td>Female</td>
<td>172</td>
<td>19.6</td>
<td>3.0</td>
<td>13.7</td>
<td>30.6</td>
</tr>
<tr>
<td>Total</td>
<td>198</td>
<td>19.7</td>
<td>3.0</td>
<td>13.7</td>
<td>30.6</td>
</tr>
</tbody>
</table>
Table V (37). Description of the Student survey sample (socio economic status)

<table>
<thead>
<tr>
<th>Socio Economic Status</th>
<th>Lower Income</th>
<th>Count</th>
<th>% within Socio Economic Status</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>33.3%</td>
</tr>
<tr>
<td>Upper low</td>
<td>6</td>
<td>50</td>
<td>56</td>
<td>10.7%</td>
</tr>
<tr>
<td>Lower middle</td>
<td>2</td>
<td>85</td>
<td>87</td>
<td>2.3%</td>
</tr>
<tr>
<td>Upper middle</td>
<td>15</td>
<td>23</td>
<td>38</td>
<td>39.5%</td>
</tr>
<tr>
<td>Higher income</td>
<td>1</td>
<td>10</td>
<td>11</td>
<td>9.1%</td>
</tr>
</tbody>
</table>
Table V (38). Number of snorers in the student survey sample (198)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Count</th>
<th>No</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>20</td>
<td>6</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76.9%</td>
<td>23.1%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>163</td>
<td>9</td>
<td>172</td>
<td></td>
</tr>
<tr>
<td></td>
<td>94.8%</td>
<td>5.2%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td>15</td>
<td>198</td>
<td></td>
</tr>
<tr>
<td></td>
<td>92.4%</td>
<td>7.6%</td>
<td>100.0%</td>
<td></td>
</tr>
</tbody>
</table>

p value 0.001

Table V (39). Frequency of snoring in the student survey sample, by gender

<table>
<thead>
<tr>
<th>Snoring frequency</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non snorer</td>
<td>20</td>
<td>163</td>
<td>183</td>
</tr>
<tr>
<td>Occasional snorer</td>
<td>5</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Frequent snorer</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>172</td>
<td>198</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Count</th>
<th>76.9%</th>
<th>19.2%</th>
<th>3.8%</th>
<th>100.0%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>94.8%</td>
<td>4.7%</td>
<td>.6%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

3. Prevalence of snoring by BMI: Analyzing the snoring prevalence by the BMI categories, it was found that seven snorers had a BMI above normal and six were in the normal category. It is noteworthy that two snorers had a BMI less than normal i.e. underweight and starvation categories. In general, there was a positive association of BMI with the prevalence of snoring and this was significant with a p value of <0.001.
### Table V (40). Prevalence of snoring, by BMI

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>Description of category</th>
<th>Non snorers</th>
<th>Snorers</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation (29)</td>
<td>&lt;14.9</td>
<td>2 (66.7%)</td>
<td>1 (33.3%)</td>
<td>3 (100%)</td>
</tr>
<tr>
<td>Underweight (105)</td>
<td>15 - 18.4</td>
<td>65 (98.5%)</td>
<td>1 (1.5%)</td>
<td>66 (100%)</td>
</tr>
<tr>
<td>Normal (56)</td>
<td>18.5 - 22.9</td>
<td>95 (94.1%)</td>
<td>6 (5.9%)</td>
<td>101 (100%)</td>
</tr>
<tr>
<td>Overweight (4)</td>
<td>23 - 27.5</td>
<td>11 (64.7%)</td>
<td>6 (35.3%)</td>
<td>17 (100%)</td>
</tr>
<tr>
<td>Obese</td>
<td>27.6 - 40</td>
<td>4 (80%)</td>
<td>1 (20%)</td>
<td>5 (100%)</td>
</tr>
<tr>
<td>Morbidly obese</td>
<td>&gt;40</td>
<td>-</td>
<td>-</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>177 (92.2%)</td>
<td>15 (7.8%)</td>
<td>192 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

(missing data in 6 subjects)  

p value <0.001

---

### Table V (41). Loudness of snoring in the student survey sample, by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Snoring loudness</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soft</td>
<td>Loud</td>
</tr>
<tr>
<td>Male</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Female</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

There was no loud snorer in this sample.

---

4. **Loudness of snoring**: In this sample of all young adults, there was not a single loud snorer.
5. Breathing pauses during sleep and snoring: in this sample, only three subjects had significant breathing pauses. And only one of them was a snorer. Even though the p value appears to be significant, no inference could be drawn.

Table V (42). Presence of apnoeic pauses in the Student study sample

<table>
<thead>
<tr>
<th>Snore frequency</th>
<th>Non snorer</th>
<th>Occ snorer</th>
<th>Freq snorer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None or insignificant</td>
<td>182</td>
<td>11</td>
<td>1</td>
<td>194</td>
</tr>
<tr>
<td>pauses</td>
<td>(93.8%)</td>
<td>(5.7%)</td>
<td>(0.5%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Significant pauses</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(66.7%)</td>
<td>-</td>
<td>(33.3%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Total</td>
<td>184</td>
<td>11</td>
<td>2</td>
<td>197</td>
</tr>
<tr>
<td></td>
<td>(93.4%)</td>
<td>(5.6%)</td>
<td>(1.0%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>

Table V (43). Presence of Excessive Daytime Sleepiness (EDS) in the Student study sample

<table>
<thead>
<tr>
<th>Snore frequency</th>
<th>Non snorer</th>
<th>Occ snorer</th>
<th>Freq snorer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDS absent</td>
<td>144</td>
<td>11</td>
<td>1</td>
<td>194</td>
</tr>
<tr>
<td></td>
<td>(92.3%)</td>
<td>(7.1%)</td>
<td>(0.6%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>EDS present</td>
<td>41</td>
<td>0</td>
<td>1</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td>(97.6%)</td>
<td>-</td>
<td>(2.4%)</td>
<td>(100%)</td>
</tr>
<tr>
<td>Total</td>
<td>185</td>
<td>11</td>
<td>2</td>
<td>198</td>
</tr>
<tr>
<td></td>
<td>(93.4%)</td>
<td>(5.6%)</td>
<td>(1.0%)</td>
<td>(100%)</td>
</tr>
</tbody>
</table>
Table V (44). Presence of snoring in subjects with a significant Epworth Sleepiness Score (10 and more), in the Student study sample

<table>
<thead>
<tr>
<th>Snore frequency</th>
<th>Non snorer</th>
<th>Occ snorer</th>
<th>Freq snorer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ESS 9 and less</strong></td>
<td>182 (94.3%)</td>
<td>10 (5.2%)</td>
<td>1 (0.5%)</td>
<td>193 (100%)</td>
</tr>
<tr>
<td><strong>ESS 10 and more</strong></td>
<td>3 (60%)</td>
<td>1 (20%)</td>
<td>1 (20%)</td>
<td>5 (100%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>185 (93.4%)</td>
<td>11 (5.6%)</td>
<td>2 (1.0%)</td>
<td>198 (100%)</td>
</tr>
</tbody>
</table>

Table V (45). Presence of snoring in subjects with clinical features of mouth breathing, in the Student study sample

<table>
<thead>
<tr>
<th>Mouth breathing</th>
<th>Snore frequency</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non snorer</td>
<td>Occ snorer</td>
<td>Freq snorer</td>
</tr>
<tr>
<td>significant mouth breathing</td>
<td>1 (50.3%)</td>
<td>0</td>
</tr>
<tr>
<td>No features of mouth breathing</td>
<td>184 (93.9%)</td>
<td>11 (5.6%)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>185 (93.4%)</td>
<td>11 (5.6%)</td>
</tr>
</tbody>
</table>

6. Excessive Daytime Sleepiness (EDS) and snoring: In this sample, 42 subjects (21%) had EDS. Only one subject among them was a snorer. The statistical significance was p 0.132. The point that should be noted is that in these young adult students, there is quite considerable EDS, even though they did not snore.
7. Epworth sleepiness Scale (EDS) and snoring: An Epworth score of ten and above was considered to indicate significant daytime sleepiness. In this sample, only 5 subjects had significant ESS scores. And, three of them were non snorers; one was an occasional snorer; and one more had frequent snorer.
On chi square analysis, this difference was found to be significant. However, the number (one snorer in each category) is insignificant.

8. The influence of morphometric features on snoring: The following morphometric variables were studied because they have a tendency to reduce the airway: Cricothyroid distance, Waist hip ratio and Neck height ratio. Their mean values and distribution characteristics were calculated separately for the snorers and non snorers - initially in the entire population and then, separately in the male population sample and in the female population sample. The results are tabulated in tables V (46).

The mean of each morphometric variable in snorers was compared with its pair in the non snorers, by chi square test. It was found that none of these three variables had a significant association with snoring. When the same process was repeated in the male population alone, the waist hip ratio alone had a significant positive association with snoring (p = 0.071). In the females, this association was not present.

The snorers were segregated into occasional and frequent snorers and the means of the morphometric variables were calculated and compared by ANOVA one way test. The waist hip ratio in the male occasional snorer was found to be significant (p = 0.017). The other variables were not significant.
Table V (46). Mean and distribution values of the morphometric variables in the entire sample population of student study, by the presence of snoring (n 198)

<table>
<thead>
<tr>
<th>Entire sample</th>
<th>Snoring</th>
<th>N</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>p value of the paired variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cricomental space distance</td>
<td>No</td>
<td>183</td>
<td>18.05</td>
<td>1.78</td>
<td>.13</td>
<td>.800</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>15</td>
<td>17.93</td>
<td>1.87</td>
<td>.48</td>
<td></td>
</tr>
<tr>
<td>Waist hip ratio</td>
<td>No</td>
<td>183</td>
<td>.89</td>
<td>.14</td>
<td>.01</td>
<td>.126</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>15</td>
<td>.95</td>
<td>.14</td>
<td>.04</td>
<td></td>
</tr>
<tr>
<td>Neck height ratio</td>
<td>No</td>
<td>183</td>
<td>19.05</td>
<td>3.26</td>
<td>.24</td>
<td>.580</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>15</td>
<td>18.55</td>
<td>1.89</td>
<td>.49</td>
<td></td>
</tr>
</tbody>
</table>

The p values for all the three variables are not significant.

Table V (47). Mean and distribution values of the morphometric variables in the male population of student study, by the presence of snoring (n 25)

<table>
<thead>
<tr>
<th>Males only</th>
<th>Snoring</th>
<th>N</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>p value of the paired variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cricomental space distance</td>
<td>No</td>
<td>20</td>
<td>18.20</td>
<td>1.47</td>
<td>.33</td>
<td>.318</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5</td>
<td>17.40</td>
<td>1.95</td>
<td>.87</td>
<td></td>
</tr>
<tr>
<td>Waist hip ratio</td>
<td>No</td>
<td>20</td>
<td>.91</td>
<td>.12</td>
<td>.03</td>
<td>.071</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5</td>
<td>1.03</td>
<td>.15</td>
<td>.66</td>
<td></td>
</tr>
<tr>
<td>Neck height ratio</td>
<td>No</td>
<td>20</td>
<td>18.74</td>
<td>1.15</td>
<td>.26</td>
<td>.492</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>5</td>
<td>18.33</td>
<td>1.26</td>
<td>.56</td>
<td></td>
</tr>
</tbody>
</table>

The p value for the waist hip ratio alone was significant
Table V (48). Mean and distribution values of the morphometric variables in the female population of student study (n 163), by the presence of snoring.

<table>
<thead>
<tr>
<th>Females only</th>
<th>Snoring</th>
<th>N</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>p value of the paired variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cricothyroidal space distance</td>
<td>No</td>
<td>163</td>
<td>18.04</td>
<td>1.81</td>
<td>.14</td>
<td>.783</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>18.20</td>
<td>1.9</td>
<td>.59</td>
<td></td>
</tr>
<tr>
<td>Waist hip ratio</td>
<td>No</td>
<td>163</td>
<td>.89</td>
<td>.14</td>
<td>.01</td>
<td>.696</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>.90</td>
<td>.13</td>
<td>.04</td>
<td></td>
</tr>
<tr>
<td>Neck height ratio</td>
<td>No</td>
<td>163</td>
<td>19.09</td>
<td>3.44</td>
<td>.27</td>
<td>.698</td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>10</td>
<td>18.66</td>
<td>2.20</td>
<td>.70</td>
<td></td>
</tr>
</tbody>
</table>

The p values for all the three variables are not significant.
Table V (49). Mean and distribution values of the morphometric variables in the occasional and frequent snorers in the male population of student study (n 25).

<table>
<thead>
<tr>
<th>Males (25)</th>
<th>Snoring</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>95% lower</th>
<th>95% upper</th>
<th>Min value</th>
<th>Max value</th>
<th>Anova Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cricomental space distance Non snorers (20)</td>
<td>18.2</td>
<td>1.47</td>
<td>.329</td>
<td>17.5</td>
<td>18.9</td>
<td>16</td>
<td>23</td>
<td>.318</td>
<td></td>
</tr>
<tr>
<td>Occ snorer (5)</td>
<td>17.4</td>
<td>1.9</td>
<td>.872</td>
<td>15</td>
<td>19.8</td>
<td>15</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (25)</td>
<td>18.0</td>
<td>1.6</td>
<td>.313</td>
<td>17.4</td>
<td>18.7</td>
<td>15</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist hip ratio Non snorers (20)</td>
<td>0.912</td>
<td>.121</td>
<td>.027</td>
<td>.856</td>
<td>.969</td>
<td>.73</td>
<td>1.10</td>
<td>.017</td>
<td></td>
</tr>
<tr>
<td>Occ snorer (5)</td>
<td>1.03</td>
<td>.148</td>
<td>.066</td>
<td>.848</td>
<td>1.215</td>
<td>.88</td>
<td>1.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (25)</td>
<td>.936</td>
<td>.133</td>
<td>.027</td>
<td>.881</td>
<td>.991</td>
<td>.73</td>
<td>1.27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck height ratio Non snorers (20)</td>
<td>18.74</td>
<td>1.15</td>
<td>.257</td>
<td>18.20</td>
<td>19.28</td>
<td>17.43</td>
<td>21.76</td>
<td>.492</td>
<td></td>
</tr>
<tr>
<td>Occ snorer (5)</td>
<td>18.33</td>
<td>1.26</td>
<td>.564</td>
<td>16.77</td>
<td>19.90</td>
<td>17.33</td>
<td>20.53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (25)</td>
<td>18.66</td>
<td>1.16</td>
<td>.231</td>
<td>18.18</td>
<td>19.13</td>
<td>17.33</td>
<td>21.76</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table V (50). Mean and distribution values of the morphometric variables in the occasional and frequent snorers in the female population of student study (n 173).

<table>
<thead>
<tr>
<th>Female (173)</th>
<th>Snoring</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>95% lower</th>
<th>95% upper</th>
<th>Min</th>
<th>Max</th>
<th>Anova Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cricomental space distance</td>
<td>Non snorer (165)</td>
<td>18.04</td>
<td>1.80</td>
<td>.140</td>
<td>17.76</td>
<td>18.31</td>
<td>14</td>
<td>24</td>
<td>.274</td>
</tr>
<tr>
<td>Occ snorer (6)</td>
<td>18.83</td>
<td>2.14</td>
<td>.872</td>
<td>16.59</td>
<td>21.08</td>
<td>17</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freq snorer (2)</td>
<td>16.50</td>
<td>.707</td>
<td>.500</td>
<td>10.15</td>
<td>22.85</td>
<td>16</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (173)</td>
<td>18.05</td>
<td>1.810</td>
<td>.138</td>
<td>17.77</td>
<td>18.32</td>
<td>14</td>
<td>24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waist hip ratio</td>
<td>Non snorer (165)</td>
<td>.888</td>
<td>.143</td>
<td>.111</td>
<td>.866</td>
<td>.910</td>
<td>.63</td>
<td>1.33</td>
<td>.852</td>
</tr>
<tr>
<td>Occ snorer (6)</td>
<td>.857</td>
<td>.0466</td>
<td>.019</td>
<td>.809</td>
<td>.905</td>
<td>.79</td>
<td>.91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freq snorer (2)</td>
<td>.906</td>
<td>.039</td>
<td>.027</td>
<td>.560</td>
<td>1.252</td>
<td>.88</td>
<td>.93</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (173)</td>
<td>.888</td>
<td>.140</td>
<td>.011</td>
<td>.866</td>
<td>.909</td>
<td>.63</td>
<td>1.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neck height ratio</td>
<td>Non snorer (165)</td>
<td>19.07</td>
<td>3.42</td>
<td>.266</td>
<td>18.55</td>
<td>19.60</td>
<td>14.12</td>
<td>23</td>
<td>.264</td>
</tr>
<tr>
<td>Occ snorer (6)</td>
<td>17.74</td>
<td>1.53</td>
<td>.624</td>
<td>16.14</td>
<td>19.35</td>
<td>16.03</td>
<td>20.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freq snorer (2)</td>
<td>22.222</td>
<td>.000</td>
<td>.000</td>
<td>22.22</td>
<td>22.222</td>
<td>22.22</td>
<td>22.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total (173)</td>
<td>19.06</td>
<td>3.37</td>
<td>.256</td>
<td>18.56</td>
<td>19.57</td>
<td>14.12</td>
<td>23</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
9. The influence of pharyngeal dimension variables on snoring: The following variables were studied for their associations with occasional and frequent snorers were studied by presence of snoring, and then on the frequency of snoring – tonsil size, the horizontal dimensions of the pharynx by the Mallampatti score and the vertical dimension by the Tsai pharyngeal grading. The values of the respective scores were tabulated in snorers and non-snorers and their associations were studied by chi square tests. The tonsil size and the Mallampatti scores were found to have significant associations with snoring, both in the occasional and in the frequent snorers. The Tsai pharyngeal grading did not have any significant associations in this sample.

10. GERD and snoring: In this sample, by clinical examination, features suggestive of GERD were not present in any persona.

11. Sinusitis and snoring: In this sample, by clinical examination, features suggestive of sinusitis were present in two percent. Only 25% i.e. one subject only had occasional snoring. The p value of the difference between the snorers and non-snorers was 0.227. (not significant). However, as the n value is only one, no inference could be drawn in this sample.

12. Nasal allergy and snoring: In this sample, features suggestive of nasal allergy were present in none.

13. Secretory otitis media and snoring: In this sample, by clinical examination, features of secretory otitis media were present in 91% of the sample. Six percent of them were snorers. The p value of the difference was <0.465. Thus, there is no association between secretory otitis media and snoring, in this sample.

14. CSOM and snoring: In this sample, by clinical examination, features suggestive of CSOM were present in 21% of children. Nearly ten percent of them had snoring. However, the p value of the difference between the snorers and non-snorers was 0.499 and hence, there is no significant association.

Discussion:

This sample comprised of the students with a mean age of 20.6 years. The overall prevalence of snoring was 7.6 per cent. It is noteworthy that even persons who had a BMI below the normal i.e. below 23 snored. BMI was
found to be significantly associated with snoring in this sample, just as in other studies. In this population, not a single person admitted to loud snoring.

Excessive daytime sleepiness: It should be noted that as many as 21% of the of this study sample comprising exclusively of young students complained of excessive daytime sleepiness when they were administered the Berlin questionnaire. The association of sleepiness with snoring was found to be significant statistically. Excessive daytime sleepiness in this population is a widespread problem and can have major negative effects on the individuals’ academic performance, health, and safety. Health care professionals have an important opportunity to evaluate their adolescent patients for evidence of excessive daytime sleepiness and underlying sleep deprivation and/or sleep

Morphometric features: In this sample, the waist hip ratio alone had significant association with the presence of snoring, that too in the male students only. This significance was present also in the occasional snorers also, in the male gender. The other types of snorers and other morphometric variables did not have any significant associations. Other morphometric features, namely cricomenatal space distance and neck height ratio were not significantly associated with snoring in this sample.

Pharyngeal dimensional indicators: The tonsil size and the Mallampatti scale had a significant positive association with snoring and with its frequency. These associations were positive. The pharyngeal grading by Tsai did not have any influence on the frequency of snoring in this sample.

Associated diseases: In the Student study sample, no subject had GERD or nasal allergy. Among the students who had sinusitis, only one had snoring i.e. 25%. However, because of the low number, no definite inference should be attempted in this sample. With regard to CSOM and Secretory otitis media, even though there were large numbers, the association with snoring was not significant in both diseases.
Table V (51). Pharyngeal airway dimensions found by clinical examination in the entire sample of Students study (number of persons in each category)

<table>
<thead>
<tr>
<th>Clinical variable</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonsil size</td>
<td></td>
<td>150</td>
<td>42</td>
<td>6</td>
<td>-</td>
</tr>
<tr>
<td>Vertical dimensions</td>
<td></td>
<td>98</td>
<td>78</td>
<td>22</td>
<td>-</td>
</tr>
<tr>
<td>Horizontal dimensions</td>
<td></td>
<td>52</td>
<td>122</td>
<td>24</td>
<td>-</td>
</tr>
</tbody>
</table>

Table V (52). Pharyngeal airway dimensions found by clinical examination in non snorers, occasional snorers and habitual snorers in the Students study.

<table>
<thead>
<tr>
<th>Tonsil size Brodsky (n)</th>
<th>Non snorers n = 185</th>
<th>Occasional snorers n = 11</th>
<th>Frequent snorers n = 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>145 (97%)</td>
<td>4 (3%)</td>
<td>1 (0.7%)</td>
<td>150 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>35 (83%)</td>
<td>7 (17%)</td>
<td>0</td>
<td>42 (100%)</td>
</tr>
<tr>
<td>3</td>
<td>5 (83%)</td>
<td>-</td>
<td>1 (17%)</td>
<td>6 (100%)</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>185 (93%)</td>
<td>11 (6%)</td>
<td>2 (1%)</td>
<td>198 (100%)</td>
</tr>
</tbody>
</table>

p value < 0.001 (significant)
Table V (53). Pharyngeal airway dimensions found by clinical examination in non snorers, occasional snorers and habitual snorers in the Students study.

<table>
<thead>
<tr>
<th>Pharyngeal dimension</th>
<th>Non snorers n = 185</th>
<th>Occasional snorers n = 11</th>
<th>Frequent snorers n = 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>vertical Mallampatti</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>95 (97%)</td>
<td>3 (3%)</td>
<td>0</td>
<td>98 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>72 (92%)</td>
<td>4 (5%)</td>
<td>2 (3%)</td>
<td>78 (100%)</td>
</tr>
<tr>
<td>3</td>
<td>18 (82%)</td>
<td>4 (18%)</td>
<td>0</td>
<td>22 (100%)</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>185 (93%)</td>
<td>11 (6%)</td>
<td>2 (1%)</td>
<td>198 (100%)</td>
</tr>
</tbody>
</table>

p value 0.027 (significant)

Table V (54). Pharyngeal airway dimensions found by clinical examination in non snorers, occasional snorers and habitual snorers in the Students study.

<table>
<thead>
<tr>
<th>Pharyngeal dimension</th>
<th>Non snorers n = 185</th>
<th>Occasional snorers n = 11</th>
<th>Frequent snorers n = 2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>horizontal Tsai</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>49 (94%)</td>
<td>2 (4%)</td>
<td>1 (2%)</td>
<td>52 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>114 (93%)</td>
<td>8 (7%)</td>
<td>0</td>
<td>122 (100%)</td>
</tr>
<tr>
<td>3</td>
<td>22 (92%)</td>
<td>1 (4%)</td>
<td>1 (4%)</td>
<td>24 (100%)</td>
</tr>
<tr>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>185 (93%)</td>
<td>11 (6%)</td>
<td>2 (1%)</td>
<td>198 (100%)</td>
</tr>
</tbody>
</table>

p value 0.329 (not significant)
Table V (55). Presence of features of associated diseases by clinical examination, among the snorers and the non snorers in the Student study (n =198).

<table>
<thead>
<tr>
<th>Features of clinical conditions</th>
<th>Non snorers</th>
<th>Occ. Snorers</th>
<th>Freq. snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERD (uvula elongated or Oedematous)</td>
<td>Absent</td>
<td>185 (93.4%)</td>
<td>11 (5.6%)</td>
<td>2 (1%)</td>
<td>198 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Absent</td>
<td>182 (93.8%)</td>
<td>10 (5.2%)</td>
<td>2 (1.0%)</td>
<td>194 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>3 (75%)</td>
<td>1 (25%)</td>
<td>0</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>Nasal allergy</td>
<td>Absent</td>
<td>185 (93.4%)</td>
<td>11 (5.6%)</td>
<td>2 (1%)</td>
<td>198 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Secretory Otitis Media</td>
<td>Absent</td>
<td>15 (88.2%)</td>
<td>2 (11.8%)</td>
<td>0</td>
<td>17 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>170 (93.9%)</td>
<td>9 (5%)</td>
<td>2 (1.1%)</td>
<td>181 (100%)</td>
</tr>
<tr>
<td>CSOM</td>
<td>Absent</td>
<td>148 (94.3%)</td>
<td>8 (5.1%)</td>
<td>1 (0.6%)</td>
<td>157 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>37 (90.2%)</td>
<td>3 (7.3%)</td>
<td>1 (2.4%)</td>
<td>41 (100%)</td>
</tr>
</tbody>
</table>
F. Results of the Adult industrial workers survey:

Six hundred and two employees of all ages formed this sample. All were men. The youngest was 21 years and the oldest was 56 years. Their BMI scores ranged from 15.7 to 34.3 with a mean of 24.2 (s.d. 3.16).

The detailed data analysis is given in tables 3-7. Among all ages, the overall prevalence of snoring was 16.8%. The prevalence of snoring is seen to increase with age. In the age group, 19-29 years, the prevalence was 7.7%. In the age group 45-59 years, the prevalence was 21.5%. The loudness is not associated with either on age groups or on BMI status.

Among the snorers, 68.2 % snored occasionally and 31.8 % snored frequently. Among the snorers, the snoring status worsened with tiredness (100%), good food(92%) and with alcohol (62%).

Table V (56). Description of the industrial survey sample, age

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-29</td>
<td>207</td>
<td>34.4%</td>
</tr>
<tr>
<td>30-59</td>
<td>395</td>
<td>65.6%</td>
</tr>
<tr>
<td>Total</td>
<td>602</td>
<td>100</td>
</tr>
</tbody>
</table>

Table V (57). The frequency distribution of the BMI of the subjects of the industrial employee survey

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>24.196</td>
</tr>
<tr>
<td>Median</td>
<td>24.081</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>3.1556</td>
</tr>
<tr>
<td>Range</td>
<td>18.6</td>
</tr>
<tr>
<td>Minimum</td>
<td>15.7</td>
</tr>
<tr>
<td>Maximum</td>
<td>34.3</td>
</tr>
</tbody>
</table>
Table V (58). Presence of snoring in the Industrial employees survey subjects, by age.

<table>
<thead>
<tr>
<th>Age</th>
<th>Non snorer</th>
<th>Snorer</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-29 yrs (207)</td>
<td>191</td>
<td>16</td>
</tr>
<tr>
<td>30-59 yrs (395)</td>
<td>310</td>
<td>85</td>
</tr>
<tr>
<td>Total</td>
<td>501</td>
<td>101</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>

Table V (59). Presence of snoring in the Industrial employees survey subjects, by BMI.

<table>
<thead>
<tr>
<th>BMI category</th>
<th>Non snorer</th>
<th>Snorer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under weight (25)</td>
<td>19</td>
<td>6</td>
</tr>
<tr>
<td>Normal weight (179)</td>
<td>163</td>
<td>16</td>
</tr>
<tr>
<td>Over weight (235)</td>
<td>214</td>
<td>21</td>
</tr>
<tr>
<td>Obese (163)</td>
<td>105</td>
<td>58</td>
</tr>
<tr>
<td>Total</td>
<td>501</td>
<td>101</td>
</tr>
<tr>
<td>p value</td>
<td>&lt;0.001</td>
<td></td>
</tr>
</tbody>
</table>
Table V (60). Presence of snoring in the Industrial employees survey subjects.

<table>
<thead>
<tr>
<th>Age</th>
<th>BMI category</th>
<th>Occ snorer</th>
<th>Freq snorer</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-29 yrs</td>
<td>Under weight</td>
<td>5</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.0%</td>
<td>.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Normal weight</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.0%</td>
<td>.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Over weight</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.0%</td>
<td>.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Obese</td>
<td>2</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>50.0%</td>
<td>50.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>14</td>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>87.5%</td>
<td>12.5%</td>
<td>100.0%</td>
</tr>
<tr>
<td>30-59 yrs</td>
<td>Under weight</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100.0%</td>
<td>.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Normal weight</td>
<td>9</td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>90.0%</td>
<td>10.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Over weight</td>
<td>19</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>95.0%</td>
<td>5.0%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Obese</td>
<td>29</td>
<td>25</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td>53.7%</td>
<td>46.3%</td>
<td>100.0%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>58</td>
<td>27</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>68.2%</td>
<td>31.8%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Table V (61). Factors which worsen the snoring among the snorers in the industrial employees survey (% among the snorers i.e. 101 subjects.

<table>
<thead>
<tr>
<th>Factors which worsen snoring</th>
<th>Tiredness</th>
<th>Good food</th>
<th>Alcohol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of persons who said their snore worsens</td>
<td>100</td>
<td>93</td>
<td>63</td>
</tr>
<tr>
<td>Percentage among the snorers</td>
<td>100%</td>
<td>92%</td>
<td>62%</td>
</tr>
</tbody>
</table>
Table V (62). %ages of snorers across all units of this study (n 3271).

<table>
<thead>
<tr>
<th>S No</th>
<th>Name of the survey component</th>
<th>Focus group</th>
<th>n</th>
<th>All snorers %age within sample</th>
<th>Occasional snorers % age within sample</th>
<th>Frequent/habitual snorers % age within sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pedex</td>
<td>All ages</td>
<td>1075</td>
<td>19.5</td>
<td>16.3</td>
<td>3.3</td>
</tr>
<tr>
<td>2</td>
<td>Street survey</td>
<td>All ages</td>
<td>937</td>
<td>21.1</td>
<td>19.8</td>
<td>1.3</td>
</tr>
<tr>
<td>3</td>
<td>Industrial employees</td>
<td>adult males</td>
<td>602</td>
<td>14.1</td>
<td>9.6</td>
<td>4.5</td>
</tr>
<tr>
<td>4</td>
<td>Households</td>
<td>All ages</td>
<td>398</td>
<td>43</td>
<td>27.9</td>
<td>15.1</td>
</tr>
<tr>
<td>5</td>
<td>students</td>
<td>Young adults</td>
<td>198</td>
<td>7.6</td>
<td>6.6</td>
<td>1.0</td>
</tr>
</tbody>
</table>

G. Consolidated value of prevalence of snoring in all the study units

The units of this Prevalence phase of the study focused on a wide range of the community. The Pedex, Street survey and the Households encompassed the entire general population. The Students survey comprised of one entire class of study (third year medical students) and one entire course (all the nursing students in the college). The industrial employee covered the adult population with shift duties. In each setting, a sequential sample was taken of those who volunteered to answer the questionnaire - over 85% of those approached. No one was excluded for any reason other than non availability. Thus, we hoped to get a broad range within the sample. Basic demographic and anthropometric data were recorded. The questionnaire ascertained whether he or she snored, how often, and conditions that made the snoring worse. The definition of snoring was a general one of noise produced while sleeping. The consolidated results are given in the Table V ( ). In the general community surveys, the prevalence of snoring ranged from 20 to 40 percent. Among the young students the prevalence was low at 7.6 per cent.
Chapter VI
Part Two of the Study

Study of children with tonsillar and adenoidal enlargement, with surgical intervention

This part of the study focused on the most common cause of snoring in children, namely adenotonsillar enlargement, surgical intervention and to find out whether the surgical intervention could modify the quality of life.

Patients and Methods

All children with adenotonsillar hypertrophy, coming for treatment in the author's clinic (ENT) participated in this study. Children with any craniofacial deformity, pulmonary, cardiac, neurologic, or auditory disorder or those who were on regular medications for chronic conditions including attention deficit hyperactivity disorder (ADHD) were excluded from the study. Children less than three years of age were not included in the sample. There was no other selection and the children entered into the sample consecutively. The sample comprised of 196 children. These children had history taking, basic anthropometric measurements, clinical examination, specific upper airway clinical examination, laboratory tests and cephalometry. A disease specific quality of life questionnaire (OSA 18) was also filled up by the parents of each child. Globally standardized tools were employed in the study sheet to ensure uniformity and comparisons. When indicated, adeno tonsillectomy was done, on established clinical grounds. In the children, who had surgery, the clinical examination and the quality of life tests (OSA 18) were repeated.

Description of the tools employed in this study

1. Brouilette SNQ questionnaire: The parents filled up a snoring questionnaire (SNQ). This SNQ questionnaire is a simple one devised originally by Brouilette and successively revised by several researchers independently, namely, Brouilette 1984, Brouilette 2000, O’Brien 2004, Sohn 2003 and Suratt 2006.
In this instrument, the parents are asked to describe the frequency of their children's snoring as – never\(^1\), rarely\(^2\) (less than once per month), occasionally\(^3\) (one to four times per month), frequently\(^4\) (more than once per week), or most nights\(^5\). They were also asked how loud the snoring was – does not snore\(^1\), faint\(^2\) (cannot hear unless near the child), light\(^3\) (can hear in the same room but not too loud), moderate\(^4\) (easy to hear), or very loud\(^5\) (bothersome and cannot ignore).

Parents were also asked whether their child had “difficulty or struggling to breathe during sleep, whether the chest caves in or see-saws during sleep, whether the child stops breathing during sleep, falls asleep in school, naps in the house on returning from school, or complains of feeling tired”. They were also asked whether the child was a mouth breather - never, sometimes, or always. An additional question was whether someone else in the family had sleep apnea.

Parental response to the question on frequency in the Brouilette’s SNQ snoring questionnaire was used to stratify the children into three groups. Those who answered as ‘never’\(^1\) to the question of frequency of snoring were non snorers. Those who responded with ‘rarely’\(^2\) and ‘occasionally’\(^3\) were categorized as occasional (mild) snorers. The children, who responded with frequently\(^4\) and most nights\(^5\), were categorized as frequent (habitual) snorers.

Snoring loudness was stratified dichotomously with a ‘loud’ category comprising of levels 4 and 5 of the relevant question in the SNQ. Levels 2 and 3 were considered soft. Level 1 signified non snoring. The questions and the significance of each item and the levels of the responses are depicted on the questionnaire format itself, below:

Resistance to air inflow during sleep is manifest as snoring. When the degree of such a block increases, the child has to necessarily increase his efforts at breathing also. This increased effort at breathing is evidenced by visible caving in of chest or visible see saw movements of the chest. A response level of 3, 4 or 5 to either of the two relevant two questions in the SNQ questionnaire was considered indicative of UARS. In the absence of any hypoxia, this condition is termed UARS.

Breathing pauses noticed during sleep are acknowledged as highly significant indicators of obstructive sleep apnoea. A response level of 3, 4
or 5 to the relevant question in the SNQ, were considered indicative of apnoea. 
Sleeping at school, napping on return from school, feeling tired always are features of excessive daytime sleepiness. Response levels of 3, 4 or 5 to the relevant two questions in the SNQ were taken as indicative of EDS.

<table>
<thead>
<tr>
<th>Scores</th>
<th>1 does not snore</th>
<th>2 faint</th>
<th>3 light</th>
<th>4 moderate</th>
<th>5 very loud</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Can not hear</td>
<td>Can hear in the same room</td>
<td>Easy to hear</td>
<td>Bother some and can not ignore</td>
<td></td>
</tr>
</tbody>
</table>

1. Loudness of snoring

<table>
<thead>
<tr>
<th>Scores</th>
<th>1. never</th>
<th>2. rarely</th>
<th>3. occasionally</th>
<th>4. frequently</th>
<th>5. most nights</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(less than once per month)</td>
<td>(1-4 times a month)</td>
<td>(more than once per week)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Frequency of snoring

<table>
<thead>
<tr>
<th></th>
<th>Non snorer</th>
<th>Occasional (mild) snorer</th>
<th>frequent (habitual) snorer</th>
</tr>
</thead>
</table>

3. Difficulty or struggle to breathe during sleep

A score of 3,4 or 5 in any of these two items is taken to indicate sleep disordered breathing (SDB)

4. Chest caves in or seesaws during sleep

5. Stops breathing during sleep

A score of 3,4 or 5 is taken to indicate apnoeic episodes

6. Falls asleep in school

A score of 3,4 or 5 indicates excessive daytime sleepiness

7. Naps on coming back from school, or complains of feeling tired

8. Mouth breathing

Yes indicates Nasal block / enlarged adenoids

9. Does anyone else in the family, have sleep apnoea

Yes indicates Familial tendency
The above categorizations are represented graphically in table no. ( ).

Table VI (1) . Categorisation of the responses to the questions in the SNQ format.

2. The OSA 18 instrument is a quality of life tool, developed specifically for obstructive sleep apnoea. It has eighteen questions about snoring and breathing during sleep. The response to each item is graded into seven levels, from 1 being nought through to 7, being the most severe degree. The individual item scores of all the eighteen items are added to yield the total score. The eighteen items are arranged in five domains, namely sleep disturbance, physical suffering, emotional disturbance, daytime symptoms and care giver concerns. At the bottom of the form, a direct global rating of QOL, again with a scale of 1 - 7 is incorporated. This provides additional global information from the perception of the care giver; but it is not used in calculating the survey score.

The OSA 18 is a disease specific quality of life assessment tool, which has been validated for both discriminant and evaluation functions. Out of the domain scores, the parental response for the questions in the Emotional distress domain was used as an expedient measure of the behaviour of the child. The domain Emotional disturbance focuses on the behaviour of the child viz. mood swings, temper tantrums, hyperactive behaviour and discipline problems, as noticed by the parents themselves (who are always with the child and have an opportunity to closely observe the child).

3. The clinical examination study sheet: The clinical examination findings are categorized in the following manner.
Table VI (2). Categorisation of associated clinical conditions from the T&A study sheet

<table>
<thead>
<tr>
<th>Clinical condition</th>
<th>is evidenced by any one of the following features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mouth Breathing</td>
<td>Lips parted</td>
</tr>
<tr>
<td></td>
<td>Teeth protruding in</td>
</tr>
<tr>
<td>Features of nasal allergy</td>
<td>Nasal concha enlarged,</td>
</tr>
<tr>
<td></td>
<td>Ant nasal discharge serous and minimal,</td>
</tr>
<tr>
<td></td>
<td>post nasal discharge serous/ mucoid</td>
</tr>
<tr>
<td>Features of nasal infection / sinusitis</td>
<td>Nasal conchae enlarged,</td>
</tr>
<tr>
<td></td>
<td>Ant nasal discharge significant &amp; thick,</td>
</tr>
<tr>
<td></td>
<td>Post nasal discharge purulent</td>
</tr>
<tr>
<td>Features of GERD</td>
<td>Uvula elongated</td>
</tr>
<tr>
<td></td>
<td>Uvula oedematous</td>
</tr>
<tr>
<td>Chronic Suppurative Otitis Media</td>
<td>Ear, any side,</td>
</tr>
<tr>
<td></td>
<td>Dry CP</td>
</tr>
<tr>
<td></td>
<td>CP with discharge</td>
</tr>
<tr>
<td>Secretary Otitis Media</td>
<td>Ear, any side, Retracted</td>
</tr>
</tbody>
</table>

4. The general learning assessment: This was done by enquiring about the academic achievement in the school. A combined average of fifty percent marks in the last terminal examination was considered ‘passable’. Marks, poorer than fifty percent, were reckoned as scholastic backwardness. This grading was done to minimize misleading conclusions due to minor variations in the marks of children.

5. Anthropometric measurements: These were done by standard techniques recommended by the WHO standards and had been fully described earlier in this thesis, in the Households study unit.

6. Cephalometry: In our study, children with enlarged adenoids and tonsils had standard lateral cephalograms. The lateral cephalogram were taken with a film focus distance of five feet with the subject’s head secured in a cephalostat, in natural head posture, sitting comfortably and looking straight using a mirror eye reference position. The teeth were held in occlusion, during the exposure. The cephalograms were electronically scanned in a flat bed transparency scanner and then, digitized by the
Quickcef 2000 ® program ver 6.2 installed on a Mac computer. (Quick Ceph Systems, Inc. San Diego, California, USA).
The following traditional cephalometric points (28) and soft tissue lines (4) were first digitized with the conventional notations.

<table>
<thead>
<tr>
<th>Point</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Sella</td>
</tr>
<tr>
<td>1</td>
<td>Porion</td>
</tr>
<tr>
<td>2</td>
<td>Basion</td>
</tr>
<tr>
<td>3</td>
<td>Hinge axis</td>
</tr>
<tr>
<td>4</td>
<td>Pterygoid</td>
</tr>
<tr>
<td>5</td>
<td>Nasion</td>
</tr>
<tr>
<td>6</td>
<td>Orbitale</td>
</tr>
<tr>
<td>7</td>
<td>ANS</td>
</tr>
<tr>
<td>8</td>
<td>PNS</td>
</tr>
<tr>
<td>9</td>
<td>A point</td>
</tr>
<tr>
<td>10</td>
<td>B point</td>
</tr>
<tr>
<td>11</td>
<td>PM</td>
</tr>
<tr>
<td>12</td>
<td>Pogonion</td>
</tr>
<tr>
<td>13</td>
<td>Menton</td>
</tr>
<tr>
<td>14</td>
<td>Corpus left</td>
</tr>
<tr>
<td>15</td>
<td>Ramus down of the</td>
</tr>
<tr>
<td>16</td>
<td>Articulare &amp;</td>
</tr>
<tr>
<td>17</td>
<td>R3</td>
</tr>
<tr>
<td>18</td>
<td>R1 of the ramus</td>
</tr>
<tr>
<td>19</td>
<td>Mx 1 crown</td>
</tr>
<tr>
<td>20</td>
<td>Mx 1 root</td>
</tr>
<tr>
<td>21</td>
<td>Md 1 crown</td>
</tr>
<tr>
<td>22</td>
<td>Md 1 root</td>
</tr>
</tbody>
</table>
Occl plane midpoint between upper and lower 1st bicuspids or incisors

Mx 6 distal contact point of maxillary 1st molar ~2 mm above occlusal plane

Mx 6 root distal buccal root of the maxillary 1st molar

Md 6 distal contact point of the mandibular 1st molar ~2 mm below the occlusal plane

Md 6 root distal root of mandibular 1st molar

Lines: (i) Upper soft tissue profile from the glabella down around the upper lip contour embrasure (ii) Lower soft tissue profile from the lower lip embrasure down along the menton and the entire chin into the neck outline (iii) Mandibular bony contour from the anterior alveolar crest passing through the B point, PM, pogonion, menton, corpus left, ramus down, articulare, over the condyle to the R3, around the muscular process to R1 and ending distal to the lower molars. (iv) Maxillary bony contour from the labial surface of the mx1 through the A point, ANS, back towards the PNS and again forwards along the palatal surface and ending distal to the upper incisor.

For the airway analysis, the following additional points and lines were digitized:

C3 the most inferior and anterior point on the C3 vertebral body
H the most superior anterior point on the body of the hyoid
Rgn the most inferior posterior point on the symphysis
Go the most posterior inferior point on the angle of the mandible.

Additional lines viz. the orbital outline, pterygoid fissure, pre vertebral soft tissue shadow i.e. the adenoids, the posterior outline of the tongue, the epiglottis and the vallecula were traced to the extent possible.
### Table VI (3) The cephalometric measurements obtained by digitisation

<table>
<thead>
<tr>
<th>Cephalometric parameter</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Posterior Facial Height (Roth)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Lower facial height (Roth)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Total facial height (Roth)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Occlusal plane- SN (Steiner) angle</td>
<td>(dg)</td>
</tr>
<tr>
<td>Retrogonion to Hyoidale</td>
<td>(mm)</td>
</tr>
<tr>
<td>Hyoidale to C 3 cervical vertebral body</td>
<td>(mm)</td>
</tr>
<tr>
<td>C 3 cervical vertebral body to Retrogonion</td>
<td>(mm)</td>
</tr>
<tr>
<td>Hyoidale to Mandibular plane (H-MP distance)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Retro palatal airway distance</td>
<td>(mm)</td>
</tr>
<tr>
<td>Retro Glottal airway distance</td>
<td>(mm)</td>
</tr>
<tr>
<td>Anterior cranial base distance, S-N (Roth)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Mandibular length (Grummond) Effective mandibular length</td>
<td>(mm)</td>
</tr>
<tr>
<td>Midfacial Length (Grummond)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Maxilmand Difference (Grummond)</td>
<td></td>
</tr>
<tr>
<td>Mand length (Rick), Horizontal mandibular length</td>
<td>(mm)</td>
</tr>
<tr>
<td>Overjet (Rick)</td>
<td>(mm)</td>
</tr>
<tr>
<td>Overbite (Rick)</td>
<td>(mm)</td>
</tr>
<tr>
<td>SN-PP angle (Rick)</td>
<td>(dg)</td>
</tr>
<tr>
<td>SNA (Steiner)</td>
<td>(dg)</td>
</tr>
<tr>
<td>SNB (Steiner)</td>
<td>(dg)</td>
</tr>
<tr>
<td>ANB (Steiner)</td>
<td>(dg)</td>
</tr>
<tr>
<td>GO-GN – SN (Steiner)</td>
<td>(dg)</td>
</tr>
<tr>
<td>Wits Appraisal</td>
<td>(mm)</td>
</tr>
<tr>
<td>Occ P – SN (steiner)</td>
<td>(dg)</td>
</tr>
</tbody>
</table>
From the above measurements, the following variables were derived:

1. **Retro palatal airway space**: This is the distance in mm from the PNS to an intersecting point on the pre vertebral soft tissue outline (i.e. the adenoidal shadow), measured along a line parallel to the B - Go line passing through the PNS. This distance is also called the superior airway space (SAS).

2. **Retro glottal airway space**: This is the distance in mm from the most posterior point on the dorsal outline of the tongue to the pre vertebral soft tissue outline, measured along a posterior extension of the B - Go line. This distance is also named as Posterior airway space (PAS), by earlier researchers viz. Acebo 1996, Millman 2000.

3. **Hypopharyngeal airway space**: C3-H distance is a surrogate measure of the airway space available at the hypopharyngeal level.

4. **MP-H distance** indicates the vertical position of the hyoid in relation to the mandibular plane. The other three distances, namely Rgn-H, H-C3, and C3-Rgn indicate the relative position of the hyoid. Because the hyoid is suspended by a muscular sling, and moves between these three points, the relative position of the hyoid determines the amount of airway space available at the hypopharyngeal level. It is well established that an inferiorly placed hyoid bone causes the muscle genio glossus to get over stretched and hence, less effective in pulling the tongue forward and splinting the retro glottal airway.
It will be fruitful if it can be established whether such scenario occurs in the Indian ethnic morphology also.

5. AN ratio (adenoid nasopharyngeal ratio, as described by Li in 2002): In the confined space of the bony nasopharynx, any enlargement of the adenoidal soft tissue will compromise the airway. Hence, it will be worthwhile to assess this measurement in snorers and non snorers.

6. In a long face syndrome (adenoid facies), the extra length of the mandible is accommodated within the facial contour by a downward rotation of the mandible. This increases the ANB angle. Such an increase implies a posteriorly placed tongue and a compromise of the airway.

7. The downward rotation of the mandible in the long face syndrome also causes the lower facial height to increase. Hence, the ratio of the lower face to the total anterior facial height is also measured in this analysis. This serves as an important measure of the adenoid facies (long face syndrome).

Fig. VI (1) Li's AN ratio of the soft tissue adenoid depth to the bony distance from the sphenoid occipital suture to the PNS.

**Methodology of the Statistical analysis**

The goals of this analysis were to ascertain the clinical features, and to find out whether there was a change after therapeutic intervention, whether these changes could be predicted pre-operatively and more
specifically, whether any failure of resolution of snoring i.e. unsuccessful outcome could be predicted by simple variables beforehand. Such information will be of immense help to the clinician to counsel the parents regarding what could be expected realistically from surgery.

All data were entered into a computer, checked, and analysed by the SPAS ver. 15 statistical package. The parameters of frequency distribution were calculated in the usual manner. The 95% confidence intervals (CI) of the prevalence figures were estimated on the assumption of a normal distribution. The interrelations among the data were first examined by Pearson’s chi square test, ‘t’ test of equality of means and by analysis of variance, as appropriate.

The total sample was first defined by its descriptive statistics. Then the prevalence of snoring was assessed, followed by the character of snoring - frequent or occasional, loud or soft.

The presence of other features of snoring viz. UARS, Apnoea and EDS were tested for significant associations. When additional disease conditions like nasal allergy, sinusitis, secretory otitis media, CSOM and GERD were present, they were also tested for significance. As for the clinical characteristics of snoring subjects, the variables were tested for the equality of means.

The longitudinal effect of therapeutic intervention was studied by the change scores of the QOL tool. The treatment effect was studied by resorting to z scores of the effect change, otherwise called as standardised response means (SRMs).

The general learning ability of the three groups, namely non snorers, occasional snorers and frequent snorers, were compared in the pre operative stage i.e. in the unchanged state without the intervention of surgery. Similarly, the emotional domain scores were tested for significant associations amongst the same three groups, in the same pre operative state.

Additionally, in the 125 operated children, the OSA 18 emotional disturbances domain scores were compared between the pre operative and the post operative states for the significance of the therapeutic effect.
Results and discussion of the Interventional study of children with adeno tonsillar enlargement

1. Description of the sample:

The sample comprised of 196 children with various degrees of tonsillar enlargement. There were 118 boys and 78 girls. Their ages ranged from 3 years to 15 years. The BMI and SES also ranged widely. Based on clinical reason, out of the 196, one hundred and twenty five children had adeno tonsillectomy. 71 children did not undergo surgery. Thus the sample was a well represented one. (Table 4)

Table VI (4). Description of the interventional study sample age groups and gender.

<table>
<thead>
<tr>
<th>Age</th>
<th>Total</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5</td>
<td>53 (27%)</td>
<td>33 (62%)</td>
<td>20 (38%)</td>
</tr>
<tr>
<td>6-8</td>
<td>77 (39.3%)</td>
<td>40 (52%)</td>
<td>20 (48%)</td>
</tr>
<tr>
<td>&gt; 8 yrs</td>
<td>66 (33.7%)</td>
<td>45 (68%)</td>
<td>21 (32%)</td>
</tr>
<tr>
<td>Total</td>
<td>196 (100%)</td>
<td>118 (60 %)</td>
<td>78 (40 %)</td>
</tr>
</tbody>
</table>

Table VI (5). Description of the interventional study sample - BMI.

<table>
<thead>
<tr>
<th>BMI Category WHO 2002 Singapore rev. for Asia</th>
<th>Description of category</th>
<th>Males (% within BMI category)</th>
<th>Females (% within BMI category)</th>
<th>Total persons in this BMI category (% of 196)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>&lt;14.9</td>
<td>20 (69%)</td>
<td>9 (31%)</td>
<td>29 (15%)</td>
</tr>
<tr>
<td>Underweight</td>
<td>15-18.4</td>
<td>57 (54%)</td>
<td>48 (46%)</td>
<td>105 (54%)</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-22.9</td>
<td>36 (64%)</td>
<td>20 (36%)</td>
<td>56 (29%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>23-27.5</td>
<td>5 (83%)</td>
<td>1 (17%)</td>
<td>6 (3%)</td>
</tr>
<tr>
<td>Obese</td>
<td>27.6-40</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Morbidly obese</td>
<td>&gt;40</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>118</td>
<td>78</td>
<td>196 (100%)</td>
</tr>
</tbody>
</table>
2. Prevalence of snoring in the interventional study sample:

(i) Overall prevalence of snoring in this sample: 191 children out of the total of 196 children were found to snore (97%). The sample population represents the children who are typically seen in an outpatient ENT clinic and all the children had consulted for adenotonsillar enlargement; hence, the higher percentage.

(ii) Prevalence of snoring by gender: Out of the 191 snoring children, 115 were males and 76 were females. Percentage-wise, 97% of all the male children in this study population snored and equal percentage among the female population children snored. Thus, among the children, there was no gender predilection for snoring. This fact is borne out in almost all the other studies.

Table VI (7). Number of snorers within the Interventional study sample by gender

<table>
<thead>
<tr>
<th>Category</th>
<th>Gender Male (number)</th>
<th>Gender Female (number)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snorers</td>
<td>115</td>
<td>76</td>
<td>191</td>
</tr>
<tr>
<td>Non snorers</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>118</td>
<td>78</td>
<td>196</td>
</tr>
</tbody>
</table>
Table VI (8). Percentages of snorers within the respective gender population in the interventional study.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male % within total male sample 118</th>
<th>Female % within total female sample 78</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snorers</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>Non snorers</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

(iii) Prevalence of snoring by age groups: Within the children available in the 3-5 year age group, 37.8 percent of children. Within the age group of 5 - 8 years, the percentage of snorers was 2.6 percent. Among the children, aged more than 8 years, 1.5% snored. This difference in the percentage of snorers by age groups was statistically significant.

This age grouping was made by keeping in mind the lymphoid growth cycle. Usually, there are two growth spurts, the first one at 3 ½ years and the second, at 7 years of age. The first age grouping of 3-5 years in this analysis, is centered around the first spurt and the second group is centered around the second spurt.

Thus, the maximum presence of snoring was seen in the 3-5 year old children, coinciding with the first spurt of lymphoid growth cycle.

Table VI (9). Number of children snoring by age groups, in the Interventions study sample

<table>
<thead>
<tr>
<th>Age (n in the age group)</th>
<th>Non snorers (% within the age group)</th>
<th>Snorers (% within the age group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5 (53)</td>
<td>2 (3.8%)</td>
<td>51 (96.2%)</td>
</tr>
<tr>
<td>5.1-8 (77)</td>
<td>2 (2.6 %)</td>
<td>75 (97.4%)</td>
</tr>
<tr>
<td>&gt; 8 (66)</td>
<td>1 (1.5%)</td>
<td>65 (98.5%)</td>
</tr>
<tr>
<td>Total (196)</td>
<td>5 (2.6%)</td>
<td>191 (97.5%)</td>
</tr>
</tbody>
</table>
(iv) **Frequency of snoring:** The parental response to the question on frequency in the Brouilette's SNQ snoring questionnaire was used to stratify the children into three groups, namely non snorer, occasional snorers and frequent snorers. It was found that within the snoring children, 81% snored frequently; 17% snored occasionally and 3% did not snore.

When analysed by the age groups (table no. VI-10), within the three age groups, the percentages of frequent snorers were respectively eighty one, seventy nine and eighty one. On statistical analysis, this difference was found to be not significant. Hence, this hypothesis is not confirmed in this sample.

Thus, while the presence of snoring itself is significantly higher in the 3-5 year old children, the frequency of snoring does not have significance,

**Table VI (10). Number of occasional and frequently snoring children by age groups, in the Interventional study sample**

<table>
<thead>
<tr>
<th>Age</th>
<th>Non snorers (% within the age group)</th>
<th>Occ Snorers (% within the age group)</th>
<th>Freq Snorers (% within the age group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5</td>
<td>2 (3.78%)</td>
<td>8 (15.1%)</td>
<td>43 (81.1%)</td>
</tr>
<tr>
<td>5.1-8</td>
<td>2 (2.6 %)</td>
<td>14 (18.2%)</td>
<td>61 (79.2%)</td>
</tr>
<tr>
<td>&gt; 8</td>
<td>1 (1.5%)</td>
<td>11 (16.7%)</td>
<td>54 (81.8%)</td>
</tr>
<tr>
<td>Total</td>
<td>5 (2.6%)</td>
<td>33 (16.8%)</td>
<td>158 (80.6%)</td>
</tr>
</tbody>
</table>

p value of the difference between the snorer type within each age group
0.91
(not significant)

(iv) **Prevalence by BMI:** The BMI of snorers and non snorers is given in the table VI (10). With regard to BMI, snoring was found in all BMI groups including starvation level category, under weight category and normal weight category. Percentage wise, the presence of snoring was found to increase steadily from the lowest category (starvation levels) through underweight up to the normal levels. In the overweight category however,
there was a fall; but the numbers in this category were small. There were no snorers in the higher categories, in this population. When the chi square test of significance was applied, the p value was 0.287 i.e. there is no significant association between the BMI category and snoring. Similarly, in several earlier studies (cf. Literature review chapter of this thesis), it had been found that in children, BMI does not have any significance.

When the prevalence of the two different types of snoring, namely occasional and frequent snoring was analysed in relation to BMI, the prevalence of snoring was found to increase, percentage wise, with increasingly higher BMI category. However, the difference was not statistically significant. p value was 0.665. Thus, neither the over all prevalence nor the frequency of snoring has any significant association with the BMI in children.

Table VI (11). Number of children snoring by BMI, in the Interventional study sample

<table>
<thead>
<tr>
<th>BMI Category WHO 2002 Singapore rev. for Asia</th>
<th>Description of category</th>
<th>Total persons in this BMI category</th>
<th>Total snorers in this BMI category</th>
<th>% age of snorers within the respective BMI category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>&lt;14.9</td>
<td>29</td>
<td>27</td>
<td>93</td>
</tr>
<tr>
<td>Underweight</td>
<td>15-18.4</td>
<td>105</td>
<td>102</td>
<td>97</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-*</td>
<td>56</td>
<td>56</td>
<td>100</td>
</tr>
<tr>
<td>Overweight</td>
<td>23-27.5</td>
<td>6</td>
<td>4</td>
<td>67</td>
</tr>
<tr>
<td>Obese</td>
<td>27.6-40</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Morbidly obese</td>
<td>&gt;40</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>All BMI categories</td>
<td></td>
<td>196</td>
<td>189*</td>
<td>BMI data missing for 2</td>
</tr>
</tbody>
</table>

p value for the difference between snorers and non snorers under each BMI category is 0.287
### Table VI (12). Frequency of snoring in different BMI categories in the interventional study sample.

<table>
<thead>
<tr>
<th>BMI Category WHO 2002 Singapore rev. for Asia (n)</th>
<th>Description of category</th>
<th>Non snorers</th>
<th>Occasional snorers</th>
<th>Frequent snorers (% of freq snorers within the respective BMI category)</th>
<th>Total snorers (% of all types of snoring children within the respective BMI category)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation (29)</td>
<td>&lt;14.9</td>
<td>2</td>
<td>4 (14%)</td>
<td>23 (79%)</td>
<td>27 (93%)</td>
</tr>
<tr>
<td>Underweight (105)</td>
<td>15 - 18.4</td>
<td>3</td>
<td>17 (16%)</td>
<td>85 (81%)</td>
<td>102 (97%)</td>
</tr>
<tr>
<td>Normal (56)</td>
<td>18.5 - 22.9</td>
<td>0</td>
<td>10 (18%)</td>
<td>46 (82%)</td>
<td>56 (100%)</td>
</tr>
<tr>
<td>Overweight (4)</td>
<td>23 - 27.5</td>
<td>0</td>
<td>1 (25%)</td>
<td>3 (75%)</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>Obese</td>
<td>27.6 - 40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Morbidly obese</td>
<td>&gt;40</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5 (3%)</td>
<td>32 (17%)</td>
<td>157 (81%)</td>
<td>194* (100%)</td>
</tr>
</tbody>
</table>

p value 0.665  * Missing data for 2 children

### Table VI (13). Loudness of snore in the snoring children in the interventional study sample by gender

<table>
<thead>
<tr>
<th></th>
<th>Soft</th>
<th>Loud</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>75 (65%)</td>
<td>40 (32%)</td>
<td>115 (100%)</td>
</tr>
<tr>
<td>Female</td>
<td>55 (72%)</td>
<td>21 (28%)</td>
<td>76 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td>130 (68%)</td>
<td>61 (32%)</td>
<td>191 (100%)</td>
</tr>
</tbody>
</table>

p value of differences in the frequencies between gender = 0.299

4. **Loudness of snoring**: Out of the 191 snorers in the interventional study group, 68% snored softly and 32% snored loudly. There was no difference between genders. As it is well established by now, that the risks of snoring is related more to the snoring frequency, the loudness attribute was not probed further.
4. Upper airway resistance syndrome (UARS) and snoring: Two children within the snoring population had features of UARS, while none of the five non snorers had such features (p value = 0.818). Thus, statistically, there was no significant association between UARS by history and the presence of snoring.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of UARS between the occasional snorers and the frequent snorers was tested for significance. The p value was 0.784. Thus, there is no significant difference between non snorers, occasional snorers and frequent snorers in the prevalence of UARS, in this sample.

5. Apnoic episodes and snoring: In this sample, breathing pauses were noticed in 32 of the snorers and in none of the non snorers.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of apnoea between the occasional snorers and the frequent snorers was tested for significance. The p value was 0.317. Thus, there is significant difference between occasional snorers and frequent snorers in the prevalence of Apnoea, in this sample.

6. Excessive daytime sleepiness (EDS) and snoring: In this sample, EDS was present in 100% of the snorers and in none of the non snorers. The p value of the differences was 0.152.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of EDS between the occasional snorers and the frequent snorers was tested for significance. The p value was < 0.001. Thus, there is significant difference between occasional snorers and frequent snorers in the prevalence of EDS, in this sample.

Inference in this study on the presence of UARS, Apnoea and EDS in snorers: In this sample population of children with adeno tonsillar enlargement, the relative frequencies of UARS, Apnoea and EDS are interesting. The following important points are noted in this sample:

(i) Struggling to breathe, chest caving in or see sawing (features of UARS), breathing pauses (a feature of apnoea), sleeping during school hours, napping at home, unrefreshed sleep and continuous tiredness (features of
EDS) were significantly present only in snorers and were absent or less frequent in the non snorers.

(ii) There is no difference in the prevalence of UARS, Apnoea and EDS among snorers and non snorers, when all snorers are clubbed together and considered as a single unit i.e. UARS, Apnoea and EDS are present in both snorers and non snorers in the same frequency.

(iii) But, when the snoring frequency is factored in, there is a significant difference - apnoea and EDS are more frequent in the frequent snorers. Hence, when a child comes with a history of snoring, care must be taken to identify this population of frequent snorers - because it is this population which is at risk.

Table VI (14). Presence of features of associated diseases by history (SNQ), among the snorers and the non snorers in the interventional study sample (n =196)

<table>
<thead>
<tr>
<th>Features of clinical condition</th>
<th>Non snorers (n 5)</th>
<th>All Snorers (n 191)</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Upper airway resistance syndrome</strong> (a response of 3, 4 or 5 to the SNQ, difficulty or struggle to breathe during sleep or Q. chest caves in or seesaws during sleep.</td>
<td>Absent 5 (3 %)</td>
<td>189 (97%)</td>
<td>194</td>
<td>.818</td>
</tr>
<tr>
<td></td>
<td>Present 0</td>
<td>2 (100%)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Apnoea</strong> (a response of 3, 4 or 5 to the SNQ. Stops breathing during sleep )</td>
<td>Absent 5 (3%)</td>
<td>159 (97%)</td>
<td>164</td>
<td>.317</td>
</tr>
<tr>
<td></td>
<td>Present 0</td>
<td>32 (100%)</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td><strong>EDS</strong> (a response of 3, 4 or 5 to the SNQ. Falls asleep in school, or naps on coming back from school, or complains of feeling tired)</td>
<td>Absent 5 (4%)</td>
<td>135 (96%)</td>
<td></td>
<td>.152</td>
</tr>
<tr>
<td></td>
<td>Present 0</td>
<td>56 (100%)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table VI (15). Presence of features of associated diseases by history (SNQ), among the snorers and the non snorers in the interventional study sample, analysed with respect to the frequency of snoring.

<table>
<thead>
<tr>
<th>Features of clinical condition</th>
<th>Non snorers</th>
<th>Occ. Snorers</th>
<th>Freq. Snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UARS</strong>&lt;br&gt;({a response of 3, 4 or 5 to the SNQ. Difficulty or struggle to breathe during sleep or Q. chest caves in or seesaws during sleep.})&lt;br&gt;Present</td>
<td>0</td>
<td>0</td>
<td>32 (100%)</td>
<td>32 (100%)</td>
<td>.01</td>
</tr>
<tr>
<td>Absent</td>
<td>5 (3%)</td>
<td>33 (20%)</td>
<td>126 (77%)</td>
<td>164 (100%)</td>
<td></td>
</tr>
<tr>
<td><strong>Apnoea</strong>&lt;br&gt;({a response of 3, 4 or 5 to the SNQ. Stops breathing during sleep})&lt;br&gt;Present</td>
<td>0</td>
<td>0</td>
<td>56 (24%)</td>
<td>56 (100%)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Absent</td>
<td>5 (4%)</td>
<td>33 (24%)</td>
<td>102 (73%)</td>
<td>140 (100%)</td>
<td></td>
</tr>
<tr>
<td><strong>EDS</strong>&lt;br&gt;({a response of 3, 4 or 5 to the SNQ. Naps on coming back from school, or complains of feeling tired or to SNQ.})&lt;br&gt;Present</td>
<td>0</td>
<td>0</td>
<td>56 (%)</td>
<td>56 (100%)</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>5 (3%)</td>
<td>33 (17%)</td>
<td>156 (80%)</td>
<td>194 (80%)</td>
<td>.784</td>
</tr>
</tbody>
</table>

7. **GERD and snoring**: In this sample, by clinical examination, features suggestive of GERD were present in 2% of children. One hundred per cent of them had snoring. However, the p value of the difference between the snorers and non snorers was 0.744 (not significant). Thus, the presence of GERD in snorers was not any different than in non snorers.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of GERD between the occasional snorers and the frequent snorers was tested for significance. The p value was still 0.197 i.e. not significant. Thus, GERD is not significantly associated with snoring, in this sample. This conclusion remains valid both when all snorers are taken together and when the frequent snorers are segregated and taken up for analysis Table VI (15).
8. Sinusitis and snoring: In this sample, by clinical examination, features suggestive of sinusitis were present in 188 (ninety three percent) children. Within these 188 children having sinusitis, 97 % had snoring. 3 % did not have any snoring. The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of sinusitis between the occasional snorers and the frequent snorers was tested for significance. The p value was <0.001 i.e. highly significant. Thus, when the frequent snorers are specifically identified and the presence of sinusitis is looked for, we find a highly significant association, in this sample. Table VI (15).

9. Nasal allergy and snoring: In this sample, by clinical examination, features suggestive of nasal allergy were present in 7% of children. 98% within them had snoring. The p value of the difference between the snorers and non snorers was 0.004. Thus, nasal allergy and snoring were significantly associated positively.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of nasal allergy between the occasional snorers and the frequent snorers was tested for significance. The p value was <0.001 i.e. highly significant. Thus, when the frequent snorers are specifically identified and the presence of nasal allergy is looked for, we find a highly significant positive association, in this sample.

10. Secretory otitis media and snoring: In this sample, by clinical examination, features of secretory otitis media were present in 77% of children. One hundred percent of them 86% were snorers. The p value of the difference was <0.001. Thus, there is a positive association between the secretory otitis media and snoring.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of secretory otitis between the occasional snorers and the frequent snorers was tested for significance. The p value was still highly significant (<0.001). Thus, regardless of the frequency of snoring, we find a highly significant positive association between snoring and secretory otitis media, in this sample.

11. CSOM and snoring: In this sample, by clinical examination, features suggestive of CSOM were present in 11 % of children. One hundred percent of them had snoring. However, the p value of the difference between the snorers and non snorers was 0.433 (not significant). Thus, the presence
of CSOM in all snorers (taken as a whole), was not any different than in non
snorers.

The sample data were further analysed with reference to the frequency of
snoring i.e. the difference for the presence of CSOM between the
occasional snorers and the frequent snorers was tested for significance.
The p value was <0.001 i.e. highly significant. Thus, when the frequent
snorers are specifically identified and the presence of CSOM is looked for,
we find a highly significant association, in this sample.

Inference in this study about the associated diseases viz. nasal allergy,
secretory otitis media, sinusitis, CSOM and GERD:–

(i) All the snorers, regardless of whether they are frequent
snorers or occasional snorers, have a higher presence of
nasal allergy and secretory otitis media.

(ii) Snorers, when taken up for statistical analysis as a whole, do
not show any increased presence of sinusitis or CSOM. But
when the frequent snores are segregated and analysed
separately, the frequent snorers have a significantly higher
presence of sinusitis and CSOM.

(iii) All snorers, regardless of whether they are analysed in toto
or whether they are segregated and analysed, do not show
any association with GERD.
Table VI (16). Presence of features of associated diseases by clinical examination, among the snorers and the non snorers in the interventional study sample (n =196).

<table>
<thead>
<tr>
<th>Features of clinical conditions</th>
<th>Non snorers</th>
<th>All Snorers</th>
<th>Total (% of total sample 196)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERD (uvula elongated or Oedematous)</td>
<td>Absent 5 (3%)</td>
<td>187 (97%)</td>
<td>192</td>
<td>.744</td>
</tr>
<tr>
<td></td>
<td>Present 0</td>
<td>4 (100%)</td>
<td>4 (2%)</td>
<td></td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Absent 0</td>
<td>8 (100%)</td>
<td>8</td>
<td>.640</td>
</tr>
<tr>
<td></td>
<td>Present 5 (3%)</td>
<td>183 (97%)</td>
<td>188 (93%)</td>
<td></td>
</tr>
<tr>
<td>Nasal allergy</td>
<td>Absent 3 (2%)</td>
<td>179 (98%)</td>
<td>182</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Present 2 (14%)</td>
<td>12 (98%)</td>
<td>14 (7%)</td>
<td></td>
</tr>
<tr>
<td>Secretory Otitis Media</td>
<td>Absent 5 (11%)</td>
<td>40 (86%)</td>
<td>45</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Present 0</td>
<td>151 (100%)</td>
<td>151 (77%)</td>
<td></td>
</tr>
<tr>
<td>CSOM</td>
<td>Absent 5 (3%)</td>
<td>170 (97%)</td>
<td>175</td>
<td>.433</td>
</tr>
<tr>
<td></td>
<td>Present 0</td>
<td>21 (100%)</td>
<td>21 (11%)</td>
<td></td>
</tr>
</tbody>
</table>
Table VI (17). Presence of features of associated diseases by clinical examination, among the snorers and the non snorers in the interventional study sample (n =196), analysed with respect to the frequency of snoring.

<table>
<thead>
<tr>
<th>Features of clinical conditions</th>
<th>Occ. Snorers</th>
<th>Freq. snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERD (uvula elongated or Oedematous)</td>
<td>Absent 31 (16.5%)</td>
<td>156 (83.5%)</td>
<td>187 (100%)</td>
<td>0.08</td>
</tr>
<tr>
<td></td>
<td>Present 2 (50%)</td>
<td>2 (50%)</td>
<td>4 (100%)</td>
<td></td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Absent 8 (100%)</td>
<td>0</td>
<td>8 (100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Present 25 (14%)</td>
<td>158 (86%)</td>
<td>183 (100%)</td>
<td></td>
</tr>
<tr>
<td>Nasal allergy</td>
<td>Absent 21 (12%)</td>
<td>158 (88%)</td>
<td>179 (100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Present 12 (100%)</td>
<td>0</td>
<td>12 (100%)</td>
<td></td>
</tr>
<tr>
<td>Secretory Otitis Media</td>
<td>Absent 12 (30%)</td>
<td>28 (70%)</td>
<td>40 (100%)</td>
<td>0.016</td>
</tr>
<tr>
<td></td>
<td>Present 21 (14%)</td>
<td>130 (86%)</td>
<td>151 (100%)</td>
<td></td>
</tr>
<tr>
<td>CSOM</td>
<td>Absent 12 (7%)</td>
<td>158 (93%)</td>
<td>170 (100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Present 21 (100%)</td>
<td>0</td>
<td>21 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

12. Size of the tonsil and snoring: The tonsil size of the children in this study was recorded as per Brodsky's recommendations. The Brodsky's sizes were dichotomized into a significantly 'enlarged' group comprising of sizes 1 and 2 and 'not enlarged' group of sizes 3 and 4.

Ninety per cent of the children in this sample had 'enlarged' tonsils. Within this group of children having enlarged tonsils, one hundred per cent children were snorers. Within the non enlarged group, 75% were snorers. This difference was significant with a p value of <0.001. On further
analysis after segregation into frequent snorer and occasional snorer groups, the p value was still highly significant (p <0.001).

Table VI (18). Presence of snoring in children with increasing tonsil size, as noticed in the clinic at the first visit among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Tonsil sizes (Brodsky) at first visit</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Just outside (25% airway obstruction)</td>
<td>n 1</td>
<td>0 (11%)</td>
<td>1 (100%)</td>
<td>47 (100%)</td>
</tr>
<tr>
<td>II. Readily seen (25 – 50 % airway obstruction)</td>
<td>n 19</td>
<td>5 (26.3%)</td>
<td>14 (73.7%)</td>
<td>19 (100%)</td>
</tr>
<tr>
<td>III. Midway (50-75% airway Obstruction)</td>
<td>n 132</td>
<td>0</td>
<td>132 (100%)</td>
<td>132 (100%)</td>
</tr>
<tr>
<td>IV. almost in the midline (. 75% airway Obstruction)</td>
<td>n 44</td>
<td>0</td>
<td>44 (100%)</td>
<td>44 (100%)</td>
</tr>
</tbody>
</table>

Table VI (19). Frequency of snoring in children with increasing tonsil size, as noticed in the clinic at the first visit among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Tonsil sizes (Brodsky) at first visit</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Just outside (25% airway obstruction)</td>
<td>n 1</td>
<td>0 (11%)</td>
<td>1 (100%)</td>
<td>0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>II. Readily seen (25 – 50 % airway obstruction)</td>
<td>n 19</td>
<td>5 (26.3%)</td>
<td>14</td>
<td>13 (68.4%)</td>
<td>1 (5.3%)</td>
</tr>
</tbody>
</table>
III. Midway (50-75% airway Obstruction)  

<table>
<thead>
<tr>
<th>Tonsil size At first visit</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total (% of the total sample of 196)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enlarged</td>
<td>5 (25%)</td>
<td>15 (75%)</td>
<td>20 (10%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Enlarged (Brodsky scale size 3 and 4 considered as enlarged)</td>
<td>0</td>
<td>176 (100%)</td>
<td>176 (90%)</td>
<td></td>
</tr>
</tbody>
</table>

Table VI (20). Presence of snoring in children with and without tonsil enlargement, as noticed in the clinic at the first visit among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Tonsil size At first visit</th>
<th>Non snorers</th>
<th>Occ. Snorers</th>
<th>Freq. snorers</th>
<th>All snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enlarged n 20</td>
<td>5 (25%)</td>
<td>14 (70%)</td>
<td>1 (5%)</td>
<td>15 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Table VI (21). Frequency of snoring in children with and without tonsil enlargement, as noticed in the clinic at the first visit among the Interventional study subjects.
13. Mallampatti score and snoring: The Mallampatti score (MS) is a measure of the vertical dimension of the airway. In this scoring system, depending on the structures which are obscured by the tongue dorsum in the vertical plane, the scores are given. The higher the number, less would be the available airway.

In this sample, within the children with a score of MS I, eighty nine percent snored. Within the children with a score of MS II and MS III, one hundred per cent snored. There were no children with MS IV score. This difference was highly significant (p < 0.001).

When the snorers were segregated into frequent and occasional snorers also, the differences continued to be significant at a p level of <0.001.

Table VI (22). Presence of snoring in children with increasing Mallampatti scores, (vertical measure of pharyngeal airway), as noticed in the clinic at the first visit among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Mallampatti score (structures seen)</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. (soft palate, uvula, fauces, pillars) n 47</td>
<td>5 (11%)</td>
<td>42 (89%)</td>
<td>47 (100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>II. (soft palate, uvula, fauces) n 142</td>
<td>0</td>
<td>142 (100%)</td>
<td>142 (100%)</td>
<td></td>
</tr>
<tr>
<td>III. soft palate, base of uvula) n 7</td>
<td>0</td>
<td>7 (100%)</td>
<td>7 (100%)</td>
<td></td>
</tr>
<tr>
<td>IV. (soft palate not seen at all) n 0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

Table VI (23). Presence of snoring in children with increasing Mallampatti scores (vertical measure of pharyngeal airway), as noticed in the clinic at the first visit among the Interventional study subjects.
### Measure of vertical pharyngeal airway

**Mallampatti score**: (structures seen)

<table>
<thead>
<tr>
<th></th>
<th>Non snorers</th>
<th>Total snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. (soft palate, uvula, fauces, pillars)</strong></td>
<td>5 (10.6%)</td>
<td>42</td>
<td>4 (8.5%)</td>
<td>38 (80.9%)</td>
<td>.001</td>
</tr>
<tr>
<td><strong>II. (soft palate, uvula, fauces)</strong></td>
<td>0</td>
<td>142</td>
<td>28 (19.7%)</td>
<td>114 (80.3%)</td>
<td></td>
</tr>
<tr>
<td><strong>III. soft palate, base of uvula</strong></td>
<td>0</td>
<td>7</td>
<td>1 (14.3%)</td>
<td>6 (85.7%)</td>
<td></td>
</tr>
<tr>
<td><strong>IV. (soft palate not seen at all)</strong></td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>

14. Tsai pharyngeal grading and snoring: The Tsai pharyngeal grade score (TS) is a measure of the vertical dimension of the airway. In this scoring system, depending on the intersection of the posterior pillar of the fauces over the dorsum of the tongue, in the horizontal plane, the scores are given. The higher the number, less would be the available airway.

In this sample, within the children with a score of Tsai I, ninety one percent snored. Within the children with a score of TS II and TS III, one hundred per cent snored. There were no children with TS IV score. This difference was highly significant (p <0.001). When the snorers were segregated into frequent and occasional snorers also, the differences continued to be significant at a p level of <0.001.

Inference in this study about the association of pharyngeal dimension measures with snoring: The tonsil sizes, Mallampatti score and Tsai pharyngeal grades are significantly higher in all snorers. Such significance is even higher in frequent snorers.

Table VI (24). Presence of snoring in children in different scores of Tsai scale (horizontal measure of pharyngeal airway), as noticed in the clinic at the first visit among the Interventional study subjects.
<table>
<thead>
<tr>
<th>Measure of horizontal pharyngeal airway (Tsai pharyngeal grading)</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. (posterior faucial arch intersects tongue at its lateral edge)</td>
<td>5 (9%)</td>
<td>48 (91%)</td>
<td>53 (100%)</td>
<td>.001</td>
</tr>
<tr>
<td>II. (arch intersects at 25% of tongue diameter)</td>
<td>0</td>
<td>135 (100%)</td>
<td>135 (100%)</td>
<td></td>
</tr>
<tr>
<td>III. (arch intersects at 50% of tongue diameter)</td>
<td>0</td>
<td>8 (100%)</td>
<td>8 (100%)</td>
<td></td>
</tr>
<tr>
<td>IV. (arch intersects at 75% or more of tongue diameter)</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table VI (25). Presence of snoring in children in different scores of Tsai pharyngeal grading (horizontal measure of pharyngeal airway), as noticed in the clinic at the first visit among the Interventional study subjects, analysed with respect to the frequency of snoring.
12. Tonsil sizes and adenoid sizes, recorded at the time of surgery, and snoring:

One hundred and twenty five children among this total sample of 196 underwent adeno tonsillectomy. Among these children, 104 snored frequently or most nights. They were classified as frequent (habitual) snorers, just like earlier. Rest of the children either did not snore or snored occasionally. These were classified as 'others', for this analysis.

In the operated children, the opportunity for a relaxed examination of the adenoid sizes and the tonsil sizes was utilized. The tonsils and the adenoids were graded by the Brodsky and the Bitar scales respectively. The Brodsky's sizes were dichotomized into a significantly 'enlarged' group comprising of sizes 1 and 2 and 'not enlarged' group of sizes 3 and 4. One hundred and twenty (90%) of the operated children had 'enlarged' tonsils. The Bitar sizes were dichotomized into a significantly 'enlarged' group comprising of sizes 1 and 2 and 'not enlarged' group of size 3. Forty three children (66%) of the operated children had 'enlarged' adenoids.

Within this group of enlarged tonsils, 87% were habitual snorers. Among the 'tonsil-non enlarged' group, there were no habitual snorers. This difference was significant with a p value of <0.001.

Within this group of enlarged adenoids, 88% were habitual snorers. Among the adenoids- not enlarged' group, 80% children were habitual snorers. This difference was not significant with a p value of 0.263.
Hence this hypothesis is inferred: on the sizes of tonsil sizes and adenoid sizes found at the time of surgery in mild and habitual snorers: Enlarged tonsils have a significant association with snoring, both mild and habitual, while the adenoid sizes did not have any such association.

Table IV (26). Presence of snoring in children with enlarged Tonsils and enlarged adenoids, as noted on the operating table at the time of surgery, in the Interventional study.

<table>
<thead>
<tr>
<th></th>
<th>Others</th>
<th>Habitual snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tonsil size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brodsky scale</td>
<td>Not enlarged sizes 1 or 2</td>
<td>5 (100%)</td>
<td>0</td>
<td>5 (100%)&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>4% of the 125 operated children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enlarged sizes 3 or 4</td>
<td>16 (13.3%)</td>
<td>104 (86.7%)</td>
<td>120 (100%)</td>
</tr>
<tr>
<td></td>
<td>96% of operated children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Adenoid size</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bitar scale</td>
<td>Not enlarged sizes 1 or 2</td>
<td>16 (19.5%)</td>
<td>66 (80.5%)</td>
<td>82 (100%) 0.263</td>
</tr>
<tr>
<td></td>
<td>66% of operated children</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Enlarged size 3</td>
<td>5 (11.6%)</td>
<td>38 (88.4%)</td>
<td>43 (100%)</td>
</tr>
<tr>
<td></td>
<td>34% of operated children</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

13. Emotional disturbances and snoring: The OSA 18 is a disease specific quality of life assessment tool, which has been validated both for discriminant and evaluation functions. The parental response for the emotional distress domain of this instrument is used in this analysis, as an expedient measure of behaviour. The habitual snorers and 'the others' were considered as two independent groups. The emotion domain score was calculated for the two groups, in the pre operative state (which is the state unchanged by any therapeutic intervention of surgery). The mean and the distribution characteristics for each group were tested for equality of means. The p value was 0.003. Thus, there is a significant association.
between the frequency of snoring and emotional disturbances, in this sample.

Table VI (27). Emotional disturbance domain scores between mild snorers and habitual snorers, in the pre operative state

<table>
<thead>
<tr>
<th>Snorer type</th>
<th>OSA 18 emotion domain scores in the pre op state</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Others (33)</td>
<td>4.29</td>
</tr>
<tr>
<td>Habitual snorers (158)</td>
<td>5.16</td>
</tr>
</tbody>
</table>

*t' test for equality of means: p 0.003

14. Learning and snoring: Fragmented sleep may impair the skill sets necessary for learning. The general learning assessment was done by enquiring about the academic achievement in the school. A combined average of fifty percent marks in the last terminal examination was considered ‘passable’. Marks, poorer than fifty percent, were reckoned as scholastic backwardness. This grading was done to minimize misleading conclusions due to minor variations in the marks of children. The percentages are given in the table no VI (28). The p value for the difference between the mild and habitual snorer was not significant.

Inference: There was no difference in the overall academic performance, as measured by the school marks between the frequent and occasional snorer groups.

Table VI (28). Over all academic performance, measured by school marks in the last terminal examination.

<table>
<thead>
<tr>
<th></th>
<th>Passable marks &gt; 50 % in the last terminal examinations</th>
<th>Scholastic backwardness &lt; 50 % in the last terminal examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild snorers n 30</td>
<td>22 (73%)</td>
<td>8(27%)</td>
</tr>
<tr>
<td>Habitual snorers n 72</td>
<td>54 (75%)</td>
<td>18(25%)</td>
</tr>
</tbody>
</table>

* missing data in 23 children p value .38
14. Cephalometric variables and snoring:

The bony framework of the head and neck defines the hard matrix, within which the soft tissues of the pharyngeal airway are juxtaposed. This bony matrix can be measured by cephalometry.

Cephalometry was done in only 81 children out of the total sample of 196 children. This was due to mainly logistic reasons like lack of time, the distance to the dental xray laboratory etc. There was no selection. In this study cephalometry was done 81 children. The following airway dimension variables were extracted from the digitized xrays and studied.

- Retro palatal airway space
- Retro glottal airway space
- Hypopharyngeal airway space (surrogate measure = Hyoid to C3 vertebra distance)
- AN ratio as described by Li in 2002
- Lower anterior face – total facial height ratio
- Angle ANB
- Measures of hyoid position, namely MP-H distance, Rgn-H, H-C3, and C3-Rgn

There were 71 habitual snorers and 10 ‘others’. The mean values of the following cephalometric variables were determined by digitization for the habitual snorers and for others. The paired mean values of habitual snorers and the others were compared and the significance was tested for ‘the equality of means’.

Further, their presence in the habitual snorer group and the ‘others’ group was tabulated and analysed for equality of means by the ‘t’ test.

Retro palatal airway space and snoring: The mean value in the sample was 18.9 mm. The values ranged very widely from a minimum of 7.4 to 18.9 mm. However, the standard deviation was only 3.9. Then the snorers were segregated into mild snorers and habitual snorers, and the respective means were tested for equality by the ‘t’ test for equality of means. (p value 0.538 – not significant).

Retro glottal airway space and snoring: The mean value in the sample was 43.62 mm. The values ranged very widely from a minimum of 31.1 to 58.9.
However, the standard deviation was only 5.47. Then the snorers were segregated into mild snorers and habitual snorers, and the respective means were tested for equality by the ‘t’ test for equality of means. (p value 0.481 - not significant).

Hypopharyngeal airway and snoring (surrogate measure = Hyoid to C3 vertebra distance): The mean value in the sample was 34.36 mm. The values ranged very widely from a minimum of 26.1 to 44.6 mm. However, the standard deviation was 4.06. Then, the snorers were segregated into mild snorers and habitual snorers, and the respective means were tested for equality by the ‘t’ test for equality of means. (p value 0.748 - not significant).

Adenoid Nasopharyngeal ratio and snoring: The mean value in the sample was 1.97 and the values ranged from a minimum of 1.2 to 11.4. On closer scrutiny of the values of the individuals, there was only one outlier with a value of 11.4 and that was a girl of 15 years with only a sliver of adenoidal tissue seen over the vertebra. However, the standard deviation was 1.15. Then, the snorers were segregated into mild snorers and habitual snorers, and the respective means were tested for equality by the ‘t’ test for equality of means. (p value 0.640 - not significant).

The lower facial height/ total facial height ratio and snoring: The mean value in the sample was 0.58 and the values ranged from a minimum of 0.52 to 0.65. The standard deviation was 0.03. Then, the snorers were segregated into habitual snorers and others. The respective paired means were tested for equality by the ‘t’ test for equality of means. (p value .244 - not significant).

The four measures of the position of hyoid, namely MP-H distance, Rgn-H distance, H-C3 distance and C3-Rgn distance were not significantly associated with habitual snoring. The p values are given in the table no VI (29).

Inference of the results of the cephalometric analysis:

In this study, out of the nine cephalometric measurements taken up for analysis, none of the variables was significantly associated with snoring and snoring frequency.
Table VI (29). The mean values of the various cephalometric variables in the entire cephalometry sample of 81 children.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro Palatal Air way</td>
<td>7.4</td>
<td>27.3</td>
<td>18.97</td>
<td>3.98</td>
</tr>
<tr>
<td>Retro glottal Air way</td>
<td>31.10</td>
<td>58.90</td>
<td>43.62</td>
<td>5.47</td>
</tr>
<tr>
<td>Hyoid to C3 vertebra (Hypo pharyngeal airway space)</td>
<td>26.1</td>
<td>44.6</td>
<td>34.36</td>
<td>4.06</td>
</tr>
<tr>
<td>A/N ratio</td>
<td>1.2</td>
<td>11.4</td>
<td>1.97</td>
<td>1.15</td>
</tr>
<tr>
<td>Lower facial height - Total facial height ratio</td>
<td>.52</td>
<td>.65</td>
<td>.58</td>
<td>.03</td>
</tr>
</tbody>
</table>
Table VI (30). The paired mean values of the various cephalometric variables in the habitual snorers and in others with the p values of difference

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean</th>
<th>s.d</th>
<th>SEM</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro Palatal Airway</td>
<td>Others</td>
<td>18.230</td>
<td>4.364</td>
<td>1.380</td>
<td>.538</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>19.062</td>
<td>3.934</td>
<td>.467</td>
<td></td>
</tr>
<tr>
<td>Retro glottal Airway</td>
<td>Others</td>
<td>44.770</td>
<td>7.132</td>
<td>2.255</td>
<td>.481</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>43.456</td>
<td>5.239</td>
<td>.621</td>
<td></td>
</tr>
<tr>
<td>Hypopharyngeal airway space (H-C3 distance)</td>
<td>Others</td>
<td>33.970</td>
<td>4.737</td>
<td>1.498</td>
<td>.748</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>34.414</td>
<td>3.989</td>
<td>.473</td>
<td></td>
</tr>
<tr>
<td>A/N ratio</td>
<td>Others</td>
<td>2.130</td>
<td>.432</td>
<td>.136</td>
<td>.640</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>1.946</td>
<td>1.220</td>
<td>.144</td>
<td></td>
</tr>
<tr>
<td>Lower facial height - Total facial height ratio</td>
<td>Others</td>
<td>.5714</td>
<td>.0290</td>
<td>.0091</td>
<td>.244</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>.5833</td>
<td>.0300</td>
<td>.0035</td>
<td></td>
</tr>
</tbody>
</table>
Table VI (31). The four cephalometric variables which define the position of the hyoid - their mean values in the entire cephalometry sample of 81 children.

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyoid to C3 vertebra</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3 vertebra to Retrogonion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyoid Mandibular plane distance</td>
<td>.9</td>
<td>29.3</td>
<td>12.572</td>
<td>5.7858</td>
</tr>
</tbody>
</table>

Table VI (32). The paired mean values of the four cephalometric variables which define the position of the hyoid - in habitual snorers and in others, with the p values of the significance of differences

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Others</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>SEM</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Hyoid to C3 vertebra</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>C3 vertebra to Retrogonion</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Hyoid Mandibular plane distance</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Others</th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
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<tr>
<td>Hyoid to C3 vertebra</td>
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<tr>
<td>C3 vertebra to Retrogonion</td>
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<tr>
<td>Hyoid Mandibular plane distance</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Hab. snr</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
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<tr>
<td>Hyoid to C3 vertebra</td>
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<tr>
<td>C3 vertebra to Retrogonion</td>
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<tr>
<td>Hyoid Mandibular plane distance</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Hab. snr</th>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
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<td></td>
<td></td>
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<tr>
<td>Hyoid to C3 vertebra</td>
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<td></td>
</tr>
<tr>
<td>C3 vertebra to Retrogonion</td>
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<td></td>
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<tr>
<td>Hyoid Mandibular plane distance</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Hab. snr</th>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hyoid to C3 vertebra</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C3 vertebra to Retrogonion</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Hyoid Mandibular plane distance</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

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Before and after therapeutic intervention i.e. adeno tonsillectomy surgery, OSA 18 QOL scoring was done. From the parental responses pre op and post op to the individual items, the domain scores were calculated. For the domain scores, the mean and the frequency distribution variables like standard deviation, SEM and 95% confidence intervals were calculated. The post operative change in the mean score for each domain was calculated. Cf. Table VI (). The two mean domain scores, pre operative and post operative, were tested by the 't' test for equality of means.

(i) In the children of this study sample, significant improvement of the quality of life occurs after therapeutic intervention by way of adeno tonsillectomy. This improvement is significantly present in four OSA 18 domains viz. sleep problems, physical suffering, daytime problems and caregiver concerns (p values <0.001 for all the four domains). In the emotion disturbance domain, the mean post operative score was found to be marginally worse with a change of 0.16. However, this change was found to be not significant (p value 0.365).
Table VI (33). Pre op and post op OSA 18 domain scores - Paired.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Pair</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sleep disturbances</td>
<td>Pre op</td>
<td>13.47</td>
<td>3.6</td>
<td>.33</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>5.19</td>
<td>1.97</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>8.29</td>
<td>4.23</td>
<td>.39</td>
<td>7.52 9.06</td>
<td></td>
</tr>
<tr>
<td>2. Physical suffering</td>
<td>Pre op</td>
<td>17.25</td>
<td>3.18</td>
<td>.29</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>7.88</td>
<td>1.20</td>
<td>.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>9.36</td>
<td>2.58</td>
<td>.24</td>
<td>8.89 9.83</td>
<td></td>
</tr>
<tr>
<td>3. Emotional Distress</td>
<td>Pre op</td>
<td>4.71</td>
<td>1.46</td>
<td>.13</td>
<td>.365</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>4.87</td>
<td>1.78</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-0.16</td>
<td>1.92</td>
<td>.18</td>
<td>- .51 .19</td>
<td></td>
</tr>
<tr>
<td>4. Daytime Problems</td>
<td>Pre op</td>
<td>8.57</td>
<td>3.14</td>
<td>.29</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>4.89</td>
<td>1.71</td>
<td>.16</td>
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<tr>
<td></td>
<td>Difference</td>
<td>3.68</td>
<td>2.08</td>
<td>.19</td>
<td>3.30 4.06</td>
<td></td>
</tr>
<tr>
<td>5. Caregiver concerns</td>
<td>Pre op</td>
<td>13.74</td>
<td>3.24</td>
<td>.3</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>6.43</td>
<td>1.96</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>7.31</td>
<td>3.80</td>
<td>.35</td>
<td>6.61 8.00</td>
<td></td>
</tr>
<tr>
<td>Total of all Domains</td>
<td>Pre op</td>
<td>57.74</td>
<td>9.82</td>
<td>.90</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>29.26</td>
<td>5.16</td>
<td>.48</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>28.48</td>
<td>8.60</td>
<td>.79</td>
<td>26.91 30.04</td>
<td></td>
</tr>
</tbody>
</table>

(ii) Further statistical analysis was done to find out whether the change score was significantly different between the habitual snorer group and the 'others' group. For this analysis, the frequency distribution characteristics (the mean, sd, SEM and 95% CI intervals) of the change scores of each domain were calculated.

The change scores of each child was converted into z scores i.e. the change scores divided by the standard deviation. This zee change score for a particular subject within a group indicates the magnitude of change of that
individual, expressed in terms of his group’s standard deviation. Such a conversion into a z score minimizes the possibility of outlying values causing a blunting of the true signal by the noises.

The habitual snorer group and the ‘others’ group, were considered as independent samples and the z scores of the two groups were tested by the t test for equality of the means.

Table VI (34). The pre op - post op change z scores of OSA 18 quality of life instrument, in the sample population of the Intervention study, for the habitual snorer (97) group and the ‘others’ group (21).

<table>
<thead>
<tr>
<th>Domain</th>
<th>Snorer group</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>T test for equality of means p</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Others</td>
<td>1.26</td>
<td>.49</td>
<td>.11</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Habitual</td>
<td>-.27</td>
<td>-.86</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>.42</td>
<td>1.43</td>
<td>.31</td>
<td>.03</td>
</tr>
<tr>
<td></td>
<td>Habitual</td>
<td>-.09</td>
<td>.86</td>
<td>.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>-.58</td>
<td>.85</td>
<td>.18</td>
<td>.003</td>
</tr>
<tr>
<td></td>
<td>Habitual</td>
<td>.13</td>
<td>.99</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>.60</td>
<td>.56</td>
<td>.12</td>
<td>.002</td>
</tr>
<tr>
<td></td>
<td>Habitual</td>
<td>-.13</td>
<td>1.03</td>
<td>.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td>.77</td>
<td>.85</td>
<td>.19</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Habitual</td>
<td>-.17</td>
<td>.95</td>
<td>.97</td>
<td></td>
</tr>
</tbody>
</table>

These zee scores were employed for this purpose by Sohn et al in 2003 and were called Standard response of the mean (SRM) by them. Sohn defines SRM as ‘the change score divided by its standard deviation’. As a measure of effect size, the SRM describes the signal to noise ratio. Ideally, the signal (variations in the change caused by true change) should be high relative to the noise (variations in the change score caused by random error). Responsiveness to longitudinal change can be better studied by
SRMs. Because the SRMs are ideally determined before and after an intervention of known efficacy, responsiveness to T&A surgery was determined in my study, by employing them. The difference in the zee change scores was significant for each of the five domains. Cf. Table (34). Comparison with previous other studies: these change scores of this study compares well with the previous studies cf “Table VI (35).

<table>
<thead>
<tr>
<th>Study</th>
<th>pre op</th>
<th>sd</th>
<th>post op</th>
<th>sd</th>
<th>mean change score</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitchell 2004</td>
<td>76.7</td>
<td>17.9</td>
<td>32</td>
<td>11.7</td>
<td>44.7</td>
<td>NA</td>
</tr>
<tr>
<td>Flanary 2003</td>
<td>76</td>
<td>17.1</td>
<td>41.4</td>
<td>17.1</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Goldstein 2002</td>
<td>70.2</td>
<td>27</td>
<td>NA</td>
<td>NA</td>
<td>41.4</td>
<td>34.2-48.6</td>
</tr>
<tr>
<td>Tran 2005</td>
<td>72</td>
<td>21.6</td>
<td>28.8</td>
<td>12.6</td>
<td>45</td>
<td>NA</td>
</tr>
<tr>
<td>Mitchell 2004</td>
<td>71.4</td>
<td>NA</td>
<td>35.8</td>
<td>NA</td>
<td>35.5</td>
<td>28.7-42.4</td>
</tr>
<tr>
<td>Sohn 2003</td>
<td>55.8</td>
<td>16.2</td>
<td>NA</td>
<td>NA</td>
<td>30</td>
<td>23.8-34.0</td>
</tr>
<tr>
<td>Mitchell 2005</td>
<td>72.8</td>
<td>18.2</td>
<td>41</td>
<td>24</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Balakrishnan 2008</td>
<td>57.7</td>
<td>9.8</td>
<td>29.3</td>
<td>5.2</td>
<td>28.5</td>
<td>26.9-30.0</td>
</tr>
</tbody>
</table>

| Sleep disturbance|        |     |         |     |                   |         |
| Mitchell 2004    | 19.4   | 4.3 | 6.6     | 2.4 | 12.8              | NA      |
| Flanary 2003     | 20.2   | 5.5 | 7.4     | 4.9 | NA                | NA      |
| Goldstein 2002   | 17.2   | 7.6 | NA      | NA  | 11.6              | 9.6-13.6|
| Tran 2005        | 20.8   | 5.6 | 5.6     | 2.4 | 15.6              | NA      |
| Mitchell 2004    | 18.4   | NA  | 6.9     | NA  | 11.5              | 9.6-13.4|
| Sohn 2003        | 14.8   | 5.6 | NA      | NA  | 6.2               | 5.0-7.3 |
| Mitchell 2005    | 18.7   | 6   | 8.4     | 6.2 | NA                | NA      |
| Balakrishnan 2008| 13.5   | 3.6 | 5.2     | 1.9 | 8.3               | 7.5-9.1 |

| Physical suffering|        |     |         |     |                   |         |
| Mitchell 2004    | 17.3   | 5.4 | 7       | 3.1 | 10.3              | NA      |
| Flanary 2003     | 18.1   | 4.8 | 8.9     | 5.7 | NA                | NA      |
| Goldstein 2002   | 17.2   | 6.8 | NA      | NA  | 9.6               | 8.0-11.6|
| Tran 2005        | 15.6   | 5.6 | 6       | 3.6 | 9.6               | NA      |
| Mitchell 2004    | 14.9   | NA  | 8       | NA  | 6.9               | 5.0-8.8 |
| Sohn 2003        | 14     | 4   | NA      | NA  | 5.2               | 4.0-6.2 |
| Mitchell 2005    | 14.6   | 5.7 | 8.9     | 5   | NA                | NA      |
| Balakrishnan 2008| 17.3   | 3.2 | 7.9     | 1.2 | 9.4               | 8.9 - 9.8|

| Emotional distress|        |     |         |     |                   |         |
| Mitchell 2004    | 10.2   | 4.6 | 7       | 3.1 | 4.2               | NA      |
| Flanary 2003     | 9.6    | 5   | 6.2     | 4   | NA                | NA      |
| Goldstein 2002   | 11.1   | 6   | NA      | NA  | 4.2               | 2.7-5.7 |
Willingness of parents to have surgery: Specifically, for the purpose of this study, the total sample of 196 children was also stratified into two groups - based on clinical criteria, namely, the temporal sequences like the onset of snoring and number of infective episodes:

(a) predominantly infective group (81) and
(b) predominantly obstructive group (115).

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>Daytime problems</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goldstein 2002</td>
<td>8.7</td>
<td>4.5</td>
<td>NA</td>
<td>NA</td>
<td>8.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.6-9.6</td>
</tr>
<tr>
<td>Tran 2005</td>
<td>9.6</td>
<td>5.4</td>
<td>6.3</td>
<td>4.2</td>
<td>3.6</td>
</tr>
<tr>
<td>Mitchell 2004</td>
<td>10.7</td>
<td>NA</td>
<td>7.2</td>
<td>NA</td>
<td>3.5</td>
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<td></td>
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<td>2.2-4.8</td>
</tr>
<tr>
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<td>4.8</td>
<td>NA</td>
<td>NA</td>
<td>1.2</td>
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<td>4.7</td>
<td>1.5</td>
<td>4.9</td>
<td>1.8</td>
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<td>(-) .2</td>
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<td></td>
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<td></td>
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</tr>
<tr>
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<td>NA</td>
<td>8.1</td>
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<td>6.6-9.6</td>
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<tr>
<td>Tran 2005</td>
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<td>5.4</td>
<td>5.1</td>
<td>2.7</td>
<td>4.5</td>
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<td>3.3</td>
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<td>NA</td>
<td>2.6</td>
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<td></td>
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<td>1.8-3.3</td>
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<tr>
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<tr>
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<td>4.9</td>
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<tbody>
<tr>
<td><strong>Caregiver concern</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goldstein 2002</td>
<td>8.7</td>
<td>4.5</td>
<td>NA</td>
<td>NA</td>
<td>8.1</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6.6-9.6</td>
</tr>
<tr>
<td>Tran 2005</td>
<td>16.8</td>
<td>7.6</td>
<td>6.4</td>
<td>3.6</td>
<td>10.8</td>
</tr>
<tr>
<td>Mitchell 2004</td>
<td>16.3</td>
<td>NA</td>
<td>7.3</td>
<td>NA</td>
<td>9</td>
</tr>
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<td>7.0-10.9</td>
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<tr>
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<td>12.8</td>
<td>5.2</td>
<td>NA</td>
<td>NA</td>
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<td></td>
<td></td>
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<td>3.6-5.8</td>
</tr>
<tr>
<td>Mitchell 2005</td>
<td>16.5</td>
<td>6.3</td>
<td>7.8</td>
<td>5.8</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Balakrishnan 2008</td>
<td>13.7</td>
<td>9.8</td>
<td>29.3</td>
<td>5.2</td>
<td>28.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>26.9</td>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>30</td>
</tr>
</tbody>
</table>
57 of the children in the predominantly infective features group had surgery, while the number in the obstructive features group was 68. The percentages of children within each group are given in Table. There was a significant difference between the two groups in terms of the willingness to undergo surgery. More children within the ‘predominantly obstructed group’ underwent surgery than children belonging to the ‘predominantly infected group’. Clearly, the clinical features of obstruction are more alarming and motivate the parents to have a definitive treatment.

Table VI (36). Number of children in the interventional study sample, who underwent surgery within the initial clinical diagnostic groups

<table>
<thead>
<tr>
<th>Initial clinical diagnosis</th>
<th>Adeno tonsillectomy</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Done</td>
<td>Not done</td>
</tr>
<tr>
<td>Number of children with Predominantly Infective features</td>
<td>57 (50%)</td>
<td>58 (50%)</td>
</tr>
<tr>
<td>Number of children with Predominantly Obstructive features</td>
<td>68 (84%)</td>
<td>13 (16%)</td>
</tr>
<tr>
<td>Total</td>
<td>125 (64%)</td>
<td>71 (36%)</td>
</tr>
</tbody>
</table>

Table VI (37). Children in the interventional study sample, who underwent surgery within the initial clinical diagnostic groups – percentages

<table>
<thead>
<tr>
<th>Initial clinical diagnosis</th>
<th>Adeno tonsillectomy (percentages)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>Done</td>
<td>Not done</td>
</tr>
<tr>
<td>Number of children with Predominantly Infective features</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Number of children with Predominantly Obstructive features</td>
<td>84</td>
<td>16</td>
</tr>
</tbody>
</table>
Discussion on the design of the interventional study:

Sample population: All children with adenotonsillar hypertrophy, coming for treatment in the author's clinic (ENT) entered the study consecutively. The only exclusions were craniofacial deformity and having not attained three years of age. This study was conducted in a referral clinic. Some of the patients had been referred by paediatricians and by other specialists. But, several patients had just walked in without any referral (as is the common practice in our country). Thus, the sample was a well represented one and would be typical of the common patient encountered in a clinical setting.

In recent decades, the number of adenotonsillectomies has decreased. But, it still remains one of the commonly performed pediatric surgical procedures. Currently, adenotonsillectomy (T&A) is performed with increasing frequency for obstructive instead of infectious indications. However, not all the patients get total relief from the airway obstruction.

In some children, a simple T&A may not be sufficient to eliminate all the anatomical narrowness of the pharynx. Considering the serious (and avoidable) implications of SDB in the development of the child, it is imperative to completely address the airway narrowing. The narrowness of the airway may be due to

(i) intra luminal factors like tonsillar or adenoidal enlargement, enlarged tongue etc.
(ii) integumental factors like lax palate,
(iii) extra luminal factors like fatty tissue deposition in the neck, or
(iv) narrowness of the bony framework.

Hence, any discussion about the causes of failure of adenotonsillectomy to relieve the snoring must address every one of the above issues. This study makes an attempt to view the above issues with a clinical applications point of view, in contrast to a pure research view.

The intra luminal factors in this study are assessed by clinical methods like tonsil size, adenoid size, Mallampatti score and Tsai lateral pharyngeal grading. A lax palate is an issue with adults only. Differences in the fat
deposits can be addressed by the neck circumference, waist hip ratio and BMI. The bony framework is studied by lateral cephalograms.

The snore questionnaire (SNQ) was devised originally by Brouilette in 1984 and successively validated and adapted by several researchers independently. This is a simple one and is still in current use. It has withstood the test of time.

The OSA 18 is a disease specific quality of life assessment tool, which has been validated both for discriminant and evaluation functions. The parental response for the emotional distress domain of this instrument is used in this analysis, as an expedient measure for the limited purpose of analyzing the behaviour of the snoring child.

Compilation of data with these two tools yielded valuable data on snoring children with adenotonsillar enlargement. The categorisation of these children into two groups - namely occasional and frequent (habitual) snoring, was made with SNQ, while the OSA 18 enabled comparisons.

Strengths and limitations of our study design: Our study design has several strengths and limitations. It is noteworthy that previous studies quoted in our literature survey above, were small with less than 50 children; a majority of them had selected children from school populations; and they did not focus on children with adenotonsillar hypertrophy. The only exception was the study by Suratt and others (34).

In our study, children attending the ENT outpatient clinics of the author, with a suspicion of adenotonsillar disease were recruited. They were entered into the study without any further selection. This design inherently engenders both advantages and disadvantages, as discussed below.

The aim of our study was to determine whether a therapeutic intervention by way of adenotonsillectomy will improve the QOL in children with snoring. Hence, children recruited from an ENT clinic will correctly reflect the type of patients likely to be encountered in every day practice. This is an advantage. In the same breath, a disadvantage may be noted. By selecting for children with adenotonsillar hypertrophy who were suspected of having OSA, we had many children who snored every night and fewer children in the less-frequent
snoring categories. By virtue of such selection, our study group may not faithfully reflect the general community.

However, in the clinic of the author, as is the case with every other specialist in our country, the practice is not restricted to referral patients only. The number of walk in patients without any referral would far outnumber the referral patients. In addition, there had been no further selection and consecutive patients were entered in the study. Additionally, the number of subjects (n = 197) is quite large. These last two factors will obviate any concern of selection bias.

The split we proposed i.e. frequent snoring category including all subjects with levels 4 and 5 to the relevant question in the SNQ tool, and an occasional snorer group including all children with levels of 2 and 3 shares the limitations of all dichotomizations based on arbitrary cut off values but has the advantage of resulting in 2 fairly balanced groups.

**Summary of the Interventional part of the study.**

A total of 196 children of ages 3 - 15 years, attending a specialist ENT clinic for recurrent throat infections and features of obstructed airway entered this study. Several of them had significant adenotonsillar enlargement. Based on their snoring pattern, they were stratified into non snorer, occasional snorer snorer group and occasional snorer groups. All the children were assessed with history taking, questionnaire tools, clinical examination, laboratory tests cephalometry, quality of life tools. The clinical variables among these three groups were different.

*Age, gender, BMI and SES:* These did not have any significant association with snoring, in this sample. There was also no linear relationship between the mild snorer and the habitual snorer groups in this regard.

*UARS, Apnoea and EDS:* In this sample population of children with adenotonsillar enlargement, the relative frequencies of UARS, Apnoea and EDS are interesting. The following important points are noted in this sample:
(i) Struggling to breathe, chest caving in or see sawing (features of UARS), breathing pauses (a feature of apnoea), sleeping during school hours, napping at home, unrefreshed sleep and continuous tiredness (features of EDS) were significantly present only in snorers and were absent or less frequent in the non snorers.

(ii) There is no difference in the prevalence of UARS, Apnoea and EDS among snorers and non snorers, when all snorers are clubbed together and considered as a single unit i.e. UARS, Apnoea and EDS are present in both snorers and non snorers in the same frequency.

(iii) But, when the snoring frequency is factored in, there is a significant difference - apnoea and EDS are more frequent in the frequent snorers. Hence, when a child comes with a history of snoring, care must be taken to identify this population of frequent snorers - because it is this population which is at risk.

**Associated diseases:** Nasal allergy, sinusitis, secretory otitis media and CSOM have significant associations with snoring. But, GERD did not show any positive association with snoring in this study.

**Results of cephalometric imaging and measurements:** In this study, the following airway measures taken up for analysis: Retro palatal airway space, Retro glottal airway space, Hypopharyngeal airway space, MP-H distance, position of hyoid (Rgn-H, H-C3, and C3-Rgn), AN ratio and Lower anterior face - total facial height ratio. Several of these variables are known to be significantly associated with snoring and sleep apnoea. In this study of exclusively children, these did not have any significant association with snoring. The digitization had been done in an academic institution by an very well experienced orthodontist. Even though some of the landmarks for the airway analysis) were relatively new and relatively unfamiliar to the orthodontic practitioners, the digitization techniques are extremely familiar to them. Also, the initial ten films had been digitized twice by two different orthodontists and cross checked. One remarkable handicap that we had was the absence of population standards for even the orthodontic measures for our ethnic population. Hence, we could not compare the individual child's measure with age appropriate values. Attempting a norming standard of our own was beyond our scope and also, means.
**Tonsil size and adenoid size:** Tonsil size was found to be significantly associated with snoring; more so with frequent snoring. Adenoid size per se (alone) was found to be of no importance in this regard. However, children with adenotonsillar enlargement were more likely to have impaired QOL scores, if they also had a history of nightly snoring. In these children with adenotonsillar enlargement, the addition of historical questionnaire data, other than snoring frequency, did not improve predictions of snoring.

**Behaviour:** In children with snoring (all the snorer groups taken together), the behaviour scores were not different from those of non snorers. But, when the habitual snorers were specifically separated and studied for difference from the others, the behaviour scores of habitual snorers were found to be worse.

**General learning:** There was no difference in the overall academic performance, as measured by the school marks between the habitual snorers and the others. This might mean that the tool used (the single marker of 50% marks in the last terminal examination) lacked precision and that it did not measure the target correctly. Such a result might also indicate the strenuous efforts of the student, his teachers and parents, to overcome the underlying impaired learning skills.

In this sample population of children with adenotonsillar enlargement, the relative frequencies of UARS, Apnoea and EDS are interesting. The following important points are noted in this sample:

1. Struggling to breathe, chest caving in or see-sawing (features of UARS), breathing pauses (a feature of apnoea), sleeping during school hours, napping at home, unrefreshed sleep and continuous tiredness (features of EDS) were significantly present only in snorers and were absent or less frequent in the non snorers.
2. There is no difference in the prevalence of UARS, Apnoea and EDS among snorers and non snorers, when all snorers are clubbed together and considered as a single unit i.e. UARS, Apnoea and EDS are present in both snorers and non snorers in the same frequency.
3. But, when the snoring frequency is additionally considered, there is a significant difference – apnoea and EDS are more frequent in the frequent snorers. Hence, when a child comes with a history of snoring, care must be
taken to identify this population of frequent snorers - because it is this population which is at risk.

Associated diseases: Nasal allergy, Secretory otitis media, Sinusitis, CSOM and GERD:-

(i) All the snorers, regardless of whether they are frequent snorers or occasional snorers, have a higher presence of nasal allergy and secretory otitis media.

(ii) Snorers, when taken up for statistical analysis as a whole, do not show any increased presence of sinusitis or CSOM. But when the frequent snores are segregated and analysed separately, the frequent snorers have a significantly higher presence of sinusitis and CSOM.

Quality of life scores (QOL - OSA 18) before and after intervention: The therapeutic improvement after surgery was assessed by OSA 18 tool, before and after adenotonsillectomy surgery. Significant improvement of the quality of life was present in four OSA 18 domains viz. sleep problems, physical suffering, daytime problems and caregiver concerns (p values <0.001 for all the four domains). In the emotion disturbance domain, the mean postoperative score was found to be marginally worse, with a change score of 0.16. However, this change did not withstand statistical scrutiny and was found to be not significant (p value 0.365). The overall parental response was positive and was highly significant.
Chapter VII

Discussions: Analysis of the results of the entire study

Part I of this study consisted of five units. For effective interpretation, all the information was collectively analysed by forming several hypotheses (1-8). The sample in the interventional part of this study comprised exclusively of children attending an ENT surgeon’s clinic. This sample represented the typical children, likely to be encountered by an ENT surgeon, in his day to day practice. Being a very specific group, this sample showed an overall snoring prevalence of 97 per cent. This sample was analysed with separate hypotheses (9 et seq). The hypotheses are listed serially and discussed below.

Hypothesis 1. The overall prevalence of snoring is significantly different in different segments of the population, namely, general community, industrial workers and adolescent students.

In this study, the general community was studied in two units, Pedex and Households survey. The combined prevalence of overall snoring in these two units was 25.8%. The overall prevalence of snoring in the industrial employees was 16.78%. The overall prevalence of snoring in the students segment was 7.58%. The differences between these three segments were found to be significant.

Table VII (1). Comparison of the percentages of overall snoring in the different segments of the general population.

<table>
<thead>
<tr>
<th>Segment</th>
<th>Snorers</th>
<th>Non snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. General community (n = 1473)</td>
<td>25.87</td>
<td>74.13</td>
</tr>
<tr>
<td>2. Industrial workers (n = 602)</td>
<td>16.78</td>
<td>83.22</td>
</tr>
<tr>
<td>3. Students (n = 198)</td>
<td>7.58</td>
<td>92.42</td>
</tr>
</tbody>
</table>

p value 0.003 (significant)
Thus, this hypothesis that the overall prevalence of snoring in the different segments of the population is different is confirmed. The snoring prevalence depends upon the particular segment which is looked at.

Comparison with other studies in other parts of the world: Several questionnaire surveys had been conducted in other countries. In 2002, Ersu et al (122) assessed the prevalence of snoring to be 7% in a sample of 2,147 primary school children in Istanbul, Turkey. In Michigan and California of the United States, one study by Cherwin and his colleagues (123) indicated a prevalence of 16% in children aged 2 to 13.9 years. In Korea, another study by Shin et al in 2003 (124) indicated a prevalence of 11.2% in children aged 15 to 18 years. In southern Italy, Brunetti and his colleagues (125) in a cohort of 895 children aged between 3 and 11 years, 4.9% of the children was identified as habitual snorers and 15.8% as occasional snorers. As the study population and the criteria of the scoring for snoring are different in different surveys, the results are not comparable in their entirety. However all the surveys done so far, including ours, indicate that snoring has a high prevalence, reaching up to 21% of the general population.

Hypothesis 2. There is a significant association between snoring and age

In each of the units, the sample was divided into age groups and the prevalence of snoring within the respective age groups was analysed statistically. Tables VII (2-4)

Table VII (2). Prevalence of snoring by age groups in Pedex survey (percentages)

<table>
<thead>
<tr>
<th>Range</th>
<th>Total number in this age group</th>
<th>% of snorers within the age group</th>
<th>% of non snorers within the age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>&lt; 12 yr</td>
<td>431</td>
<td>12.99</td>
</tr>
<tr>
<td>Adolescent</td>
<td>13-18</td>
<td>117</td>
<td>11.97</td>
</tr>
<tr>
<td>Adults</td>
<td>19-45</td>
<td>469</td>
<td>24.31</td>
</tr>
<tr>
<td>Older adults</td>
<td>&gt; 46 yr</td>
<td>58</td>
<td>44.83</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1075</td>
<td>19.53</td>
</tr>
</tbody>
</table>

p value <0.001
Table VII (3). Prevalence of snoring by age groups in the Households survey (percentages)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total number available in the sample in this age group</th>
<th>% of snorers within the age group</th>
<th>% of non snorers within the age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Children</td>
<td>114</td>
<td>34.21</td>
<td>65.79</td>
</tr>
<tr>
<td>Adolescents</td>
<td>64</td>
<td>40.63</td>
<td>59.37</td>
</tr>
<tr>
<td>Young adults</td>
<td>49</td>
<td>36.73</td>
<td>63.27</td>
</tr>
<tr>
<td>Older adults</td>
<td>168</td>
<td>52.98</td>
<td>47.02</td>
</tr>
<tr>
<td>60 and more</td>
<td>3</td>
<td>66.67</td>
<td>33.33</td>
</tr>
</tbody>
</table>

p value 0.034 (significant)

Pedex Unit: In this unit, children and adolescents had a prevalence of around 12 percent. The adults showed a higher prevalence of 24 percent. The elder group had an even higher prevalence with nearly one half reporting snoring. This positive association of snoring with increasing age was found to be significant (χ²=36.57, p = 0.001).

Households study: in this unit, the overall prevalence of snoring in children was children was 34 percent, in adolescents 41 percent, in young adults 37 percent and in older adults 53 percent. The differences among the age groups were found to be significant.

Industrial employee study: In this sample, the prevalence among the 19-29 age group was 7.7 percent, which increased to 21.5 percent in the 30-59 age group. The difference was found to be significant. Thus, the prevalence of snoring is positively associated with age, with an increase in the prevalence with increasing age. This hypothesis is fully confirmed.
Table VII (4). Prevalence of snoring by age groups in the industrial employees study (percentages)

<table>
<thead>
<tr>
<th>Age group</th>
<th>Total number in this age group</th>
<th>% of snorers in this age group</th>
<th>% of non snorers in this age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>19-29</td>
<td>207</td>
<td>7.7</td>
<td>92.3</td>
</tr>
<tr>
<td>30-59</td>
<td>395</td>
<td>21.5</td>
<td>78.5</td>
</tr>
</tbody>
</table>

p value 0.001 (significant)

This increase in the prevalence of snoring with increasing age, had been noted by several other researchers also. Gibson noted that the prevalence of snoring appeared to increase steadily from pre-adolescence to adults, with a preponderance in males in this age group (8).

Hypothesis 3. There is a significant association between snoring and gender. A minor hypothesis in this is that the male gender has a higher predilection for snoring than female.

The prevalence of snoring was analysed with respect to the gender in each of the units.

Pedex unit: In this sample, the percentage of snorers was found to be higher in the males than in the females - 24 % in males vs 13 % of females. This difference was found to be significant. On further analysis within the age groups, the male predominance was found to be significant only in the adult category and not in the other age groups, namely children, adolescents and the elder cf. Table VII (5 - 6).

Table VII (5). Prevalence of snoring by gender, in the Pedex study

<table>
<thead>
<tr>
<th>Gender</th>
<th>Persons in the sample belonging to this gender</th>
<th>% age of Snorers</th>
<th>% age of non snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>611</td>
<td>24.4</td>
<td>75.6</td>
</tr>
<tr>
<td>Female</td>
<td>464</td>
<td>13.1</td>
<td>86.9</td>
</tr>
</tbody>
</table>

p value 0.045 (not significant)
### Table VII (6). Gender wise distribution of snorers by age groups, Pedex study

<table>
<thead>
<tr>
<th>Age group</th>
<th>Child (n=431)</th>
<th>Adolescent (n=117)</th>
<th>Adult (n=469)</th>
<th>Elder (n=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Sno rers</td>
<td>%</td>
<td>Total</td>
</tr>
<tr>
<td>Male</td>
<td>238</td>
<td>34</td>
<td>14.3</td>
<td>70</td>
</tr>
<tr>
<td>Female</td>
<td>193</td>
<td>22</td>
<td>11.4</td>
<td>47</td>
</tr>
</tbody>
</table>

$\chi^2$ 0.786 0.131 20.7 1.97  
P values 0.375 0.717 0.01 0.16

Households Study: In this sample, the percentage of snorers within the available males was 47.3 percent and the same within the female population was 37.5 percent. This difference was statistically not significant (Table 8). However, when the prevalence of snoring among the male population and among the female population were analysed separately, the percentages were found to have a two fold increase.

Students study: Out of the total males in this sample, 23 per cent snorers and 77 per cent were non snorers. Among the female subjects, 5 per cent were snorers and 95 per cent were non snorers. This difference was found to be significant. Cf. Table VII -9.

### Table VII (7). Prevalence of snoring by gender, in the households study, %ages.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Persons in the sample belonging to this gender</th>
<th>% age of Snorers within the gender</th>
<th>% age of non snorers, within the gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>222</td>
<td>47.3</td>
<td>52.7</td>
</tr>
<tr>
<td>Female</td>
<td>176</td>
<td>37.5</td>
<td>62.5</td>
</tr>
</tbody>
</table>

P value 0.19 (not significant)
Table VII (8). Gender wise distribution of snorers by the age groups in the

<table>
<thead>
<tr>
<th>Age group (total n in this age group)</th>
<th>Percentage of snorers within the male subjects in this age group</th>
<th>Percentage of snorers within the female subjects in this age group</th>
</tr>
</thead>
<tbody>
<tr>
<td>12 yr and less (114)</td>
<td>56</td>
<td>44</td>
</tr>
<tr>
<td>13-18 (64)</td>
<td>58</td>
<td>42</td>
</tr>
<tr>
<td>19-29 (49)</td>
<td>44</td>
<td>56</td>
</tr>
<tr>
<td>30-44 (131)</td>
<td>63</td>
<td>37</td>
</tr>
<tr>
<td>45-59 (37)</td>
<td>83</td>
<td>17</td>
</tr>
<tr>
<td>60 and more (3)</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

Households sample - percentages

Table VII (9) Percentages of snorers, male and female, within their gender population in the 30-44 age groups, in the households sample

<table>
<thead>
<tr>
<th></th>
<th>Snorers</th>
<th>Non snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>63</td>
<td>37</td>
</tr>
<tr>
<td>Females</td>
<td>37</td>
<td>63</td>
</tr>
</tbody>
</table>

Table VII (10). Prevalence of snoring by gender, in the Student sample. %ages.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Persons in the sample belonging to this gender</th>
<th>% age of Snorers within the gender</th>
<th>% age of non snorers, within the gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>172</td>
<td>5.2</td>
<td>94.8</td>
</tr>
<tr>
<td>Male</td>
<td>26</td>
<td>23.1</td>
<td>76.9</td>
</tr>
</tbody>
</table>

p value 0.001 (significant)
Thus, the hypothesis that the prevalence of snoring is higher in the male gender is confirmed, in the adult age groups. However, this predilection for the male gender is not present in children.

Such association is well known. There are several studies which indicate an increased prevalence in women. A recent study with a good design is the one by O’Connor et al (126) in 2000. They note that various reasons like different patterns of fat deposition, neck height ratio and waist hip ratio could be attributed to be the reasons. In addition, because the decreased prevalence of snoring and sleep apnoea in women levels off when the women reach the age of menopause was considered to indicate a hormonal basis.

Hypothesis 4. There is an association between BMI and the presence of snoring:

In order to test this hypothesis, the total sample in each of the study units, was divided into BMI categories and the prevalence of snoring was analysed between the BMI categories. This was followed up, by an in-depth study within the age groups, for association of the BMI category with snoring. The following interesting facts were discernible.

Pedex sample: In this sample population of the Pedex survey, the adult age group showed a significant increase in snoring with increasing BMI (p = 0.01). This association was not evident in the children and in adolescents. In the age group beyond 60 years, though the percentages of snorers were high, statistical inference could not be relied upon, because of the small numbers.
Table VII (11). The prevalence of snoring in the different BMI categories, within the age groups, in the Pedex sample

<table>
<thead>
<tr>
<th>Age group</th>
<th>Child</th>
<th>Adolescent</th>
<th>Adult</th>
<th>Elder</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI &lt;20</td>
<td>Total</td>
<td>Sno * rers</td>
<td>%</td>
<td>Total</td>
</tr>
<tr>
<td></td>
<td>375</td>
<td>48</td>
<td>12.8</td>
<td>81</td>
</tr>
<tr>
<td>20 -25</td>
<td>46</td>
<td>7</td>
<td>15.2</td>
<td>29</td>
</tr>
<tr>
<td>26 -29</td>
<td>8</td>
<td>1</td>
<td>12.5</td>
<td>7</td>
</tr>
<tr>
<td>&gt;30</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total each age group</td>
<td>431</td>
<td>56</td>
<td>12.9</td>
<td>117</td>
</tr>
</tbody>
</table>

χ² | 0.003 | 0.184 | 16.96 | 0.042 |

p value | 0.958 | 0.912 | 0.01  | 0.837 |

Students study sample: In this sample, there were 7 snorers out of the 160 available subjects (4.4%) with a BMI between 23 and 15 i.e. in the normal and underweight categories. In the same sample, within the 22 available subjects in the higher overweight and obese BMI categories (BMI above 23), there were 7 snorers (31.8%). The p value of significance as tested by the chi square test was <0.001.

Historically, right from the days of Charles Dickens and Shakespeare, a snorer is portrayed as a fat person i.e. higher BMI. Sleep apnea is typically characterized as a disease of obese, middle-aged men. (Stradling Cr osby 1991, Gislason 1988, Almqvist 1988). This stereotype is a result of older studies completed in the United States, Europe, and Australia that found that 60 to 90% of all OSA patients are obese, as defined by a body mass index of >
28 kg/m². A landmark study by Young, Peppard, Palta et al (127) determined that the risk for OSA increased in close association with measures of truncal obesity.

The studies (81, 82) by Ip et al done in 2001, among Chinese office workers in Hong Kong, showed that snoring and OSA might occur in non obese persons also, with similar prevalence. The mean BMI of the study subjects of that study for this study cohort was only 23.9 Kg/m².

In our study, snoring is found in leaner persons also. It is noteworthy that in the lowest category with a BMI less than 15, classified by WHO as the starvation category, one snorer was present and seven snorers in the BMI group)were present with a BMI between 23 and 15. Percentagewise, this works out to thirty three percent and five percent of all persons in the respective BMI groups.

Table VII (12). Prevalence of snoring by BMI category in the Students sample

<table>
<thead>
<tr>
<th>BMI Category WHO 2002 Singapore rev. for Asia</th>
<th>Description of category</th>
<th>Number of persons available in the sample in each BMI category</th>
<th>Non snorers % within the BMI category</th>
<th>Snorers % within the BMI category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation &lt;14.9</td>
<td></td>
<td>3</td>
<td>2 (67%)</td>
<td>1 (33%)</td>
</tr>
<tr>
<td>Underweight 15-18.4</td>
<td></td>
<td>66</td>
<td>65 (98.5%)</td>
<td>1 (1.5%)</td>
</tr>
<tr>
<td>Normal 18.5-22.9</td>
<td></td>
<td>101</td>
<td>95 (94%)</td>
<td>6 (6%)</td>
</tr>
<tr>
<td>Overweight 23-27.5</td>
<td></td>
<td>17</td>
<td>11 (65%)</td>
<td>6 (35%)</td>
</tr>
<tr>
<td>Obese 27.6-40</td>
<td></td>
<td>5</td>
<td>4 (80%)</td>
<td>1 (20%)</td>
</tr>
<tr>
<td>Morbidly obese &gt;40</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

All the subjects were in the age group 18-25 yrs. p value <0.001
Thus, the hypothesis that BMI has significant association with the prevalence is partially confirmed. Significant positive association exists between BMI and snoring in the adult age groups only. In children, there is no significant association between the BMI and the prevalence of snoring.

**Hypothesis 5. There is an association between upper respiratory infections (episodes of cold and sore throat) and the presence of snoring:**

Upper respiratory infections increase airway resistance and thereby may cause snoring. However, not all persons manifest snoring with each episode of upper respiratory infection. Additionally, the upper airway resistance is a function of the cranio facial morphology, which varies in different ethnic populations. Is the hypothesis that colds and sore throats lead to snoring true in the Indian population?

Pedex unit of the survey: Among the children, 169 did not have any sore throat in the eight months since the last school vacation; only 12 had snoring (7.1 %). In contrast, in children having a history of sore throat (n = 269), 44 had snoring (16.7%). This positive association of snoring and sore throat was statistically significant ($\chi^2 = 207, p = 0.01$). The elders i.e. those aged 46 years and above showed a highly significant association.

This type of association was not evident in the Adolescent and in the Adult subgroups.
Table VII (13). Association of snoring with sore throat - age group wise distribution in the Pedex study

<table>
<thead>
<tr>
<th>Age group</th>
<th>Child (n=431)</th>
<th>Adolescent (n=117)</th>
<th>Adult (n=469)</th>
<th>Elder (n=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>h/o Sore throat</td>
<td>%</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>present</td>
<td>262</td>
<td>44</td>
<td>16.8</td>
<td>67</td>
</tr>
<tr>
<td>absent</td>
<td>169</td>
<td>12</td>
<td>7.1</td>
<td>50</td>
</tr>
<tr>
<td>( \chi^2 )</td>
<td>8.53</td>
<td>0.32</td>
<td>3.87</td>
<td>13.94</td>
</tr>
<tr>
<td>p value</td>
<td>.003</td>
<td>.571</td>
<td>.049</td>
<td>.001</td>
</tr>
</tbody>
</table>

Student survey: In this study, features suggestive of upper respiratory infections (sinusitis) were present in two percent of the total sample. Among the subjects with features of sinusitis, 25% had snoring. The p value of the difference between the percentage of the snorers in the sinusitis group and the non sinusitis group was 0.227 (not significant). This is similar to the results we obtained in our earlier Pedex survey. There also, no association with snoring was seen, in the adolescent and adult age groups.

Households study: The prevalence of snoring among the persons with sinusitis (Table VII - 15) was highly significant with a p value of 0.001.

In summary, a significant association was found between sore throat and snoring in children and in older adults, but not in adolescents and in the younger adults.
Table VII (14). Presence of snoring in students with features of sinusitis in the Student study group.

<table>
<thead>
<tr>
<th>Features of sinusitis</th>
<th>Snoring frequency</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non snorer</td>
<td>Occasional snorer</td>
</tr>
<tr>
<td>Absent</td>
<td>180</td>
<td>12</td>
</tr>
<tr>
<td>% within Features of Sinusitis</td>
<td>92.8%</td>
<td>6.2%</td>
</tr>
<tr>
<td>Present</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>% within Features of Sinusitis</td>
<td>75.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Total</td>
<td>183</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>92.4%</td>
<td>6.6%</td>
</tr>
</tbody>
</table>

p value 0.227

Table VII (15). Presence of snoring in subjects with features of cold in the Household study.

<table>
<thead>
<tr>
<th>Features of sinusitis</th>
<th>Snoring frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non snorer</td>
</tr>
<tr>
<td>Absent (n 203)</td>
<td>135</td>
</tr>
<tr>
<td>% within Features of Sinusitis</td>
<td>43</td>
</tr>
<tr>
<td>Present (n 195)</td>
<td>92</td>
</tr>
<tr>
<td>% within Features of Sinusitis</td>
<td>68</td>
</tr>
</tbody>
</table>
Hypothesis 6. There is an association between the socio economic status and the presence of snoring:

In the Pedex sample, the prevalence of snoring was found to increase with increasing affluence ($p < 0.008$). In the household sample, all the subjects belonged to the middle income group. The industrial employee sample and the student study sample were too specific a population. The street study sample, the affluence was expected to be assessed by the vehicle that each subject was travelling in. However, it was found that the data turned out to be less than standard, because the respondents did not have time or motivation to answer correctly in the busy streets.

Table VII (16). Prevalence of snoring by the Economic status, in the Pedex survey

<table>
<thead>
<tr>
<th>Economic status</th>
<th>Total number</th>
<th>Snorers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaker section</td>
<td>211</td>
<td>25</td>
<td>11.8</td>
</tr>
<tr>
<td>Middle income</td>
<td>601</td>
<td>127</td>
<td>21.1</td>
</tr>
<tr>
<td>Affluent</td>
<td>263</td>
<td>58</td>
<td>22.1</td>
</tr>
</tbody>
</table>

$p \text{ value } 0.008$

Thus, taking into account the Pedex survey results, increasing affluence may be positively related to the affluence. But, the affluence of different categories may have a great impact on sedentary life style, drinking habits and smoking habits - thus, bringing several confounders. Hence, this hypothesis is left unanswered, in this study. If at all, in future, it is found necessary to have such a data, an appropriate design may be devised, taking into account the several socio economic factors and personal habits as described above.
Hypothesis 7. Perception of snoring as a risk indicator is lacking in the general community in our country. A minor hypothesis in this regard is that "there is a significant association between the presence of snoring and the perception of snoring as a risk indicator" i.e. those who have snoring would be interested in more information.

This was studied by asking all the subjects whether each would like to get additional information on snoring and sleep apnoea. The underlying premise was that those who answer 'yes' would be interested in more information.

In the Pedex survey, the overall request for further information came from only 58%. And, nearly 20% of the snorers themselves said that they were not interested in getting further information booklets regarding snoring. This shows that they considered snoring only as a social nuisance. They were simply not aware of the ill effects of snoring.

Table VII (17). Persons interested in getting more information about snoring in the Pedex survey

<table>
<thead>
<tr>
<th>Single Question: Would you like to have further information (pamphlets and information sheets) regarding snoring and sleep apnoea?</th>
<th>Number</th>
<th>%age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects who said 'yes' within the total sample (1075)</td>
<td>624</td>
<td>58</td>
</tr>
<tr>
<td>Subjects who said 'yes' within Snorers</td>
<td>171</td>
<td>81.4</td>
</tr>
<tr>
<td>Subjects who said 'yes' within non snorers</td>
<td>453</td>
<td>52.3</td>
</tr>
</tbody>
</table>

Table VII (18). Persons interested in getting further info regarding snoring in the Pedex survey

<table>
<thead>
<tr>
<th>Not Interested in further info</th>
<th>Snorers</th>
<th>Non snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>(451)</td>
<td>39</td>
<td>412</td>
</tr>
<tr>
<td>(624)</td>
<td>171</td>
<td>453</td>
</tr>
</tbody>
</table>
Similarly, in the household survey, regardless of the presence or the absence of snoring, all the individuals were asked whether they would like to be mailed any further literature regarding snoring. Only 43% of snorers and an equal percentage of non-snores wanted additional information on snoring and sleep apnoea. It should be noted that a majority (57%) of snorers themselves were not worried and did not feel the necessity to know more about their snoring problem. This may be taken to indicate a lack of awareness about the possible associated effects of snoring, in the general community.

Table VII (19). Persons in household sample who requested further information on snoring.

<table>
<thead>
<tr>
<th>Non snorers (227)</th>
<th>Info not reqd.</th>
<th>Info reqd.</th>
</tr>
</thead>
<tbody>
<tr>
<td>82 (57%)</td>
<td>145 (57%)</td>
<td>109 (43%)</td>
</tr>
<tr>
<td>p value 0.978 (not significant)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

However, 455 persons out of the total sample of 1175 i.e. 58 per cent in the Pedex sample and 227 subjects out of the total sample of 398 persons i.e. 57 per cent in the households had requested additional information (regardless of the fact whether they are snorers or not). Thus, there is awareness among the general community - at least as a social nuisance, if not as a risk. This is a redeeming feature.

Hypothesis 8. Specifically, in the typical sample of children attending an ENT out patient clinic, age has a significant association with the presence of snoring.

The interventional study sample is typical of what an ENT surgeon will encounter regularly. The age grouping of this sample was done by keeping in mind the lymphoid growth cycle. Usually, there are two growth spurts, the first one at 3 ½ years and the second, at 7 years of age. The first age
grouping of 3-5 years in this analysis, is centered on the first spurt and the second group is centered on the second spurt.

Table VII (20). Number of children snoring by age groups, in the Interventional study sample

<table>
<thead>
<tr>
<th>Age</th>
<th>Non snorers (% within the age group)</th>
<th>Snorers (% within the age group)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3-5 (53)</td>
<td>2 (3.8%)</td>
<td>51 (96.2%)</td>
</tr>
<tr>
<td>5.1-8 (77)</td>
<td>2 (2.6%)</td>
<td>75 (97.4%)</td>
</tr>
<tr>
<td>&gt; 8 (66)</td>
<td>1 (1.5%)</td>
<td>65 (98.5%)</td>
</tr>
<tr>
<td>Total (196)</td>
<td>5 (2.6%)</td>
<td>191 (97.5%)</td>
</tr>
</tbody>
</table>

Within the children available in the 3-5 year age group, 37.8 percent of children snored. Within the age group of 5 - 8 years, the percentage of snorers was 2.6 percent. Among the children, aged more than 8 years, 1.5% snored. Thus, this hypothesis is confirmed. It could be noted that the maximum presence of snoring was seen in the 3-5 year old children, coinciding with the first spurt of lymphoid growth cycle.

Hypothesis 9. Age has a significant association with the frequency of snoring, (in children, attending an ENT clinic with adeno tonsillar enlargement).

Within the three age groups, as seen in the table VII (21), the percentages of frequent snorers were respectively eighty one, seventy nine and eighty one. 
On statistical analysis, this difference was found to be not significant. Hence, this hypothesis is not confirmed in this sample. Thus, while the presence of snoring itself is significantly higher in the 3-5 year old children, the frequency of snoring does not have significant association with snoring.
Hypothesis 10. Gender has a significant association with the presence of snoring (in the children attending an ENT clinic).

Out of the 191 snoring children in this sample, 115 were males and 76 were females. Percentage wise, 97% of all the male children in this study population snored and equal percentage among the female population children snored. Hence, this hypothesis is not confirmed.

Table VII (22). Percentages of snorers within the respective gender population, in the interventional study.

<table>
<thead>
<tr>
<th>Category</th>
<th>Gender</th>
<th>% within total male sample</th>
<th>% within total female sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snorers</td>
<td>Male</td>
<td>97</td>
<td>97</td>
</tr>
<tr>
<td>Non snorers</td>
<td>Male</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis 11. There is a significant association between obesity (BMI) and the presence of snoring (in children, attending an ENT clinic)

The BMI of snorers and non snorers is given in the table VII (23). Percentage wise, the presence of snoring was found to increase steadily from the lowest category (starvation levels) through underweight up to the normal levels. In the overweight category however, there was a fall; but the numbers in this category were small. Only six children were present in this BMI group and four of them snored. There were no subjects at all in the higher categories, in this sample. When the chi square test of significance was applied, the p value was 0.287 i.e. there is no significant association between the BMI category and snoring. Similarly, in several earlier studies (cf. Literature review chapter of this thesis), it had been found that in children, BMI does not have any significance.

Table VII (23). Percentages of snoring children in the different BMI categories, in the interventional study sample

<table>
<thead>
<tr>
<th>BMI Category</th>
<th>Description of category</th>
<th>n in each BMI category</th>
<th>Non snorers % within the BMI category</th>
<th>Snorers % within the BMI category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation</td>
<td>&lt;14.9</td>
<td>29</td>
<td>2 (67%)</td>
<td>27 (93%)</td>
</tr>
<tr>
<td>Underweight</td>
<td>15-18.4</td>
<td>105</td>
<td>3 (98.5%)</td>
<td>102 (97%)</td>
</tr>
<tr>
<td>Normal</td>
<td>18.5-22.9</td>
<td>56</td>
<td>0 (0 %)</td>
<td>56 (100%)</td>
</tr>
<tr>
<td>Overweight</td>
<td>23-27.5</td>
<td>6</td>
<td>2 (33%)</td>
<td>4 (67%)</td>
</tr>
<tr>
<td>Obese</td>
<td>27.6-40</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Morbidly obese</td>
<td>&gt;40</td>
<td>0</td>
<td>-</td>
<td>Total n 189* BMI data missing for 2</td>
</tr>
</tbody>
</table>

p value for the difference between snorers and non snorers under each BMI category is 0.287
Hypothesis 12. There is a significant association between obesity and **frequency** of snoring, (in children attending an ENT clinic with adenotonsillar enlargement).

It was seen above that the BMI does not have any significant association in children. This sample was further segregated by the frequency of snoring into occasional and frequent snorers. When the prevalence of the two different types of snoring, namely occasional and frequent snoring was analysed in relation to BMI, the prevalence of snoring was found to increase, percentage wise, with increasingly higher BMI category. However, the difference was not statistically significant. The p value was 0.665. Hence, this hypothesis is not confirmed.

Table VII (24). Frequency of snoring in different BMI categories in the interventional study sample.

<table>
<thead>
<tr>
<th>BMI Category WHO 2002 Singapore rev. for Asia (n)</th>
<th>Description of category</th>
<th>Non snorers</th>
<th>Occasional snorers (% within the respective BMI category)</th>
<th>Frequent snorers (% within the respective BMI category)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starvation (29) &lt;14.9</td>
<td></td>
<td>2</td>
<td>4 (14%)</td>
<td>23 (79%)</td>
</tr>
<tr>
<td>Underweight (105) 15 - 18.4</td>
<td></td>
<td>3</td>
<td>17 (16%)</td>
<td>85 (81%)</td>
</tr>
<tr>
<td>Normal (56) 18.5 - 22.9</td>
<td></td>
<td>0</td>
<td>10 (18%)</td>
<td>46 (82%)</td>
</tr>
<tr>
<td>Overweight (4) 23 - 27.5</td>
<td></td>
<td>0</td>
<td>1 (25%)</td>
<td>3 (75%)</td>
</tr>
<tr>
<td>Obese (0) 27.6 - 40</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Morbidly obese (0) &gt;40</td>
<td></td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>5 (3%)</td>
<td>32 (17%)</td>
<td>157 (81%)</td>
</tr>
</tbody>
</table>

p value 0.665  
* Missing data for 2 children
Thus, neither the overall presence nor the frequency of snoring has any significant association with the BMI in this sample, comprising entirely of children.

Hypothesis 13. There is a significant association of gender with the loudness of snoring, (in children attending an ENT clinic with adeno tonsillar enlargement).

Out of the 191 snorers in the interventional study group, 68% snored softly and 32% snored loudly. The difference in gender between the loud snorers and the soft snorers was not significant. As it is well established by now, that the risks of snoring is related more to the snoring frequency, the loudness attribute was not probed further, in this study.

Table VII (25). Loudness of snoring by gender, within the total snoring children in the interventional study sample by gender

<table>
<thead>
<tr>
<th></th>
<th>Soft</th>
<th>Loud</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>75</td>
<td>40</td>
<td>115</td>
</tr>
<tr>
<td>Female</td>
<td>55</td>
<td>21</td>
<td>76</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>61</td>
<td>191</td>
</tr>
</tbody>
</table>

p value of differences in the loudness between genders is 0.299

Hypothesis 14. There is a significant association between Upper airway resistance syndrome (UARS) and the presence and the frequency of snoring, (in children, attending an ENT clinic with adeno tonsillar enlargement).

Two children within the snoring population had features of UARS, while none of the five non snorers had such features (p value = 0.818). Thus, statistically, there was no significant association between snoring and the presence of UARS by history. Hence, this hypothesis was not confirmed, in this sample.

The sample data were further analysed with reference to the frequency of snoring. The difference in the presence of UARS features between the occasional snorers and the frequent snorers was tested for significance. The p value was 0.784. Thus, there is no significant difference between non
snorers, occasional snorers and frequent snorers in the prevalence of UARS, in this sample. Hence, this hypothesis was not confirmed cf. Table VII (26-27).

Table VII (26). Presence of UARS, Apnoea and EDS, by history (SNQ), among the snorers and the non snorers in the interventional study sample

<table>
<thead>
<tr>
<th>Features of clinical condition</th>
<th>Non snorers (n 5)</th>
<th>All Snorers (n 191)</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper airway resistance syndrome (a response of 3, 4 or 5 to the SNQ. difficulty or struggle to breathe during sleep or Q. chest caves in or seesaws during sleep.)</td>
<td>Absent</td>
<td>5 (3 %)</td>
<td>189 (97%)</td>
<td>194</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>2 (100%)</td>
<td>2</td>
</tr>
<tr>
<td>Apnoea (a response of 3, 4 or 5 to the SNQ. Stops breathing during sleep )</td>
<td>Absent</td>
<td>5 (3%)</td>
<td>159 (97%)</td>
<td>164</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>32 (100%)</td>
<td>32</td>
</tr>
<tr>
<td>EDS (a response of 3, 4 or 5 to the SNQ. Falls asleep in school, or naps on coming back from school, or complains of feeling tired)</td>
<td>Absent</td>
<td>5 (4%)</td>
<td>135 (96%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>56 (100%)</td>
<td></td>
</tr>
</tbody>
</table>
Table VII (27). Presence of UARS, Apnoea and EDS, by history (SNQ), among the occasional snorers and the frequent snorers, in the interventional study sample

<table>
<thead>
<tr>
<th>Features of clinical condition</th>
<th>Non snorers</th>
<th>Occ. Snorers</th>
<th>Freq. snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>UARS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>5 (3%)</td>
<td>33 (17%)</td>
<td>156 (80%)</td>
<td>194</td>
<td>.784</td>
</tr>
<tr>
<td>Present</td>
<td>0</td>
<td>0</td>
<td>2 (100%)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Apnoea</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>5 (3%)</td>
<td>33 (20%)</td>
<td>126 (77%)</td>
<td>164</td>
<td>.01</td>
</tr>
<tr>
<td>Present</td>
<td>0</td>
<td>0</td>
<td>32 (100%)</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td><strong>EDS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Absent</td>
<td>5 (4%)</td>
<td>33 (24%)</td>
<td>102 (73%)</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>0</td>
<td>0</td>
<td>56 (100%)</td>
<td>56</td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 15. There is a significant association between Apnoeic episodes and the presence and frequency of snoring, (in children, attending an ENT clinic with adenotonsillar enlargement).

In this sample, breathing pauses were noticed in 32 of the snorers and in none of the non snorers. A chi square test showed a p value of 0.317. However, with a nought value in the analysis, no conclusive inference was possible.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of apnoea between the occasional snorers and the frequent snorers was tested for significance. The p value was
0.01. Thus, there is a significant difference between occasional snorers and frequent snorers in the prevalence of Apnoea, in this sample cf. Table VII (26-27).

Hence, this hypothesis is confirmed partially – apnoiec episodes are not significantly associated with snoring as such; but a significant association is manifest when the frequent snorers are identified and tested.

**Hypothesis 16.** There is a significant association between excessive daytime sleepiness (**EDS**) and the presence and the **frequency** of snoring, (in children, attending an ENT clinic with adenotonsillar enlargement).

In this sample, EDS was present in 100% of the snorers and in none of the non snorers. The sample was further segregated and the difference in the presence of EDS between the occasional snorers and the frequent snorers was tested for significance. The p value was < 0.001. Thus, the significance persists also when the frequency of snoring is considered cf. Table VII (26-27). Thus, this hypothesis is fully confirmed. EDS is more common in the frequent snorers.

**Inferences in this study on the presence of UARS, Apnoea and EDS in snorers**

In this sample population of children with adenotonsillar enlargement, the relative frequencies of UARS, Apnoea and EDS are interesting. The following important points are noted in this sample:

(i) Struggling to breathe, chest caving in or see sawing (features of UARS), breathing pauses (a feature of apnoea), sleeping during school hours, napping at home, unrefreshed sleep and continuous tiredness (features of EDS) were significantly present only in snorers and were absent or less frequent in the non snorers.

(ii) There is no difference in the prevalence of UARS, Apnoea and EDS among snorers and non snorers, when all snorers are clubbed together and considered as a single unit i.e. UARS, Apnoea and EDS are present in both snorers and non snorers in the same frequency.
(iii) But, when the snoring frequency is factored in, there is a significant
difference - apnoea and EDS are more frequent in the frequent snorers.
Hence, when a child comes with a history of snoring, care must be taken to
identify this population of frequent snorers - because it is this population
which is at risk.

**Associated diseases:**
Certain diseases viz. Nasal allergy, sinusitis, secretory otitis media (Sec OM),
chronic suppurative otitis media (CSOM), and gastro esophageal reflux
disease (GERD) may have a higher prevalence in snorers. This is tested in this
sample by the formulation of the following hypotheses 20- 19)

**Hypothesis 17. Gastro esophageal reflux disease (GERD) has a significant
association with the presence and the frequency of snoring, in children,
attending an ENT clinic with adeno tonsillar enlargement.**

In this sample, by clinical examination, features suggestive of GERD were
present in 2 % of children. One hundred per cent of them had snoring.
However, the p value of the difference between the snorers and non snorers
was 0.744 (not significant). Thus, snoring is present in the same proportion in
children with GERD and in children without GERD. Hence, this hypothesis is
not substantiated in our study.

The sample data were further analysed with reference to the frequency of
snoring i.e. the difference between the presence of occasional snoring and
frequent snoring in persons with GERD, was tested for significance. The p
value was still 0.197 i.e. not significant. Thus, neither the presence nor the
frequency of snoring is different in persons having GERD, in this sample.
Table VII (28). Presence of GERD, sinusitis, nasal allergy, secretory otitis media and CSOM by clinical examination, among the snorers and the non snorers in the interventional study sample (n =196).

<table>
<thead>
<tr>
<th>Features of clinical conditions</th>
<th>Non snorers</th>
<th>All Snorers</th>
<th>Total (% of total sample 196)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERD (uvula elongated or Oedematous)</td>
<td>Absent</td>
<td>5 (3%)</td>
<td>187 (97%)</td>
<td>192</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>4 (100%)</td>
<td>4</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Absent</td>
<td>0</td>
<td>8 (100%)</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>5 (3%)</td>
<td>183 (97%)</td>
<td>188</td>
</tr>
<tr>
<td>Nasal allergy</td>
<td>Absent</td>
<td>3 (2%)</td>
<td>179 (98%)</td>
<td>182</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>2 (14%)</td>
<td>12 (98%)</td>
<td>14</td>
</tr>
<tr>
<td>Secretory Otitis Media</td>
<td>Absent</td>
<td>5 (11%)</td>
<td>40 (86%)</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>151 (100%)</td>
<td>151</td>
</tr>
<tr>
<td>CSOM</td>
<td>Absent</td>
<td>5 (3%)</td>
<td>170 (97%)</td>
<td>175</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>21 (100%)</td>
<td>21</td>
</tr>
</tbody>
</table>
Table VII (29). Presence of GERD, sinusitis, nasal allergy, secretory otitis media and CSOM by clinical examination, among the occasional snorers and frequent snorers in the interventional study sample (n = 196)

<table>
<thead>
<tr>
<th>Features of clinical conditions</th>
<th>Non snorers</th>
<th>Occ. Snorers</th>
<th>Freq. snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>GERD (uvula elongated or Oedematous)</td>
<td>Absent</td>
<td>5 (3%)</td>
<td>31 (16%)</td>
<td>156 (81%)</td>
<td>192 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>2 (50%)</td>
<td>2 (50%)</td>
<td>4 (100%)</td>
</tr>
<tr>
<td>Sinusitis</td>
<td>Absent</td>
<td>0</td>
<td>8 (100%)</td>
<td>0</td>
<td>8 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>5 (3%)</td>
<td>25 (13%)</td>
<td>158 (84%)</td>
<td>188 (100%)</td>
</tr>
<tr>
<td>Nasal allergy</td>
<td>Absent</td>
<td>3 (2%)</td>
<td>21 (12%)</td>
<td>158 (87%)</td>
<td>182 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>2 (14%)</td>
<td>12 (86%)</td>
<td>0</td>
<td>14 (100%)</td>
</tr>
<tr>
<td>Secretory Otitis Media</td>
<td>Absent</td>
<td>5 (11%)</td>
<td>12 (27%)</td>
<td>28 (62%)</td>
<td>45 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>21 (14%)</td>
<td>130 (86%)</td>
<td>151 (100%)</td>
</tr>
<tr>
<td>CSOM</td>
<td>Absent</td>
<td>5 (3%)</td>
<td>12 (7%)</td>
<td>158 (90%)</td>
<td>175 (100%)</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>0</td>
<td>21 (100%)</td>
<td>0</td>
<td>21 (100%)</td>
</tr>
</tbody>
</table>

Hypothesis 18. Nasal allergy has a significant association with the presence and the frequency of snoring, in children, attending an ENT clinic with adenotonsillar enlargement.
In this sample, by clinical examination, features suggestive of nasal allergy were present in 7% of children. 98% within them had snoring. The p value of the difference between the snorers and non snorers was 0.004. Thus, nasal allergy and snoring were significantly associated positively. Hence, This hypothesis is substantiated.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference in the presence of nasal allergy between the occasional snorers and the frequent snorers was tested for significance. The p value was <0.001 i.e. highly significant.

Thus, on the basis of this study, we can conclude that children with nasal allergy snore more commonly and also more frequently.

Hypothesis 19. Sinusitis, has a significant association with the presence of snoring, in children, attending an ENT clinic with adeno tonsillar enlargement.

In this sample, by clinical examination, features suggestive of sinusitis were present in 93 % of children. Within these children having sinusitis, 97 per cent had snoring. 3 per cent did not have any snoring. The percentages appear to be very impressive and indicate that 97 percent of children with sinusitis also have snoring. But, when the statistical significance is tested by Pearson’s chi square tests, comparing the presence of snoring in children with sinusitis and the presence of snoring among children without sinusitis, the p value was 0.640 (not significant). Hence, this hypothesis is not substantiated. However, this is an issue which might need more extensive studies, in future.

Hypothesis 20. Sinusitis has a significant association with the frequency of snoring, in children, attending an ENT clinic with adeno tonsillar enlargement.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of sinusitis between the occasional snorers and the frequent snorers was tested for significance. The p value was <0.001 i.e. highly significant. Thus, this hypothesis is substantiated. Thus, when the frequent snorers are specifically identified and
the presence of sinusitis is looked for, we find a highly significant association, in this sample.

**Hypothesis 21.** Secretory otitis media has a significant association with the **presence** and the **frequency** of snoring, in children, attending an ENT clinic with adeno tonsillar enlargement.

In this sample, by clinical examination, features of secretory otitis media were present in 77% of children. One hundred percent of them 86% were snorers. The p value of the difference was <0.001. Thus, there is a positive association between the secretory otitis media and snoring.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of secretory otitis between the occasional snorers and the frequent snorers was tested for significance. The p value was still highly significant (<0.001). Hence, this hypothesis is fully confirmed. Thus, in children with snoring, secretory otitis media is commonly present. This association is also present when the snoring is frequent.

**Hypothesis 22.** CSOM has a significant association with the **presence** of snoring, in children, attending an ENT clinic with adeno tonsillar enlargement.

In this sample, by clinical examination, features suggestive of CSOM were present in 11% of children. One hundred percent of them had snoring. However, the p value of the difference between the snorers and non snorers was 0.433 (not significant). Thus, the presence of CSOM in all snorers (taken as a whole), was not any different than in non snorers. This hypothesis is not substantiated in this sample.

**Hypothesis 21.** CSOM has a significant association with the **frequency** of snoring, in children, attending an ENT clinic with adeno tonsillar enlargement.

The sample data were further analysed with reference to the frequency of snoring i.e. the difference for the presence of CSOM between the occasional snorers and the frequent snorers was tested for significance. The p value was <0.001 i.e. highly significant. This hypothesis is substantiated. Thus, when the
frequent snorers are specifically identified and the presence of CSOM is 
looked for, we find a highly significant association, in this sample.

Inference in this study about the associated diseases viz. nasal allergy, 
secretory otitis media, sinusitis, CSOM and GERD:

(iii) All the snorers, regardless of whether they are frequent 
snorers or occasional snorers, have a higher presence of 
nasal allergy and secretory otitis media.

(iv) Snorers, when taken up for statistical analysis as a whole, 
do not show any increased presence of sinusitis or CSOM. 
But when the frequent snores are segregated and analysed 
separately, the frequent snorers have a significantly 
higher presence of sinusitis and CSOM.

(v) All snorers, regardless of whether they are analysed in 
toto or whether they are segregated and analysed, do not 
show any association with GERD.

Soft tissue encroachments in the available airway:

The bony dimensions of the pharynx determine the lumen available for the 
passage of air during breathing. The soft tissues line the bony matrix and 
reduce the airway. The vertical airway dimensions can be assessed clinically by 
the Mallampatti scale. The horizontal airway dimensions can be assessed by 
the Tsai pharyngeal grading. The tonsils lie on either side of the oropharynx 
and when are enlarged, they further encroach on the airway. 
Hence these three soft tissue measures can be considered together. The 
following hypotheses were formed to test their association with the presence 
of snoring and also its frequency.

Hypothesis 22. Tonsil size, as recorded in the consultation office, has a 
significant association with the snoring characteristics namely the presence 
of snoring and the frequency of snoring.

Ninety per cent of the children in this sample had 'enlarged' tonsils. Within 
this group of children having enlarged tonsils, one hundred per cent children 
were snorers. Within the non enlarged group, 75% were snorers. This
difference was significant with a p value of <0.001. On further analysis after segregation into frequent snorer and occasional snorer groups, the p value was still highly significant (p <0.001).

Table VII (30). Presence of snoring in children with and without tonsil enlargement, as noticed in the clinic at the first visit among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Tonsil size At first visit</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total (% of the total sample of 196)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enlarged</td>
<td>5 (25%)</td>
<td>15 (75%)</td>
<td>20 (10%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Enlarged</td>
<td>0</td>
<td>176 (100%)</td>
<td>176 (90%)</td>
<td></td>
</tr>
</tbody>
</table>

( Brodsky scale size 3 and 4 considered as enlarged)

Table VII (31). Frequency of snoring in children with and without tonsil enlargement, as noticed in the clinic at the first visit among the Interventional study subjects

<table>
<thead>
<tr>
<th>Tonsil size At first visit</th>
<th>Non snorers</th>
<th>Occ. Snorers</th>
<th>Freq. snorers</th>
<th>All snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not enlarged n 20</td>
<td>5 (25%)</td>
<td>14 (70%)</td>
<td>1 (5%)</td>
<td>15 (100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Enlarged n 176</td>
<td>0</td>
<td>19 (11%)</td>
<td>157 (89%)</td>
<td>176 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis 23. Mallampatti score, as recorded in the consultation office, has a significant association with the snoring characteristics namely the presence of snoring and the frequency of snoring.

In this sample, within the children with a score of MS I, eighty nine per cent snored. Within the children with a score of MS II and MS III, one hundred
per cent snored. There were no children with MS IV score. This difference was highly significant (p <0.001). When the snorers were segregated into frequent and occasional snorers also, the differences continued to be significant at a p level of <0.001. Hence, this hypothesis is confirmed.

Table VII (32). Presence of snoring in children with increasing Mallampatti scores, among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Mallampatti score (structures seen)</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. (soft palate, uvula, fauces, pillars)</td>
<td>5 (11%)</td>
<td>42 (89%)</td>
<td>47 (100%)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>II. (soft palate, uvula, fauces)</td>
<td>0</td>
<td>142 (100%)</td>
<td>142 (100%)</td>
<td></td>
</tr>
<tr>
<td>III. soft palate, base of uvula)</td>
<td>0</td>
<td>7 (100%)</td>
<td>7 (100%)</td>
<td></td>
</tr>
<tr>
<td>IV. (soft palate not seen at all)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Table VII (33). Frequency of snoring in children with increasing Mallampatti scores among the Interventional study subjects.

<table>
<thead>
<tr>
<th>Mallampatti score</th>
<th>Non snorers</th>
<th>Total snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. n 47</td>
<td>5 (10.6%)</td>
<td>42 (89.4%)</td>
<td>4 (8.5%)</td>
<td>38 (80.9%)</td>
<td>.001</td>
</tr>
<tr>
<td>II. n 142</td>
<td>0</td>
<td>142 (100%)</td>
<td>28 (19.7%)</td>
<td>114 (80.3%)</td>
<td></td>
</tr>
<tr>
<td>III. n 7</td>
<td>0</td>
<td>7 (100%)</td>
<td>1 (14.3%)</td>
<td>6 (85.7%)</td>
<td></td>
</tr>
<tr>
<td>IV. n 0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis 24. Tsai pharyngeal grade, as recorded in the consultation office, has a significant association with the snoring characteristics namely the presence of snoring and the frequency of snoring.

In this sample, within the children with a Tsai pharyngeal grade score I, ninety one percent snored. Within the children with a score of II and III, one hundred per cent snored. There were no children with a score of IV. This difference was highly significant (p <0.001). When the snorers were segregated into frequent and occasional snorers also, the differences continued to be significant at a p level of <0.001. Hence, this hypothesis is confirmed.

Table VII (34). Presence of snoring in children in different scores of Tsai scale (horizontal measure of pharyngeal airway), in the Interventional study subjects.

<table>
<thead>
<tr>
<th>Measure of horizontal pharyngeal airway (Tsai pharyngeal grading)</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Total</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. (posterior faucial arch intersects tongue at its lateral edge)</td>
<td>N 53</td>
<td>5 (9%)</td>
<td>48 (91%)</td>
<td>53 (100%)</td>
</tr>
<tr>
<td>II. (arch intersects at 25% of tongue diameter)</td>
<td>N 135</td>
<td>0</td>
<td>135 (100%)</td>
<td>135 (100%)</td>
</tr>
<tr>
<td>III. (arch intersects at 50% of tongue diameter)</td>
<td>N 8</td>
<td>0</td>
<td>8 (100%)</td>
<td>8 (100%)</td>
</tr>
<tr>
<td>IV. (arch intersects at 75% or more of tongue diameter)</td>
<td>n 0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
</tbody>
</table>
Table VII (35). Presence of snoring in children in different scores of Tsai pharyngeal grading (horizontal measure of pharyngeal airway), as noticed in the clinic at the first visit among the Interventional study subjects, analysed with respect to the frequency of snoring.

<table>
<thead>
<tr>
<th>Measure of horizontal pharyngeal airway (Tsai pharyngeal grading)</th>
<th>Non snorers</th>
<th>All snorers</th>
<th>Occ. snorers</th>
<th>Freq. snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. (posterior faucial arch intersects tongue at its lateral edge)</td>
<td>5 (9.4%)</td>
<td>48</td>
<td>4 (8.5%)</td>
<td>38 (80.9%)</td>
<td>.001</td>
</tr>
<tr>
<td></td>
<td>N 53</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. (arch intersects at 25% of tongue diameter)</td>
<td>0</td>
<td>135</td>
<td>22 (16.3%)</td>
<td>113 (83.7%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N 135</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III. (arch intersects at 50% of tongue diameter)</td>
<td>0</td>
<td>8</td>
<td>1 (12.5%)</td>
<td>7 (87.5%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N 8</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IV. (arch intersects at 75% or more of tongue diameter)</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>N 0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Inference in this study about the association of pharyngeal dimension measures with snoring:

The tonsil sizes, Mallampatti score and Tsai pharyngeal grades, as noted in the consultation office, are significantly higher in all snorers. Such significance is even higher in frequent snorers.

Hypothesis 25. Behaviour of children is significantly associated with the presence and the frequency of snoring.

The OSA 18 is a disease specific quality of life assessment tool, which has been validated both for discriminant and evaluation functions. The parental response for the emotional distress domain of this instrument is used in this
analysis, as an expedient measure of the behaviour of the snoring child. The habitual snorers and 'the others' were considered as two independent groups. The emotion domain score was calculated for the two groups, in the pre operative state (which is the state unchanged by any therapeutic intervention of surgery). The mean and the distribution characteristics for each group were tested for equality of means. The p value was 0.003. Thus, there is a significant association between the frequency of snoring and emotional disturbances and this hypothesis is confirmed.

Table VII (36). Emotional disturbance domain scores between mild snorers and habitual snorers, in the pre operative state

<table>
<thead>
<tr>
<th>Snorer type</th>
<th>OSA 18 emotion domain scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Others (33)</td>
<td>4.29</td>
</tr>
<tr>
<td>Habitual snorers (158)</td>
<td>5.16</td>
</tr>
</tbody>
</table>

‘t’ test for equality of means: p 0.003

Hypothesis 26. Learning of children is significantly associated with the presence and the frequency of snoring:

Fragmented sleep may impair the skill sets necessary for learning. The general learning assessment was done by enquiring about the academic achievement in the school. A combined average of fifty percent marks in the last terminal examination was considered ‘passable’. Marks, poorer than fifty percent, were reckoned as scholastic backwardness. This grading was done to minimize misleading conclusions due to minor variations in the marks of children. The number of academically poor children among the habitual snorers was tested for significance with the same in 'the others'. The p value for the difference was 0.38 (not significant). Hence, this hypothesis is not confirmed in this sample.
Table VII (37). The over all academic performance, measured by school marks in the last terminal examination.

<table>
<thead>
<tr>
<th></th>
<th>Passable marks &gt; 50 % in the last terminal examinations</th>
<th>Scholastic backwardness &lt; 50 % in the last terminal examinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Others</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>n 30</td>
<td>(73%)</td>
<td>(27%)</td>
</tr>
<tr>
<td>Habitual snorers</td>
<td>54</td>
<td>18</td>
</tr>
<tr>
<td>n 72</td>
<td>(75%)</td>
<td>(25%)</td>
</tr>
<tr>
<td>*missing data in 23 children</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

p value 0.38

Inference: There was no difference in the over all academic performance between the habitual snorers and the others in this sample, as measured by the school marks. However, the issue of the appropriateness and the adequacy of the measuring tool will have to be considered. Additionally, any compensatory hard work on the part of the student to overcome any impairment that might have occurred will have to be taken into consideration. These were not done in this study.

**Cephalometry variables:**

The bony framework of the head and neck defines the hard matrix, within which the soft tissues of the pharyngeal airway are juxtaposed. This bony matrix can be measured by cephalometry. To test the role of the bony framework in snoring, the following hypothesis was formed and tested:

**Hypothesis 27. There is a significant association between cephalometric variables and habitual snoring.**

In this study, cephalometry was done 81 children. The following airway dimension variables were extracted from the digitized x rays and studied.
Retro palatal airway space
Retro glottal airway space
Hypo pharyngeal airway space
AN ratio as described by Li in 2002
Lower anterior face - total facial height ratio
Measures of hyoid position, namely MP-H distance, Rgn-H, H-C3, and C3-Rgn

There were 71 habitual snorers and 10 ‘others’. The mean values of the following cephalometric variables were determined by digitization for the habitual snorers and for others. The paired mean values of habitual snorers and the others were compared and the significance was tested for ‘the equality of means’. The results are given in tables VII (38-39). In this study, none of the cephalometric variables had significant association with snoring. Hence, this hypothesis is not confirmed in this sample (comprising entirely of children)

Table VII (38). The paired mean values of the various cephalometric variables in the habitual snorers and in others with the p values of difference

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Mean</th>
<th>s.d</th>
<th>SEM</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro Palatal Airway</td>
<td>Others</td>
<td>18.230</td>
<td>4.364</td>
<td>1.3801</td>
<td>.538</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>19.062</td>
<td>3.9348</td>
<td>.4670</td>
<td></td>
</tr>
<tr>
<td>Retro glottal Airway</td>
<td>Others</td>
<td>44.770</td>
<td>7.13209</td>
<td>2.25537</td>
<td>.481</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>43.4563</td>
<td>5.23970</td>
<td>.62184</td>
<td></td>
</tr>
<tr>
<td>Hypo pharyngeal airway space (H-C3 distance)</td>
<td>Others</td>
<td>33.970</td>
<td>4.7376</td>
<td>1.4982</td>
<td>.748</td>
</tr>
<tr>
<td></td>
<td>Habitual snorer</td>
<td>34.414</td>
<td>3.9898</td>
<td>.4735</td>
<td></td>
</tr>
</tbody>
</table>
Table VII (39). The paired mean values of the four cephalometric variables which define the position of the hyoid - in habitual snorers and in others, with the p values of differences

<table>
<thead>
<tr>
<th>Variables of hyoid position</th>
<th>Mean</th>
<th>s d</th>
<th>SEM</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retro gonion to Hyoid</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>35.180</td>
<td>7.8882</td>
<td>2.4945</td>
<td>.561</td>
</tr>
<tr>
<td>Habitual snorer</td>
<td>33.854</td>
<td>6.5618</td>
<td>.7787</td>
<td></td>
</tr>
<tr>
<td>Hyoid to C3 vertebra</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>33.970</td>
<td>4.7376</td>
<td>1.4982</td>
<td>.748</td>
</tr>
<tr>
<td>Habitual snorer</td>
<td>34.414</td>
<td>3.9898</td>
<td>.4735</td>
<td></td>
</tr>
<tr>
<td>C3 vertebra to Retrogonion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>68.110</td>
<td>10.1229</td>
<td>3.2011</td>
<td>.784</td>
</tr>
<tr>
<td>Habitual snorer</td>
<td>67.390</td>
<td>7.3698</td>
<td>.8746</td>
<td></td>
</tr>
<tr>
<td>Hyoid Mandibular plane distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>11.710</td>
<td>7.5979</td>
<td>2.4027</td>
<td>.618</td>
</tr>
<tr>
<td>Habitual snorer</td>
<td>12.693</td>
<td>5.5421</td>
<td>.6577</td>
<td></td>
</tr>
</tbody>
</table>
Hypothesis 28. Presence and frequency of snoring are significantly associated with enlarged tonsils and adenoids (as relaxedly recorded on the operating table).

One hundred and twenty five children among this total sample of 196 underwent adeno tonsillectomy. Among these children, 104 snored frequently or most nights. They were classified as frequent (habitual) snorers, just like earlier. Rest of the children either did not snore or snored occasionally. These were classified as 'others', for this analysis. In the operated children, the opportunity for a relaxed examination of the adenoid sizes and the tonsil sizes was utilized. The tonsils and the adenoids were graded by the Brodsky and the Bitar scales respectively. The Brodsky's sizes were dichotomized into a significantly 'enlarged' group comprising of sizes 1 and 2 and 'not enlarged' group of sizes 3 and 4. The Bitar sizes were dichotomized into a significantly 'enlarged' group comprising of sizes 1 and 2 and 'not enlarged' group of size 3.

Table VII (40). Categorization of snorers into habitual snorers and others

<table>
<thead>
<tr>
<th>Scores</th>
<th>1. never</th>
<th>2. rarely (less than once per month)</th>
<th>3. occasionally (1-4 times a month)</th>
<th>4. frequently (more than once per week)</th>
<th>5. most nights</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of snoring</td>
<td>Others</td>
<td>Habitual (frequent) snorer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One hundred and twenty (90%) of the operated children had 'enlarged' tonsils. Forty three children (66%) of the operated children had 'enlarged' adenoids.

Within this group of enlarged tonsils, 87% were habitual snorers. Among the 'tonsil-non enlarged' group, there were no habitual snorers. This difference was significant with a p value of <0.001. Within this group of enlarged adenoids, 88% were habitual snorers. Among the adenoids- not enlarged' group, 80% children were habitual snorers. This difference was not significant.
with a p value of 0.263. Hence this hypothesis is partially confirmed. Tonsils have significant association with snoring and adenoid sizes did not any such association.

Table VII (41). Presence and frequency of snoring in children with enlarged tonsils and adenoids (as noted at the time of surgery)

<table>
<thead>
<tr>
<th></th>
<th>Others</th>
<th>Habitual snorers</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tonsil Not enlarged (n 5)</td>
<td>5</td>
<td>0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>sizes 1 or 2 Brodsky</td>
<td>(100%)</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Tonsil Enlarged (n 120)</td>
<td>16</td>
<td>104</td>
<td></td>
</tr>
<tr>
<td>sizes 3 or 4 Brodsky</td>
<td>(13.3%)</td>
<td>(86.7%)</td>
<td></td>
</tr>
<tr>
<td>Adenoid Not enlarged (n 82)</td>
<td>16</td>
<td>66</td>
<td>0.263</td>
</tr>
<tr>
<td>sizes 1 or 2 Bitar</td>
<td>(19.5%)</td>
<td>(80.5%)</td>
<td></td>
</tr>
<tr>
<td>Adenoid Enlarged (n 43)</td>
<td>5</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>size 3 Bitar</td>
<td>(11.6%)</td>
<td>(88.4%)</td>
<td></td>
</tr>
</tbody>
</table>

Inference on the sizes of tonsil sizes and adenoid sizes found at the time of surgery: Enlarged tonsils have a significant association with habitual snoring, while the adenoid sizes did not have any such association.

Hypothesis 29. There is a positive change in the OSA specific quality of life before and after adenotonsillectomy in children.

The quality of life was assessed in this study by employing a disease specific QOL instrument, the OSA 18. This waas administered before and after therapeutic intervention i.e. adenotonsillectomy surgery. This tool had been fully described in the methodology section. From the parental responses pre op and post op to the individual items, the domain scores were calculated. For the domain scores, the mean and the frequency distribution variables like s.d.,
SEM and 95% CI intervals were calculated. The post operative change in the mean score for each domain was calculated. The two mean domain scores, pre operative and post operative, were tested by the ‘t’ test for equality of means cf. Table VII (42).

(i) In the children of this study sample, significant improvement of the quality of life occurs after therapeutic intervention by way of adenotonsillectomy. This improvement is significantly present in four OSA 18 domains viz. sleep problems, physical suffering, daytime problems and care giver concerns (p values <0.001 for all the four domains). In the emotion disturbance domain, the mean post operative score was found to be marginally worse with a change of 0.16. However, this change was found to be not significant (p value 0.365).

Table VII (42). Pre op and post op OSA 18 domain scores - Paired.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Pair</th>
<th>Mean</th>
<th>sd</th>
<th>SEM</th>
<th>95% CI</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Sleep disturbances</td>
<td>Pre op</td>
<td>13.47</td>
<td>3.6</td>
<td>.33</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>5.19</td>
<td>1.97</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>8.29</td>
<td>4.23</td>
<td>.39</td>
<td>7.52 9.06</td>
<td></td>
</tr>
<tr>
<td>2. Physical suffering</td>
<td>Pre op</td>
<td>17.25</td>
<td>3.18</td>
<td>.29</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>7.88</td>
<td>1.20</td>
<td>.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>9.36</td>
<td>2.58</td>
<td>.24</td>
<td>8.89 9.83</td>
<td></td>
</tr>
<tr>
<td>3. Emotional Distress</td>
<td>Pre op</td>
<td>4.71</td>
<td>1.46</td>
<td>.13</td>
<td></td>
<td>.365</td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>4.87</td>
<td>1.78</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>-0.16</td>
<td>1.92</td>
<td>.18</td>
<td>-.51 .19</td>
<td></td>
</tr>
<tr>
<td>4. Daytime Problems</td>
<td>Pre op</td>
<td>8.57</td>
<td>3.14</td>
<td>.29</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>4.89</td>
<td>1.71</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>3.68</td>
<td>2.08</td>
<td>.19</td>
<td>3.30 4.06</td>
<td></td>
</tr>
<tr>
<td>5. Caregiver concerns</td>
<td>Pre op</td>
<td>13.74</td>
<td>3.24</td>
<td>.3</td>
<td></td>
<td>&lt;0.001</td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>6.43</td>
<td>1.96</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(ii) Further statistical analysis was done to find out whether the change score was significantly different between the habitual snorer group and the 'others' group. For this analysis, the frequency distribution characteristics (the mean, sd, SEM and 95 % CI intervals) of the change scores of each domain were calculated. Then for each individual subject, the change in the domain score was divided by its standard deviation; the resultant is the Z score for the pre op - post op changes. This Z change score for a particular subject within a group indicates the magnitude of change of that individual, expressed in terms of his group's standard deviation. The Z change score pre op and post op, were calculated for the individuals within the habitual snorer group and the 'others' group. Then, the mean of these two groups were derived and were tested for the equality of means cf. Table VII (43).

Table VI (43). Z scores for the mean change scores of the individual domains of OSA 18 for the habitual snorer group and the mild snorer group.

<table>
<thead>
<tr>
<th>Domain Name</th>
<th>Snorer group</th>
<th>Distribution variables of the z change scores, pre op and post op</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>I. Sleep problems</td>
<td>Others n 21</td>
<td>1.262</td>
</tr>
<tr>
<td></td>
<td>Habitual Snorers n 97</td>
<td>-0.273</td>
</tr>
<tr>
<td>II. Physical suffering</td>
<td>Others n 21</td>
<td>.418</td>
</tr>
<tr>
<td></td>
<td>Habitual Snorers n 97</td>
<td>- 0.091</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Domain Name</th>
<th>Snorer group</th>
<th>Distribution variables of the z change scores, pre op and post op</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Total of all Domains</td>
<td>Pre op</td>
<td>57.74</td>
</tr>
<tr>
<td></td>
<td>Post op</td>
<td>29.26</td>
</tr>
<tr>
<td></td>
<td>Difference</td>
<td>28.48</td>
</tr>
</tbody>
</table>
### III. Emotional disturbance

<table>
<thead>
<tr>
<th></th>
<th>Others n 21</th>
<th>- 0.579</th>
<th>.847</th>
<th>.185</th>
<th>.003</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitual Snorers n 97</td>
<td>0.125</td>
<td>.990</td>
<td>.101</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### IV. Daytime problems

<table>
<thead>
<tr>
<th></th>
<th>Others n 21</th>
<th>0.600</th>
<th>.559</th>
<th>.122</th>
<th>.002</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitual Snorers n 97</td>
<td>- 0.130</td>
<td>1.029</td>
<td>.104</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### V. Caregiver concerns

<table>
<thead>
<tr>
<th></th>
<th>Others n 21</th>
<th>0.771</th>
<th>.852</th>
<th>.186</th>
<th>&lt;.001</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitual Snorers n 97</td>
<td>- 0.167</td>
<td>.954</td>
<td>.097</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 't' test for equality of the means

These Z scores were employed for this purpose by Sohn et al in 2003 (99) and were called Standard response of the mean (SRM) by them. Sohn defines SRM as 'the change score divided by its standard deviation'. As a measure of effect size, the SRM describes the signal to noise ratio. Ideally, the signal (variations in the change caused by true change) should be high relative to the noise (variations in the change score caused by random error).

Because the SRMs are ideally determined before and after an intervention of known efficacy, responsiveness to T&A surgery was determined in my study, by employing them. The difference in the Z change scores was significant for each of the five domains.

Such effect size improvements had been noticed in several other studies also. In another controlled study. In the randomised controlled trial conducted by Jenkinson et al, very large improvements were seen (128). Engleman in his excellent review (129) in 2004, noted that the improvement in the QOL measures occurs as a function of initial impairment, with the worst affected subscale scores showing the greatest improvements.
Table VI (44). OSA 18 Domain scores - Differences pre and post op in the T&A study.

OSA 18 tool could be administered both times only for 118 out of the 126 operated children. The eight children, who were left out, could not complete the questionnaire post op because the care giver who brought the child for review was different from the initial one. Parents rated symptom frequency during the previous 4 weeks using a 7-point ordinal scale of (1) none of the time, (2) hardly any of the time, (3) a little of the time, (4) some of the time, (5) a good bit of the time, (6) most of the time, and (7) all of the time.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Pre op score mean</th>
<th>sd</th>
<th>SE</th>
<th>Post op score mean</th>
<th>sd</th>
<th>SE</th>
<th>Paired Difference in scores mean</th>
<th>sd</th>
<th>SE</th>
<th>95% CI</th>
<th>t</th>
<th>df</th>
<th>signif two tailed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep disturbances</td>
<td>13.470</td>
<td>3.616</td>
<td>0.333</td>
<td>5.190</td>
<td>1.974</td>
<td>0.182</td>
<td>8.288</td>
<td>4.227</td>
<td>0.389</td>
<td>7.518-9.059</td>
<td>21.301</td>
<td>117</td>
<td>0.000</td>
</tr>
<tr>
<td>Physical suffering</td>
<td>17.250</td>
<td>3.181</td>
<td>0.293</td>
<td>7.880</td>
<td>1.199</td>
<td>0.110</td>
<td>9.364</td>
<td>2.578</td>
<td>0.237</td>
<td>8.894-9.834</td>
<td>39.465</td>
<td>117</td>
<td>0.000</td>
</tr>
<tr>
<td>Emotional distress</td>
<td>4.710</td>
<td>1.457</td>
<td>0.134</td>
<td>4.870</td>
<td>1.781</td>
<td>0.164</td>
<td>-0.161</td>
<td>1.921</td>
<td>0.177</td>
<td>(-0.511-0.189)</td>
<td>-0.910</td>
<td>117</td>
<td>0.365</td>
</tr>
<tr>
<td>Daytime problems</td>
<td>8.570</td>
<td>3.136</td>
<td>0.289</td>
<td>4.890</td>
<td>1.709</td>
<td>0.157</td>
<td>3.678</td>
<td>2.083</td>
<td>0.192</td>
<td>3.298-4.058</td>
<td>19.178</td>
<td>117</td>
<td>0.000</td>
</tr>
<tr>
<td>Caregiver concerns</td>
<td>13.740</td>
<td>3.243</td>
<td>0.299</td>
<td>6.430</td>
<td>1.955</td>
<td>0.180</td>
<td>7.305</td>
<td>3.795</td>
<td>0.349</td>
<td>6.613-7.997</td>
<td>20.910</td>
<td>117</td>
<td>0.000</td>
</tr>
<tr>
<td>All domains</td>
<td>57.740</td>
<td>9.821</td>
<td>0.904</td>
<td>29.260</td>
<td>5.158</td>
<td>0.475</td>
<td>28.475</td>
<td>8.599</td>
<td>0.792</td>
<td>26.907-30.042</td>
<td>35.971</td>
<td>117</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Table VI (45). Parental responses to the Individual items of OSA 18 in the T&A study.

Parents rated symptom frequency during the previous 4 weeks using a 7-point ordinal scale: (1) none of the time, (2) hardly any of the time, (3) a little of the time, (4) some of the time, (5) a good bit of the time, (6) most of the time, and (7) all of the time.

<table>
<thead>
<tr>
<th>Domain</th>
<th>Item</th>
<th>No. of survey responses in each point of the scale i.e. no. of children responding positive. Pre Op</th>
<th>No. of survey responses in each point of the scale i.e. no. of children responding positive Post Op</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep disturbance</td>
<td>1. Loud snoring</td>
<td>5 1 58 29 70 30 3</td>
<td>30 63 21 4</td>
</tr>
<tr>
<td></td>
<td>2. Breath holding/pauses</td>
<td>2 17 8 92 12 66</td>
<td>102 13 3</td>
</tr>
<tr>
<td></td>
<td>3. Choking or gasping</td>
<td>59 65 56 16</td>
<td>95 20 3</td>
</tr>
<tr>
<td></td>
<td>4. Fragmented sleep</td>
<td>14 86 34 57 2 3</td>
<td>85 28 5</td>
</tr>
<tr>
<td>Physical suffering</td>
<td>5. Mouth breathing</td>
<td>1 59 36 71 29</td>
<td>24 55 36 3</td>
</tr>
<tr>
<td></td>
<td>6. Frequent colds or URIs</td>
<td>1 60 45 73 17</td>
<td>5 69 44</td>
</tr>
<tr>
<td></td>
<td>7. Rhinorrhea</td>
<td>2 22 89 41 34 8</td>
<td>39 55 24</td>
</tr>
<tr>
<td>Category</td>
<td>Description</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------------------------------------------------</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>8. Dysphagia</td>
<td></td>
<td>90</td>
<td>17</td>
</tr>
<tr>
<td>Emotional distress</td>
<td>9. Mood swings or tantrums</td>
<td>69</td>
<td>12</td>
</tr>
<tr>
<td>10. Aggression/hyperactivity</td>
<td></td>
<td>118</td>
<td>71</td>
</tr>
<tr>
<td>11. Discipline problems</td>
<td></td>
<td>145</td>
<td>48</td>
</tr>
<tr>
<td>Daytime problems</td>
<td>12. Daytime drowsiness</td>
<td>34</td>
<td>71</td>
</tr>
<tr>
<td>13. Poor attention span</td>
<td></td>
<td>50</td>
<td>101</td>
</tr>
<tr>
<td>14. Difficulty awakening</td>
<td></td>
<td>2</td>
<td>43</td>
</tr>
<tr>
<td>Caregiver concerns</td>
<td>15. Caregiver worried over child health</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>16. Caregiver concerned not enough air</td>
<td></td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>17. Caregiver missed activities</td>
<td></td>
<td>15</td>
<td>104</td>
</tr>
<tr>
<td>18. Caregiver frustration</td>
<td></td>
<td>54</td>
<td>60</td>
</tr>
</tbody>
</table>
Table VI (46). Comparison with other studies

<table>
<thead>
<tr>
<th>OSA 18 domain</th>
<th>previous study</th>
<th>pre op</th>
<th>sd</th>
<th>post op</th>
<th>sd</th>
<th>mean change score</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total score</td>
<td>Mitchell 2004</td>
<td>76.7</td>
<td>17.9</td>
<td>32</td>
<td>11.7</td>
<td>44.7</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Flanary 2003</td>
<td>76</td>
<td>17.1</td>
<td>41.4</td>
<td>17.1</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Goldstein 2002</td>
<td>70.2</td>
<td>27</td>
<td>NA</td>
<td>NA</td>
<td>41.4</td>
<td>34.2-48.6</td>
</tr>
<tr>
<td></td>
<td>Tran 2005</td>
<td>72</td>
<td>21.6</td>
<td>28.8</td>
<td>12.6</td>
<td>45</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Mitchell 2004</td>
<td>71.4</td>
<td>NA</td>
<td>35.8</td>
<td>NA</td>
<td>35.5</td>
<td>28.7-42.4</td>
</tr>
<tr>
<td></td>
<td>Sohn 2003</td>
<td>55.8</td>
<td>16.2</td>
<td>NA</td>
<td>NA</td>
<td>30</td>
<td>23.8-34.0</td>
</tr>
<tr>
<td></td>
<td>Mitchell 2005</td>
<td>72.8</td>
<td>18.2</td>
<td>41</td>
<td>24</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Balakrishnan 2008</strong></td>
<td>Mitchell 2004</td>
<td>19.4</td>
<td>4.3</td>
<td>6.6</td>
<td>2.4</td>
<td>12.8</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Flanary 2003</td>
<td>20.2</td>
<td>5.5</td>
<td>7.4</td>
<td>4.9</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Goldstein 2002</td>
<td>17.2</td>
<td>7.6</td>
<td>NA</td>
<td>NA</td>
<td>11.6</td>
<td>9.6-13.6</td>
</tr>
<tr>
<td></td>
<td>Tran 2005</td>
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Chapter VIII.
Summary and Conclusions

Summary of the prevalence studies

Collection of data on the prevalence of snoring and other features of sleep disordered breathing was achieved by a series of surveys with wide ranging bases, namely Pedex survey, Street survey, Households survey, Adolescent Students survey and Adult industrial workers survey.

**Pedex survey**: In this survey, the prevalence of snoring in the general community was ascertained by a questionnaire. BMI was calculated by taking height and weight. In this Pedex survey, with a sample size of 1075 persons of all ages and economic background, the total prevalence of snoring was 19.5%. The percentage of snorers was found to be 24.4% in males vs. 13% of females (higher in the males). Among the age groups, with increasing age, the prevalence of snoring increased – children: 12%, adults: 24%. The prevalence of snoring in children and in adolescents was found to be independent of BMI. In contrast, the adult age group showed a significant increase in snoring with increasing BMI. The prevalence of snoring was found to increase positively with increasing affluence. Children with sore throat had a significant tendency to have snoring. In the general community, awareness of the condition exists. However, many persons (snorers and non snorers alike) are not interested in getting more information.

**Street survey**: Trained personnel interviewed persons at busy streets consecutively, and and recorded the answers in a standard survey format. In the novel street survey with a sample size of 937 persons of all ages, gender and build, the overall prevalence of snoring was 21.1% (males 11% and females 10.1%). In this sample, the self reported prevalence and the frequency of snoring showed no significant difference between the genders. This is at variance to the conventional belief that more males snored more frequently. However, it was seen that females tend to snore less loudly than males. The method of obtaining sample subjects from the streets is found by this study to yield less appropriate data.
On analysing the prevalence of the self reported snoring, it was found that no one below the age of 30 years (male and female) reported snoring, even though they constituted 43.8 percent of the sample. This is in contradiction with similar surveys and our own surveys. This method of getting subjects from the streets is commonly adopted in opinion surveys and in election predictions. This method had even been employed to estimate the prevalence data for snoring itself. With the experience gained in this survey, we find that this method of obtaining the prevalence data is not yielding correct data.

A relatively comfortable environment, where the patient has the time, inclination and willingness to think and answer (not one where the subject awaits the change of signals or for the arrival of the next bus) would be appropriate.

**Households survey:** All the inhabitants of an entire housing colony in Chennai, formed the sample. A total of 398 persons (222 males and 176 females) were included in this study. In addition to the questionnaire, each person had a clinical examination.

The overall prevalence of snoring in this sample was found to be quite high at 43 percent (26.4% males and 16.6% females). Among the total of 114 children below the age of 12 years, 34% were snorers. Out of the male snorers, 18.5 % snored frequently. Oropharyngeal indicators like tonsil size and Mallampatti had significantly higher scores in this sample.

**Students survey:** One of the important problems engendered by snoring and sleep apnoea is learning impairment. Hence, this part of the survey had a focus on young adult students. 198 medical students and nursing students of both gender formed the sample. The medical history and details of snoring, if any, were recorded. The subjects underwent morphological and clinical examination. This sample comprised of the students with a mean age of 20.6 years. The over all prevalence of snoring was 7.6 per cent. It is noteworthy that even persons who had a BMI below the normal i.e. below 23 snored. BMI was found to be significantly associated with snoring in this sample.

It should be noted that as many as 21% of the of this study sample comprising exclusively of young students complained of excessive daytime sleepiness when they were administered the Berlin questionnaire. The association of sleepiness with snoring was found to be significant statistically. In addition, waist hip ratio was higher in all snoreers.
**Adult industrial workers survey:** This part of the study focused on industrial workers, who have shift duties. All the employees on shift duty in a large industrial establishment formed the subjects of this study. The subjects had their heights and weights measured. Then, each one of them filled up a questionnaire. The questions pertained to the presence of snoring, its frequency and any precipitating factors, if present. 602 employees of all ages formed this sample. All were men.

Six hundred and two employees of all ages formed this sample. All were men. Among all ages, the overall prevalence of snoring was 16.8%. The prevalence of snoring is seen to increase with age. In the age group, 19-29 years, the prevalence was 7.7%. In the age group 45-59 years, the prevalence was 21.5%. The loudness is not associated with either on age groups or on BMI status. Among the snorers, 68.2% snored occasionally and 31.8% snored frequently. Among the snorers, the snoring status worsened with tiredness (100%), good food (92%) and with alcohol (62%).

**Summary of the interventional part of the study**

A total of 197 children of ages 3 - 15 years, attending a specialist ENT clinic for recurrent throat infections and features of obstructed airway entered this study. Several of them had adenotonsillar enlargement. Based on their snoring pattern, they were stratified into frequent snorer group and occasional snorer groups. All the children were assessed with tests for behaviour and learning. The above variables among these three groups were different.

**Age, gender, BMI and SES:** These did not have any significant association with snoring, in this sample. There was also no linear relationship between the mild snorer and the habitual snorer groups in this regard.

**UARS, Apnoea and EDS:** In this sample population of children with adenotonsillar enlargement, the relative frequencies of UARS, Apnoea and EDS are interesting.

Struggling to breathe, chest caving in or see sawing (features of UARS), breathing pauses (a feature of apnoea), sleeping during school hours, napping at home, unrefreshed sleep and continuous tiredness (features of
EDS) were significantly present only in snorers and were absent or less frequent in the non snorers.

When the snoring frequency is factored in, there is a further significant difference – apnoea and EDS are more frequent in the frequent snorers. Hence, when a child comes with a history of snoring, care must be taken to identify this population of frequent snorers – because it is this population which is at a higher risk.

**Tonsil size and adenoid size:** Tonsil size was found to be significantly associated with snoring; more so with frequent snoring. Adenoid size per se (alone) was found to be of no importance in this regard. However, children with adenotonsillar enlargement were more likely to have impaired QOL scores if they had a history of frequent snoring. In these children with adenotonsillar enlargement, the addition of historical questionnaire data, other than snoring frequency, did not improve predictions of snoring.

**Pharyngeal dimensions in children with snoring:** The tonsil sizes and Tsai pharyngeal grades are significantly higher in all snorers. Such significance is even higher in frequent snorers. The Mallampatti score is not significant, when the total group of all snorers is considered as a whole. But, it becomes significant when the frequent snorers are segregated and considered. Hence, in every snorer, examination of the oral cavity is important. Taking a history of the frequency is equally or perhaps more important, thereby alerting the clinician to bestow a little more attention to the oral cavity examination.

**Associated diseases:** Nasal allergy, sinusitis, secretory otitis media and CSOM have significant associations with snoring. But, GERD did not show any positive association with snoring in this study.

All the snorers, regardless of whether they are frequent snorers or occasional snorers, have a higher presence of nasal allergy and secretory otitis media. Snorers, when taken up for statistical analysis as a whole, do not show any increased presence of sinusitis or CSOM. But when the frequent snores are segregated and analysed separately, the frequent snorers were found to have a significantly higher presence of sinusitis and CSOM.

A snoring child has a high possibility of having nasal allergy and secretory otitis media. Hence, in the clinical examination of snoring children, a
focused effort must be made to identify whether a child has nasal allergy (including wheezing). The ears must be specifically examined for secretory otitis and CSOM. In a frequently snoring child, this becomes more imperative.

**Cephalometric imaging and measurements:** In this study, out of the seven cephalometric measurements taken up for analysis, namely, Retro palatal airway space, Retro glottal airway space, Hypopharyngeal airway space, MP-H distance, position of hyoid (Rgn-H, H-C3, and C3-Rgn), AN ratio, Lower anterior face - total facial height ratio, the former six were not associated with snoring at all. Only the LFH/TFH ratio, indicating the long face syndrome (adenoid facies), was significantly associated with snoring and snoring frequency. All the others were not significantly associated. The digitization had been done in an academic institution by a very well experienced orthodontist. Even though the airway analysis was novel and hence, relatively unfamiliar to the orthodontic practitioners, the digitization techniques are extremely familiar to them. Even then, the initial ten films had been digitized twice by two different orthodontists and cross checked. With all these precautions, the cephalometry did not yield any positive association with snoring.

**Behaviour:** In children with snoring (all the snorer groups taken together), the behaviour scores were not different from those of non snorers. But, when the frequent snorers were specifically studied separately, the behaviour scores were found to be worse than mild snorers. And, after surgery, these worse scores of frequent scores were found to improve significantly.

**General learning:** There was no difference in the over all academic performance, as measured by the school marks between the frequent and occasional snorer groups. This might mean that the tool used (the single marker of 50% marks in the last terminal examination ) lacked precision (did not measure the academic performance correctly) or that the underlying impaired learning skills have been compensated to some extent by the strenuous efforts of the student, his teachers and parents.

**Effect of therapeutic intervention:** In this sample, almost all the parameters of the QOL OSA 18 tool improved well, with the sole exception of emotional domain, which showed a marginal worsening after
surgery; however, this change was very minimal (0.16 increase in the mean domain score value) and was not at all significant. Overall, the QOL scores improved after the therapeutic intervention in the snoring children.

A snoring child has a high possibility of having nasal allergy, secretory otitis media. Hence, in the clinical examination of snoring children must include a pointed effort to identify whether a child has nasal allergy (including wheezing). The ears must be specifically examined for secretory otitis and CSOM. Look allergy associated feature of wheezing, attention must be made to identify all snorers pointed atten and the ears must be specifically examined in a snoring child. When the frequent snorers are specifically identified and the presence of nasal allergy is looked for,

The tonsil sizes and Tsai pharyngeal grades are significantly higher in all snorers. Such significance is even higher in frequent snorers. The Mallampatti score is not significant, when the total group of all snorers is considered as a whole. But, it becomes significant when the frequent snorers are segregated and considered.

Hence, in every snorer, examination of the oral cavity is important; Taking a history of the frequency is equally or perhaps more important, thereby alerting the clinician to bestow a little more attention to the oral cavity examination.

However, on statistical analysis did not show any significance between relative frequencies between the snorers and non snorers. The adequacy of the sample size may be the issue. In this connection, further investigations like polysomnography, oesophageal pressure studies and MSLT would have yielded assertive diagnostic labels. However, those studies could not be suggested to the patients, because of reasons like (1) their invasive nature (2) necessity for overnight hospitalization (3) non availability (4) waiting time and consequent delay in treatment (5) expensiveness and (6) the ethical issue of not suggesting any extra investigation which may not have a bearing on management of the child.
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### Pedex KKCTH Questionnaire survey

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<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor cycle /Scooter</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Car</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

### Educational status of family members: Tick the right answer

<table>
<thead>
<tr>
<th>not entered school^{1}</th>
<th>upto 9^{th} std^{2}</th>
<th>10 std^{3}</th>
<th>Plus two^{5}</th>
<th>Graduat e^{6}</th>
<th>Professional, PG &amp; above^{7}</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Questions for adults only: Tick the right answer

<table>
<thead>
<tr>
<th>Item</th>
<th>Never</th>
<th>Yes</th>
<th>This yr only</th>
<th>2 yr</th>
<th>5 yr</th>
<th>More yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you smoke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have Blood pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you have Hypothyroidism</td>
<td>Never</td>
<td>Yes</td>
<td>This yr only</td>
<td>2 yr</td>
<td>5 yr</td>
<td>More yr</td>
</tr>
<tr>
<td>---------------------------</td>
<td>-------</td>
<td>-----</td>
<td>--------------</td>
<td>------</td>
<td>------</td>
<td>--------</td>
</tr>
</tbody>
</table>

From April 2003, (in the last one year), how many times ...

<table>
<thead>
<tr>
<th>Did you have cold / sore throat?</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>more times</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 5</th>
<th>Do you snore</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 6</th>
<th>Number of yrs of snoring</th>
<th>Never</th>
<th>This yr only</th>
<th>2 yr</th>
<th>5 yr</th>
<th>More yr</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Did you go to a doctor for the same?</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>more times</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Did you have ear pain?</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>more times</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Did you go to a doctor for the same?</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>more times</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 7</th>
<th>Snoring frequency</th>
<th>Never</th>
<th>Rarely once per week</th>
<th>2,3 days in a week</th>
<th>4 or more days</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 8</th>
<th>Do other people complain about your snoring</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 9</th>
<th>While sleeping, do you move in bed or kick persons</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 10</th>
<th>During daytime, do you have sleepiness or fall asleep easily</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 11</th>
<th>Have you had any operation</th>
<th>No</th>
<th>Yes</th>
<th>Name of operation:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Q 12</th>
<th>Are you interested to get pamphlets about snoring</th>
<th>No</th>
<th>Yes</th>
</tr>
</thead>
</table>
Snoring questions

**Street survey Individual questionnaire**

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Gender</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>2</td>
<td>Do you snore</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>if yes, how many times in a week</td>
<td>Rarely (once per week)</td>
<td>Occasionally (2 times per week)</td>
</tr>
<tr>
<td>4</td>
<td>Loudness of snoring</td>
<td>Soft</td>
<td>Loud</td>
</tr>
<tr>
<td>5</td>
<td>Is the snoring worse sometimes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>If so, what makes it worse</td>
<td>alcohol</td>
<td>good food</td>
</tr>
<tr>
<td>7</td>
<td>What is your age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>Gender</td>
<td>Age years</td>
<td>Build</td>
</tr>
<tr>
<td>----</td>
<td>--------</td>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>1</td>
<td>M/F</td>
<td>&lt;12</td>
<td>Lean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-18</td>
<td>Mod.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-29</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 60</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>M/F</td>
<td>&lt;12</td>
<td>Lean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-18</td>
<td>Mod.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-29</td>
<td>Large</td>
</tr>
<tr>
<td></td>
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<td>30-59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 60</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>M/F</td>
<td>&lt;12</td>
<td>Lean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-18</td>
<td>Mod.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-29</td>
<td>Large</td>
</tr>
<tr>
<td></td>
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<td>30-59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 60</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>M/F</td>
<td>&lt;12</td>
<td>Lean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-18</td>
<td>Mod.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-29</td>
<td>Large</td>
</tr>
<tr>
<td></td>
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<td>30-59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 60</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>M/F</td>
<td>&lt;12</td>
<td>Lean</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12-18</td>
<td>Mod.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19-29</td>
<td>Large</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30-59</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; 60</td>
<td></td>
</tr>
</tbody>
</table>
Household Questionnaire Survey 2004 (English translation)

Name

Gender

Height cm

Weight Kg

Date of birth d d m m yr yr yr yr

Does your household have any of the following (Tick the correct boxes)

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Radio</th>
<th>TV</th>
<th>Bicycle</th>
<th>Scooter / motorcycle</th>
<th>land ownership</th>
<th>Car</th>
<th>Fridge</th>
</tr>
</thead>
</table>

Educational status of family members (Tick the correct boxes)

<table>
<thead>
<tr>
<th>Name</th>
<th>not entered school</th>
<th>Upto 9th std</th>
<th>10 std</th>
<th>Plus two</th>
<th>Graduate</th>
<th>professional PG &amp; above</th>
<th>Occupation</th>
</tr>
</thead>
</table>

Questions for adults only: (Tick the correct boxes)

<table>
<thead>
<tr>
<th>Item</th>
<th>No</th>
<th>Yes</th>
<th>Ex smoker, now stopped</th>
<th>Light smoker 10 or less cig per day</th>
<th>Heavy smoker 11 or more per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you smoke</td>
<td>No</td>
<td>Yes</td>
<td>Ex smoker, now stopped</td>
<td>Light smoker 10 or less cig per day</td>
<td>Heavy smoker 11 or more per day</td>
</tr>
<tr>
<td>Do you drink</td>
<td>No</td>
<td>Yes</td>
<td>Ex drinker, now stopped</td>
<td>light drinker &lt;140 ml (one quarter) per wk</td>
<td>heavy drinker &gt;140 ml (one quarter) per wk</td>
</tr>
<tr>
<td>Do you have diabetes</td>
<td>No</td>
<td>Yes</td>
<td>Actual number of years</td>
<td>I do not know</td>
<td>I do not know</td>
</tr>
<tr>
<td>Do you have Blood pressure</td>
<td>No</td>
<td>Yes</td>
<td>Actual number of years</td>
<td>I do not know</td>
<td>I do not know</td>
</tr>
</tbody>
</table>
In the last one year,

<table>
<thead>
<tr>
<th>Question</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>more times</th>
</tr>
</thead>
<tbody>
<tr>
<td>How many times did you have ear pain?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you go to a doctor for the same?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How many times did you have sore throat?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did you go to a doctor for the same?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Questions on Snoring and daytime sleepiness (Households survey)

<table>
<thead>
<tr>
<th>Question</th>
<th>No</th>
<th>Yes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you snore</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Snoring frequency</td>
<td>Never</td>
<td>Occasionally, 1 or 2 nights in a week</td>
<td>3 or more nights in a week</td>
</tr>
<tr>
<td>Number of yrs of snoring</td>
<td>(actual number of years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do other people complain about your snoring</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>While sleeping, do you move in bed or kick persons</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>During daytime, do you regularly feel sleepy or fall asleep easily (EDS)</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Have you had any operation</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Do you exercise?</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Are you interested to get pamphlets about snoring</td>
<td>No</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Exercise years (actual no. of years)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical Examination</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>General</strong></td>
<td>Height cm</td>
<td>Weight Kg</td>
<td>BP systolic</td>
</tr>
<tr>
<td><strong>Lips</strong></td>
<td>Closed 0</td>
<td>Parted 1</td>
<td></td>
</tr>
<tr>
<td><strong>Teeth</strong></td>
<td>Normal 0</td>
<td>protruding 1</td>
<td></td>
</tr>
<tr>
<td><strong>Tonsils</strong></td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Brodsky grade</td>
<td>absent</td>
<td>just outside (25% airway obstruction)</td>
<td>readily seen, (25-50% obstruction)</td>
</tr>
<tr>
<td><strong>Ph Vertical</strong></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>extent of airway</td>
<td>soft palate, fauces, uvula, pillars seen</td>
<td>soft palate, fauces, uvula seen</td>
<td>soft palate, base of uvula seen</td>
</tr>
<tr>
<td>Modified Mallampatt (Samsoon and Young 1987)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ph Horizontal</strong></td>
<td>I</td>
<td>II</td>
<td>III</td>
</tr>
<tr>
<td>extent of airway</td>
<td>Posterior arch at edge of tongue</td>
<td>arch intersects at 25% or more of tongue diameter</td>
<td>arch intersects at 50% or more of tongue diameter</td>
</tr>
<tr>
<td>Tsai ph grading classes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Uvula Length</strong></td>
<td>Normal 0</td>
<td>elongated 1</td>
<td></td>
</tr>
<tr>
<td><strong>Uvula Oedema</strong></td>
<td>Normal 0</td>
<td>oedematous 1</td>
<td></td>
</tr>
<tr>
<td><strong>Nasal Septum</strong></td>
<td>Midline 0</td>
<td>DNS 1</td>
<td></td>
</tr>
<tr>
<td><strong>Nasal conchae</strong></td>
<td>Normal 0</td>
<td>enlarged 1</td>
<td>Atrophic 2</td>
</tr>
<tr>
<td><strong>Ant nasal discharge</strong></td>
<td>Absent 0</td>
<td>Minimal 1</td>
<td>Significant 2</td>
</tr>
<tr>
<td><strong>Post nasal discharge</strong></td>
<td>Absent 1</td>
<td>Significant 2</td>
<td>and thick</td>
</tr>
<tr>
<td><strong>Left ear</strong></td>
<td>Normal 0</td>
<td>Retracted 1</td>
<td>Dry CP 2</td>
</tr>
</tbody>
</table>
Right ear | Normal<sup>0</sup> | Retracted<sup>1</sup> | Dry CP<sup>2</sup> | CP with discharge<sup>3</sup> |  
UDC nodes | Normal<sup>0</sup> | Enlarged<sup>1</sup> |  

**Industrial Employees' Questionnaire**

Kindly fill up the information as correctly as possible.

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of birth</td>
<td>d</td>
<td>d</td>
<td>m</td>
<td>m</td>
<td>yr</td>
</tr>
<tr>
<td>Height cm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight kg</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Do you snore</td>
<td>No</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

If you snore, proceed further and answer the following questions ...

How many times in a week do you snore?  
- Rarely<sup>1</sup> (once per week)  
- Occasionally<sup>2</sup> (Two times in a week)  
- Frequently<sup>3</sup> (3-4 times a week)  
- Almost always<sup>4</sup> (> Four times a week)

Do other people complain about it?  
- No<sup>1</sup>  
- Yes<sup>2</sup>

Is the snoring worse sometimes?  
- No<sup>1</sup>  
- Yes<sup>2</sup>

If so, what makes it worse?  
- Alcohol<sup>1</sup>  
- Good food<sup>2</sup>  
- Over work or tiredness<sup>3</sup>

Thank you very much for spending your time. The information given by you will be kept strictly confidential.
Govt. Chengalpattu Medical College
Medical / Nursing Students questionnaire

<table>
<thead>
<tr>
<th>Name</th>
<th>Course</th>
<th>Med</th>
<th>Nurs.</th>
<th>Year of Study</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>Date of birth</th>
<th>d</th>
<th>d</th>
<th>m</th>
<th>m</th>
<th>yr</th>
<th>yr</th>
<th>Gender</th>
<th>M</th>
<th>F</th>
<th>Educational status of family</th>
<th>not entered school</th>
<th>upto 9th std</th>
<th>10 std</th>
<th>Plus two</th>
<th>Graduate 6</th>
<th>Professional, PG &amp; above</th>
<th>Occupatin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In your house, which of the following are present? Please make a tick mark in the correct box.

<table>
<thead>
<tr>
<th>Electricity</th>
<th>Radio</th>
<th>TV</th>
<th>Bicycle</th>
<th>Scooter / motorcycle</th>
<th>land ownership</th>
<th>Car</th>
<th>Fridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Do you have any of the following diseases?

<table>
<thead>
<tr>
<th>Item</th>
<th>No°</th>
<th>Yes¹</th>
<th>Don't know</th>
<th>If yes, duration</th>
<th>med taken exact name</th>
<th>med dosage</th>
<th>Yr from which it is taken</th>
<th>Are you taking the med now</th>
<th>No°</th>
<th>Yes¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Any other disease,</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Have you ever been admitted in a hospital at any time for any illness?

<table>
<thead>
<tr>
<th>Have you ever been admitted in a hospital at any time for any illness</th>
<th>No°</th>
<th>Yes¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any hospital admission before</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Your age at that time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration stay (days)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>medicines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II Time</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any operation I</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

xxii
<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you exercise?</td>
<td>No</td>
</tr>
<tr>
<td>If yes, how much time, per session?</td>
<td>20 min.</td>
</tr>
<tr>
<td>How many sessions in a week?</td>
<td>one</td>
</tr>
</tbody>
</table>

**Berlin Questionnaire (Snoring and Sleep)**

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Has your weight changed recently (in the last 6 months)?</td>
<td>Increased</td>
</tr>
<tr>
<td>Do you snore?</td>
<td>Yes</td>
</tr>
<tr>
<td>Snoring loudness</td>
<td>Loud as breathing</td>
</tr>
<tr>
<td>Snoring frequency</td>
<td>Almost every day</td>
</tr>
<tr>
<td>Does your snoring bother other people?</td>
<td>Yes</td>
</tr>
<tr>
<td>How often have your breathing pauses been noticed?</td>
<td>Almost every day</td>
</tr>
<tr>
<td>Are you tired after sleeping?</td>
<td>Almost every day</td>
</tr>
<tr>
<td>Are you tired during wake time?</td>
<td>Almost every day</td>
</tr>
</tbody>
</table>
Have you ever fallen asleep while driving?  
Yes  
No  
Never or almost never

Do you have high blood pressure?  
Yes  
No  
Do not know

**Epworth Sleepiness Scale (ESS)**

*How likely are you to doze off or fall asleep in the following situations, in contrast to just feeling tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently, try to work out how they would have affected you. Put a tick mark in the correct box.*

<table>
<thead>
<tr>
<th>Situation</th>
<th>Chances of Dozing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No chance</td>
</tr>
<tr>
<td>Sitting and reading</td>
<td></td>
</tr>
<tr>
<td>Watching TV</td>
<td></td>
</tr>
<tr>
<td>Sitting inactive in a public place (e.g. a theater or a meeting)</td>
<td></td>
</tr>
<tr>
<td>As a passenger in a car for an hour without a break</td>
<td></td>
</tr>
<tr>
<td>Lying down to rest in the afternoon when circumstances permit</td>
<td></td>
</tr>
<tr>
<td>Sitting and talking to someone</td>
<td></td>
</tr>
<tr>
<td>Sitting quietly after a lunch without alcohol</td>
<td></td>
</tr>
<tr>
<td>In a car, while stopped for a few minutes in traffic</td>
<td></td>
</tr>
</tbody>
</table>
## General examination

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Height</td>
<td>cm</td>
</tr>
<tr>
<td>Weight</td>
<td>kg</td>
</tr>
<tr>
<td>Chest (insp) cm</td>
<td></td>
</tr>
<tr>
<td>Chest (exp) cm</td>
<td></td>
</tr>
<tr>
<td>Neck cm</td>
<td></td>
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<tr>
<td>Waist cm</td>
<td></td>
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<tr>
<td>Hip cm</td>
<td></td>
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<tr>
<td>Crico mental dist</td>
<td></td>
</tr>
</tbody>
</table>

## Clinical Examination

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Lips</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonsils</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ph Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cm</td>
<td>cm</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Ph Horizontal</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>cm</td>
<td>cm</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uvula length</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uvula</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Lips**: Closed 0, Parted 1
- **Teeth**: Normal 0, protruding 1
- **Tonsils**: Brodsky grade 0, fully inside; 1, just outside (25% airway obstruction); 2, readily seen, (25-50% obstruction); 3, midway (50-75% obstruction); 4, >75% obstruction
- **Ph Vertical**: I, soft palate, fauces, uvula, pillars seen; II, soft palate, fauces, uvula seen; III, soft palate, base of uvula seen; IV, soft palate not visible at all
- **Ph Horizontal**: I, posterior arch at edge of tongue; II, arch intersects at 25% or more of tongue diameter; III, arch intersects at 50% or more of tongue diameter; IV, arch intersects at 75% or more of tongue diameter
- **Uvula**: Normal 0, elongated 1; Normal 0, oedematous 1
<table>
<thead>
<tr>
<th>oedema</th>
<th>Nasal Septum</th>
<th>Midline 0</th>
<th>DNS¹</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal conchae</td>
<td>Normal 0</td>
<td>enlarged¹</td>
<td>Atrophic²</td>
<td></td>
</tr>
<tr>
<td>Ant nasal discharge</td>
<td>Absent 0</td>
<td>Minimal¹</td>
<td>Significant²</td>
<td></td>
</tr>
<tr>
<td>Post nasal discharge</td>
<td>Absent 0</td>
<td>Serous¹</td>
<td>Significant²</td>
<td></td>
</tr>
<tr>
<td>Left ear</td>
<td>Normal 0</td>
<td>Retracted¹</td>
<td>Dry CP²</td>
<td>CP with discharge³</td>
</tr>
<tr>
<td>Right ear</td>
<td>Normal 0</td>
<td>Retracted¹</td>
<td>Dry CP²</td>
<td>CP with discharge³</td>
</tr>
<tr>
<td>UDC nodes</td>
<td>Normal 0</td>
<td>Enlarged¹</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**T&A Interventional Study Sheet**

**Contact Information**

<table>
<thead>
<tr>
<th>Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>MRD Number</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>M</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Address 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pin code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phone ® landline</td>
<td>STD code</td>
<td></td>
</tr>
<tr>
<td>Phone(mobile)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height cm</td>
<td>veg</td>
<td></td>
</tr>
<tr>
<td>Weight Kg</td>
<td>Mixed</td>
<td></td>
</tr>
<tr>
<td>Date of birth</td>
<td>d d m m yr yr</td>
<td></td>
</tr>
</tbody>
</table>

xxvi
Educational Status of family members - Please put a tick mark in the correct box.

<table>
<thead>
<tr>
<th></th>
<th>not entered school</th>
<th>upto 9th std</th>
<th>10 std</th>
<th>Plus two</th>
<th>Graduate</th>
<th>Professional, PG &amp; above</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Father</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>You</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In your house, which of the following are present? Please make a tick mark in the correct box.

<table>
<thead>
<tr>
<th></th>
<th>Electricity</th>
<th>Radio</th>
<th>TV</th>
<th>Bicycle</th>
<th>Scooter / motorcycle</th>
<th>land ownership</th>
<th>Car</th>
<th>Fridge</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>U</td>
<td>NE</td>
<td>NE</td>
</tr>
</tbody>
</table>

Do you have any of the following diseases?

<table>
<thead>
<tr>
<th>Item</th>
<th>No&lt;sup&gt;0&lt;/sup&gt;</th>
<th>Yes&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Don't know&lt;sup&gt;6&lt;/sup&gt;</th>
<th>If yes, duration</th>
<th>Diab med taken exact name</th>
<th>Diab med dosage</th>
<th>Yr from which it is taken</th>
<th>Are you taking the med now</th>
<th>No&lt;sup&gt;0&lt;/sup&gt;</th>
<th>Yes&lt;sup&gt;1&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diabetes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypothyroidism</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any other disease, specify details</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Have you ever been admitted in a hospital at any time for any illness? No<sup>0</sup> Yes<sup>1</sup>

<table>
<thead>
<tr>
<th>Any hospital admission before</th>
<th>Your age at that time</th>
<th>Diagnosis</th>
<th>Duration stay (days)</th>
<th>medicines</th>
</tr>
</thead>
<tbody>
<tr>
<td>I time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II Time</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any operation I</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In this academic year, how many times... Please make a tick mark in the correct box:

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>more times</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you have cold / sore throat?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>more times</td>
</tr>
<tr>
<td>Did you go to a doctor for the same?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>more times</td>
</tr>
<tr>
<td>Did you have ear pain?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>more times</td>
</tr>
<tr>
<td>Did you go to a doctor for the same?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>more times</td>
</tr>
</tbody>
</table>
SNQ Brouilette questionnaire. (Snoring) Please make a tick mark in the correct box:

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency of snoring</td>
<td>never</td>
<td>rarely</td>
<td>occasionally</td>
<td>frequently</td>
<td>most nights</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(less than once per month)</td>
<td>(1- 4 times per month)</td>
<td>(more than once per week)</td>
<td></td>
</tr>
<tr>
<td>Loudness of snoring</td>
<td>Does not snore</td>
<td>Faint, can not hear unless near the child</td>
<td>Light, can hear in the same room, but not too loud</td>
<td>Moderate, easy to hear</td>
<td>Very loud, bothersome and can not ignore</td>
</tr>
<tr>
<td>difficulty or struggle to breathe during sleep</td>
<td>never</td>
<td>do</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Chest caves in or seesaws during sleep</td>
<td>never</td>
<td>do</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Stops breathing during sleep</td>
<td>never</td>
<td>do</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Falls asleep in school</td>
<td>never</td>
<td>do</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Naps on coming back from school, or complains of feeling tired</td>
<td>never</td>
<td>do</td>
<td>do</td>
<td>do</td>
<td>do</td>
</tr>
<tr>
<td>Mouth breathing</td>
<td>never</td>
<td>sometimes</td>
<td>always</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does anyone else in the family, have sleep apnoea</td>
<td>no</td>
<td>yes</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Clinical Examination

<table>
<thead>
<tr>
<th>General</th>
<th>Height cm</th>
<th>Weight Kg</th>
<th>BP systolic</th>
<th>BP diastolic</th>
<th>Any other findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lips</td>
<td>Closed 0</td>
<td>Parted 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teeth</td>
<td>Normal 0</td>
<td>protruding 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tonsils Brodsky grade</td>
<td>0 fully inside</td>
<td>1 just outside (25% airway obstruction)</td>
<td>2 readily seen, (25 - 50% obstruction)</td>
<td>3 midway (50 - 75% obstruction)</td>
<td>4 &gt; 75% obstruction</td>
</tr>
<tr>
<td>Ph Vertical extent of airway Modified Mallampatti (Samsoon and Young 1987)</td>
<td>I soft palate, fauces, uvula, pillars seen</td>
<td>II soft palate, fauces, uvula seen</td>
<td>III soft palate, base of uvula seen</td>
<td>IV soft palate not visible at all</td>
<td></td>
</tr>
<tr>
<td>Ph Horizontal extent of airway Tsai ph grading classes</td>
<td>I posterior arch at edge of tongue</td>
<td>II arch intersects at 25% or more of tongue diameter</td>
<td>III arch intersects at 50% or more of tongue diameter</td>
<td>IV arch intersects at 75% or more of tongue diameter</td>
<td></td>
</tr>
<tr>
<td>Uvula length</td>
<td>Normal 0</td>
<td>elongated 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uvula oedema</td>
<td>Normal 0</td>
<td>oedematous 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal Septum</td>
<td>Midline 0</td>
<td>DNS 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nasal conchae</td>
<td>Normal 0</td>
<td>enlarged 1</td>
<td>Atrophic 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ant nasal discharge</td>
<td>Absent 0</td>
<td>Minimal 1</td>
<td>Significant 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post nasal discharge</td>
<td>Absent 1</td>
<td>Significant 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left ear</td>
<td>Normal 0</td>
<td>Retracted 1</td>
<td>Dry CP 2</td>
<td>CP with discharge 3</td>
<td></td>
</tr>
<tr>
<td>Right ear</td>
<td>Normal 0</td>
<td>Retracted 1</td>
<td>Dry CP 2</td>
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Test of Variables of Attention TOVA® (Pre Op and post op):

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T&A surgery (Date)

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Other details, if any

Please make a tick mark in the correct box.
OSA-18 என்னவாறு என்னவென் தீர்ப்பிட்டல்

எனவாறு 4 என்னவாறு என்னவென் காண்பவர் காவென் என்னவென் தீர்ப்பிட்டல்?

தமிழ் 2.25வது என்னவாறு என்னவென் தீர்ப்பிட்டலை விளக்குவதற்கு குறுக்கு முதலை (மூலம்) காவென் என்னவென்.

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</table>
பழுப்பு/ பயர்பிறானில் காட்டுவதற்கு

1. பயன்படுத்தப்பட்ட வேண்டியும் பயன்படுத்தப்பட்ட வேண்டும் முறை 1 2 3 4 5 6 7

2. பயன்படுத்தப்பட்ட வேண்டியும் பயன்படுத்தப்பட்ட வேண்டும் முறை 1 2 3 4 5 6 7

3. பயன்படுத்தப்பட்ட வேண்டியும் பயன்படுத்தப்பட்ட வேண்டும் முறை 1 2 3 4 5 6 7

4. பயன்படுத்தப்பட்ட வேண்டியும் பயன்படுத்தப்பட்ட வேண்டும் முறை 1 2 3 4 5 6 7

5. பயன்படுத்தப்பட்ட வேண்டியும் பயன்படுத்தப்பட்ட வேண்டும் முறை 1 2 3 4 5 6 7


பழுப்பு/ பயர்பிறானில் காட்டுவதற்கு

0 1 2 3 4 5 6 7 8 9 10

மிகுதியான
மிகுதியான
மிகுதியான
The prevalence of Snoring in Madras, India – Report on phase 1.

Balakrishnan D¹, Thirunavukkarasu S¹, Edwin R², Virudhagirinathan B S³

¹Department of ENT, Kanchi Kamakoti Childs Trust Hospital, ²Department of Epidemiology Tamilnadu Dr. M.G.R. Medical University, ³Institute of Neurology, Madras Medical College, Chennai, India.

Address for communication: Prof. D. Balakrishnan, 6, 16th Cross Street, Indira Nagar, Chennai 600 020, India. E mail: balaent@gmail.com

Introduction:

All over the world, there is an increasing awareness of the problems of sleep, snoring and apnoea. Even in countries, where such awareness had been in existence for two decades, the available data is not consistent and can only be regarded as best estimates. Such data from the west cannot be extrapolated to the South Asia, as the social parameters are very different. The upward mobility of the South Asian communities has led to an urgent need of reliable data in this field. This study begins a process of obtaining reliable data, in phases. This report is a statistical analysis of the data collected by a partially administered questionnaire survey of the prevalence of snoring in the Indian metropolitan city of Chennai (Madras).

Material and methods:

Visitors of all ages to a medical exhibition constituted the study population. Of a total of 1133 recruited to the study, 58 were excluded from the study because they were less than two years of age. On getting an informed consent, demographic data like name, address, economic level, date of birth, height and weight were recorded. After this, each individual entered a questionnaire survey. The questionnaire was deliberately kept simple (vide appendix). The participants were guided by the surveyors in filling up the forms.
The participants were assigned to different age groups: Individuals aged 2 – 12 years were classified as Children; 13 -18 as Adolescents, 19 - 45 years as Adults and those aged 46 years and above as Elders. Their economic levels were classed into three categories, in consultation with a community health expert, by a simple and expedient scale of ownership of powered vehicles. Families having at least one motor cycle were categorised as middle class. Those having at least one car in the family were termed affluent. Those having no motor cycle or car were classed as economically weaker.

The data were analysed with a standard statistical software (SPSS 7.5 ver). In the analysis, a p value of <0.05 was considered to be significant.

Results and Discussion:

a) Demographic profile of the sample: The total sample of 1075 individuals consisted of 431 children, 117 adolescents, 469 adults and 58 elders. Considering their economic levels were considered, the total sample consisted of 263 affluent, 601 middle income and 211 economically weaker individuals.

b) Prevalence of snoring: The total frequency of snorers in the entire survey population of 1075 was 210, amounting to 19.5 % (95% CI = 17.13 to 21.87).

c) Age group and snoring: The subgroups of children and the adolescents had a prevalence of around 12 percent. The adults showed a higher prevalence of 24 percent; the elder group had even a higher prevalence with nearly one half reporting snoring(Table 1). This positive association of snoring with increasing age was found to be significant ($\chi^2$=36.57, p = 0.001).
Table 1: Prevalence of snoring by age groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Total Number</th>
<th>No. of Snorers</th>
<th>%</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td>Child</td>
<td>431</td>
<td>56</td>
<td>13</td>
<td>9.83 - 16.17</td>
</tr>
<tr>
<td>Adolescent</td>
<td>117</td>
<td>14</td>
<td>12</td>
<td>6.12 - 17.88</td>
</tr>
<tr>
<td>Adult</td>
<td>469</td>
<td>114</td>
<td>24.3</td>
<td>20.42 - 28.18</td>
</tr>
<tr>
<td>Elders</td>
<td>58</td>
<td>26</td>
<td>44.8</td>
<td>32.01 - 57.59</td>
</tr>
<tr>
<td>Total</td>
<td>1075</td>
<td>210</td>
<td>19.5</td>
<td>17.13 - 21.87</td>
</tr>
</tbody>
</table>

d) Gender and Snoring: The percentage of snorers was found to be higher in the males than in the females - 24.4% in males vs 13% of females - Table 2.

Table 2: Prevalence of snoring by gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>Total</th>
<th>Snorers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>611</td>
<td>149</td>
<td>24.4</td>
</tr>
<tr>
<td>Female</td>
<td>464</td>
<td>61</td>
<td>13</td>
</tr>
</tbody>
</table>

This higher prevalence among the males was further analysed with reference to age groups. The male predominance was found to significant only in the adult category. Such a higher prevalence in the male gender was not present in the sub groups of children, adolescents and the elder - Table 3

Table 3: Gender wise distribution of snorers by age groups

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Child  (n=431)</th>
<th>Adolescent (n=117)</th>
<th>Adult  (n=469)</th>
<th>Elder  (n=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Snorers</td>
<td>%</td>
<td>Total Snorers</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>238</td>
<td>34</td>
<td>70</td>
<td>12.9</td>
</tr>
<tr>
<td>Female</td>
<td>193</td>
<td>22</td>
<td>47</td>
<td>10.6</td>
</tr>
<tr>
<td>χ²</td>
<td>0.786</td>
<td>0.131</td>
<td>20.7</td>
<td>1.97</td>
</tr>
<tr>
<td>P value</td>
<td>0.375</td>
<td>0.717</td>
<td>0.01</td>
<td>0.16</td>
</tr>
</tbody>
</table>
e) Body Mass Index and Snoring: The prevalence of snoring within each age group was analysed in relation to the BMI (Table 4). The prevalence of snoring in children and in adolescents was found to be independent of BMI. In contrast, the adult age group showed a significant increase in snoring with increasing BMI ($\chi^2=16.96$, $p = 0.01$). In the elder group, though the percentages of snorers were high, statistical significance was not evident because of the small numbers.

<table>
<thead>
<tr>
<th>Age group &gt;</th>
<th>Child</th>
<th>Adolescent</th>
<th>Adult</th>
<th>Elder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
<td>Total</td>
</tr>
<tr>
<td>BMI &lt;20</td>
<td>375</td>
<td>81</td>
<td>80</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>48</td>
<td>9</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>12.8</td>
<td>11.1</td>
<td>16.3</td>
<td>80</td>
</tr>
<tr>
<td>20-25</td>
<td>46</td>
<td>29</td>
<td>205</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>4</td>
<td>37</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>15.2</td>
<td>13.8</td>
<td>18.0</td>
<td>37.5</td>
</tr>
<tr>
<td>26-29</td>
<td>8</td>
<td>7</td>
<td>154</td>
<td>21</td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>51</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>12.5</td>
<td>14.3</td>
<td>33.1</td>
<td>33.3</td>
</tr>
<tr>
<td>&gt;30</td>
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<tr>
<td></td>
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<td>0</td>
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<td>6</td>
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<td>75.0</td>
</tr>
<tr>
<td>Total each age group</td>
<td>431</td>
<td>117</td>
<td>469</td>
<td>58</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>0.003</td>
<td>0.184</td>
<td>16.96</td>
<td>0.042</td>
</tr>
<tr>
<td>p value</td>
<td>0.958</td>
<td>0.912</td>
<td>0.01</td>
<td>0.837</td>
</tr>
</tbody>
</table>
f) Socio economic status and Snoring: The prevalence of snoring was found to increase positively with increasing affluence (Table 3) ($\chi^2 = 7.034$, $p = 0.008$).

Table 3: Prevalence of snoring by the Economic status

<table>
<thead>
<tr>
<th>Economic status</th>
<th>Total number</th>
<th>Snorers</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaker section</td>
<td>211</td>
<td>25</td>
<td>11.8</td>
</tr>
<tr>
<td>Middle income</td>
<td>601</td>
<td>127</td>
<td>21.1</td>
</tr>
<tr>
<td>Affluent</td>
<td>263</td>
<td>58</td>
<td>22.1</td>
</tr>
</tbody>
</table>


g) Snoring in relation to history of sore throat: Among the children, 169 did not have any sore throat in the eight months since the last school vacation; only 12 had snoring (7.1 %). In contrast, in children having a history of sore throat ($n = 269$), 44 had snoring (16.7%). This positive association of snoring and sore throat was statistically significant (Table 4) ($\chi^2 = 207$, $p = 0.01$). This type of association was not evident in the Adolescent and in the Adult subgroups. The elders i.e. those aged 46 years and above showed a highly significant association. Within this group of elders, eleven persons were aged more than 60 years. Five of them had snoring and all these five had had sore throat during the period of recall. However, no worthwhile inference could be drawn because of the small numbers.
Table 4: Association of snoring with sore throat - age group wise distribution

<table>
<thead>
<tr>
<th>Age group &gt;</th>
<th>Child (n=431)</th>
<th>Adolescent (n=117)</th>
<th>Adult (n=469)</th>
<th>Elder (n=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>Total snores</td>
<td>%</td>
<td>Total snores</td>
<td>%</td>
</tr>
<tr>
<td>h/o Sore throat absent</td>
<td>169 12 7.1</td>
<td>50 5 10.0</td>
<td>172 33 19.2</td>
<td>22 3 13.6</td>
</tr>
<tr>
<td>present</td>
<td>262 44 16.8</td>
<td>67 9 13.4</td>
<td>297 81 27.3</td>
<td>36 23 63.9</td>
</tr>
<tr>
<td>$\chi^2$</td>
<td>8.53 0.32 3.87 13.94</td>
<td>3.87 0.049 13.94</td>
<td></td>
<td></td>
</tr>
<tr>
<td>p value</td>
<td>.003 .571 .049 .001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

h) Awareness about the possible effects of snoring: Regardless of the presence or the absence of snoring, all the individuals were asked whether they would like to be mailed any further literature regarding snoring. 81.4% of snorers and 52.3% of non-snorers replied in the affirmative i.e. nearly a fifth of the snorers did not feel the necessity to know more about their snoring problem. This may be taken to indicate a lack of awareness about the possible associated effects of snoring.

Table 5: Persons interested in getting further info regarding snoring

<table>
<thead>
<tr>
<th>Interested in further info</th>
<th>Snorers</th>
<th>Non snorers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not Interested in further info</td>
<td>39</td>
<td>412</td>
</tr>
</tbody>
</table>
i) Comparison with other studies in other parts of the world: Several questionnaire surveys had been conducted in other countries. Ersu R, Arman A R, Save D et al (2004) assessed the prevalence of snoring to be 7% in a sample of 2,147 primary school children in Istanbul, Turkey. In Michigan and California of the United States, one study indicated a prevalence of 16% in children aged 2 to 13.9 years. In Korea, another study indicated a prevalence of 11.2% in children aged 15 to 18 years. In southern Italy in a cohort of 895 children aged between 3 and 11 years, 4.9% of the children was identified as habitual snorers and 15.8% as occasional snorers. As the study population and the criteria of the scoring for snoring are different in different surveys, the results are not comparable in their entirety. However all the surveys done so far, including ours, indicate that snoring has a significant prevalence all over the world.

Summary:

In a first attempt to gather data about the prevalence of snoring in this part of the world, a questionnaire survey was conducted in Chennai, India. The survey sample of 1075 consisted of various age groups. The overall prevalence of snoring was 19.5%. Across the age groups, the male gender and affluence had a positive association with snoring. The BMI increased the snoring prevalence only in the adults. A history of sore throat was positively associated with snoring significantly in the children less than 12 years of age only. This survey broadly indicates the profile of snorers in this part of the world. The lack of concern among a fifth of the snorers was noted in this study.

Limitations of this study:

This study has all the limitations of a questionnaire survey. While a positive association had been noted between sore throat and snoring, no further attempt at defining the nature of snoring (primary or secondary) was attempted in this phase 1 of the study.
Acknowledgements:

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References: