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Snoring and Its-management (Part 1/2): A Review

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Abstract
In-this-study '*snoring*' was considered under-the-umbrella of sleep-disordered-breathing. The-article reflects concise-background-information, selected *via* document-analysis, on: *Snoring* (definitions, types, causes, prevalence, and effects, including: (i) acoustic-disturbance (noise-pollution) and resulted sleep- deprivation, and relationship-problems; and (ii) health-effects, due-to Upper Airway-obstruction); and *Snoring-management* (treatments and remedies**)**, including the-concept of anti-snoring chin-strap-device. Although, snoring is a-medical-issue, this-review, primarily-targeted, *non*-medics – *product*-designers, in-particular; also, it was *not* intended to-be *fully*-comprehensive, and, hence, should-be-considered for illustrative-purpose. Nevertheless, the-author trusts, this-review, provided a-contribution (in its-small-way) to the-body of knowledge, on the-subject-matter. Moreover, the-study constituted an-important-step, toward deeper-understanding, of snoring, and its-management-options, alongside with their-limitations, in-the preparation for the-design of an-anti-snoring-device (Part 2/2). Finally, further-research-areas were recommended, on: (1) country-wise-survey on snoring-prevalence; (2) perceptions on snoring; (3) anti- snoring-treatments and remedies, available, and their-cost implications; and (4) the-design of anti-snoring-device (for-example uncomplicated chin-strap-device), to-offer an-affordable-solution, to untapped-local-population of snorers.
Keywords: OSA; sleep-disordered-breathing; anti-snoring-devices; anti-snoring-surgery.

1. Introduction.

The-term 'sleep-disordered-breathing' is commonly-used, to-describe the-full-range of breathing-problems, during sleep, in-which, *not* enough-air reaches the-lungs (hypopnea and apnea)--a-common-condition in the-middle-aged adult-population. All-airflow-disruption, which lasts two-complete respiratory-cycles, is called *apnea,* while the-*hypopnea* is identified as the-partial-obstruction of more than 50% of the-air-flow (Rangel *et al.,* 2012). According to Izci *et al.* (2006), the-impact of sleep-disordered-breathing on society, health-care, and affected-individuals, is considerable. In-this-study '*snoring*' was considered under-the umbrella of sleep-disordered-breathing.

2. Snoring.

2.1. Definitions.

According to MedTerms™ Medical-Dictionary, snoring is:

> A rough rattling noise made on inspiration during sleep by vibration of the soft palate (the back of the roof of the mouth) and the uvula (the prominent structure dangling down at the back of the mouth). On inspiration, air on its way to the lungs travels by the tongue, the soft palate, the uvula, and the tonsils. When a person is awake, the muscles in the back of the throat tighten to hold these structures in place and prevent them from collapsing and vibrating in the airway. During sleep, the soft palate and uvula may vibrate causing the sounds of snoring.

The-Webster-Dictionary, provided shorter-definition, of snoring, as: 'The action or sound of breathing during sleep with harsh, snorting noises caused by vibration of the soft palate'.

In the-Cambridge-English-Dictionary, *no* definition for snoring, is provided; a-verb 'snore'[snɔr, snoʊr], however, is defined as: 'to make loud noises as you breathe while you are sleeping'**.**

Simply put, snoring occurs when a-collapse, blockage, or restriction, to-the-upper-airway, obstructs air-movement (through the-back of the-mouth, throat, or nose), during breathing, while sleeping. The-sound (snoring) is created by the-vibration of the-affected-soft-tissues. In-some-cases, the-sound may-be soft, but in most-cases, it can-be loud and unpleasant, for their bed-partners.

2.2. Predisposing factors/ Causes.

It-is beneficial to-look at the-mechanism of snoring, first. Generally-speaking, snoring is the-result of the-relaxation of the-uvula and soft-palate, and, subsequent, partial-blockage the-airway, resulting in-irregular-airflow and vibrations (Chokroverty, 2007). During the-stage when the-muscles go into deep relaxation, they become completely-loose, and incapable of movement. For-example, with open-mouth-snorers, the-muscles, in the-jaw, and the-chin, tends to-drop-down, leaving the-mouth hanging-open. Besides, the-tongue, and other-soft-tissues, in the-throat, also tend-to-fall-back, blocking the-airways, and causing the-typical snoring-sounds, to-emerge. Snoring is simply the-sound of resistance and turbulence, in the-upper-airway.

The-upper-airway (UA) is a-very-complex-structure, which plays vital-roles for respiratory, digestive, and

phonatory-functions (Kuna & Remmers, 2000; Remmers *et al.,* 1978). It consists of the-nasal-airway, the-pharynx, the-larynx, and the-trachea (Ayappa & Rapoport, 2003; Kuna & Remmers, 2000). Figure 1 shows the-anatomy of the-UA.

Ayappa & Rapoport (2003); Douglas (2002); and Kuna & Remmers (2000) indicated, that the-pharynx is the-main-site of airflow-obstruction, during-sleep, due-to-lack of bony and cartilaginous-support. According to Isono *et al.* (2003); Schwab *et al.* (2003); Isono *et al.* (1997); and Schwab *et al.* (1995; 1993), however, the-most-common-sites, of obstruction, are: the-retropalatal (in-almost 100% at the-retropalatal airway), and retroglossal-regions (in 50% of the-patients, at the-level of oropharynx); obstruction may-also-occur in the-hypopharyngeal-airway (Hudgel, 1998).

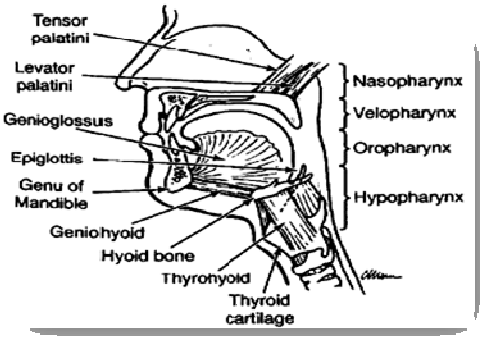

Figure 1: The-anatomy of the upper-airway (Kuna & Remmers, 2000).

Factors, causing UA-obstruction, in-patients with sleep-disordered-breathing, are: (1) Skeletal-factors (Verin *et al.,* 2002; Sforza *et al.,* 2000; Gunn *et al.,* 2000); (2) Soft-tissue-factors (Schwa*b et al.,* 2003; Schellenber*g et al.,* 2000; Deegan & McNicholas, 1995). For-example, the-pharynx, in-UA, has a-collapsible-structure, due to the-lack of bony-formation. Both; passive-mechanical and active-neural factors contribute to its-patency and collapsibility (Izci *et al.,* 2006); (3) Combining skeletal-factors and obesity (Douglas, 2002; Tangugsorn *et al.,* 2000); and (4) Other-factors, such-as: oedema, nasal-obstruction, and respiratory-control-instability; as-well-as active/passive-smoking (Pae *et al.,* 2005; Franklin *et al.,* 2004).

UA-patency depends on many-factors, including, but *not* limited to: (1) *Mechanical factors*: Lung-volume (Fogel *et al.,* 2003; Stanchina *et al.,* 2003); Body-position and gravity (Isono *et al.,* 2004; 2002); Breathing-route (e.g., nasal, oral, or both)(Fitzpatrick *et al.,* 2003); Surface-adhesive-forces and fluid-elasticity of the-mucosa (Kirkness *et al.,* 2003); The-vascular-tone of the-blood-vessels (Wasicko *et al.,* 1990); (2) *Gender differences as regards upper airway* (Jordan *et al.,* 2005; Shahar *et al.,* 2003; Liu *et al.,* 2003; Rowley *et al.,* 2002; Kamal, 2002; Malhotra *et al.,* 2002; O'Connor *et al.,* 2000; Huang *et al.,* 1998); (3) *the balance between dilating and collapsing forces* (Kuna & Remmers, 2000); and (4) *Upper airway compliance and collapsibility* (Schneider *et al.,* 1986) among-other-factors.

Heavy-snoring is a-result in sleep-related upper-airway narrowing, which leads to-respiratory flow-limitation. The-narrower the UA becomes, the-greater the-vibration, and the-louder the-snoring. The-soft-tissues of the-pharynx, including the-tonsils, soft-palate, uvula, tongue, and the-lateral pharyngeal-walls, in the-adult, are important in influencing airway-size (Schwab *et al.,* 2003; Schellenberg *et al.,* 2000; Deegan & McNicholas, 1995; Schwab *et al.,* 1995; 1993). Constriction or narrowing, of UA, can happen for many-reasons, such-as: cartilage-deformities, in the-nose or nasal-structure. The-most common-cause, however, is a-tongue-muscle, which relaxes too-much, during sleep, and allows the-tongue to-be-sucked-back, into the-airway, with each-breath.

On-the-other-hand, there is *no* single-cause for snoring; Cote (1988), for-instance, includes conditions, such-as: sleep-related-loss of muscle-tone, in the-tissues supplied by the-glosso-pharyngeal-nerve; anatomical-obstruction of nasal-passages; large-tonsils; large-tongue; a retrognathic-mandible; allergies; and certain-medical-conditions. For-example, asthma, can-potentially cause a-shrinking, of the-air-passages, which can-lead-to-snoring. Besides, snoring can-be-accredited to-one, or more, of the-following: (1) Obesity, that has caused fat to-gather in and around-the-throat. For-example, Fogel *et al.* (2003); Deegan & McNicholas (1996); Mortimore *et al.* (1998); and Davies & Stradling (1990) stated, that anthropomorphic measurements, such-as upper-body-obesity, neck-circumference, and waist- hip-ratio (WHR) are better-predictors, of sleep-disordered-breathing, including snoring, than BMI; (2) Obstructive-sleep-apnea (OSA); (3) Sleep-deprivation; (4) Relaxants, such-as: alcohol or other-drugs, relaxing throat-muscles; (5) Sleeping on one's back, which may-result in the-tongue-dropping to-the-back of the-mouth; (6) Mis-positioned-jaw, frequently caused by tension in the-muscles (Mayo Clinic, 2015); (7) throat-weakness, causing the-throat-to-close, during-sleep. Throat loses muscle-tone, but does

not completely-collapse. Throat-tissues (mainly uvula and soft-palate) rattle and produce the-noise of snoring, while breathing-effort increases; and (8) A-muscular-tonus-change, in the-UA-region, results in a-failure of maintaining the-proper-pace for the-airflow, especially in the-deepest-stages of sleep, is an-important-cause of snoring, in-adults (Rangel *et al.,* 2012).

Moreover, UA-obstruction can-be-caused by: anatomic-deviations, tumors, polyps, large-adenoids and tonsils, large-uvula, or a-long-soft-palate (Pataka & Riha, 2013; Arias *et al.,* 2005).

To-summarize, the-ability of UA-muscles to-act, in-response to-different-conditions, is reduced, during-sleep. This-ability includes changes in-UA-muscle dilator-activity and related-changes, in the-mechanics, and reflex-activity of the-muscles. Thus, sleep-related-changes, in-UA, are the-key-factors, for understanding the-mechanism of UA-obstruction. Presently, sleep-disordered-breathing, including snoring, is considered to-result from a-*combination* of the-anatomical UA-predisposition and the-changes in-reflex-activity of the-muscles, during-sleep (Izci *et al.,* 2006).

1.3. Types.

As-mentioned earlier, snoring is associated with breathing-abnormalities, during-sleep. *Snoring* is a-sign of partial-UA-obstruction, occurring during, most-commonly, *via* oral-breathing; however, in-some-people, it can-occur during-both; oral, and nasal-breathing, or, exclusively, during nasal-breathing (Hsia *et al.,* 2014). Besides, snoring can-happen in any-part of the-UA, such-as: the-nose, the-soft-palate; the-back of the-tongue; and the-back of the-throat.

Primary/simple-snoring is defined-as loud aspiratory-sounds, in-sleep, without apnoea or hypoventilation (American-Academy of Sleep-Medicine, 2001), which occurs due to-turbulent-air-flow, through a-narrow oropharyngeal or nasopharyngeal-space (Bradley & Floras, 2009). *Habitual-snoring* is a-chronic-condition, which may-be-described as snoring 'almost-every-night', or 'every-night, per-week' (Young *et al.,* 2001; 1993). All-snorers have UA-obstruction (characterized by increased respiratory-effort), and most-habitual-snorers have complete-episodes of UA-obstruction, during-sleep (American-Academy of Sleep-Medicine, 2001; Guilleminault *et al.,* 1976). Snoring generally-arises in the-supineposition, but habitual-snoring occurs in all-body-postures (Guilleminault & Abad, 2004; Bassiri & Guilleminault, 2000).

Inflammation and trauma, which are caused by snoring, and other-respiratory-events, may play a-role in the-progression of sleep-disordered-breathing (Izci *et al.,* 2006), transforming primary, or habitual snoring, to much-more-serious-condition, known as Sleep-Apnea. *Sleep-Apnea,* a-*severe*-form of sleep disordered-breathing, is characterized by recurrent-episodes of complete (apnoea), or partial UA-obstruction (hypopnoea), at the-pharyngeal- level, during-sleep, resulting in cortical-arousal, and oxygen-de-saturation (American-Academy of Sleep-Medicine, 2001), with sleep-disturbance, and transient-rises in blood-pressure (BP) (Davies *et al,* 2000). Each-pauses, in- breathing, or periods of shallow-breathing, can-last for a-few-seconds to-several-minutes, and they happen many-times, a-night. In the-most-common form, this follows loud-snoring. There may-be a-choking or snorting-sound, as breathing resumes **(***NHLBI, 2012).* There are 3 of sleep apnea: obstructive (OSA); central (CSA); and a-combination of the two, called mixed. OSA is the-most common form, accounting for 84% **(**De Backer, 2013; *NHLBI, 2012), and* CSA for less than 1%, and 15% of cases, are mixed (Morgenthaler *et al.,* 2006).

When breathing is paused, carbon-dioxide builds up, in the-bloodstream. Chemo-receptors, in the-blood-stream, note the-high carbon-dioxide-levels, which, often, lead to-a-loud-gasp, or snort. The-brain is signaled, to-wake the-person, sleeping, and breathe-in air. Breathing, normally, will-restore oxygen-levels, and the-person will fall-asleep, again (AASM Task Force, 1999).

1.4. The-Prevalence.

It has-been-estimated, that roughly 30-50%, of the U.S.A.-population, snore, and almost 1/3 of them, suffers from OSA (Aston-Acton-Q., 2013; Jovanovic & NightLase, 2011). Epidemiological-studies indicate that, the-prevalence of OSA affects at least 9% of the-adult-male, and 4% of the-adult female-population (Pracharktam *et al.,* 1994). Besides, in a-sample of 1500 Israeli-factory-workers, 3% had OSA-symptoms. Almost 82 to 95% of OSA-cases are middle-aged men (Marklund *et al.,* 2001). According to Katsantonis, 45% of adults snore, at-least-occasionally, and 25% are habitual-snorers. Ten to twenty-million-adults have OSA (4% of males and 2% of females). Besides, children can-also suffer from OSA (usually caused by enlargement of tonsils and adenoids) (Katsantonis, *nd*).

One-survey, of 5,713 American-residents, identified habitual-snoring in 24% of men and 13.8% of women, rising to 60% of men and 40% of women aged 60 to 65 years; this suggests an-increased susceptibility to-snoring as age-increases (Lugaresi *et al*., 1983). Jennum & Sjol (1992), in their-study, in a-Danish-population, identified, that habitual-snoring was 19.1%, in-males, and 7.9%, in-females. Young *et al.* (1993) in a-study of 602 employees, between 30 and 60 years of age, reported, that 52% of women and 64% of men, were habitual-snores. Although the-estimated-ratio of male/female has-been-reported as 8 to 10:1 in-sleep-laboratories

(Redline *et al.,* 1994; Guilleminault *et al.,* 1995; 1988), in population-based studies this-ratio is 2 to 4:1 (Bixler *et al.,* 2001; Young *et al.,* 1993). Women tend to-start to-snore, during-pregnancy and again later-in-life (Chervin 2000; Franklin *et al.,* 2000; Edwards *et al.,* 2002; Loube *et al.,* 1996), with an-increased-prevalence after-menopause (Bixler *et al.,* 2001). The-predominance of sleep-disordered-breathing, in men, rather than women, decreases-with increasing- age, and after age 50, the occurrence of sleep-disordered-breathing is similar, between males and females (Tishler *et al,* 2003).

The-prevalence of snoring, and OSA, increases with age, and this-proportion peaks between the-ages of 50 to 60 years (Ohayon *et al.,* 1997; Young *et al.,* 1993). Duran and his-colleagues (2001) found, that habitual-snoring occurred in 46% of men, and 25% of women, with a- significant-trend to-increase with age, among 2,148 subjects, aged 30-70 years old, in Spain. In-the-UK, an-interview of 2,894 women and 2,078 men, aged 15-100 years old, reported that 47.7% of males, and 33.6% of females, snored. This-percentage increased to 97%, in a-patient-group with suspected-sleep-apnoea (Whyte *et al.,* 1989).

Sleep-disordered-breathing is usually considered a-disease of middle-aged-adults, between 30 and 65 years-old (Stradling & Crosby, 1991), but studies have-also-shown that sleep-disordered breathing is very-common in the- elderly, over 65 years-old (Young *et al.,* 2002b; Bixler *et al.,* 2001; 1998). An-increased BMI, a-reduction in UA-muscle-tone, thinning of the-facial bones, and loss of teeth, that can manifest, with-age, may all predispose to sleep-disordered-breathing.

In-addition, Bearpark *et al* (1995), study on 294 men, aged 40-65 years old, found that 81% snored, for more-than 10% of the-night, and 22% for more-than-half the-night.

Besides, some-studies also-have shown, that risk-factors, for sleep-disordered-breathing, do vary, among-different-ethnic-groups. Craniofacial-bony-structure is a-relatively important-risk-factor, for sleep-disordered-breathing, in-people with Chinese, and other-Far-Eastern-origin (Lam *et al.,* 2005). Moreover, Li and colleagues observed that Asian-men, with OSA, have more severe-OSAHS and less-obesity, than Caucasian. OSAHS, among Asian-groups, appears to-be-related to-different craniofacial-morphology (the-cranial-base-dimensions were significantly-decreased) than that associated with OSAHS, in Caucasians (Li *et al.,* 2000). Furthermore, African-descendants face a-higher-risk for OSA, than any-other ethnic-group, in the-U. S. A. Other-groups, at increased-risk, include Pacific-Islanders, and Mexicans. Besides, people, with a-family-history of OSA, are at increased-risk of developing the-condition (Grandner *et al.,* 2013).

In-summary, there are more *male*-snorers; snoring also-tends to-increase with-age; large-share of habitual-snorers will become sufferers from OSA, particularly those with family-history of the-condition; while risk-factors, for sleep-disordered-breathing, *do* vary, among-different-ethnic-groups.

1.5. Effects.

The-potential-effects of snoring can-be-grouped as: (1) acoustic-disturbance (noise-pollution) and resulted sleep-deprivation, and relationship-problems; and (2) health-effects, due to UA-obstruction.

1.5.1. Acoustic-disturbance (noise-pollution), and resulted sleep-deprivation.

Many-snorers are, usually, *not* aware of their-snoring; Their-bed-partners (if any), or family-members, or roommates, or, even, neighbors, may notice and complain/report, to the-snorers, very-loud, roaring, unrelenting, highly-unpleasant, annoying, irritating, intrusive, and, at-times, interrupted-snoring, associated-with choking or gasps. This often-occurs in a-crescendo-pattern, with the-loudest-noises, occurring at the-very-end, and then the-snorer immediately fall-back to-sleep, which is *not* the-case for their-partners.

Loud-intrusive-snoring results in sleep-interruptions, and sleep-fragmentation, affecting bed-partners and other-family-members. Sleep-needs do vary, from person-to-person, and they also-change, throughout the-life-cycle. Most-adults, however, need 7-8 hours of sleep, each-night (Dreher *et al.,* 2009). Snoring can deprive a-spouse/partner of sleep, which can *not* only lead-to arguments, and lost-patience, but a-spouse/partner also experience terrible-physical and psychological-effects, of sleep-deprivation, such-as fatigue, daytime-sleepiness, clumsiness, or weight-loss, or weight-gain (Sharma & Kavuru, 2010). Sleep-deprivation is a-serious-issue, which can-be just as-harmful, to the-human-body, as starvation, or dehydration (Luboshitzky *et al.,* 2002).

As-a-result, many-couples sleep-apart, because of snoring (Izci *et al.,* 2005), some have severe-marital-conflicts, some, even, divorce. For-example, Fitzpatrick *et al.* (1993); Gall *et al. (*1993); and Armstrong *et al.* (1999) and Cartwright & Knight (1987) discovered a-statistically-significant-improvement in marital-relations, *after* snoring was surgically-corrected.

Besides, there-are several-adverse-effects of sleep-deprivation on the-human-body, such-as: Lower-metabolism; it-has-been demonstrated, that the-metabolic-activity, of the-human-brain, decreases, considerably, after 24 hours of sustained-wakefulness (Spiegel *et al.,* 1999); Increased-appetite (Taheri *et al.,* 2004); Risk of type 2 Diabetes (Renee *et al.,* 2010; Kendzerska *et al.,* 2014), and of Dementia (American-Academy of Neurology, 2014); Change in brain-activity (National-Sleep-Foundation (2006); High-blood-pressure (Miguel-Angel *et al.,* 2013); Stroke (Barbé *et al.,* 2012); and Heart-failure (Somers *et al.,* 2008; 2011), among-others.

Moreover, sleep-deprivation results in a-decrease of body-temperature, a-decrease in immune-system-

function, as-measured by white-blood-cell-count, and a-decrease in the-release of growth-hormone. Sleep-deprivation can-also-cause increased heart-rate-variability. Moreover, sleep is paramount, for human-nervous-system, to-work-well. Sleep-deprivation makes a-person drowsy, and unable-to-concentrate, the-next-day. It-also leads to-impairment of memory, and physical-performance. If sleep-deprivation continues, hallucinations, and mood-swings, may-develop (Somers, 2011).

In-addition, sleep-depravation can result in excessive-daytime-sleepiness, due to-sleep-fragmentation (Lindberg *et al.,* 1998; Martin *et al.,* 1996), sometimes in-embarrassing or hazardous-situations (Dawjee, 2007). *Daytime-Sleepiness*, generally-occurs in monotonous-situations, such-as: watching TV, or films; sitting as a-passenger, in a-car; attending meetings or conferences; eating; working, for a-long-time, with computers, or, even, while-driving (Guilleminault & Abad, 2004; Douglas, 2002; Bassiri & Guilleminault, 2000). Other-effects are: daily-fatigue; lethargy; lack of energy; insomnia; depressed-mood (Chervin, 2000), and impaired-concentration/less-mental-alertness, which has a-major-effect on reaction-time, memory, judgment, and cognitive-performance of tasks, requiring dexterity and alertness (Bassiri & Guilleminault, 2000; Cheshire *et al.,* 1992), such-as driving, or operating-machinery.

In-addition, Douglas (2002); and Bassiri & Guilleminault (2000) documented complains of repeated-morning-headache. Besides, it-can-cause emotional-problems, such-as: personality-changes, mood-disturbance, and depression (Wells *et al.,* 2004; Bassiri & Guilleminault, 2000). Moreover, sexual-dysfunction (decreased-libido and/or impotence) (Bassiri & Guilleminault, 2000; Whyte *et al.,* 1989), and irritation/aggression is common (Dawjee, 2007).

Sufficient-amount of 'quality' sleep is, therefore, paramount, for both; physical-survival, and proper-functionality, of a-person.

1.5.2. Health-effects, due to UA-obstruction.

According to Verin *et al.* (2002), researchers have-shown, that snoring-is the-most important-symptom connected-with the-obstructive-sleep-apnea (OSA) syndrome.

OSA-sufferers will characteristically fall-asleep, experience a-UA-airway-blockage, exhibit loud-snoring, stop-breathing, experience a-drop in-blood-oxygen-levels, attempt to-breathe, arouse, gasp for air, breathe for a-few-seconds, and fall-back-to-sleep. The-Respiratory- Disturbance-Index (RDI) is a- measure of the-number of OSA-events, occurring, per-hour of sleep. An-index, of fewer than five-episodes, per-hour, is considered normal; 10-20 episodes, per-hour, is mild; 20-40 is moderate, while more than 40 is regarded-as severe (Ivanhoe & Attanasio, 2001).

OSA is among the-most-common and most-dangerous-types of sleep-breading-disorders. OSA sufferers *never* get a 'good-night-sleep', because repeated-arousals deprive them of REM(deep-sleep-stage), leading-to *chronic*-daytime-exhaustion, and long-term cardiovascular-stress. People, with sleep-disordered breathing, including snoring, often-suffer from *un-refreshing-sleep*; irrespective of how-many-hours they actually-sleep (Young *et al.,* 1993). For-example, 18-31% of snorers, diagnosed with OSA, reported that their-sleep was-interrupted, by an-awareness of choking, or breathlessness (Bassiri & Guilleminault, 2000; Whyte *et al.,* 1989).

The-short-term-consequences of UA-obstruction, during-sleep, include: arousals, sleep-fragmentation, intermittent-hypoxemia, and hypercapnia, and nocturnal-blood-pressure-surges. The-long-term complications of OSA are important, and may contribute to-mortality: hypertension, cardiovascular, and cerebra-vascular-diseases. Some-neurobehavioral-morbidities, such-as daytime-sleepiness and impaired cognitive-function, are also-linked-with OSA, and may-contribute to-motor-vehicle-crashes and work-related-accidents, in untreated-patients, with OSA (Young *et al.,* 2002a).

Snoring is also a-sign of different-disorders, such-as: pre-eclampsia; and foetal-growth-restriction (Franklin *et al.,* 2000), Diabetes; Gastroesophageal-Reflux-Disease (GERD); and Polycystic-Ovary Syndrome (PCOS) (Guilleminault *et al.,* 2000), among-others. Besides, sore-throat, dry-mouth, and drooling, are frequent-consequences of snoring and mouth-breathing, during-sleep (Guilleminault & Abad, 2004).

It has-been-reported, that the-association between sleep-disordered-breathing and hypertension (Moller *et al,* 2003; Peppard *et al.,* 2000; Nieto *et al.,* 2000, Bixler *et al.,* 2000); Ischaemic-heart-disease (Davies *et al.,* 2000; Veale *et al.,* 2000); Cardiovascular-complications (Ryan *et al.,* 2005; Svatikova, 2005; Lavie, 2003). Endothelial-dysfunction, and oxidative-stress, are also reported, to-be-associated-with cardiovascular-disease, in the later-life of pre-eclamptic-women (Duley, 2003; Longo *et al.,* 2003; Roberts & Lain, 2002); Endothelial-dysfunction (Nieto *et al.,* 2004); and atrial-fibrillation (Gami *et al.,* 2004). Moreover, Lavie *et al* (2005) and Marin *et al* (2005) stated, that the-risk of mortality increases, in untreated snorers, with moderate or severe-forms, of sleep-disordered-breathing. If left-untreated, OSA will increase hypoxemia, which-will, in-turn, result in pulmonary-vascular-constriction and increase pulmonary-arterial-pressure. This-sequence of events can result in a-marked-increase in the-load, on the- right-side of the-heart, which can ultimately-cause right-ventricular-hypertrophy and failure (Cote, 1988). The-National-Sleep-Foundation reports, that 70% of all-congestive-heart-failure and 60% of all-strokes is directly-related to a-sleep-disorder.

Decreased-libido and impotence is common, among-patients, with OSA; 33-36 % of patients, with-OSA,

reported sexual-dysfunction, either decreased-libido, or impotence (Bassiri & Guilleminault, 2000; Whyte *et al.,* 1989). Approximately 50% of patients, with OSA, complain of repeated-morning-headache. There is also a-'chicken-egg' scenario, in that the-researchers found that *not* only does asthma create bad-sleep, but that bad-sleep can worsen an-asthmatic's breathing (Douglas, 2002; Bassiri & Guilleminault, 2000; Guilleminault *et al.,* 1976). There-is also strong-evidence for an-association between OSA and cardiovascular-diseases, with hypertension. This-association occurs, possibly, due to-increased-sympathetic-activity, or atherogenesis (or both), as free-radical-production, occurs in-OSA, as a-consequence of the-cyclic de-oxygenation/re-oxygenation. Multiple-studies reveal a-positive-correlation, between loud-snoring and risk of heart-attack (about 34% higher-chance) and stroke (about 67% higher-chance) (BBC News, 2008). In-addition, sleep-disordered breathing-related motor-vehicle-crashes and work-accidents, in untreated/undiagnosed-patients, are possible-causes of increased-mortality-rate (Young *et al.,* 2002a).

Moreover, a-2012-study has-shown, that hypoxia (an-inadequate-supply of oxygen) that characterizes sleep-apnea promotes angiogenesis, which increase vascular and tumor-growth, which in-turn, results in a 4.8 times higher-incidence of cancer-mortality (Nieto *et al.,* 2012; Yan-fang & Yu-ping, 2009). Other-studies associate loud 'snoring' with the-development of carotid-artery-atherosclerosis (Lee *et al.,* 2008). Amatoury *et al.* (2006) demonstrated, that snoring-vibrations are transmitted to the-carotid-artery; this can potentially-lead-to atherosclerotic-plaque-rupture and, as a-result, ischemic-stroke.

Besides, studies report an-association between *severe*-apnea and psychological-problems. The-risk for depression rises with increasing-severity of sleep-apnea. Sleep-related breathing-disorders can also-worsen nightmares and post-traumatic stress-disorder. It-has-been also-revealed, that people, with OSA, show tissue-loss, in-brain-regions, that help store memory, thus linking OSA with memory-loss. Using magnetic resonance imaging (MRI), the-scientists also-discovered, that people, with sleep apnea, have '*mammillary-bodies*' that are about 20% smaller, particularly on the-left-side. One of the-key-investigators hypothesized, that repeated-drops in oxygen, lead to the-brain-injury (Chang & Kezirian, 2013).

In-a-nutshell, sleep-disordered-breathing is *not* only associated with sleep-disturbance, but also with an-increased-risk of many-serious-conditions, such-as: hypertension, cardiovascular, and cerebra-vascular-diseases; as-well-as some-neurobehavioral-morbidities, with potential-risk of increased-mortality. According to Izci *et al.* (2006) 'the-impact of sleep-disordered-breathing on affected-individuals, society, and health-care, at-large, is considerable'.

2. Treatments and remedies.

According-to Katsantonis, sophistication of options, in snoring-management, ranges from simple life-style-changes, 'over the-counter'-devices and medication, dental-appliances, Continuous-Positive Air-Pressure (CPAP) machine, to minimally-invasive-procedures, and lastly, radical-surgery.

2.1. Behavioral or Lifestyle-Modifications.

Behavioral or Lifestyle-Modifications are usually-advised, as a-first-step to-treat snoring and OSA, of any-severity. These-include: (1) losing-weight, if one is overweight; (2) *not* drinking alcohol, particularly few-hours, before going to-bed; (3) giving-up smoking, if one smokes; (4) exercising-regularly – this can-help-strengthen neck-muscles, which may help prevent the-airways-narrowing; (5) sleeping position--trying to-sleep on the-side, and *not* on the-back; and (6) improving sleep-hygiene i.e., a-regular sleep-wake-schedule (Guilleminault & Abad, 2004; Scottish-Intercollegiate-Guidelines-Network, 2003; Douglas, 2002).

It-is also advisable to-keep the-bedroom air-moist (for-example *via* using a-humidifier). The-membranes, of the-nose and throat, are, normally, very-sensitive, when exposed to-dry air and, often, dry-air irritates the-membranes, which, in-turn, causes narrowing of air-passages. Besides, throat-exercises, to-strengthen the-muscles, has proven to-be an-effective-way (for some-people), to-reduce-snoring, gradually. For-example, curling the-tongue, repeatedly, and pronouncing each-vowel (a-e-i-o-u), for a-few-times, a-day, loudly, can strengthen the-upper-respiratory-tract-muscles, and, thus, reduce snoring. It-is recommended practicing-these-exercises, for 20-30 minutes, a-day. In-addition, singing-exercises, were-also-proposed, for reduction of snoring, for-example, Irumee *et al.* (2008) pointed-out, that professional singers seldom-snore, but Valbuza *et al.* (2008) stated, that 'there have been *no* medical-studies to-fully-link the- two'. More-recently Hilton *et al.* (2013), pointed-out, that singing can, indeed, improve the-tone and strength of pharyngeal-muscles, a-group of muscles, near the-soft-palate and upper-throat. They also revealed, that daily-singing-exercise, for 3 months, significantly-reduced the-severity, frequency, and loudness, of snoring, in-participants. Moreover, Puhan *et al* (2006), also advocating playing the '*didgeridoo*' (Australian-musical-instrument); their-study, performed to-evaluate the-effectiveness of this-instrument, published in the-British-Medical-Journal, found, that regular-playing of a-didgeridoo, was an-effective treatment for reducing both; daytime-sleepiness, and snoring, in-participants with moderate-OSA.

If lifestyle-changes, however, do *not* help, there are a-number of anti-snoring-devices, to-consider, in-order-

to-reduce snoring.

2.2. Anti-snoring-devices.

A-variety of anti-snoring-*devices* are, currently, offered; these can-be classified, by-type, as: (1) *Oral/Dental-Appliances:* Custom-made and Non-custom-made; Mandibular-Advancement-Devices (MADs); and Tongue-retaining-Devices (TRD); (2) *Nasal-Devices* (External-Nasal-Dilators; and Other Nasal-Devices); (3) *Position-Control-Devices* (*e.g.,* anti-snore-pillows); (4) *Chin-Straps*; (5) *Tongue-stabilizing-Devices*; and (6) *Positive-Airway-Pressure* (PAP) Therapy-Devices, among-others. Majority of them are so-called: 'over the-counter'-devices. The-phrase 'over-the-counter' meaning here: 'available without a-prescription, or clinical-guidance' (CDRH, 2004). Selected-devices were highlighted in the-following-sub-sections.

(a) Continuous Positive Air Pressure (CPAP/BIPAP) is the-use of a-constant-stream of pressurized-air, to-maintain airway-integrity, and prevent OSA (Tan *et al.,* 2002). Basically, CPAP is a-mechanical-device, consisting of a-flow-generator, a-flexible-air-tube, and a-nasal, or oro-nasal-mask (see, for-example, Scottish-Intercollegiate-Guidelines Network, 2003; Douglas, 2002; and Sullivan *et al.,* 1981). **CPAP-**machine functions by forcing-air into-the-airways, through a-nasal-mask, preventing tissue, in-the-throat, from collapsing, and cutting-off air, and, therefore, oxygen-supply. The-standard CPAP-machine delivers a-fixed, constant-flow of air. Variations of CPAP include: (1) *Autotitrating positive airway pressure (APAP)* devices automatically-respond to-changes in-the-sleeper's breathing-patterns, by adjusting and varying the-air-pressure-flow, throughout the-night. Some-patients find this makes CPAP easier-to-tolerate; and (2) *Bilevel positive airway pressure (BPAP)* systems deliver two-different-pressures, a-higher-one, for inhalation (breathing-in) and a-lower-one, for exhalation (breathing-out).

Patients, with the-mild to moderate-forms of sleep-disordered-breathing, who are *not* sleepy, often *cannot* tolerate CPAP-treatment, or simply refuse it, altogether, due to its-cumbersome-nature (Giles *et al.,* 2006; McArdle *et al.,* 1999). A-large-number of patients refuse CPAP due its-side-effects (e.g., Cranio-facial-changes (Tsuda *et al.,* 2010), nasal-congestion and irritation, rhinitis, nasal-bridge-sores, discomfort, claustrophobia, conjunctivitis, and noise) (Giles *et al.,* 2006); and also, due to-discomfort, and, sometimes, for psychological-reasons. Such-problems may-be improved, by using chin-straps-devices, or full-face-masks, heated-humidification, and local-treatments (moisturizers or corticosteroids) (Scottish-Intercollegiate-Guidelines-Network, 2003; Douglas, 2002). In-addition, the-equipment is rather-expensive (prices of suppliers range USD 1, 000-2,000, or, even-more (Ballard, 2008).

A-more-common and widely-used-approach, for the-management of OSA, is the-use of oral/dental-appliances, to-reposition the-mandible, in a-forward, and downward-location (Johnston *et al.,* 2002; Tan *et al.,* 2002; Rose *et al.,* 2002).

(b) Oral/Dental-Appliances (OAs) are placed in the-mouth, during-sleep, to-prevent UA-obstruction. OAs-function by increasing UA-size, and preventing the-collapse of the-tongue and the-soft-tissue, behind the-throat, by: (1) repositioning the-mandible, tongue, soft-palate, and uvula; (2) stabilizing the-mandible, tongue, and hyoid-bone; and (3) increasing the-muscle-tone-activity of the-tongue (Lowe, 2000). All-OAs fall into 2 categories: tongue-retaining-appliances, and mandibular-repositioning/advancing-device (MRS/MAD), which is most-commonly-used in-clinics. *Disadvantages of Dental/oral Devices:* Dental devices are *not* as-effective, as CPAP-therapy. The-cost of these-devices tends to-be-high. Side-effects, associated with dental-devices include: (1) Nighttime pain, dry-lips, tooth-discomfort, and excessive-salivation. In-general, these-side-effects are mild, although, over-the-long-term, they cause nearly-half of patients to-stop using dental-devices. Devices, made of softer-materials, may produce fewer-side-effects; (2) Permanent-changes, in the-position of the-teeth, or jaw, and bite-alignment, can occur, with long-term-use. Teeth-shift, both; temporary and permanent, is well-documented; (3) Users of dental-devices should-regularly visit a-health-professional, to-check the-devices and make-adjustments (if needed); (4) Many of these-devices can*not* be used if the-person has poor-dental-health and dental-hygiene (for-example: people with several-missing-teeth, dentures, etc.); and (5) In a-small-number of patients, the-treatment may-worsen apnea (Chan *et al.,* 2007). In-addition, the-most-reported-side-effects of the-devices, are: initial or persistent-discomfort, excessive-salivation, dryness of the mouth, and long-term-effects of temporo-mandibular-joint-discomfort, possible-dental-damage, bite-change, and periodontal-disease (Ferguson *et al.,* 2006; Izci *et al.,* 2005; Engleman *et al.,* 2002; Mehta *et al.,* 2001; Lowe, 2000).

(c) On-the-other-hand, if snoring is, mainly, coming from one's-nose, they may-benefit-from using nasal-strips, or nasal-dilators. With open-mouth-snorers, chin-straps, or a-vestibular-shield, could-be of help. *Chin-straps* are one of the-simplest anti-snoring-devices. *A-chin-strap-device* includes a-chin-cup, side-straps, and rear-straps. The-chin-strap is used to-support a-snorer's lower-jaw, upwards jaw (the-chin, and forwards the-mandibula, and the-base-tongue), during-sleep, and substantially-close the-person's mouth. *A-vestibular-shield* is a-plastic-device that looks-similar to a-gum-shield. It fits inside the-mouth, and blocks the- flow of air. This-forces one to-breathe, through the-nose, which may-prevent one, from opening the-mouth and snoring.

(d) Besides, if snoring is, mainly, due to the-base of the-tongue-vibration, a-mandibular advancement-

device (MAD) may-be recommended. A-MAD is similar to a-vestibular-shield, but it-is designed to-push one's jaw and tongue, forward.

(e) Orthopedic-pillows are the-least-intrusive-option, for reducing snoring. These-pillows are designed to-support the- head and neck, in a-way, that-ensures the-jaw stays-open and slightly forward. This-helps keep the-airways as unrestricted, as-possible, and, in-turn, can lead to a-small-reduction, in-snoring. For-example, the-pillow may provide contouring, graded-cushioning, and/or head/neck-configuration, to-promote jaw-closure.

(f) Moreover, a-lip-adhesive, or lip-seal, may-be-used (including one or more, of the-following: a-lip-gel, to- adhere, or stick-lips-together; butterfly-closure; mouth-block; and/or gaffer-tape. With a-chin-strap, for-example, lip seal can-be used.

The-cost, of anti-snoring-devices, ranges from USD 30 to USD150. Anti-snoring-mouthpieces, which are made by dentists, however, may cost over USD 1,000. Besides, most-snoring-devices are *not* expected to-last for more-than 1 year, also they do *not* work with-denture-users (Ballard, 2008).

Moreover, there is a-limited evidence on which-type of device is more-effective, so the-choice will-be-down to one-s type of snoring, as-well-as their-personal-preference.

1.3. Medication

Pharmacotherapy is a-potentially-attractive-alternative, for treatment of sleep-disordered-breathing. Medication, however, can*not*, directly, treat the-symptoms of snoring, *but* it can-be-used to-help-treat *some* of the-underlying-causes. For-example, if allergic-rhinitis (nasal-irritation and swelling) is causing one's snoring, an-antihistamine nasal-spray may-help relieve these-symptoms. If snoring is as a-result of having a-blocked-nose, a-short-course of nasal-decongestants might help. Other-specific-examples include: (1) *Modafinil (Provigil*), a central-nervous-system-stimulant (also-used to-treat narcolepsy), may marginally-improve alertness, in-snorers and their-partners (Kingshott *et al.,* 2001). The-drug was approved, by-the-FDA, as the-first-drug to-treat the-sleepiness, associated-with OSA. However, modanifil is meant to-be-used in-combination-with standard apnea-treatments, such-as CPAP. Modafinil can cause rare, *but* serious, side-effects, such-as life-threatening rash; and (2) *Thyroid-hormone,* which may help OSA, in those with low-thyroid-levels (hypothyroidism).

It-is very-important to-note, on the-use on sedatives; some-snorers may assume them beneficial. Sedatives, narcotics, antidepressants, and anti-anxiety-drugs, however, can actually, worsen the-breathing disturbances, and arousal-conditions, that occur, with OSA. These-substances cause the-soft-tissues, in-the-throat, to-over-relax and sag, increasingly-diminishing the-body's ability to-inhale. Apnea-sufferers should *never* use sleeping-pills or tranquilizers (Ballard, 2008).

To-sum-up, according-to Izci *et al.* (2006) 'So-far, there are *no* drugs, which usefully decrease sleep-disordered-breathing' and according-to Smith *et al.* (2002): 'the role of pharmacotherapy for sleep-disordered breathing remains controversial'.

1.5. Surgery.

Surgery, for snoring, is usually regarded-as a-last-resort, when *all*-other-treatment-options have-been-tried, with *no* success. Generally, surgical-procedures are attempted to-modify the-retropalatal-pharynx, the-retrolingual-pharynx, or both (Sher, 2002), and directly, or, indirectly, focused-on increasing the-pharyngeal airway-size.

Anti-snoring *Surgical-Procedures* are categorized-as (Raynov *et al.,* 2015): (1) Intranasal-operation; (2) UPPP (uvulo-palato-pharyngoplasty); (3) Laser-assisted uvulo-palato-plasty (LAUP); (4) Laser-midline glossectomy (LMG); (5) Adenotonsillectomy; (6) Tracheotomy; (7) Radiofrequency-Ablation; (8) Pillar Procedure; (9) Injection-Snoreplasty; (10) Palatal-Stiffening; and (11) Other-Surgical-Procedures. Selected-surgical-procedures were highlighted, below.

Tracheostomy used to-be the-only-treatment, for OSA. Tracheostomy is the-first-effective surgical-procedure, for the-treatment of OSA, which is aimed to-bypass the-site of UA-closure. It-is quite-uncomplicated; a-surgeon makes an-opening, through the-neck, into the-windpipe, and inserts a-tube. It-is almost 100% successful, *but* it requires a rather-large-size-opening, in the-throat, which produces a-number of medical and psychological-problems, associated-with recovery (Thatcher & Maisel, 2003; Partinen & Guilleminault 1990). Today, this-operation is performed very-rarely, due-to-significant medical and psychological-morbidity; usually *only* if OSA is life-threatening (Friedman & Schalch, 2007).

Uvulopalatopharyngoplasty (UPPP) is used when it-is been-confirmed, that-soft-tissue in one's mouth (excluding the-tongue) is responsible for snoring. UPPP is a-commonly-performed-procedure that enlarges the-retropalatal-airway, by removal of the-tonsils, along with-portions of the-anterior and posterior-tonsillar pillars, and the-free-margin of the soft-palate, including the-uvula (American-Sleep-Disorders Association, 1996). This is an-operation, done with a-general-anesthetic. According-to Kezirian *et al.* (2013), and Franklin *et al.* (2009), UPPP is among the-most-painful-treatments for OSA, and recovery takes several-weeks. The-procedure also-has a-number of potentially-serious-complications, including: Infections; Impaired-function, in the-soft-palate and muscles of the throat (called velopharyngeal-insufficiency), which can make-it-difficult to-keep liquids out of

the-airway; Mucus in the-throat; Changes in voice-frequency; Swallowing-problems; Removing of uvula, can also-affect the-ability to- pronounce certain-sounds; Regurgitation, of fluids, through the-nose or mouth; Impaired-sense of smell; and Failure and recurrence of OSA. UPPP is also associated-with significant post-operative-mortality and morbidity (Izci *et al.,* 2006).

Laser-assisted-uvulopalatoplasty (LAUP) is a-similar, to-UPPP, procedure, *but* done with a-laser, which burns away the-uvula and some of the-soft-palate. This stiffens the-soft-palate, to-reduce it vibration. An-electrode is put into the-roof of the-mouth, and radiofrequency-waves are sent into soft-palate, through the-electrode. It-is done with a-local-anesthetic. So-far, the-procedure achieved very-limited-efficacy (Izci *et al.,* 2006). With LAUP, throat-dryness, after-surgery, and throat-narrowing, and scarring, have-been reported. Besides, in a-minority of patients, snoring becomes worse, afterward. In-this-regard, the-American-Academy of Sleep-Medicine (AASM), stated, that LAUP is *not* routinely-recommended as treatment, for OSA. According to the AASM, this-surgery, generally, does *not* help improve symptoms, and may actually worsen the-condition.

Soft-palate-implants: These are implants, injected into soft-palate, which stiffen it. This should-reduce it vibration. This is also-done with a-local-anesthetic. NICE (2007) stated that there are *no* safety-concerns, over the-use of soft-palate-implants; however, there-is limited-evidence about whether they are an-effective long-term-treatment.

Radiofrequency-ablation (RFA) of the-soft-palate is an-alternative-treatment to soft-palate-implants. However, evidence as to their-long-term-effectiveness is limited.

Another palate-tightening-treatment is the-***Pillar-****implant-system*, where small-plastic-rods are inserted in the-palate, causing it to-become-firm and reduce-vibration.

Other-surgical-procedures may-be-appropriate, to-correct facial-abnormalities, or obstructions, that cause OSA. They may-be used alone, or in combination-with each-other, or with UPPP. Most are invasive, and, hence, reserved for patients with severe-OSA, who fail-to-respond-to, or comply-with CPAP. Overall, there is limited-evidence as to their-effectiveness, in treating OSA. These-procedures include: Maxillomandibular-advancement (MMA), which moves the-upper (maxilla) or lower (mandible) jawbone forward. MMA was found by Bettega *et al.* (2000), as *not* beneficial, for most-patients with sleep-apnoea; Genioglossus (tongue-advancement), in which an-opening is cut, where the-tongue-joins the-jawbone, and the area is pulled-forward; Genioplasty, which is plastic surgery on the-chin; Hyoid-advancement-surgery, in which the-movable-bone, underneath the-chin is moved forward, pulling the-tongue-muscle along with it; and Surgery for nasal-obstructions (such as a-deviated-septum), that contribute to-snoring and other-symptoms of OSA (Caples *et al.,* 2010; Epstein *et al.,* 2009; Sundaram *et al.,* 2005). These-treatments are considered less-invasive, than other-surgical-procedures; they can-be-done under local- anesthetic; do *not* involve cutting, and stitching; little, if any, down-time; and little-post operational-pain, afterwards. However, these-therapies may still cost thousands of dollars, *without* providing a-long-term solution, as one may-need to-go-back, for more.

Overall, jaw and UA-surgeries may-be beneficial, in-*selected*-patients, with primary-snoring, or mild-OSA (Izci *et al.,* 2006). The-use of surgery, however, is rather-limited, due to-their-high-cost, invasiveness, irreversibility, post-operative-swelling, pain, discomfort, and long-recovery-period. Besides, according-to Izci *et al.* (2006), the-role of surgery, in treating OSA is still-poorly-understood, and there is significant-disagreement, as regards its-use as a-treatment. Both; snoring, and OSA, are cause for several-health-issues, and are, potentially-life-threatening (Mannarino *et al.,* 2012). Still, most-patients are unwilling to-treat these, due to-multiple-side-effects, unsuccessful-*non*-surgical and surgical-treatments, and uncomfortable-procedures (Lindman *et al.,* 2001).

On-the-other-hand, most of the-above-procedures are *not* available in-Kenya, moreover, 'medical-tourism' expenses, to-undertake such-procedures and operations, even, within-Africa (say, in-Egypt, or South-Africa), currently, is *not* covered by the-NHIF (National-Health-Insurance-Fund), Kenya.

4. Conclusion and Recommendations.

Not only sleep, but enough-sleep, and 'quality'-sleep, is absolutely-essential, for a-person's physical- survival, health, wellbeing, and for maintaining their *optimal*-emotional and social-functioning.

Although many-people consider snoring as rather-normal, and absolutely-harmless,snoring can, actually, indicate serious-underlying-medical-condition(s). Besides, left-untreated, habitual-snoring can-develop into more-serious-condition, named OSA. Sleep-disordered-breathing, including OSA and snoring, is *not* only associated with sleep-deprivation, *but* also-with an-increased-risk of many-serious-conditions, such-as: hypertension; cardiovascular and cerebra-vascular-diseases; as-well-as some-neuro-behavioral-morbidities, with potential-risk of increased-mortality. Snoring, hence, should *not* be ignored.

On-the-other-hand, at the-local-context, currently, there is a-very-limited (*if any*) attention, given to-snoring, as a-phenomena, as a-medical-condition, and also as a-research-subject. This-review, however, have illustrated, that snoring has-been-linked *not* only-to OSA, but also to: diabetes, stroke, heart-failure, cancer, dementia, and many-more. More-importantly, snoring can also be a-*symptom* of an-underlying-health-condition, which may-

lead to-further health-complications. Left-untreated, complications from snoring, disrupted-breathing, and sleep-deprivation, can, even, lead to-lethal health-problems, as-well-as occupational and driving-accidents.

Sleep-disordered-breathing, including snoring, is considered to-result from a-*combination* of the-anatomical UA-predisposition and the-changes in-reflex-activity, of the-muscles, during-sleep. Many-different-treatments and remedies, are offered, globally, however, most of them are *yet* to-be available, in-Kenya. Besides, even when they become available, for them, to-be covered by NHIF, Kenya, the-snoring, and its-potential-dangers, should-be-taken with all-seriousness, it is rightfully-deserve.

For-a-developing-country, like Kenya, limited-awareness on the-ill-effects of snoring, lack of treatment-options, available, and high-cost of treatments, abroad, are additional-barriers, or excuses, for *not* treating and largely-disregarding, snoring. The-author believes, this-concise-review will play a-role (in its-small-way) in increasing-awareness on the-subject-matter.

Finally, the-current-study recommended to-conduct further-research on: (i) country-wise-survey on snoring-prevalence; (ii) perceptions on snoring; (iii) anti-snoring-treatments and remedies, available, and their-cost implications; and (iv) the-design of anti-snoring-device (for-example uncomplicated chin-strap-device), to-offer an-affordable-solution, to untapped-local-population of snorers.

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References.

AASM Task-Force (1999). "Sleep–Related Breathing Disorders in Adults – Recommendations for Syndrome Definition and Measurement Techniques in Clinical Research", *Sleep*, 22 (5).

Amatoury, J; Howitt, L; Wheatley, J.; Avolio, A. and Amis, T. (2006). "Snoring-related energy transmission to the carotid artery in rabbits", *Journal of applied physiology,* 100 (5).

American-Academy of Neurology (2014). Proceedings of the 66th AAN Annual Meeting at the Pennsylvania Convention Center in historic Philadelphia April 26 through May 3, 2014.

American-Academy of Sleep-Medicine (2001). AASM: ICSD-International Classification of Sleep Disorders: Revised Diagnostic and Coding Manual. Rochester, MN.

American Sleep-Disorders-Association (1996). "Practice parameters for the treatment of obstructive sleep apnea in adults: the efficacy of surgical modifications of the upper airway", *Sleep,* 19(2).

Armstrong, M.; Wallace, C. and Marais, J. (1999). "The effect of surgery upon the quality of life in snoring patients and their partners: a between-subjects case-controlled trial", *Clinical Otolaryngology & Allied Sciences*, 24(6).

Arias, M.; Garcia-Rio, F.; Alonso-Fernández, A.; Mediano, O.; Martinez, I. and Villamor, J. (2005). "Obstructive Sleep Apnea syndrome affects left ventricular diastolic function: effects of nasal continuous positive airway pressure in men", *Circulation*, 112 (3).

Aston Acton, Q. (2013). Anhydrides – Advances in Research and Application, Scholarly Editions TM.

Ayappa, I. and Rapoport, D. (2003). "The upper airway in sleep: physiology of the pharynx", *Sleep Med Rev,* 7(1).

Bassiri, A. and Guilleminault, C. (2000). Clinical features and evaluation of obstructive sleep apnea—hypopnea syndrome. In: Kryger M, Roth T, Dement W, eds. Principles and Practice of Sleep Medicine. *3rd ed*. Philadelphia: WB Saunders.

Ballard, R. (2008). "Management of patients with obstructive sleep apnea", *J Fam Pract,* 57(8).

Barbé, F.; Durán-Cantolla, J.; Sánchez-de-la-Torre, M.; Martínez-Alonso, M.; Carmona, C.; Barceló, A; et al. (2012). "Effect of continuous positive airway pressure on the incidence of hypertension and cardiovascular events in nonsleepy patients with obstructive sleep apnea: a randomized controlled trial", *JAMA,* 23.

BBC News (2008-03-01). "Snoring linked to heart disease".

Bearpark, H.; Elliott, L.; Grunstein, R.; Cullen, S.; Schneider, H.; Althaus, W.; *et al.* (1995). "Snoring and sleep apnea: A population study in Australian men", *Am J Respir Crit Care Med,* 151(5).

Bettega, G.; Pepin, J.; Veale, D.; Deschaux, C.; Raphael, B. and Levy, P. (2000). "Obstructive sleep apnea syndrome: fifty-one consecutive patients treated by maxillofacial surgery", *Am J Respir Crit Care Med,* 162(2).

Bixler, E.; Vgontzas, A.; Lin, H.; Rein, J.; Vela-Bueno, A.; *et al.* (2001). "Prevalence of sleep-disordered breathing in women: effects of gender", *Am J Respir Crit Care Med,* 163 (3 Pt 1).

Bixler, E.; Vgontzas, A.; Lin, H.; Leiby, B.; Vela-Bueno, A.; *et al.* (2000). "Association of hypertension and sleep-disordered breathing", *Arch Intern Med,* 160(15).

Bixler, E.; Vgontzas, A.; Tyson, K. and Kales, A. (1998). "Effects of age on sleep apnea in men: I. Prevalence and severity", *Am J Respir Crit Care Med,* 157(1).

Bradley, T. and Floras, J. (2009). "Obstructive sleep apnoea and its cardiovascular consequences", *Lancet,* 3; 373(9657).

Caples, S.; Rowley, J.; Prinsell, J.; Pallanch, J.; Elamin, M.; Katz, S.; *et al.* (2010). "Surgical modifications of the upper airway for obstructive sleep apnea in adults: a systematic review and meta-analysis", *Sleep,* 33(10).

Cartwright, R. and Knight, S. (1987). "Silent partners: The wives of sleep apneic patients", *Sleep,* 10:244–8.

CDRH (2004). Centre for Devices and Radiological-health. PPT "Snoring and Obstructive Sleep Apnea (OSA) Devices for Over-the-counter (OTC) Use Ear, Nose, and Throat Devices Branch".

Chan, A.; Lee, R. and Cistulli, P. (2007). "Dental appliance treatment for obstructive sleep apnea", *Chest,* 132(2).

Chang, J. and Kezirian, E. (2013). "What are the health risks of untreated snoring without obstructive sleep apnea?", *The Laryngoscope,* 123: 1321–1322. doi:10.1002/lary.23670

Chervin, R. (2000). "Sleepiness, fatigue, tiredness, and lack of energy in obstructive sleep apnea", *Chest,* 118(2).

Cheshire, K.; Engleman, H.; Deary, I.; Shapiro, C. and Douglas, N. (1992). "Factors impairing daytime performance in patients with sleep apnea/hypopnea syndrome", *Arch Intern Med,* 152:538.

Chokroverty, S. (2007). 100 Questions & Answers About Sleep And Sleep Disorders. Jones & Bartlett Learning, ISBN 0763741205.

Cote, E. (1988). "Obstructive Sleep Apnea - An Orthodontic Concern", *American Journal of Orthodontics and Dento-facial Orthopedics*; 58.

Davies, R. and Stradling, J. (1990). "The relationship between neck circumference, radiographic pharyngeal anatomy, and the obstructive sleep apnoea syndrome", *Eur Respir J,* 3(5).

Davies, C.; Crosby, J.; Mullins, R.; Barbour, C.; Davies, R. and Stradling, J. (2000). "Case-control study of 24 hour ambulatory blood pressure in patients with obstructive sleep apnoea and normal matched control subjects", *Thorax,* 55(9).

Dawjee, S. (2007). A Simple Appliance for the Management of Obstructive Sleep Apnoea - the MEDUNSA

Anti Snoring Device (MASD), In: Sleep Apnea Syndrome Research Focus, Editor: Andrew O. Lang, Nova Science Publishers, Inc. ISBN: 978-1-60021-528-5.

De Backer, W. (2013). "Obstructive sleep apnea/hypopnea syndrome", *Panminerva medica,* 55 (2).

Deegan, P. and McNicholas, W. (1996). "Predictive value of clinical features for the obstructive sleep apnoea syndrome", *Eur Respir J,* 9.

Deegan, P. and McNicholas, W. (1995). "Pathophysiology of obstructive sleep apnoea", *Eur Respir J,* 8(7).

Douglas, N. (2002). Obstructive sleep apnoea/hypopnoea syndrome. In: Clinicians' Guide to Sleep Medicine. London: Arnold.

Dreher, A.; Rader, T.; Patscheider, M.; *et al*., (2009). "The annoyance of snoring", *Eur Arch Otorhinolaryngol*.; 266:293–6.

Duley L. (2003). "Pre-eclampsia and the hypertensive disorders of pregnancy", *Br Med Bull,* 67.

Duran, J.; Esnaola, S.; Rubio, R. and Iztueta, A. (2001). "Obstructive sleep apnea-hypopnea and related clinical features in a population-based sample of subjects aged 30 to 70 yr", *Am J Respir Crit Care Med,* 163(3 Pt 1).

Edwards, N.; Middleton, P.; Blyton, D. and Sullivan, C. (2002). "Sleep disordered breathing and pregnancy", *Thorax,* 57(6).

Engleman, H.; McDonald, J.; Graham, D.; Lello, G.; Kingshott, R.; Coleman, E.; Mackay, T, and Douglas, N. (2002)."Randomized crossover trial of two treatments for sleep apnea/hypopnea syndrome: continuous positive airway pressure and mandibular repositioning splint", *Am J Respir Crit Care Med,* 166(6).

Irumee, P.; Lo, S.; Wolf, D. and Azgher, A. (2008). "The effect of singing on snoring and daytime somnolence", *Sleep and Breathing*, 12 (3).

Epstein, L.; Kristo, D.; Strollo, P.; Friedman, N.; Malhotra, A.; *et al*. (2009). "Clinical guideline for the evaluation, management and long-term care of obstructive sleep apnea in adults", *J Clin Sleep Med,* 5(3).

Ferguson, K.; Cartwright, R.; Rogers, R. and Schmidt-Nowara, W. (2006*).* "Oral Appliances for Snoring and Obstructive Sleep Apnea: A Review", *Sleep, Vol. 29, No. 2.*

Fitzpatrick, M.; Martin, K.; Fossey, E.; *et al.* (1993). "Snoring, asthma and sleep disturbance in Britain: a community-based survey", *Eur. Respir. J.*, 69.

Fitzpatrick, M.; McLean, H.; Urton, A.; Tan, A.; O'Donnell, D. and Driver, H. (2003). "Effect of nasal or oral breathing route on upper airway resistance during sleep", *Eur Respir J,* 22(5).

Fogel, R.; Malhotra, A.; Dalagiorgou, G.; Robinson, M.; Jakab, M.; Kikinis, R.; Pittman, S. and White, D. (2003). "Anatomic and physiologic predictors of apnea severity in morbidly obese subjects", *Sleep* 26(2).

Franklin, K.; Anttila, H.; Axelsson, S.; Gislason, T.; Maasilta, P.; Myhre, K.; *et al.* (2009). "Effects and side-effects of surgery for snoring and obstructive sleep apnea--a systematic review", *Sleep,* 32(1).

Franklin, K.; Gislason, T.; Omenaas, E.; Jogi, R.; Jensen, E.; Lindberg, E.; Gunnbjornsdottir, M.; Nystrom, L.; Laerum, B.; Bjornsson, E.; Toren, K. and Janson, C. (2004). "The influence of active and passive smoking

on habitual snoring", *Am J Respir Crit Care Med,* 170(7).
Franklin, K.; Holmgren, P.; Jonsson, F.; Poromaa, N.; Stenlund, H. and Svanborg, E. (2000). "Snoring, pregnancy-induced hypertension, and growth retardation of the fetus", *Chest,* 117(1).
Friedman, M. and Schalch, P. (2007). "Surgery of the palate and oropharynx", *Otolaryngol Clin North Am,* 40(4).
Gall, R.; Isaac, L. and Kryger, M. (1993). "Quality of life in mild obstructive sleep apnea", *Sleep,* 16 (S. 8).
Gami, A.; Pressman, G.; Caples, S.; Kanagala, R.; Gard, J.; Davison, D.; Malouf, J.; Ammash, N.; Friedman, P. and Somers, V. (2004). "Association of atrial fibrillation and obstructive sleep apnea", *Circulation,*110(4).
Giles, T.; Lasserson, T.; Smith, B.; White, J.; Wright, J. and Cates, C. (2006). "Continuous positive airways pressure for obstructive sleep apnoea in adults", *Cochrane Database Syst Rev,* (1), CD001106.
Grandner, M.; Patel, N.; Louis, G.; Jackson, N.; Gehrman, P.; Perlis, M. and Gooneratne, N. (2013). "Sleep related behaviors and beliefs associated with race/ethnicity in women", *J Natn Med Assoc*, 105(1).
Guilleminault, C. and Abad, V. (2004). "Obstructive sleep apnea syndromes", *Med Clin North Am,* 88(3).
Guilleminault, C.; Querra-Salva, M.; Chowdhuri, S. and Poyares, D. (2000). "Normal pregnancy, daytime sleeping, snoring and blood pressure", *Sleep Med,* 1(4).
Guilleminault, C.; Stooh, Y.; Kim, R.; Chervin, J.; Black, A. and Clerk, S. (1995). "Upper airway sleep-disordered breathing in women", *Ann Intern Med,* 122:493-501.
Guilleminault, C.; Quera-Salva, M.; Partinen, M. and Jamieson, A. (1988). "Women and the obstructive sleep apnea syndrome", *Chest,* 93(1).
Guilleminault, C.; Tilkian, A. and Dement, W. (1976). "The sleep apnea syndromes", *Annu Rev Med,* 27:465-484.
Gunn, T.; Tonkin, S.; Hadden, W.; Davis, S. and Gunn, A. (2000). "Neonatal micrognathia is associated with small upper airways on radiographic measurement", *Acta Paediatr,* 89(1).
Hilton, M.; Savage, J.; Hunter, B.; McDonald, S.; Repanos, C. and Powell, R. (2013). "Singing Exercises Improve Sleepiness and Frequency of Snoring among Snorers—A Randomised Controlled Trial", *International Journal of Otolaryngology and Head & Neck Surgery,* 4(2).
Hsia, J.; Camacho, M. and Capasso, R. (2014). "Snoring exclusively during nasal breathing: a newly described respiratory pattern during sleep", *Sleep Breath*, 18.
Huang, J.; Shen, H.; Takahashi, M.; Fukunaga, T.; Toga, H.; Takahashi, K. and Ohya, N. (1998). "Pharyngeal cross-sectional area and pharyngeal compliance in normal males and females", *Respiration,* 65(6).
Hudgel, D.; Gordon, E.; Thanakitcharu, S. and Bruce, E. (1998). "Instability of ventilatory control in patients with obstructive sleep apnea", *Am J Respir Crit Care Med,* 158(4).
Isono, S.; Tanaka, A.; Tagaito, Y.; Ishikawa, T. and Nishino, T. (2004). "Influences of head positions and bite opening on collapsibility of the passive pharynx", *J Appl Physiol,* 97(1).
Isono, S.; Tanaka, A. and Nishino, T. (2003). "Dynamic interaction between the tongue and soft palate during obstructive apnea in anesthetized patients with sleep-disordered breathing", *J Appl Physiol,* 95(6).
Isono, S.; Tanaka, A. and Nishino, T. (2002). "Lateral position decreases collapsibility of the passive pharynx in patients with obstructive sleep apnea", *Anesthesiology,* 97(4).
Isono, S.; Remmers, J.; Tanaka, A.; Sho, Y.; Sato, J. and Nishino, T. (1997). "Anatomy of pharynx in patients with obstructive sleep apnea and in normal subjects", *J Appl Physiol,* 82(4).
Ivanhoe, J. and Attanasio, R. (2001). "Sleep disorders and oral devices", *Dental Clinics of North America,* 45.
Izci, B. (2006). Breathing during sleep: studies related to Upper Airway calibre in pregnancy. Doctor of Philosophy Dissertation, Department of Sleep Medicine, The University of Edinburgh & Royal Infirmary of Edinburgh.
Izci, B.; McDonald, J.; Coleman, E.; Mackay, T.; Douglas, N. and Engleman, H. (2005). "Clinical audit of subjects with snoring & sleep apnoea/hypopnoea syndrome fitted with mandibular repositioning splint", *Respir Med* 99(3).
Jennum, P. and Sjol, A. (1992). "Epidemiology of snoring and obstructive sleep apnoea in a Danish population, age 30-60", *J Sleep Res,* 1(4).
Johnston, C.; Gleadhill, I.; Cinnamond, M.; Gabbey, J. and Burden, D. (2002). "Mandibular advancement appliances and obstructive sleep apnoea: a randomised clinical trial", *European Journal of Orthodontics*; 24.
Jordan, A.; Wellman, A.; Edwards, J.; Schory, K.; Dover, L.; MacDonald, M.; *et al.* (2005). "Respiratory control stability and upper airway collapsibility in men and women with obstructive sleep apnea", *J Appl Physiol* 99(5).
Jovanovic, J. and NightLase, T. (2011). "Laser-Assisted Snoring and Apnea Reduction, 9 Months of Experience (Summary)", *LA&HA – Journal of Laser and Health Academy*, Vol. 2011, Number 1.
Kamal, I. (2002). "Lung volume dependence of pharyngeal cross-sectional area by acoustic pharyngometry", *Otolaryngol Head Neck Surg,* 126(2).
Katsantonis, G. (*nd*). SNORING: Significance and Management. www.lakesidepress.com/pulmonary/Sleep/sleep.html

Kezirian, E. (2013). Pillar Procedure May Improve Snoring with Palatal Implants. Surgical Solution Can Offer Relief by Stabilizing the Soft Palate. Available[online]:
http://sleepdisorders.about.com/od/sleepdisorderstreatment/a/Pillar-Procedure-May-Improve-Snoring- with-Palatal-Implants.htm (21/11/2017).
Kendzerska, T.; Gershon, A. ; Hawker, J.; Tomlinson, G. and Leung, R. (2014). "Obstructive Sleep Apnea and Incident Diabetes. A Historical Cohort Study", *AJRCCM,* Vol. 190, No. 2.
Kingshott, R.; Vennelle, M.; Coleman, E.; Engleman, H.; Mackay, T. and Douglas, N. (2001). "Randomized, double-blind, placebo-controlled crossover trial of modafinil in the treatment of residual excessive daytime sleepiness in the sleep apnea/hypopnea syndrome", *Am J Respir Crit Care Med,* 163(4).
Kirkness, J.; Madronio, M.; Stavrinou, R.; Wheatley, J. and Amis, T. (2003). "Relationship between surface tension of upper airway lining liquid and upper airway collapsibility during sleep in obstructive sleep apnea hypopnea syndrome", *J Appl Physiol,* 95(5).
Kuna, S. and Remmers, J. (2000). Principles and Practice of Sleep Medicine, 3rd Edition.
Lam, B.; Tench, E. and Ryan, C. (2005). "Craniofacial profile in Asian and white subjects with obstructive sleep apnoea", *Thorax,* 60(6).
Teschler, H. and Randerath, W. (2010). "Sleep-related breathing disorders – historical development, current status, future prospects", *Pneumologie*, 64(9).
Lavie, P.; Lavie, L. and Herer, P. (2005). "All-cause mortality in males with sleep apnoea syndrome: declining mortality rates with age", *Eur Respir J,* 25(3).
Lavie, L. (2003). "Obstructive sleep apnoea syndrome--an oxidative stress disorder", *Sleep Med Rev,* 7(1).
Lee, S.; Amis, T.; Byth, K.; Larcos, G.; Kairaitis, K.; Robinson, T. and Wheatley, J. (2008). "Heavy snoring as a cause of carotid artery atherosclerosis", *Sleep,* 31 (9): 1207–1213. ISSN 0161-8105.
Li, K.; Kushida, C.; Powell, N.; Riley, R. and Guilleminault, C. (2000). "Obstructive sleep apnea syndrome: a comparison between Far-East Asian and white men" *Laryngoscope,* 110(10 Pt 1).
Lindberg, E.; Taube, A.; Janson, C.; Gislason, T.; Svardsudd, K. and Boman, G. (1998). "A 10-year follow-up of snoring in men", *Chest* 114(4).
Lindman, R.; Bondemark, L. and Swed, D. (2001). "A review of oral devices in the treatment of habitual snoring and obstructive sleep apnoea", *Sleep*, 25(1).
Liu, P.; Yee, B.; Wishart, S.; Jimenez, M.; Jung, D.; Grunstein, R. and Handelsman, D. (2003). "The short-term effects of high-dose testosterone on sleep, breathing, and function in older men", *J Clin Endocrinol Metab,* 88(8).
Longo, S.; Dola, C. and Pridjian, G. (2003). "Preeclampsia and eclampsia revisited", *South Med J,* 96(9).
Loube, D.; Poceta, J.; Morales, M.; Peacock, M. and Mitler, M. (1996). "Self-reported snoring in pregnancy. Association with fetal outcome", *Chest,* 109(4).
Lowe, A. (2000). Oral appliances for sleep breathing disorders. In: Kryger MH, Roth T, Dement WC, eds. Principles and practice of sleep medicine. *3rd ed*. Philadelphia: WB Saunders.
Luboshitzky, R.; Aviv, A.; Hefetz, A.; Herer, P.; Shen-Orr, Z.; Lavie, L. and Peretz Lavie, P. (2002). "Decreased Pituitary-Gonadal Secreti", *Journal of Clinical Endocrinology & Metabolism,* 87 (7).
Lugaresi, E.; Mondini, S.; Zucconi, M.; Montagna, P. and Cirignotta, F. (1983). "Staging of heavy snorers disease. A proposal", *Bull Eur Physiopathol Respir,* 19(6).
Malhotra, A.; Pillar, G.; Edwards, J.; Ayas, N.; Akahoshi, T.; Hess, D.; *et al.* (2002). "Pharyngeal pressure and flow effects on genioglossus activation in normal subjects", *Am J Respir Crit Care Med,* 165 (1).
Mannarino, M.; Di Filippo, F. and Pirro, M. (2012). "Obstructive sleep apnea syndrome", *Eur J Intern Med*, 23(7).
Marin, J.; Carrizo, S.; Vicente, E. and Agusti, A. (2005). "Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study", *Lancet,* 365(94640).
Marklund, M.; Franklin, K. and Person, M. (2001). "Orthodontic side-effects of mandibular advancement devices during treatment of snoring and sleep aonoea", *European Journal of Orthodontics,* 23.
Martin, S.; Engleman, H.; Deary, I. and Douglas, N. (1996). "The effect of sleep fragmentation on daytime function", *Am J Respir Crit Care Med,* 153(4 Pt 1).
Mayo Clinic (26 April 2015). "Snoring Causes".
McArdle, N.; Devereux, G.; Heidarnejad, H.; Engleman, H.; Mackay, T. and Douglas, N. (1999). "Long-term use of CPAP therapy for sleep apnea/hypopnea syndrome", *Am J Respir Crit Care Med,* 59.
Mehta, A.; Qian, J.; Petocz, P.; Darendeliler, M. and Cistulli, P. (2001). "A randomized, controlled study of a mandibular advancement splint for obstructive sleep apnea", *Am J Respir Crit Care Med,* 163(6).
Miguel-Angel, M.; Capote, F.; Campos-Rodríguez, F. (2013). "Effect of CPAP on Blood Pressure in Patients with Obstructive Sleep Apnea and Resistant Hypertension", *Journal of the American Medical Association,* 310 (22).

Moller, D.; Lind, P.; Strunge, B. and Pedersen, E. (2003). "Abnormal vasoactive hormones and 24-hour blood pressure in obstructive sleep apnea", *Am J Hypertens,* 16(4).

Morgenthaler, T.; Kagramanov, V.; Hanak, V. and Decker, P. (2006). "Complex sleep apnea syndrome: is it a unique clinical syndrome", *Sleep,* 29 (9).

Mortimore, I.; Marshall, I.; Wraith, P.; Sellar, R. and Douglas, N. (1998). "Neck and total body fat deposition in nonobese and obese patients with sleep apnea compared with that in control subjects", *Am J Respir Crit Care Med,* 157(1).

National-Sleep-Foundation (2006). "Sleep in America Poll, 2001-2002: Brain Activity is Visibly Altered Following Sleep Deprivation", *UC San Diego Health System,* Washington, DC.

NHLBI (2012). "Sleep Apnea: What Is Sleep Apnea?" *NHLBI: Health Information for the Public. U. S. Department of Health and Human Services.*

NICE (2007). The-National Institute for Health and Care Excellence (NICE).

Nieto, F.; Herrington, D.; Redline, S.; Benjamin, E. and Robbins, J. (2004). "Sleep apnea and markers of vascular endothelial function in a large community sample of older adults", *Am J Respir Crit Care Med,* 169(3).

Nieto, F.; Young, T.; Lind, B.; Shahar, E.; Samet, J.; Redline, S.; *et al.* (2000). "Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study", *Sleep Heart Health Study*, *JAMA* 283(14).

Nieto, F.; Peppard, P.; Young, T.; Finn, L.; Hla, K. and Farré, R. (2012). "Sleep disordered breathing and cancer mortality: results from the Wisconsin Sleep Cohort Study", *Am J Respir Crit Care Med,* 186.

O'Connor, C.; Thornley, K. and Hanly, P. (2000). "Gender differences in the polysomnographic features of obstructive sleep apnea", *Am J Respir Crit Care Med,* 161(5).

Ohayon, M.; Guilleminault, C.; Priest, R. and Caulet, M. (1997). "Snoring and breathing pauses during sleep: telephone interview survey of a United Kingdom population sample", *BMJ,* 314(7084).

Pae, E.; Wu, J.; Nguyen, D.; Monti, R. and Harper, R. (2005). "Geniohyoid muscle properties and myosin heavy chain composition are altered after short-term intermittent hypoxic exposure", *J Appl Physiol,* 98(3).

Partinen, M. and Guilleminault, C. (1990). "Daytime sleepiness and vascular morbidity at seven-year follow-up in obstructive sleep apnea patients", *Chest,* 97(1).

Pataka, A. and Riha, R. (2013). "Continuous positive airway pressure and cardiovascular events in patients with obstructive sleep apnea", *Curr Cardiol Rep*, 15(8).

Peppard, P.; Young, T.; Palta, M. and Skatrud, J. (2000). "Prospective study of the association between sleep-disordered breathing and hypertension", *N Engl J Med*, 342(19).

Pracharktam, N.; Hans, M.; Strohl, K. and Redline, S. (1994). "Upright and supine cephalometric evaluation of obstructive sleep apnea syndrome and snoring subjects", *Angle Orthodontist,* 64.

Puhan, M.; Suarez, A.; Lo Cascio, C.; Zahn, A.; Heitz, M. and Braendli, O. (2006). "Didgeridoo playing as alternative treatment for obstructive sleep apnoea syndrome: randomised controlled trial", *BMJ (Clinical research ed.), 332* (7536).

Rangel, A.; Barros, V. and Seraidarian, P. (2012). "Snoring and Obstructive Sleep Apnea Syndrome: A reflection on the role of Dentistry in the current scientific scenario", *Dental Press J Orthod*, 17(3).

Raynov, A.; Milkov, M.; Nikolova, M.; Rankov, K. (2015). "Non-Conservative Treatment Alternatives for Patients with Obstructive Sleep Apnea/Hypopnea Syndrome", *International Journal of Science and Research* (IJSR), ISSN (Online): Vol. 4(4).

Redline, S.; Kump, K.; Tishler, P.; Browner, I. and Ferrette, V. (1994). "Gender differences in sleep disordered breathing in a community-based sample", *Am J Respir Crit Care Med,* 149(3 Pt 1).

Remmers, J.; Degroot, W.; Sauerland, E. and Anch, A. (1978). "Pathogenesis of upper airway occlusion during sleep" *J Appl Physiol,* 44(6).

Renee, S.; Aronsohn, H.; Whitmore1, E.; Cauter, V. and Tasali, E. (2010). "Impact of Untreated Obstructive Sleep Apnea on Glucose Control in Type 2 Diabetes", *American Journal of Respiratory and Critical Care Medicine,* Vol. 181.

Roberts, J. and Lain, K. (2002). "Recent Insights into the pathogenesis of pre-eclampsia", *Placenta,* 23(5).

Rose, E.; Staats, R.; Virchow, C. and Jonas, I. (2002). "A comparative study of two mandibular advancement appliances for the treatment of obstructive sleep apnoea", *European Journal of Orthodontics*; 24.

Rowley, J.; Sanders, C.; Zahn, B. and Badr, M. (2002). "Gender differences in upper airway compliance during NREM sleep: role of neck circumference", *J Appl Physiol*, 92(6).

Ryan, S.; Taylor, C. and McNicholas, W. (2005). "Selective activation of inflammatory pathways by intermittent hypoxia in obstructive sleep apnea syndrome", *Circulation,* 112.

Schellenberg, J.; Maislin, G. and Schwab, R. (2000). "Physical findings and the risk for obstructive sleep apnea. The importance of oropharyngeal structures", *Am. J. Respir. Crit. Care Med*, 162.

Schneider, B.; Pickett, C.; Zwillich, C.; Weil, J.; McDermott, M.; Santen, R.; Varano, L. and White, D. (1986).

"Influence of testosterone on breathing during sleep", *J Appl Physiol,* 61(2).

Schwab, R.; Gefter, W.; Hoffman, E.; Gupta, K. and Pack, A. (1993). "Dynamic upper airway imaging during awake respiration in normal subjects and patients with sleep disordered breathing", *Am Rev Respir Dis,* 148(5).

Schwab, R.; Gupta, K.; Gefter, W.; Metzger, L.; Hoffman, E. and Pack, A. (1995). "Upper airway and soft tissue anatomy in normal subjects and patients with sleep-disordered breathing. Significance of the lateral pharyngeal walls", *Am J Respir Crit Care Med,* 152(5 Pt 1).

Schwab, R.; Pasirstein, M.; Pierson, R.; Mackley, A.; Hachadoorian, R.; Arens, R.; Maislin, G. and Pack, A. (2003). "Identification of upper airway anatomic risk factors for obstructive sleep apnea with volumetric magnetic resonance imaging", *Am J Respir Crit Care Med,* 168(5).

Scottish Intercollegiate Guidelines Network (2003). Management of obstructive sleep apnoea/hypopnoea syndrome in adults a national clinical guideline. Scottish Intercollegiate Guidelines Network, Edinburgh

Sforza, E.; Bacon, W.; Weiss, T.; Thibault, A.; Petiau, C. and Krieger, J. (2000). "Upper airway collapsibility and cephalometric variables in patients with obstructive sleep apnea" *Am J Respir Crit Care Med,* 161(2 Pt 1).

Sharma, S. and Kavuru, M. (2010). "Sleep and Metabolism: An Overview", *Int J Endocrinol*, 270832.

Shahar, E.; Redline, S.; Young, T.; Boland, L.; Baldwin, C.; Nieto, F.; *et al.* (2003). "Hormone replacement therapy and sleep-disordered breathing", *Am J Respir Crit Care Med,* 167(9).

Sher, A. (2002). "Upper airway surgery for obstructive sleep apnea", *Sleep Med Rev,* 6(3).

Smith, I.; Lasserson, T. and Wright, J. (2002). "Drug treatments for obstructive sleep apnoea", *Cochrane Database Syst Rev,* 2(2).

Somers, V. (2011). Sleep apnea and cardiovascular disease. In: Bonow RO, Mann DL, Zipes DP, Libby P, eds. *Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine.* 9th ed. Saunders; chap 79.

Somers, V.; White, D.; Amin, R.; Abraham, W.; Costa, F.; Culebras, A.; Daniels, S.; Floras, J.; Hunt, C.; Olson, L.; *et al.* (2008). *Sleep apnea and cardiovascular disease: an American Heart Association/American* College of Cardiology Foundation Scientific Statement from the American Heart Association Council for High Blood Pressure Research Professional Education Committee, Council on Clinical Cardiology, Stroke Council, and Council on Cardiovascular Nursing, *J Am Coll Cardiol; 52:686–717.*

Spiegel, K.; Leproult, R. and Van Cauter, C. (1999). "Impact of sleep debt on metabolic and endocrine function", *Lancet,* 354.

Stanchina, M.; Malhotra, A.; Fogel, R.; Trinder, J.; Edwards, J.; Schory, K. and White, D. (2003). "The influence of lung volume on pharyngeal mechanics, collapsibility, and genioglossus muscle activation during sleep", *Sleep* 26 (7).

Stradling, J. and Crosby, J. (1991). "Predictors and prevalence of obstructive sleep apnoea and snoring in 1001 middle aged men", *Thorax,* 46(2).

Sullivan, C.; Issa, F.; Berthon-Jones, M. and Eves, L. (1981). "Reversal of obstructive sleep apnoea by continuous positive airway pressure applied through the nares", *Lancet*, 18(1).

Sundaram, S.; Bridgman, S.; Lim, J. and Lasserson, T. (2005). "Surgery for obstructive sleep apnoea", *Cochrane Database Syst Rev,* 19(4).

Svatikova, A.; Wolk, R.; Lerman, L.; Juncos, L.; Greene, E.; McConnell, J. and Somers, V. (2005). "Oxidative stress in obstructive sleep apnoea", *Eur Heart J,* 26 (22).

Tan, Y.; L'Strange, P.; Luo, Y.; Smith, C.; Grant, H.; Simonds, A.; Spiro, S. and Battagel, JM. (2002). "Mandibular advancement splints and continuous positive airway pressure in patients with obstructive sleep apnoea: a randomized cross-over trial", *European Journal of Orthodontics,* 24.

Tangugsorn, V.; Krogstad, O.; Espeland, L. and Lyberg, T. (2000). "Obstructive sleep apnoea: multiple comparisons of cephalometric variables of obese and non-obese patients", *J Craniomaxillofac Surg,* 28(4).

Taheri, S.; Lin, L.; Austin, D.; Young, T. and Mignot, E. (2004). "Short Sleep Duration Is Associated with

Reduced Leptin, Elevated Ghrelin, and Increased Body Mass Index", *PLOS Medicine,* 1 (3).

Thatcher, G. and Maisel, R. (2003). "The long-term evaluation of tracheostomy in the management of severe obstructive sleep apnea", *Laryngoscope,* 113(2).

Tishler, P.; Larkin, E.; Schluchter, M. and Redline, S. (2003). "Incidence of sleep-disordered breathing in an urban adult population: the relative importance of risk factors in the development of sleep-disordered breathing" *JAMA,* 289(17).

Tsuda, H.; Almeida, F.; Tsuda, T.; Moritsuchi, Y. and Lowe, A. (2010). "Craniofacial changes after 2 years of nasal continuous positive airway pressure use in patients with obstructive sleep apnea", *Chest*, 138 (4).

Valbuza, J.; de Oliveira, M.; Conti, C.; Prado, L.; de Carvalho, L. and do Prado, G. (2008). "Methods to increase muscle tonus of upper airway to treat snoring: Systematic review", *Arq Neuropsiquiatr*, 66 (3-B).

Veale, D.; Chailleux, E.; Hoorelbeke-Ramon, A.; Reybet-Degas, O.; Humeau-Chapuis, M.; Alluin-Aigouy, F.; *et al.* (2000). "Mortality of sleep apnoea patients treated by nasal continuous positive airway pressure

registered in the ANTADIR observatory. Association Nationale pour le Traitement A Domicile de l'Insuffisance Respiratoire chronique" *Eur Respir J,* 15(2).

Verin, E.; Tardif, C.; Buffet, X.; Marie, J.; Lacoume, Y.; Andrieu-Guitrancourt, J. and Pasquis, P. (2002). "Comparison between anatomy and resistance of upper airway in normal subjects, snorers and OSAS patients", *Respir Physiol,* 129(3).

Wasicko, M.; Hutt, D.; Parisi, R.; Neubauer, J.; Mezrich, R. and Edelman, N. (1990). "The role of vascular tone in the control of upper airway collapsibility", *Am Rev Respir Dis,* 141(6).

Wells, R.; Day, R.; Carney, R.; Freedland, K. and Duntley, S. (2004). "Depression predicts self-reported sleep quality in patients with obstructive sleep apnea", *Psychosom Med,* 66(5).

Whyte, K.; Allen, M.; Jeffrey, A.; Gould, G. and Douglas, N. (1989). "Clinical features of the sleep apnoea/hypopnoea syndrome", *Q J Med ,* 72(267).

Yan-fang, S. and Yu-ping, W. (2009). "Sleep-disordered breathing: impact on functional outcome of ischemic stroke patients", *Sleep Medicine*, 10 (7).

Young, T.; Peppard, P. and Gottlieb, D. (2002a). "Epidemiology of obstructive sleep apnea: a population health perspective", *Am J Respir Crit Care Med,* 165(9).

Young, T.; Shahar, E.; Nieto, F.; Redline, S.; Newman, A.; Gottlieb, D.; *et al.* (2002b). "Predictors of sleep-disordered breathing in community-dwelling adults: the Sleep Heart Health Study", *Arch Intern Med,* 162(8).

Young, T.; Finn, L. and Palta, M. (2001). "Chronic nasal congestion at night is a risk factor for snoring in a population-based cohort study" *Arch Intern Med,* 161(12).

Young, T.; Palta, M.; Dempsey, J.; Skatrud, J.; Weber, S. and Badr, S. (1993). "The occurrence of sleep-disordered breathing among middle-aged adults", *N Engl J Med,* 328(17).