

Obesity and Voice

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Contents

<i>Preface</i>	<i>vii</i>
<i>Contributors</i>	<i>xi</i>
1 The Epidemic of Obesity: Incidental Dysphonia <i>Abdul-Latif Hamdan, Mary J. Hawkshaw, and Robert Thayer Sataloff</i>	1
2 Clinical Anatomy and Physiology of the Voice <i>Robert Thayer Sataloff</i>	13
3 Patient History <i>Robert Thayer Sataloff</i>	65
4 Physical Examination <i>Robert Thayer Sataloff</i>	97
5 Obesity, Body Size, and Voice <i>Abdul-Latif Hamdan, Robert Thayer Sataloff, and Mary J. Hawkshaw</i>	115
6 Obesity, Sex Hormones, and Voice <i>Abdul-Latif Hamdan, Robert Thayer Sataloff, and Mary J. Hawkshaw</i>	131
7 Respiratory Dysfunction <i>Robert Thayer Sataloff, John R. Cohn, and Mary J. Hawkshaw</i>	143
8 Obesity, Respiration, and Voice <i>Abdul-Latif Hamdan, Robert Thayer Sataloff, and Mary J. Hawkshaw</i>	161
9 Reflux and Other Gastroenterologic Conditions That May Affect the Voice <i>Robert Thayer Sataloff, Donald O. Castell, Philip O. Katz, Dahlia M. Sataloff, and Mary J. Hawkshaw</i>	183
10 The Adverse Role of Obesity in Gastroesophageal and Laryngopharyngeal Reflux Disease <i>Abdul-Latif Hamdan, Robert Thayer Sataloff, and Mary J. Hawkshaw</i>	321

11	Nutrition and the Professional Voice	339
	<i>Jennifer A. Nasser, Nyree Dardarian, Abigail D. Gilman, and Sobhana Rarijan</i>	
12	Effect of Weight Loss on Voice	369
	<i>Abdul-Latif Hamdan, Robert Thayer Sataloff, and Mary J. Hawkshaw</i>	
13	Conclusion	383
	<i>Abdul-Latif Hamdan, Robert Thayer Sataloff, and Mary J. Hawkshaw</i>	
	<i>Index</i>	385

Preface

Obesity is a worldwide epidemic threat. Its prevalence is rising steadily and currently it affects one-third of the world's population, spanning several countries across the globe.¹ Based on a report published in the *New England Journal of Medicine* 2017, close to 2 billion people are either obese or overweight, and the rate of obesity is higher in children than in adults.² The economic implications of obesity are devastating. In a study by Finkelstein et al,³ the annual health cost of obese people in the United States was reported to be 60% higher than that of normal-weight subjects, accounting for a significant proportion of the gross national income. In addition to the increase in health care cost, obesity is associated with a reduction in productivity secondary to absenteeism, which in turn might impair the economic competitiveness.⁴ In countries like the United States, China, and Mexico, obesity also is considered a threat to the national security as the compromised physical fitness puts military preparedness in jeopardy.⁴ Several strategies have been adopted to motivate obese individuals to lose weight. These include publicizing information on healthy dietary behavior and ehealth communication that constitutes mass customization.⁵ The "Let's Move" campaign that was launched by former First Lady Michelle Obama was another initiative to prevent obesity in children and foster accessibility to healthy food and diet.⁶

Still, the global spread of obesity continues, and the 2 main related concerns are the self-image/esteem and health-related

hazards. The association between poor self-esteem and obesity stems from the emphasis on thinness in our contemporary culture and the labeling of overweight and obese individuals.⁷ The stigmatization of overweight and obese individuals in society often leads to psychological disturbances that result in suffering of the affected individual.^{8,9} Body image dissatisfaction has become a salient attribute in obese subjects and the negative body image linked to obesity has been associated with appearance anxiety and low self-compassion.¹⁰ The seriousness of this matter has led to the emergence of body image therapy as a psychological approach to alleviate obesity-induced psychological disturbances.¹¹ In addition, there is a strong association between body image and overall health. The importance of body image in obesity is not confined only to self-esteem and satisfaction. It also can have an impact on physical health-related issues. "Does body satisfaction matter?" is a question that has been addressed by Neumark-Sztainer et al¹² in their investigation on the association between body satisfaction and health behaviors in a sample of 2516 adolescents over the course of 5 years. The results showed that low body satisfaction is associated with unhealthy behaviors such as binge eating, poor weight control, reduced physical activity, and smoking.

Obesity is becoming one the leading causes of disabilities and death. Obese subjects are at a higher risk to develop cardiovascular illnesses, endocrine disorders, and kidney diseases, in addition to psychologi-

cal disturbances.^{13,14} All systems in the body are affected either directly or indirectly to various degrees. The state of meta-inflammation caused by the excess of adipose tissue, a metabolically active organ, is partially responsible for the impairment in function of these systems.¹⁵ As voice is a reflection of our well-being,¹⁶ phonatory effects of obesity are inevitable. All 3 components of voice production, the respiratory system and abdominal back and thoracic muscles as the power source, the vocal folds as the oscillator, and the vocal tract as the resonator, are targets of anatomic and systemic obesity-induced changes. Hence, weight gain affects voice production.

The purpose of this book is to review the current literature on the impact of obesity on phonation and to highlight the various means by which excessive weight may jeopardize voice quality and endurance. Another impetus for writing this book was the unanswered questions regarding the impact of weight loss and weight fluctuation on voice. “Does weight loss affect my voice?” is a frequent question asked by obese patients, particularly professional voice users who are interested in preserving their individual vocal characteristics. This book discusses weight loss and voice, and it suggests future research trends on the link between weight loss, weight gain, obesity, and phonation.

Chapter 1 reviews the increasing prevalence of obesity and its implications for voice dysfunction. Chapter 2 summarizes current understanding of clinical anatomy and physiology of the voice. Chapters 3 and 4 present state-of-the-art information on medical history and physical examination for patients with voice disorders. In Chapter 5, the authors present core information on obesity, and they review literature correlating body size with voice characteristics. Chapter 6 explains the effects of obesity on

sex hormones and the related effects of sex hormone alterations on phonation in obese individuals. Chapter 7 provides insights into basic information about respiration and its importance in phonation. In Chapter 8, the authors explore the relationship between obesity and respiration, explaining the important effects of obesity-related changes in lung function and their consequences for phonation. Chapter 9 includes an exceptionally comprehensive overview of laryngopharyngeal reflux, including more than 600 references. In Chapter 10, the authors highlight what is known about the relationship between reflux and obesity and the effects of obesity-related reflux on the larynx and voice. Chapter 11 is a comprehensive chapter reviewing the most current concepts regarding nutrition and nutrition science, and the relationship between nutrition and voice. In Chapter 12, the authors review the clinically important subject of the effects of weight loss on voice, including “yo-yo” dieting, and bariatric surgery. In the concluding Chapter 13, the authors summarize the information presented in other chapters and highlight the substantial deficits in knowledge about obesity and its impact upon the voice and vocal tract. Clearly, additional research is needed. Considering the epidemic nature of obesity, obesity-related voice research appears to deserve much more attention than it has received, so far.

References

1. Friedrich MJ. Global obesity epidemic worsening. *JAMA*. 2017;318(7):603.
2. Gregg EW, Shaw JE. Global health effects of overweight and obesity. *N Engl J Med*. 2017; 377(1):80–81.
3. Finkelstein EA, DiBonaventura MD, Burgess SM, Hale BC. The costs of obesity in the

- workplace. *J Occup Environ Med.* 2010;52:971–976.
4. Popkin BM. Is the obesity epidemic a national security issue around the globe? *Curr Opin Endocrinol.* 2011;18:328–331.
 5. Enwald HPK, Huotari MLA. Preventing the obesity epidemic by second generation tailored health communication: an interdisciplinary review. *J Med Internet Res.* 2010;12(2):e24.
 6. Let's Move. America's move to raise a healthier generation of kids. 2010. <http://letsmove.obamawhitehouse.archives.gov/learn-facts/epidemic-childhood-obesity>. Accessed December 10, 2018.
 7. Schwartz MB, Brownell KD. Obesity and body image. *Body Image.* 2004;1(1):43–56.
 8. Choi E, Choi I. The associations between body dissatisfaction, body figure, self-esteem, and depressed mood in adolescents in the United States and Korea: a moderated mediation analysis. *J Adolesc.* 2016;53:249–259.
 9. Willows ND, Ridley D, Raine KD, Maximova K. High adiposity is associated cross-sectionally with low self-concept and body size dissatisfaction among indigenous Cree schoolchildren in Canada. *BMC Pediatr.* 2013;13:118.
 10. Seekis V, Bradley GL, Duffy A. The effectiveness of self-compassion and self-esteem writing tasks in reducing body image concerns. *Body Image.* 2017;23:206–213.
 11. Rosen JC. Improving body image in obesity. In: Thompson, ed. *Body Image Disorders and Obesity: An Integrative Guide for Assessment and Treatment.* Washington, DC: American Psychological Association; 2001:425–440.
 12. Neumark-Sztainer D, Paxton SJ, Hannan PJ, Haines J, Story M. Does body satisfaction matter? Five-year longitudinal associations between body satisfaction and health behaviors in adolescent females and males. *J Adolesc Health.* 2006;39(2):244–251.
 13. Field AE, Coakley EH, Must A, et al. Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Arch Intern Med.* 2001;161(13):1581–1586.
 14. Guh DP, Zhang W, Bansback N, et al. The incidence of co-morbidities related to obesity and overweight: a systematic review and meta-analysis. *BMC Public Health.* 2009;9:88.
 15. Fonseca-Alaniz MH, Takada J, Alonso-Vale MI, Lima FB. Adipose tissue as an endocrine organ: from theory to practice. *J Pediatr.* 2007;83(5)(suppl):S192–S203.
 16. Sataloff RT. Introduction. In *Professional Voice: The Science and Art of Clinical Care.* 4th ed. San Diego, CA: Plural Publishing; 2017:3–7.

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The Epidemic of Obesity: Incidental Dysphonia

Abdul-Latif Hamdan, Mary J. Hawkshaw, and Robert Thayer Sataloff

The Epidemic of Obesity

Several surveys have documented the epidemic nature of obesity as a health crisis worldwide.¹⁻⁹ The increase in its prevalence started in the 1960s with adults being affected more than children and women more than men.⁴ In the United States, the past 3 decades have witnessed a twofold increase in obesity,⁵ with 34.9% of the adult population reported as being obese.³ Using national survey data, Wang et al⁶ projected an increase in the prevalence of overweight or obesity in the United States to 86.3% of the adult population by year 2030 and to 100% by year 2048. This epidemic affects all age groups, including children. Based on multiple National Health and Nutrition Examination Surveys, which included 40,780 children and adolescents between the ages of 2 and 19 years, 17% of the participants were reported to be obese.⁷ There are also ethnic disparities, with Hispanic women and non-Hispanic black people being affected the most.³ According to Li et al,⁸ Mexican Americans have the highest mean percent body fat in comparison to non-Hispanic whites. The study was con-

ducted using the National Health and Nutrition Examination Survey, which included 6559 men and 6507 women. The total body fat and fat-free mass were measured using dual-energy x-ray absorptiometry.⁸

Why the rise in obesity prevalence? The pathogenesis of obesity cannot be attributed to one cause. A holistic approach is needed to determine the many factors contributing to this epidemic entity.¹⁰ A thorough understanding of obesity requires understanding not only the dietary volitional behavior but also numerous other issues. Looking at the cause is essential in understanding the interplay between obesity and environmental factors. Numerous etiological models have been developed by many authors.¹¹⁻¹⁷ Egger and Dixon¹¹ described a hierarchy of layers of influence in the etiology of obesity. These were stratified as risk factors/markers, immediate determinants, and/or nonimmediate determinants. The hierarchy included an array of factors partly related to lifestyle and behavior and partly to sociocultural influences, relationships, occupation, and environment.^{11,12} Based on a report by Swinburn et al,¹³ obesogenic environmental factors can be classified as macro and micro factors that include small

air, soil, and water-polluted particles. These latter have been shown to play a major role in oxidative stress and in disrupting various body systems.^{14–16} The same authors had also previously described an ecological model consisting of 3 main pillars that maintain the energy balance in a human subject. These include biological influence, behavioral influence, and environmental influence.¹⁷ Thus, widespread obesity is the result of many factors that can interact with each other.

But how does it all start? Obesity is the result of a mismatch between the environment we are programmed for and the one we live in.¹¹ This mismatch creates stress that is fueled by manmade inducers referred to as anthropogens.¹⁸ The interface with or adoption of these anthropogens leads to a state of chronic inflammation that worsens with time.^{17–20} Several have been identified in the literature, the most important of which are nutrition and inactivity. The intake of processed food, in addition to excessive sugar, has been shown to induce meta-inflammation.¹⁹ Similarly, sedentary activity or physical inactivity has been linked to several inflammatory biomarkers, whereas exercise, irrespective of its type and duration, has been shown to be of health benefit.²¹ Other important anthropogens that were linked to obesity include sleep deprivation, stress, anxiety, and depression.^{22–24}

Obesity, a Prelude to Systemic Diseases

The anthropogens that induce obesity incite a metabolic response that becomes systemic over time and leads to low-grade chronic inflammation.^{11,18,25} When compounded with genetic predisposition, these events predispose to chronic diseases such as cardiac, respiratory, renal, and endocrine disor-

ders.^{26,27} A large study by Field et al²⁸ investigating the association between overweight and health risks revealed an increase in the incidence of diabetes (DM), hypertension, and heart illnesses with an increase in body weight. The study was conducted on men and women between the ages of 30 and 55 years followed over a period of 10 years.

Several studies concur that obesity and overweight are among the most important risk factors associated with the development of DM and its complications.^{29–31} Guh et al²⁹ reported that obese men and women have 7- and 12-fold increased risk for DM type 2, respectively. A systemic review on the prevalence of obesity and DM by Colosia et al³⁰ showed that 30% to 50% of patients with DM are obese. Weight loss following bariatric surgery has been shown to reverse DM type 2 and is considered a management strategy preferable to medical therapy.³¹ Similar to the association between obesity and DM, obesity is associated also with higher risk of cardiovascular diseases.^{32–40} A body mass index (BMI) of less than 25 kg/m² is considered ideal for cardiovascular health,⁴¹ whereas excessive weight is an independent risk factor that increases the odds for coronary artery diseases (1.46 for men and 1.64 for women).³⁴ The effect is mediated through several mechanisms: (1) obesity-induced structural changes, where the increase in weight leads to an increase in peripheral resistance, which in turn leads to hypertrophy of cardiac muscles and worsening of their function³³; (2) the effect of obesity on systemic diseases such as hypertension, diabetes, and dyslipidemia, which impact cardiac function adversely and are considered as cardiac risk factors^{34,35}; and (3) adipose tissue-induced inflammatory response and its known systemic impact.⁴² Numerous studies also have documented that obesity is associated with abnormal kidney function and high prevalence of kidney diseases.^{43–53} The effect of obesity

on kidney function is direct and indirect. The direct effect is mediated by the release of inflammatory mediators such as adiponectin and leptin, which lead to abnormal metabolic response and oxidative stress, whereas the indirect effect is induced by exacerbation of comorbid conditions such as hypertension and diabetes.^{35,54–58} Commonly reported kidney diseases in obese subjects include nephrolithiasis, glomerulomegaly, glomerulosclerosis, and kidney stones. Scales et al⁵⁹ described a higher prevalence of kidney stones in obese subjects than in normal-weight subjects (11.2% vs 6.1%), and Curhan et al⁶⁰ reported an odds ratio of developing kidney stones of 1.76 when BMI exceeds 32 kg/m².

Obesity also is linked to various types of cancer. According to the International Agency for Research on Cancer (IARC), adding weight increases the risk of developing cancer, whereas losing weight by dieting and physical activity can mitigate that risk.⁶¹ Obesity is considered as an independent prognostic factor that impacts not only prevalence of cancer but also disease-free survival, stage of disease, response to chemotherapy, and overall mortality.^{62–66} The association between obesity and cancer is not surprising given the chronic state of inflammation induced by adipose tissue, which acts as a favorable milieu for tumor cell growth and proliferation. Several mechanisms that link cancer to obesity have been proposed. These include (1) high blood level of insulin and IGF-1, which have been associated with a higher risk of cancer by facilitating tumor proliferation;^{67–69} (2) the release of inflammatory biomarkers such as adiponectin, adipokines, and leptin;^{70,71} and (3) obesity-induced angiogenesis.⁷² Presumably as a consequence of the above, obesity has been associated with an increased risk of death. Epidemiologic studies have found that obesity diminishes life expectancy and increases the risk of death^{73–76} up to 40%

in overweight subjects and 3-fold in obese patients.⁷⁶ A prospective study by Adams et al,⁷⁶ conducted on a cohort of 527 625 men and women between the ages of 50 and 71 years, identified a strong association between risk of death, as well as obesity and overweight in all ethnic and racial groups.

Incidental Dysphonia in Obesity

The impact of obesity on voice has scarcely been discussed in the literature. There are studies on the phonatory characteristics of obese patients in comparison to normal-weight subjects, and on vocal parameters' predictive value of body size and contour,^{77–84} with only a few studies on the impact of weight loss on voice.^{85–87} The impact of weight gain on voice has not been investigated thoroughly. This scarcity of reports is surprising given that voice is a reflection of our well-being. The complexity of voice production and the multiplicity of factors that contribute to phonation are indisputable. In addition to our genetic background and phonatory habits, body traits and health are important influences on acoustic cues that determine one's vocal identity. Numerous reviews highlight the vulnerability of voice vis-à-vis systemic diseases^{88,89} and the importance of adipose tissue as an endocrine organ.⁹⁰ Review of 3 facets of the interplay between obesity and voice helps clarify clinical issues, as summarized in the next section.

The Systemic Effect

It is well established that obesity leads to numerous metabolic disorders through its immune-modulatory effect. The release of adipokines results in systemic inflammation

that predisposes to numerous diseases.⁹⁰ In addition to playing a major role in energy homeostasis and its metabolic effect, obesity impacts systems in the body that are integral to voice production. Excessive weight can adversely affect breathing by mechanical impairment, reduction in chest compliance, and alteration in lung perfusion.^{91–96} Obesity also can alter the sex hormone environment in both men and women.^{97–103} There is reduction in total and free testosterone levels in men and peripheral conversion of androgen to estrogen via several enzymes.^{99,100} In menopausal women, the excess fat can act as a reservoir for estrogen replenishment to mitigate the postmenopausal androgenic state.^{102,104,105} Obesity also can affect the gastrointestinal system. It has been proven to exacerbate the symptoms and signs of reflux disease by delaying gastric emptying time, altering the function of the lower esophageal sphincter, displacing the gastroesophageal junction zone, and increasing the risk of hiatal hernia.^{106–113}

As phonation is a complex process intimately linked to these systems, it is reasonable to infer that obesity-induced alterations in the function of these systems may jeopardize phonation and lead to voice disorders. Further discussion on this topic is presented in Chapters 5, 6, 7, and 8 of this book.

The Positive Energy Imbalance

As previously mentioned in this chapter, obesity is the result of excessive energy intake and/or decrease in energy use (activity level). Both factors are linked to voice production. Diet and voice are discussed in Chapter 58, “Nutrition and the Professional Voice,” of the fourth edition of *Professional Voice*,¹¹⁴ republished for the readers’ convenience as Chapter 11 of this book. In summary, dietary behavior in terms of amount and type of nutrients as well as fluid

intake is important for vocal performance. A nutrition strategy based on a balanced diet is often needed in order to meet the dietary requirements of professional voice users just as it is to meet the requirements of other professional athletes. For instance, a meal rich in carbohydrate and low in fat often is recommended a few hours prior to a long performance. Similarly, consumption of fruits and vegetables with lean proteins is always advised.¹¹⁵ The eating pattern and dietary behavior of obese subjects may have an adverse effect on their vocal performance.^{116,117} The imbalance in energy intake and energy expenditure in obese subjects may put the singer at risk of vocal fatigue, hunger, or gastrointestinal discomfort. By the same reasoning, the sedentary activity experienced by obese patients may also affect vocal performance adversely. Jarosz et al¹¹⁸ examined the correlation between BMI, physical inactivity, and fatigue in 69 African American women (BMI greater than 30 kg/m²). The results indicated a significant correlation between obesity and body fatigue, which substantiates the deterrent effect of obesity on body activity and lifestyle. Vgontzas et al¹¹⁹ correlated the excessive daytime sleepiness and fatigue in obese subjects with metabolic disorders even in the absence of obstructive sleep apnea. Given that professional voice users are vocal athletes,¹²⁰ body fatigue associated with obesity may have a detrimental effect on voice performance and lead to vocal disorders.^{118–120} Further research on this topic is needed to elucidate the relationship between obesity, body fatigue, and voice.

The Vocal Tract and the Bottleneck

Although the vocal signal is energized by breathing and is emitted at the level of the vocal folds, what shapes our vocal iden-

tity is the morphology and contour of the supraglottic vocal tract, the bottleneck for sound production. With obesity, there is alteration in the shape and cross-sectional area of the pharyngeal lumen, as well as the configuration of other regions of the vocal tract, which may affect voice quality.^{121–124} The upper airway is a target for morphologic changes in obese subjects. Weight-induced fat deposition at various sites of the vocal tract has been described by numerous authors. For example, a study by Busetto et al¹²⁵ conducted on female obese subjects showed a strong correlation between weight, fat distribution, and size of the upper airway. Accumulation of fat was noted at the base of tongue, lateral pharyngeal walls, and at the palatopharyngeal folds. Several other studies also have documented an association between obesity and upper airway fat distribution.^{123,126} Similarly, Pahkala et al¹²⁷ reported hypertrophy of the pharyngeal fat pad in obese subjects scheduled for bariatric surgery. This alteration in the size and configuration of the vocal tract in relation to BMI certainly carries acoustic implications given that formants' dispersion and position depend heavily on the shape of the vocal tract.^{128–132} A more thorough discussion on the correlation between vocal tract morphology in obese subjects and phonatory output is reviewed in Chapter 5 of this book, namely, on obesity, body size, and vocal tract.

References

1. An R. Prevalence and trends of adult obesity in the US, 1999–2012. *ISRN Obes.* 2014;2014:185132.
2. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of obesity and trends in body mass index among US children and adolescents, 1999–2010. *JAMA.* 2012;307(5):483–490.
3. Ogden CL, Carroll MD, Kit BK, Flegal KM. Prevalence of childhood and adult obesity in the United States, 2011–2012. *JAMA.* 2014;311(8):806–814.
4. Bhupathiraju SN, Hu FB. Epidemiology of obesity and diabetes and their cardiovascular complications. *Circ Res.* 2016;118(11):1723–1735.
5. World Health Organization. Obesity and overweight. <http://www.who.int/mediacentre/factsheets/fs311/en/>. Retrieved December 14, 2018.
6. Wang Y, Beydoun MA, Liang L, Caballero B, Kumanyika SK. Will all Americans become overweight or obese? Estimating the progression and cost of the US obesity epidemic. *Obesity (Silver Spring).* 2008;16(10):2323–2330.
7. Ogden CL, Carroll MD, Lawman HG, et al. Trends in obesity prevalence among children and adolescents in the United States, 1988–1994 through 2013–2014. *JAMA.* 2016;315(21):2292–2299.
8. Li C, Ford ES, Zhao G, Balluz LS, Giles WH. Estimates of body composition with dual-energy X-ray absorptiometry in adults. *Am J Clin Nutr.* 2009;90(6):1457–1465.
9. Skinner AC, Skelton JA. Prevalence and trends in obesity and severe obesity among children in the United States, 1999–2012. *JAMA Pediatr.* 2014;168(6):561–566.
10. Have MT, Van der Heide, Machenbach JP, De Beaufort ID. An ethical framework for the prevention of overweight and obesity: a tool for thinking through a programme's ethical aspects. *Eur J Public Health.* 2013;23(2):299–305.
11. Egger G, Dixon J. Beyond obesity and lifestyle: a review of 21st century chronic disease determinants. *BioMed Res Int.* 2014;2014(5):731685.
12. Brownell KD, Wadden TA. Etiology and treatment of obesity: understanding a serious, prevalent and refractory disorder. *J Consult Clin Psychol.* 1992;60(4):505–517.
13. Swinburn B, Egger G, and Raza F. Dissecting obesogenic environments: the development and application of a framework for identifying and prioritizing environmental interventions for obesity. *Prev Med.* 1999;29(6, pt 1):563–570.