PEDAGOGICAL IMPLICATIONS OF THE RESPIRATORY EFFECTS OF ASTHMA IN SINGERS

by

DAVID MICHAEL THOMAS

(Under the Direction of Stephanie Tingler)

ABSTRACT

The ability to maintain proper breath function and appropriate levels of respiratory flow are vitally important to the singer. Asthma affects the vocal performer's ability to properly control these required parameters, causing vocal fatigue, shortness of breath, decreased range, and loss of amplitude control. Incorrect respiratory coordination, a condition common in asthma, is generally mistaken for flawed vocal technique rather than identified as a pulmonary disease. This study examines parameters of lung function in order to ascertain the physiological differences between those of the vocalist and the asthmatic and attain a greater understanding of breath efficiency issues in the singer with asthma. Physical fitness regimens, commonly recommended to improve breath function for both the singer and the asthmatic, are compared to determine activities that are beneficial to the singer with asthma. Breathing strategies common in asthma are examined and compared with those of the singer to determine their effect on vocal training. Respiratory training exercises from asthma therapy and vocal training are compared, and some modified, to maximize respiratory efficiency and reduce asthmatic risks for the singer with the disease. Respiratory exercises are categorized by pedagogical function and grouped to

provide maximum training benefits to beginning, intermediate, and advanced levels of singers with asthma.

INDEX WORDS: Asthma, Vocal Pedagogy, Pulmonary Function Values, Exercise-Induced Asthma, Respiratory Muscle Training, Inspiratory Muscle Training

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DEDICATION

To my wife and best friend, Michelle. Thank you for your unending support, encouragement, and most of all, love.

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CHAPTER 1

INTRODUCTION

The ability to inhale and exhale in a relaxed state is essential to human existence. The musculature used during this process must be trained in order to meet the demands that singing imposes. Educators who work with singers understand the need to create and sustain a healthy, efficient flow of air through the vocal folds. Vocal pedagogues commonly refer to the appropriate level of airflow required during phonation as "breath support" or "breath management."

Learning to maintain the appropriate level of airflow while singing is imperative, as this alone creates the amount of expiratory force that vibrates the vocal folds. When performing, the singer increases ventilatory flow from the lungs, with the continuation of this airstream through the bronchial tract, larynx, oral cavity, and resonators. This managed level of breath support enables singers to consistently produce a healthy, resonant sound, without the occurrence of medical complications.

The required level of breath control can be hindered if a respiratory dysfunction, such as asthma, is present. Due to the inappropriate use of extrinsic muscles in the head and neck, an asthmatic singer's inability to adequately regulate the airflow needed for phonation can cause

vocal fatigue, shortness of breath, decreased range, and loss of amplitude control. Even minute changes in pulmonary function during singing can create problems of breath management.[1]

Despite advancements in the treatment of asthma, it is still one of the most common and costly chronic diseases, with the number of people diagnosed with this disorder increasing dramatically. Between 1982 and 1996, asthma prevalence across all age, race, and gender groups rose by 58%.[2] In 1993, studies estimated that 13.7 million persons in the United States suffered from asthma, a 75% increase over cases reported in 1980. By 1998, this number rose to 17.3 million,[3] including approximately 12 million children under the age of 16. Data collected between 1980 and 1994 show asthma increased 160% for children ages 0-4 years and increased 74% for ages 5-14 years. Particularly alarming is the considerably higher prevalence of the disease among children residing in large urban areas. Studies during the last few decades suggest a worldwide increase of 5%-6% per year, with recent estimates placing the global number of asthmatics above 150,000,000.[4]

WHAT IS ASTHMA?

The term *asthma* is derived from the Greek meaning "gasping for breath." Symptoms consist of coughing, shortness of breath, and a wheezing or rattle in the chest. These symptoms are most pronounced upon exhalation and are often entirely absent during inhalation.[5] In an asthmatic episode, the bronchial passages of the lungs become narrowed in three ways: (1) the muscles surrounding the bronchial tubes contract, constricting the volume area of the passages;

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[1] John R. Cohn et al., "Airway Reactivity-Induced Asthma in Singers (ARIAS)," *Journal of Voice* 5, no. 4 (1991): 332.
[2] Deborah O. Lucas et al, "Two-Year Results from the Asthma Self-Management Program: Long-Term Impact on Health Care Services, Costs, Functional Status, and Productivity," *Journal of Asthma* 38, no. 4 (2001), 322.
[3] Anne Marie Muth, ed. *Asthma Sourcebook* (Detroit: Omnigraphics, 2000), ix.
[4] Peter J. Barnes et al, eds., *Asthma and COPD: Basic Mechanisms and Clinical Management* (San Diego: Academic Press, 2002), 8-9.
[5] Irvin Caplin, *The Allergic Asthmatic* (Springfield: Charles C. Thomas, 1968), 5.

(2) the bronchial tissue lining the tubes swells; and (3) the mucosal secretions of the bronchial tubes increase.[6] These three elements combine to restrict the amount of airflow both into and out of the lungs. In the most extreme cases, persons not treated for an acute asthmatic episode can asphyxiate and die, with nearly 5,500 deaths attributed to asthma in 1998 alone.[7] These problems can all be caused by the hyper-reactive response of the bronchial tubes.[8]

Although asthma has traditionally been considered a fully reversible airway disease, evidence now suggests that it may be only partially reversible. A recent National Institutes of Health guideline supports these findings, defining asthma as the following:

> A chronic inflammatory disorder of the airways…. In susceptible individuals, this inflammation causes recurrent episodes of wheezing, breathlessness, chest tightness, and cough, particularly at night and in the early morning. These episodes are usually associated with widespread but variable airflow obstruction that is often reversible either spontaneously or with treatment. The inflammation also causes an associated increase in the existing bronchial hyper-responsiveness to a variety of stimuli.[9]

The exact reasons for the onset of an asthmatic episode are not fully understood by doctors or researchers, but studies have shown that many causes induce this debilitating process.[10] Common asthmatic "triggers" are allergies, exercise, medications, emotional responses, weather and climate conditions, respiratory infections, and atmospheric pollutants.[11]

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[6] Nancy Hogshead and Gerald Secor Couzens, *Asthma and Exercise* (New York: Henry Holt and Company, 1990), 24.
[7] David M. Mannino et al., "Surveillance for Asthma --- United States, 1980—1999," *Morbidity and Mortality Weekly Report: Surveillance Summaries* 51(SS01): 11, 29 March 2002 [journal on-line]; available from http://www.cdc.gov/mmwr/preview/mmwrhtml/ss5101a1.htm#tab10; Internet; accessed 28 August 2004.
[8] Hogshead and Couzens, 29.
[9] National Asthma Education and Prevention Program Expert Panel Report 2, *Guidelines for the Diagnosis and Management of Asthma* (National Institute of Health, National Heart, Lung, and Blood Institute: NIH Publication 97-4051, 1997); quoted in Peter J. Barnes et al, eds., *Asthma and COPD: Basic Mechanisms and Clinical Management* (San Diego: Academic Press, 2002), 3.
[10] Hogshead and Couzens, 49-50.
[11] Barnes et al., 447.

RESPIRATION AND THE SINGER

Proper breathing is the foundation of good singing, providing the energy necessary for phonation, resonance, and articulation. Without respiration supporting vocal function, none of the elements of singing are supplied with sufficient energy.[12] This physical act increases the body's demands for oxygen, requiring deeper inhalation to provide sufficient airflow throughout the sung phrase.[13] The diaphragm is the primary muscle of inhalation, its descent pulling air deep into the lungs. The secondary muscles of inspiration, the external intercostals, lift the rib cage, increasing its diameter and contributing to greater air volume. These two muscle groups combine to completely fill the lungs and provide sufficient air pressure to cause vibration of the vocal folds during singing. Deep inhalation is necessary for this task and is the primary responsibility of the diaphragm, whose strong contraction aids its descent and increases the potential force of expiratory airflow available during singing.[14]

The primary muscles of expiration are the abdominal muscles, comprising the external and internal obliques, transversus abdominus, and the rectus abdominus. These muscles form the abdominal wall, which contract and press the abdominal viscera against the lowered diaphragm.[15] The diaphragm resists, creating air pressure in the lungs sufficient for phonation.[16]

The task of singing requires voluntary control of both the primary and supplementary muscle groups necessary for respiration. To maintain the air pressure necessary for singing, the muscles of the abdominal wall contract, generating a balanced force of energy against the

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[12] Richard Alderson, *Complete Handbook of Voice Training* (New York: Parker Publishing Company, Inc., 1979), 28.
[13] Barbara M. Doscher, *Functional Unity of the Singing Voice* 2d ed. (Metuchen, New Jersey: The Scarecrow Press, Inc., 1994), 1.
[14] Ibid., 11-2.
[15] Marilee David, *The New Voice Pedagogy* (Lanham, Maryland: The Scarecrow Press, Inc., 1995), 23-4.
[16] Doscher, 12-6.

diaphragm, lifting the rib cage. This synergistic relationship of muscular contractions provides the constant force of expiratory breath necessary for singing sustained musical phrases.[17]

It is taken for granted that the lung capacity of singers increases over a period of time through the efficient application of breath management techniques.[18] Various studies in the latter-half of the twentieth century confirm these conclusions through comparative analysis of lung-function measurements in singers and non-singers. Further evidence suggests that incorrect breath management, due to improper training or reduced physical capability, may cause singers to employ neck and laryngeal muscles as compensation for inadequate breath support. When utilized, these extraneous muscle actions may result in potentially dangerous phonation, injurious to the long-term health of the vocal folds.[19] A recent study demonstrates that inappropriate use of these muscles, combined with decreased levels of respiratory support, is directly related to asthmatic effects on the singing voice.[20]

Given the necessity for efficient breath management by any singer, the challenges faced by the singer with asthma are numerous. This inference, combined with the growing prevalence of asthma (see introduction), suggests an examination of current pedagogical research and methodologies with attention to accommodations for singers with this disease.

NEED FOR THE STUDY

To date, research regarding the respiratory training and the enhancement of lung function of the singer has been limited to persons possessing normal lung function, with singers who demonstrate any form of pulmonary dysfunction being purposefully excluded from these studies.

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[17] Marcia Petitt, "Quiet Breathing and Breathing for Singing: Anatomic and Physiologic Parameters," *Journal of Research in Singing and Applied Vocal Pedagogy* 18, no. 2 (1995): 31-5.
[18] John Large, "Observations of the Vital Capacity of Singers," *The NATS Bulletin* 27, no. 3 (1971): 34.
[19] Petitt, 35.
[20] Cohn et al., 333-5.

Case histories examining the specific relationship between singing and asthma reveal a correlation between strenuous vocal performance and the onset of asthma; however, these representative cases focused on singing as a trigger of exercise-induced asthma.[21] Absent from this research is any reference to reduced lung function and respiratory muscle-strength levels caused by the asthmatic condition, as well as how these physiological differences directly affect certain parameters of vocal training. This lack of specific information makes it necessary to hypothesize on the relationship between methods of respiratory training for singing and their possible effect on the asthmatic condition. As a result, it may be possible to postulate a causal connection between singing and asthma through the examination of medical case studies that deal with asthma.

Numerous studies on the treatment of asthma show that respiratory training increases inspiratory muscle strength and endurance and improves measurements of respiratory function, such as vital capacity, residual volume, and forced expiratory volume. These clinical investigations also show reductions of bronchodilator usage, decreased sensitivity to "asthmatic triggers," increased airflow rates, and reductions in lung hyperinflation, all of which are problems common to asthma and detrimental to the singer with the disease. Subsequently, specific inspiratory muscle training may provide an alternative method of reducing and controlling the symptoms of bronchial asthma,[22] thereby providing a basis for developing a pedagogical intervention and training methodology.

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[21] Ibid., 332-5.
[22] Paltiel Weiner et al., "Inspiratory Muscle Training in Patients with Bronchial Asthma," *Chest* 102, no. 5 (1992): 1360-1.

PURPOSE OF THE STUDY

The purpose of this study is to examine the possible effects of asthma on traditional pedagogical methods of vocal training. Specifically, this study examines and compares lung function readings, physical conditioning regimens, and respiratory training exercises in order to determine the conditioning and respiratory methodologies most beneficial to the vocal development of singers with asthma. Four questions are examined by this study:

(1) How does asthma affect measurements of lung function; how do these levels of lung function in the asthmatic compare with those of non-asthmatic singers; and what differences in pulmonary efficiency should be expected by singers with asthma?

(2) Which exercise regimens are recommended for the singer and for the asthmatic; are there exercises for optimal efficiency common to both groups; and are there possible health concerns for singers with asthma?

(3) Do asthmatics commonly employ methods of breathing or use compensatory breathing strategies that may contribute to problems of posture, muscle tension, and respiratory fatigue during singing?

(4) Do healthy singers utilize respiratory training exercises that could be compatible with the training of singers with asthma; and what modifications, if any, may be necessary to adapt these exercises for vocal respiratory training of singers with asthma?

LIMITATIONS OF THE STUDY

Clinical trials of the conclusions of this study were not undertaken; therefore, all intervention and training methodologies are based on a comparative study of existing research, subjected to deductive analysis and pedagogical application. Comparative parameters of lung function, pertinent to question one, are summarized from the following sources.

Lung Function Values in Asthmatics

Barnes, Peter J., Jeffrey Drazen, Stephen Rennard, and Neil C. Thompson, eds. *Asthma and COPD: Basic Mechanisms and Clinical Management.* San Diego: Academic Press, 2002.

Cherniack, Reuben M. "Physiologic Diagnosis and Function in Asthma." *Clinics in Chest Medicine* 16, no. 4 (1995): 567-581.

Jackson, Larry K. "Functional Aspects of Asthma." *Clinics in Chest Medicine* 5, no. 4 (1984): 573-87.

Lavietes, Marc H. "Ventilatory Control in Asthma." *Clinics in Chest Medicine* 5, no. 4 (1984): 607-17.

Mannix, Edward T., Melanie Roberts, Daniel P. Fagin, Brandie Reid, and Mark O. Farber. "The Prevalence of Airways Hyperresponsiveness in Members of an Exercise Training Facility." *Journal of Asthma* 40, no. 4 (2003): 349-355.

McFadden, E. R., Jr. and Rana B. Hejal. "The Pathobiology of Acute Asthma." *Clinics in Chest Medicine* 21, no. 2 (2000): 213-24.

Muth, Annemarie S., ed. *Asthma Sourcebook.* Detroit: Omnigraphics, 2000.

Lung Function Values in Singers

Carroll, Linda M., Robert Thayer Sataloff, Reinhardt J. Heuer, Joseph R. Spiegel, Sharon L. Radionoff, and John R. Cohn. "Respiratory and Glottal Efficiency Measures in Normal Classically Trained Singers." *Journal of Voice* 10, no. 2 (1996): 139-145.

Gould, Wilbur. "The Effect of Voice Training on Lung Volumes in Singers, and the Possible Relationship to the Damping Factor of Pressman." *Journal of Research in Singing* 1, no. 1 (1977): 3-15.

Large, John. "Observations of the Vital Capacity of Singers." *The NATS Bulletin* 27, no. 3 (1971): 34-5, 52-3.

Monoson, Patricia, Cathleen Vollertsen, and Jon Hufnagle. "The Relationship Between Selected Physiologic Respiratory Parameters and Singing Ability." *Journal of Research in Singing* 3, no. 2 (1980): 1-13.

Murry, Thomas. "Air Flow Rate During Phonation." In *Transcripts of the Tenth Symposium on Care of the Professional Voice Held in New York June 1981,* edited by Van L. Lawrence, 16-21. New York, 1982.

Petitt, Marcia. "Quiet Breathing and Breathing for Singing: Anatomic and Physiologic Parameters." *Journal of Research in Singing and Applied Vocal Pedagogy* 18, no. 2 (1995): 21-39.

The medical sources provide specific information about lung-function parameters for mild, chronic, and acute forms of asthma, while the vocal pedagogy sources provide similar values for singers with broad differences in their number of years of training.

The comparative elements of the study that are concerned with recommended exercise regimens for singers and asthmatics (contained in question two) are taken from the following sources.

Exercise Regimens for Asthmatics

Firshein, Richard N. *Reversing Asthma: Reduce Your Medications with this Revolutionary New Program.* New York: Warner Books, 1996.

Hogshead, Nancy and Gerald Secor Couzens. *Asthma and Exercise.* New York: Henry Holt and Company, 1990.

Katz, Roger M. "Asthma and Sports." *Annals of Allergy* 51 (August 1983): 153-160.

Exercise Regimens for Singers

Bunch, Meribeth. *Dynamics of the Singing Voice,* 3d ed. Vienna: Springer-Verlag, 1995.

McKinney, James C. *The Diagnosis and Correction of Vocal Faults: A Manual for Teachers of Singing and for Choir Directors*, revised ed. Nashville: Genevox Music Group, 1994.

Miller, Richard. *The Structure of Singing: System and Art in Vocal Technique.* New York: Schirmer Books, 1986.

Vennard, William. *Singing: The Mechanism and the Technic,* revised ed. New York: Carl Fischer, Inc., 1967.

Ware, Clifton. *Basics of Vocal Pedagogy: The Foundations and Process of Singing.* Boston: McGraw-Hill, 1998.

These sources are specific in their recommendations of fitness training regimens considered beneficial to the singer or the asthmatic, thus enabling greater feasibility in comparison.

Both the examination of asthmatic breathing habits that can contribute to specific problems found in singers with asthma (pertinent to question three) and the comparison of vocal respiratory training exercises suitable for use by the singer with asthma (illustrated in question four) are limited to the following sources.

Asthmatic Breathing Strategies and Respiratory Exercises

Firshein, Richard N. *Reversing Asthma: Reduce Your Medications with this Revolutionary New Program.* New York: Warner Books, 1996.

Hogshead, Nancy and Gerald Secor Couzens. *Asthma and Exercise.* New York: Henry Holt and Company, 1990.

Sorvino, Paul. *How to Become a Former Asthmatic.* New York: William Morrow and Company, Inc., 1985; Signet Books, 1986.

Vocal Respiratory Training Exercises

Bunch, Meribeth and Cynthia Vaughn. *The Singing Book.* New York: W. W. Norton & Company, 2004.

Schmidt, Jan. *Basics of Singing,* 3d ed. New York: Schirmer Books, 1994.

McKinney, James C. *The Diagnosis and Correction of Vocal Faults: A Manual for Teachers of Singing and for Choir Directors*, revised ed. Nashville: Genevox Music Group, 1994.

Miller, Richard. *The Structure of Singing: System and Art in Vocal Technique.* New York: Schirmer Books, 1986.

Vennard, William. *Singing: The Mechanism and the Technic,* revised ed. New York: Carl Fischer, Inc., 1967.

Ware, Clifton. *Basics of Vocal Pedagogy: The Foundations and Process of Singing.* Boston: McGraw-Hill, 1998.

All of these sources supply detailed descriptions of respiratory training exercises that can be compared for their possible benefit to the singer with asthma, while the asthma-specific sources explain (a) particular breathing strategies that are commonly employed by the asthmatic and (b) recommend breath re-training methodologies similar to those taught to singers.

ORGANIZATION OF THE STUDY

This document contains five chapters and a bibliography. The contents of each chapter can be summarized as follows:

- Chapter One includes (1) introductory remarks, (2) need for the study, (3) purpose of the study, (4) limitations of the study, and (5) a description of the organization of the study. Within the introductory remarks are brief discussions of asthma, asthmatic triggers and symptoms, and respiration for singing.
- Chapter Two examines the effects of asthma and vocal training on parameters of lung function. The information examined, analyzed and summarized in this chapter is from the listed sources and establishes a range of differences in lung efficiency that may affect the vocal capabilities of the singer with asthma.
- Chapter Three examines recommended exercise regimens from the listed sources for both the singer and the asthmatic, to compare specific activities in each field of study and determine similar exercises from both areas that can enhance pulmonary effectiveness with minimal risk of asthmatic exacerbation. Direct comparison suggests possible

modifications of specific exercises for the asthmatic, to make them suitable for singers with asthma. A brief summary of research concerning exercise-induced asthmatic inflammation and its triggers is provided in the chapter as well.

- Chapter Four describes specific methods of breathing commonly employed by asthmatics during attacks, and compares the differences between these breathing strategies, normal breathing patterns, and breathing techniques utilized for singing. Recommendations are provided regarding breathing techniques most beneficial to the singer with asthma, based on examination, deductive analysis, and pedagogical application of existing research from the sources listed. The chapter concludes with a detailed listing of the respiratory training exercises from the above sources on asthma and vocal pedagogy, comparing individual breathing exercises for compatibility in the training of singers with asthma, and suggesting possible modifications of individual exercises to accommodate these singers.
- Chapter Five presents conclusions derived from the study, outlines continuing study that is necessary to establish the validity of the deductive analysis regarding pedagogical strategies postulated for singers with asthma, and describes areas of additional research that could prove useful to this population, as well as to healthcare providers and educators who serve it.

CHAPTER 2

LUNG VOLUME MEASUREMENTS IN SINGERS WITH ASTHMA

The respiratory effects of asthma directly contribute to the reduction of pulmonary function values. Examining measured levels of respiratory efficiency is extremely important in order to understand how singing can be affected by asthma. Due to the lack of specific information regarding respiratory parameters in the asthmatic singer, it is necessary to compare the available statistical data of singers with that of asthmatics, in order to identify significant differences and determine the possible effects of the disease upon the vocalist.

In order to discuss functional capacity of the lungs, it is first necessary to define specific terms related to pulmonary volume. *Forced Expiratory Volume* (FEV) is the strong exhalation of as much air as possible within one second. *Vital Capacity* (VC) represents the total volume of usable air in the lungs, a measurement extremely important to the singer. *Residual Volume* (RV) is the amount of air that remains in the lungs after forced expiration, generally calculated as approximately twenty-five percent of the total lung capacity of the individual. RV is then combined with VC to create *Total Lung Capacity* (TLC).[23] Normal levels of these respiratory parameters are based on statistical predictions that employ specific physiological measurements (i.e., height, size of rib cage, etc.). Through the examination of these measurements, it is possible to compare the pulmonary-function levels of singers with those of asthmatics, in order to achieve a hypothetical value range for the singer with asthma.

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[23] Oren L. Brown, *Discover Your Voice* (San Diego: Singular Publishing Group, Inc., 1996), 30.

LUNG CAPACITIES OF SINGERS

Studies of lung function in singers are invaluable for differentiating problems related to vocal technique from respiratory function abnormalities,[24] and in providing applicable statistical information for comparison. Several studies in the latter half of the twentieth century support the hypothesis that singers possess higher than normal efficiency of lung function, reporting average VC measurements among singers of 116%,[25] 107% (student),[26] 123% (professional),[27] 89%,[28] and 102%,[29] versus control-group measurements of 99% (Figure 2.1). Gould's study (1977) showed reduced measurements of RV, ranging from 72.5 to 90.6%, indicating that "the VC of the professional singer is expanded within the TLC in large part through a reduction in the RV," and that this "implies that the impressive singing potential of the professional rises in part from this expansion of vital capacity."[30] Monoson et al. (1980) tested this hypothesis by measuring RV, VC, and TLC and judging four variables of singing (breath support, phrasing, intonation, and diction). Their findings suggest that singers demonstrate a more efficient use of air and conclude that there is a "relationship between respiratory function and judged singing ability," and that "individuals who increased their vital capacity at the expense of their residual volume … were judged better singers."[31]

This research indicates that respiratory training utilized by singers positively affects lung efficiency, with differences in statistical measurements attributed to the size and diversity of each

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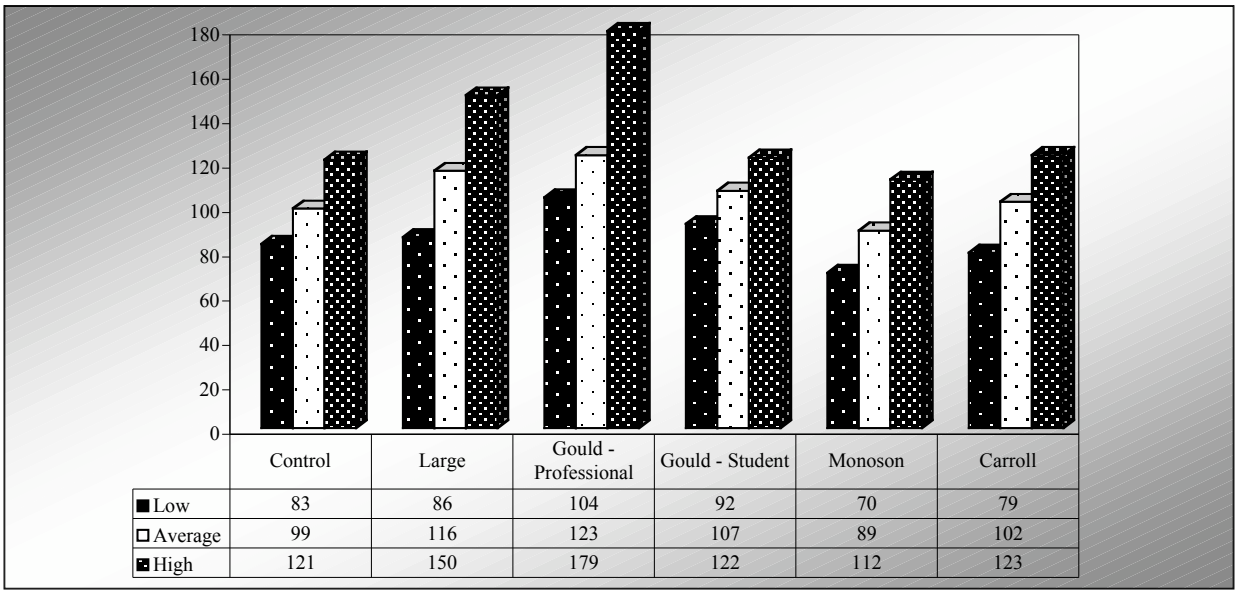
[24] Linda M. Carroll et al., "Respiratory and Glottal Efficiency Measures in Normal Classically Trained Singers," *Journal of Voice* 10, no. 2 (1996): 139.
[25] John Large, "Observations of the Vital Capacity of Singers," *The NATS Bulletin* 27, no. 3 (1971): 35, 52.
[26] Wilbur Gould, "The Effect of Voice Training on Lung Volumes in Singers, and the Possible Relationship to the Damping Factor of Pressman," *Journal of Research in Singing* 1, no. 1 (1977): 3-5.
[27] Ibid., 3-5.
[28] Patricia Monoson et al., "The Relationship Between Selected Physiologic Respiratory Parameters and Singing Ability," *Journal of Research in Singing* 3, no. 2 (1980): 7-12.
[29] Carroll et al., 141-2.
[30] Gould, 3-7.
[31] Monoson et al., 10-12.

study group. Studies based on professional singers with an average of six or more years of training demonstrate marked increases in pulmonary function, whereas singers with an average of five or fewer years of training produce lung-function measurements near the norm for all individuals. Additionally, these studies determined that airflow pressure within the lungs is sufficient for most singing demands and that the primary respiratory task in singing is to generate a constant, graded level of subglottic pressure.[32] Airflow rates are of primary concern to the singer with asthma, as their decrease directly impacts other lung-function values. Any decrease in expiratory capabilities traps air in the lungs and subsequently increases residual volume, having devastating effects on the singing voice (these effects on the respiratory system will be fully illustrated in figure 2.2).



	Control	Large	Gould - Professional	Gould - Student	Monoson	Carroll
Low	83	86	104	92	70	79
Average	99	116	123	107	89	102
High	121	150	179	122	112	123

Figure 2.1
Comparison of Vital Capacity Measurements in Singers
(Values shown represent lowest and highest individual vital-capacity measurements and an average of all participants within each study.)

[32] Petitt, 33.

LUNG-FUNCTION VALUES IN ASTHMATICS

Diagnosis of an asthmatic condition assists the singer and teacher in assessing specific issues of breath function and pedagogical concern. Physiological changes, such as increased mechanical load of the inspiratory musculature, functional muscle weakness, increased restriction of the chest wall, decreased expiratory capability, and oxygen exchange abnormalities are common in asthma.[33] Each of these symptoms can impede the respiratory and vocal development of the singer with asthma. Decreases in respiratory efficiency are identified through measurements of forced expiratory volume (FEV), residual volume (RV), and vital capacity (VC). In persons suffering from mild asthmatic symptoms, FEV readings average approximately 80% of the predicted normal values, with VC levels averaging 65%.[34]

Sudden asthmatic attacks, caused by allergies, exercise, atmospheric conditions, or a combination of "triggers," are particularly problematic to the singer with asthma. Research by McFadden and Hejal (2000) found that VC averaged approximately 50% of predicted levels in persons suffering from acute asthma attacks. Additionally, FEV averaged less than 35% with a substantial amount of air trapping occurring in the lungs, which resulted in RV levels as high as 400% above normal. Approximately half of the subjects in their study (55%) demonstrated VC values lower than 40% of predicted norms.[35]

A study by Cherniack (1995) that examined physiological changes caused by acute exacerbations of asthma identified improper ventilation of carbon dioxide as a significant factor. Carbon-dioxide levels increased within the lungs due to their inability to exchange it with oxygen, leading to more severe asthmatic responses. This study showed FEV levels at 39% and

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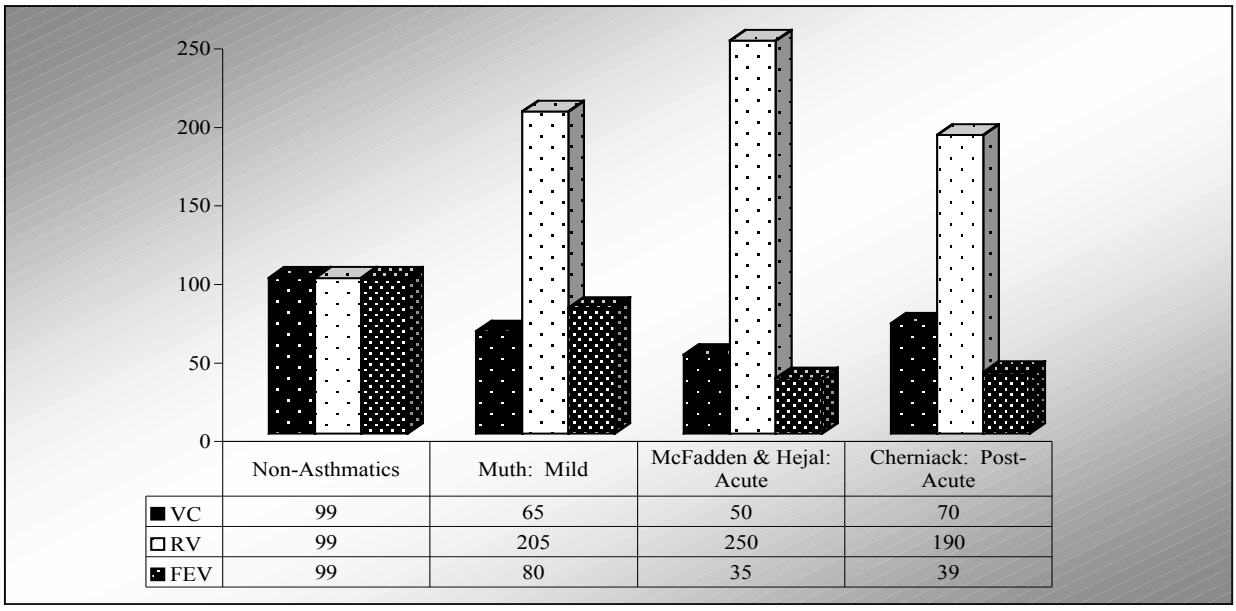
[33] Rik Gossilink, "Controlled Breathing and Dyspnea in Patients with Chronic Obstructive Pulmonary Disease (COPD)," *Journal of Rehabilitation Research and Development* 40, no. 5, supp. 2 (2003): 25.
[34] Muth, 366.
[35] E. R. McFadden, Jr. and Rana B. Hejal, "The Pathobiology of Acute Asthma," *Clinics in Chest Medicine* 21, no. 2 (2000): 216-7.

VC levels at 70% during an acute attack (Figure 2.2). Reduced airflow levels occurring during acute asthmatic episodes are of primary concern to the singer with asthma, due to the interrelationship between the lungs and the respiratory musculature. Physiological consequences resulting from severe airway obstructions include distention of the rib cage, through intercostal muscle contraction, and hyperinflation of the lungs, which subsequently flattens the diaphragm and reduces its capacity to create inhalatory pressure, directly leading to respiratory muscle fatigue.[36]



	Non-Asthmatics	Muth: Mild	McFadden & Hejal: Acute	Cherniack: Post-Acute
VC	99	65	50	70
RV	99	205	250	190
FEV	99	80	35	39

Figure 2.2
Average Percentages of Vital Capacity, Residual Volume, and Forced Expiratory Volume during Asthmatic Episodes
(Values shown represent averages of lung function in asthmatics suffering mild or acute asthmatic episodes. VC and FEV percentages are average airflow measurements from each asthmatic study. RV measurements are approximated based on VC averages from each study.)

Cherniak's study hypothesized that recurring acute asthmatic inflammation alters the airways of the lungs, subjecting them to long-term changes that further reduce functional measurements. Studies on the long-term effects of asthma on lung function values confirm that

[36] Reuben M. Cherniack, "Physiologic Diagnosis and Function in Asthma," *Clinics in Chest Medicine* 16, no. 4 (1995): 578-80.

FEV is greatly reduced over time. One long-term study, reported by Muth (2000), separated persons afflicted with childhood asthma into three groups: subjects with (1) FEV levels greater than or equal to 80% of normal; (2) FEV levels from 60% – 80%; and (3) FEV levels less than 60%. This study determined that FEV levels above 80% of normal are common for asthmatics (80%-89% of study participants demonstrated this level of lung function) under the age of 35. Over the next twenty years, FEV levels drop considerably, with approximately half remaining in the highest range of lung function (51%-63% of participants showed FEV levels above 80%), and increased percentages (37%-49% of participants showed FEV levels below 80%) in the lower two ranges of FEV (Figure 2.3), with approximately half of these subjects demonstrating FEV levels below 60%.[37]

Sears' study (2000) on the long-term effects of asthma confirmed these findings and attributed the differences in adults to their hindered growth of lung function due to the disease, confirming that children with asthma suffer increased severity of airway restriction with age. Sears' research showed FEV measurements ranging from 76% to 84% in adult asthmatics who had suffered from childhood asthma, compared to FEV measurements of 88% to 92% in adult asthmatics who were not diagnosed with the disease as children.[38]

A study by Barnes et al. (2002) examined long-term airway reductions in non-asthmatic and asthmatic subjects, determining that FEV declines with age in both groups. However, the findings of the study indicate that asthma is responsible for increased levels of lung-function deterioration, with average FEV levels of 88% for non-asthmatic individuals and 54% for

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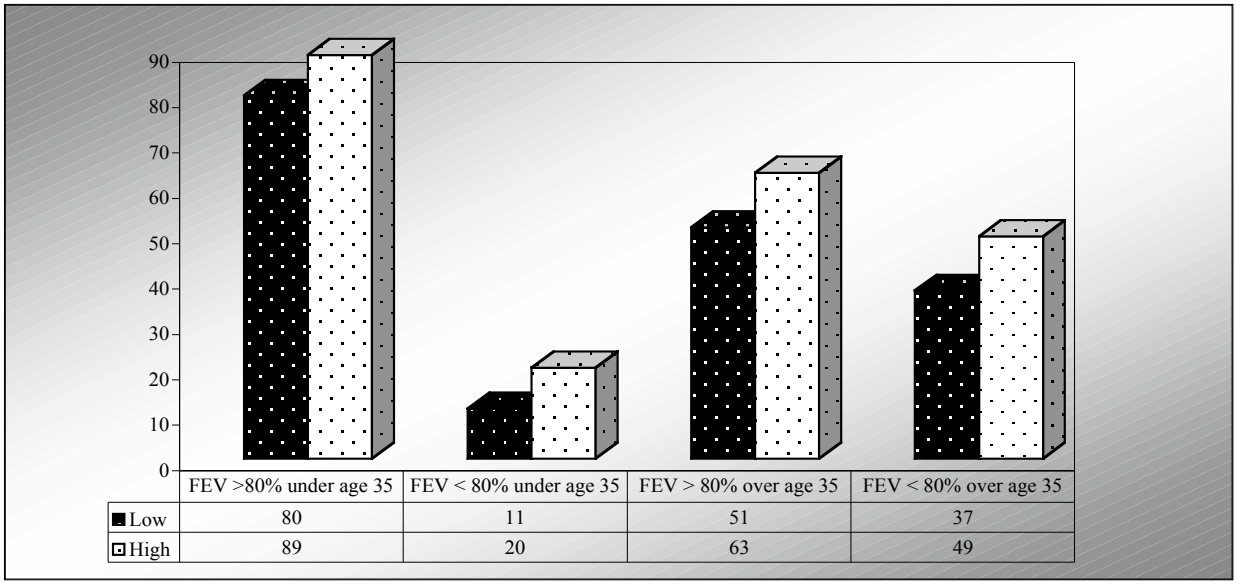
[37] Muth, 175.
[38] Malcolm R. Sears, "Consequences of Long-Term Inflammation: The Natural History of Asthma," *Clinics in Chest Medicine* 21, no. 2 (2000): 317-8.

asthmatics. The authors of the study attribute differences in pulmonary function to long-term asthmatic inflammation in all bronchial airways.[39]



	FEV >80% under age 35	FEV < 80% under age 35	FEV > 80% over age 35	FEV < 80% over age 35
Low	80	11	51	37
High	89	20	63	49

Figure 2.3
Changes in Forced Expiratory Volume Measurements in Asthmatics Due to Age
(Values shown represent a percentage range of expected lung-function measurement of asthmatics within specific age groups, demonstrating long-term progression of the disease.)

Allergic reactions and/or exercise are often responsible for the misdiagnosis of or failure to diagnose asthma in many individuals since disease symptoms occur only in the presence of specific triggers. Persons with allergy- or exercise-induced asthma may demonstrate statistically normal levels of lung function during periods when these specific triggers are not present, thus allowing the disease to be undiagnosed. Sears' study (2000) demonstrated a reduction of FEV in children with allergy-induced asthma, while also revealing differences in severity due to gender. Data from the study conclusively demonstrated reductions of lung function averaging 8% for males and 16% for females where allergic reactions were the specific cause (Figure 2.4), and also found that corrective medical treatment increased lung-function levels.[40]

[39] Barnes et al., 47.
[40] Sears, 321.

A study by Jackson (1984) demonstrates that exercise-induced asthma is characterized by a minimum 15% reduction of FEV following exercise (Figure 2.4). The study also shows reductions in FEV during exercise, following an initial period of pulmonary increase, confirming that airway constriction is related to pulmonary workload, with asthmatic symptoms appearing as respiration nears 80% of maximum. The study concludes that airway reduction due to exercise-induced asthma lasts from fifteen minutes to several hours,[41] which presents specific problems for singers who suffer from this form of the disease. The duration of asthmatic effects and the appearance of symptoms during exercise, of which singing is a form, can cause reductions in lung function and respiratory stamina that severely hinder the performance of the vocalist.

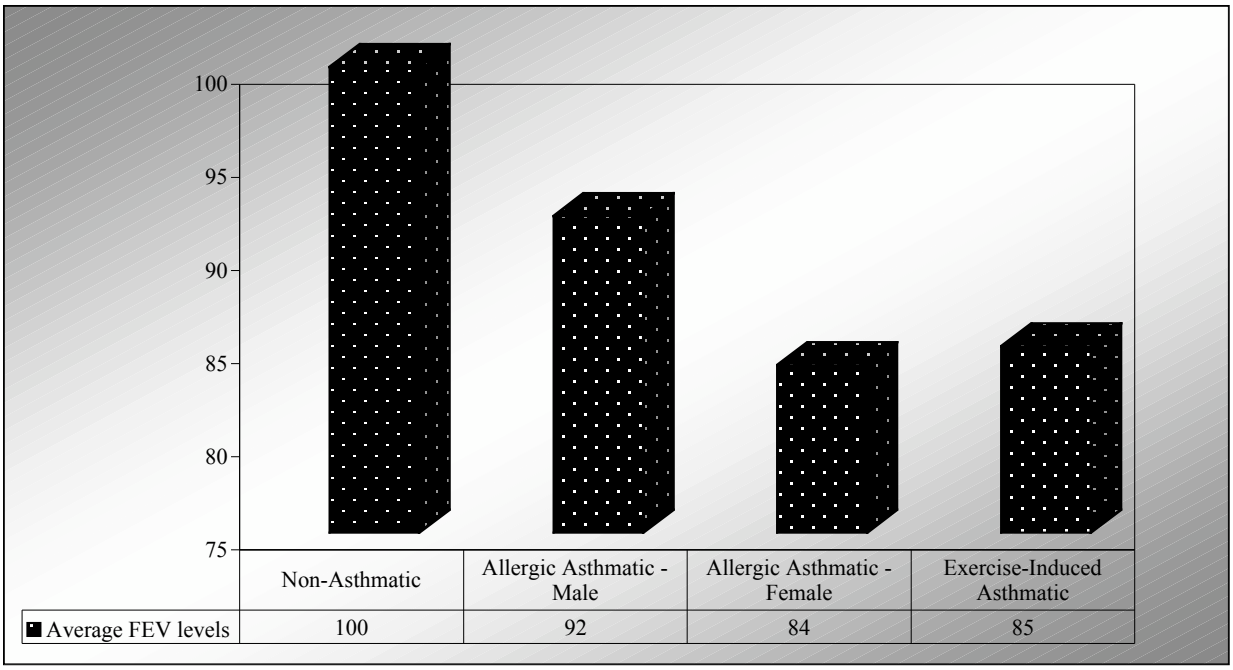


Figure 2.4
Forced Expiratory Volume Measurements in Allergy and Exercise-Induced Forms of Asthma
(Values shown illustrate average reductions of respiratory function based on gender and/or asthmatic trigger.)

[41] Jackson, 581-2.

EXPECTATIONS FOR THE SINGER WITH ASTHMA

For the singer, asthma presents specific issues due to the lung capacity restrictions associated with the disease. Spirometric readings (measurements of breath function) in asthma demonstrate chronic reductions of more than 10% for mild forms of asthma, while more severe forms decrease lung function by more than 20%. These base-line percentages conclusively identify levels of physiological function present without medication or symptoms of the disease. As demonstrated by studies on the lung function of singers, proper respiratory training enhances these measurements, allowing the singer with asthma to attain normal levels of lung function. However, the positive effects of respiratory training on VC, FEV, and RV will vary with the severity of the disease, the asthmatic trigger or triggers involved, and their influence on the pulmonary workload of the individual.

Acute asthmatic reactions caused by allergies, exercise, or climate are particularly insidious for the singer with asthma. Allergies increase mucus levels in the lungs, causing a reduction in vital capacity of more than 8%. Exercise-induced asthma, as noted previously, reduces lung function by more than 15% and is often "triggered" by singing. However, in persons whose primary cause of asthma is exercise, allergic triggers are generally not present.

Where allergy is the primary cause of asthma, 90% of individuals are also susceptible to exercise-induced asthma, suffering asthmatic symptoms and the subsequent reductions of lung function that result from allergic reactions, exercise, or both. Moreover, because lung-function levels in these individuals are reduced through allergic reaction, these individuals may also demonstrate reduced respiratory efficiency during exercise or singing, even when allergens are *not* present. Therefore, when allergic reactions and exercise triggers for asthma are combined, the asthmatic suffers even greater levels of airflow reduction than evidenced from either

individual trigger. Climate conditions, which can further exacerbate asthmatic inflammation caused by exercise or the introduction of allergens, will be discussed further in chapter three.

Each of these acute asthmatic triggers is capable of causing airway inflammation that significantly reduces lung-function levels in the singer, with corresponding increases of residual volume that contribute to lung hyperinflation, distention of the rib cage, and diaphragmatic fatigue.[42] Comparing lung-function measurements from both vocal-pedagogy and asthma studies, statistics show a broad difference in VC measurements between the professional singer and the asthmatic, demonstrating the potential reduction of airflow in the singer with asthma and why the condition is problematic to vocal production (Figure 2.5).

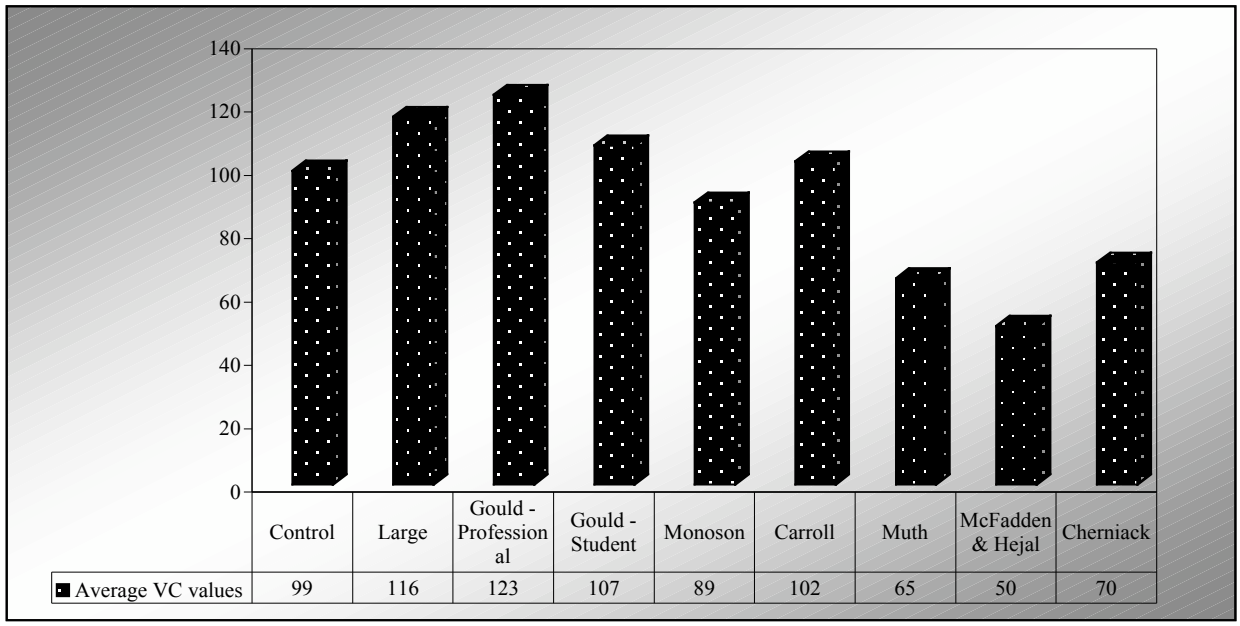


Figure 2.5
Comparison of Vital Capacity Measurements for Singers and Asthmatics
(Vocal studies: Large, Gould, Monoson, Carroll; Asthmatic studies: Muth, McFadden & Hejal, Cherniack; Values represent average lung-function measurements within each study, showing a possible range of expected differences in pulmonary efficiency for the singer with asthma.)

[42] Malcolm R. Sears, "Consequences of Long-Term Inflammation: The Natural History of Asthma," *Clinics in Chest Medicine* 21, no. 2 (2000), 315.

CHAPTER 3

PHYSICAL FITNESS FOR THE SINGER WITH ASTHMA

Good physical health, muscular coordination, and postural balance are vitally important to the act of singing. Singers who suffer from an illness or who fail to maintain appropriate levels of muscle tone and respiratory endurance experience a loss of control over the voice, and they typically compensate through the use of inappropriate muscle groups that contribute to vocal dysfunction.[43] Physical fitness improves respiratory function without tiring the voice; therefore, exercises that enhance the physical attributes of the asthmatic singer's body should be practiced apart from singing.[44] While individual preferences differ in regard to specific exercise regimens, regular physical activity is highly recommended.[45] The type, duration, frequency, and strenuousness of physical activity, however, require careful selection.

Large and Patton (1981) studied the effects of two fitness regimens, weight training and jogging, on general health and vocal attributes. This study demonstrated increased vital-capacity measurements in the jogging group, as well as enhanced vocal power and duration in the weight-training group. Participants in both groups increased their ability to sing longer phrases and to sing more notes in less time,[46] demonstrating conclusively the value of exercise for the singer.

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[43] Robert Thayer Sataloff, Alice G. Brandfonbrener, and Richard J. Lederman, eds., *Textbook of Performing Arts Medicine* (New York: Raven Press, 1991), 239.
[44] Victor Alexander Fields, *Training the Singing Voice: An Analysis of the Working Concepts Contained in Recent Contributions to Vocal Pedagogy* (New York: King's Crown Press, 1947), 82.
[45] Doscher, 255.
[46] John Large and Robert Patton, "The Effects of Weight Training and Aerobic Exercise on Singers," *Journal of Research in Singing* 4, no. 2 (1981): 23-31.

EXERCISE AND OTHER TRIGGERS OF ASTHMA

Exercise has been associated with the onset of asthmatic symptoms for centuries, having been recorded as early as the second century A. D. by Aretaeus the Cappadocian.[47] When exercise adversely affects the pulmonary systems of persons with asthma, the condition is commonly referred to as exercise-induced asthma (EIA). Studies of lung function during exercise show that there is some improvement during the beginning stages of strenuous activity.[48] As the exercise period progresses, however, lung function deteriorates and continues to drop for five to ten minutes after the conclusion of the activity, with normal lung function returning only over an extended time period.[49]

When performing, singers exhibit increased respiratory levels similar to those of athletes, making singers with asthma susceptible to the same airway constriction associated with other forms of exercise.[50] The effects of asthma on the respiratory system can be extremely detrimental to vocal quality and potentially damaging to the voice. Vocal strain, fatigue, range limitations, and vocal-fold lesions can be linked to manifestations of reduced airflow due to asthma.[51] Due to the possibility of asthmatic episodes being caused by singing, methods of physical training that reduce the severity of disease symptoms and enhance respiratory capabilities should be of considerable benefit to the singer with asthma.

Studies demonstrate that increases in pulmonary fitness reduce airway sensitivity to asthmatic triggers.[52] Due to the variety of triggers that can cause asthmatic reactions during exercise--including temperature, humidity, and heightened levels of airflow--the singer with

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[47] Roger M. Katz, "Asthma and Sports," *Annals of Allergy* 51 (August 1983): 154.
[48] Barnes et al., 421.
[49] Katz, 154-5
[50] Cohn et al., 332.
[51] Cohn, 51.
[52] Hogshead and Couzens, 20.

asthma must carefully evaluate physical activities for maximum effect with minimal possibility of asthmatic exacerbation.

RECOMMENDED FITNESS ACTIVITIES FOR SINGERS WITH ASTHMA

A comparison of recommended exercises from the sources listed in chapter one suggests that aerobic forms of exercise--activities requiring higher heart rates for periods of at least twenty minutes--are considered the most beneficial to both healthy singers and singers with asthma. It is universally accepted that fitness activities improve general health and provide enhanced levels of cardio-vascular fitness, vocal stamina, power and agility.[53] For singers with asthma, exercise provides the additional benefits of increased measurements of vital capacity and forced expiratory volume, and reduced symptomatic inflammation of respiratory passageways.[54]

Swimming

The following chart (Table 3.1) provides a concise overview of the sources consulted for this component of the study, ranking the physical activities by frequency, recommendation, and benefit. Of these, swimming is most highly recommended through its utilization of a majority of muscle groups in the body, while causing minimal impact on joints and connective tissue. The additional advantages to asthmatics are its focus on enhancing the strength and flexibility of the breathing muscles as well as the warm, humid environment of the indoor pool.

Nasal congestion and water retention within the inner ear that are associated with swimming are issues of general concern to singers and can be avoided by using nose and ear plugs and limiting submersion of the head. For singers with asthmatic sensitivities to chlorine

[53] Large and Patton, 23-31.
[54] Hogshead and Couzens, 12-4.

and other chemical purification methods, swimming in natural bodies of water or in pools that utilize alternative purification regimens provides training benefits with minimal asthmatic risk.

Table 3.1
Frequency of Recommended Fitness Activities

Activity	Bunch	Miller	Vennard	Ware	Firshein	Hogshead/Couzens	Katz	Advantages	Disadvantages	Modifications
Swimming	X	X		X	X	X	X	uses major muscle groups; minimal impact on joints; enhances respiratory strength; warm, humid environment	nasal congestion; water retention in the inner ear; allergies to chlorine and other water purifiers	use of nose and ear plugs; limited submersion; swimming in natural bodies of water
Running/Jogging	X	X		X		X	*	reduces body fat and weight; increases lung function; improves vocal performance parameters	exacerbates asthma through mucosal drying, as well as weather and atmospheric conditions inflaming lung tissues	*sprinting utilizes short duration and intense respiration; walking/jogging provides short intense periods and durational benefits
Walking	X			X	X	X		minimal asthmatic risk due to intensity and atmospheric factors; longer exercise duration	cold, dry weather and pollution create minimal asthmatic risk	breathing over specific time intervals enhances pulmonary system; nose breathing reduces asthmatic possibilities
Weight Training	X	X		X			X	improves vocal performance parameters; brief, intense exercise periods; minimal asthmatic risk	may damage vocal folds; minimal pulmonary enhancement; asthmatic hyperinflation of the lungs; negation of diaphragmatic strength	provide greater aerobic possibilities; reduced amounts of weight decrease pressure on vocal folds and lungs
Cycling				X	X	X		reduces body fat and weight; increases lung function; improves vocal performance parameters; variety of exercise intensity	exacerbates asthma through mucosal drying and weather and atmospheric conditions inflaming lung tissues	lower exercise intensity, masks, and stationary bicycles reduce asthmatic risks
Aerobic Dance	X	X	X					low impact; improves cardio-vascular fitness; improved respiratory muscle strength; enhancement of posture	sensitivity to indoor allergens and dry atmosphere may exacerbate asthma	
Racquet Sports	X	X						muscular coordination; brief, intense exertion with sufficient exercise duration provides physical conditioning	air pollution and humidity levels may cause asthmatic inflammation; grunting can injure vocal folds	indoor racquet sports can alleviate air pollution concerns
Cross-Country Skiing				X	X			uses major muscle groups; minimal impact on joints; enhances respiratory strength	cold, dry weather exacerbates asthma, increasing airway constriction	use of indoor skiing machine

Running/Jogging

Running and jogging are equally recommended for significantly reducing body fat and weight while increasing spirometric measurements of vital capacity. However, given the high probability of asthmatic exacerbation, respiratory requirements over distance, and mucosal drying, as well as weather and atmospheric conditions that may contribute to inflammation of the lung tissues, these activities should be modified for the singer with asthma. Sprinting, a modification recommended for the asthmatic by Katz, utilizes intense respiratory episodes of short duration.[55] Activities such as this provide brief, intense periods of exercise that increase fitness levels, yet create minimal risk of asthmatic exacerbation.

The combination of jogging and walking may provide a still greater fitness benefit, yielding an exercise of significant duration with incremental periods of pulmonary intensity. While jogging intervals of two to five minutes are optimal for training purposes, periods of walking should be longer in duration, allowing the heart rate and respiration levels to drop, thereby reducing the risk of exercise-induced asthma. As fitness levels increase, increments of each exercise may be altered to accommodate heightened exercise capacity.

Walking

Hippocrates once said that walking is man's best medicine because it improves aerobic capacity, produces extremely low levels of stress on the joints, muscles, and tendons, and helps control weight.[56] Walking is an effective way to get regular exercise with little chance of injury: it requires no special equipment and provides significant benefits to the singer with asthma, as its reduced pulmonary requirements present minimal risk of asthmatic exacerbation. Varying the

[55] Katz, 154-5.
[56] Hogshead and Couzens, 188.

levels of exercise intensity provides effective fitness enhancement by elevating the heart rate, thus strengthening the pulmonary system.[57] Of significant benefit to the singer with asthma is the ability to exercise for longer periods of time at optimal fitness intensities without the risk of respiratory stress.

Air pollution, airborne allergens, and humidity levels that pose the greatest risk to the asthmatic can be avoided by utilizing indoor treadmills or by wearing masks while exercising outdoors. Climate changes while walking seldom create severe issues of asthmatic inflammation; however, inhaling through the nose is recommended during cold, dry weather to reduce the probability of asthmatic complication.[58] Additionally, timed breathing cycles (e.g., inhaling for five counts and exhaling for five counts) can benefit the lungs, as this variation is capable of increasing respiratory function and muscle strength while reducing airway sensitivity to asthmatic triggers.

Weight Training

Weight training is an exercise form capable of enhancing the singer's range, power, duration, agility, and expiratory levels, and it is recommended in both vocal pedagogy and asthma research. Demonstrated increases in forced expiratory volume have been linked to weight training, producing greater power while singing. As an exercise for the asthmatic, weight training requires brief, intense periods of exercise, which is beneficial for minimizing the risk of exercise-induced bronchospasm, while it simultaneously strengthens the expiratory musculature and increases respiratory muscle coordination.

[57] Ibid., 188-9.
[58] Hogshead and Couzens, 80.

These positive aspects must be balanced with caution for the singer with asthma, as specific concerns arise when utilizing weight training for enhancing fitness levels. For singers in general, weight training can be detrimental to the voice, as lifting heavy weights with the glottis closed heightens lung pressure and inadvertently strengthens the muscles of the neck, increasing the risk of permanent damage to the vocal folds. For singers with asthma, weight training is an *anaerobic* exercise, providing minimal effect in the enhancement of pulmonary function and the reduction of bronchial airway sensitivity. The associated hyperinflation of the rib cage, caused by increased pressure in the lungs, may be a concern for the singer with asthma, because isometric strengthening of the external intercostal muscles can negate the mechanical capabilities of the diaphragm and thus further reduce available airflow. Unless modified, the potential benefits of weight training may be outweighed by concerns of asthmatic exacerbation for the singer with asthma.

Modifications that provide for greater aerobic possibilities and utilize lesser amounts of weight may be necessary in adapting this form of exercise for the benefit of the singer with asthma. Increased aerobic possibilities may be achieved through weight circuit training, where major muscle groups are exercised in rapid succession. Weight training in this manner utilizes lesser amounts of weight but with greater repetition, thus providing significant muscle toning and moderate levels of aerobic activity while reducing risks to the larynx and rib cage of the singer.

Cycling

Cycling is recommended for improving cardiovascular fitness and reducing body fat and weight, while increasing the measurements of respiratory function. Diaphragmatic strengthening, due to relaxed expansion of the rib cage, is responsible for such pulmonary

enhancements. Additionally, cycling utilizes larger muscle groups, places minimal stress on the joints, and provides considerable variety in exercise intensity, as rest is possible without the cessation of activity. Alternating intense exercise with rest allows the body to adjust to the pulmonary workload and attain greater physical benefit. Through enhanced aerobic capacity, cycling can reduce lung hyperinflation and airway sensitivity, greatly benefiting a singer with asthma.

Asthmatic reactions to climatic conditions and atmospheric pollutants, however, can adversely affect a singer with asthma, particularly if the cyclist passes through different environmental conditions on a long ride.[59] Cycling in unhealthy air environments and at heightened intensity levels is linked to incidences of asthmatic symptoms, yet it can be effectively modified to reduce the possibility of asthmatic provocation. Reducing intensity levels, in addition to taking brief rest periods, assists in lowering the heart rate, diminishes the demands on the pulmonary system, and minimizes asthmatic risk. Finally, wearing masks or filtering devices while riding outdoors--or even riding a stationary bicycle indoors--may provide protection against asthmatic exacerbation due to changes in climate or atmospheric pollutants. With modifications such as these, cycling can be an enjoyable and varied form of exercise for the singer with asthma.

Aerobic Dance

Aerobic dance offers the singer with asthma a low-impact exercise program that improves cardiovascular fitness, strengthens the breathing muscles, decreases the sensitivity of the lungs to exercise, and enhances postural alignment. Conversely, common asthmatic responses to indoor allergens, humidity levels, and increased possibilities of exercise-induced

[59] Hogshead and Couzens, 206-7.

asthma can adversely affect the benefits of this type of physical activity, and should therefore be carefully evaluated by the individual before such a regimen is begun. Regardless of specific asthma triggering issues, aerobic dance also demonstrates excellent potential for the enhancement of lung function and the development of postural aspects that benefit the singer with asthma.

Racquet Sports

Racquet sports such as tennis, squash, and racquetball require utilization and coordination of the major muscles of the body, combined with strong pulmonary effort. These activities include brief, intense exercise periods of sufficient duration to benefit physical conditioning and are therefore ideal for the asthmatic. However, inhaling air pollutants and/or allergens during outdoor activities can contribute to airway inflammation, a circumstance that is problematic to the singer with asthma and should be taken into consideration.

Participation in indoor racquet sports--squash and racquetball--can provide significant benefit to the singer with asthma due to the reduced risk of airway inflammation from air pollutants, allergens, and insufficient humidity. Indoor activities allow the singer more control over environmental conditions, thereby providing greater fitness potential and removing asthmatic concerns attributable to outdoor atmospheric or climatic conditions.

Cross-Country Skiing

Cross-country skiing is yet another form of aerobic exercise that utilizes major muscle groups to enhance fitness levels and pulmonary parameters. This exercise also provides additional postural benefits to the singer through the coordinated use of the skeletal muscles.

Concerns about atmospheric conditions tend to negate cross-country skiing as an exercise choice by the singer with asthma. Climatic conditions during winter months--specifically those of cold, dry air--directly affect asthmatic inflammation and increase airway constriction as pulmonary demands heighten. High intensity levels and duration of exercise can further exacerbate asthmatic symptoms, making this activity ill suited to asthmatics.

A less problematic modification of this exercise utilizes a machine that simulates cross-country skiing in a controlled, indoor environment. This alteration can provide stable temperature and humidity levels capable of reducing asthmatic reactions to intense physical activity. Additional benefits can be obtained by humidifying the internal environment to reduce the risk of lung tissue dehydration, thus alleviating concerns of asthmatic inflammation.

Promoting greater levels of fitness and providing enhanced levels of vocal power, stamina, agility, and control to the singer with asthma are vitally important. Because physical fitness regimens require variety and consistency to be effective, each individual must also determine the exercise(s) that are both beneficial and personally enjoyable. The singer with asthma has many fitness options available, most of which can increase pulmonary measurements that enhance vocal performance, even as they minimize the risk and severity of asthmatic complications associated with exercise or allergens.

CHAPTER 4

RESPIRATORY TRAINING OF THE SINGER WITH ASTHMA

Breath function is vitally important to the singer, and most methods of breath management for singers use some combination of interactions between the diaphragmatic, intercostal, and abdominal muscles. Employing proper breathing during singing produces efficient, effective air movement into and out of the lungs. Terms such as *appoggio,*[60] *diaphragmatic-intercostal-abdominal breathing,* [61] and *middle-low torso breathing*[62] are common among vocal pedagogues, each describing a methodology of breathing where inspiration is a function of the diaphragm and the intercostal muscles and where controlled exhalation is accomplished by the external intercostals and abdominal musculature.

Vocal educators generally classify less efficient methods of breathing into four categories: (1) abdominal or belly breathing, (2) rib or costal breathing, (3) back breathing, and (4) upper chest or clavicular breathing.[63] This last method, clavicular breathing, requires raising the shoulders to increase the size of the chest cavity. Traditionally avoided by singers and vocal pedagogues, this breathing method creates tension in the throat, causes constriction of the larynx, and is inefficient as a means of controlling vital capacity. Studies show that a vast majority

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[60] Miller, 23.
[61] James C. McKinney, *The Diagnosis and Correction of Vocal Faults,* revised edition (Nashville: Genevox Music Group, 1994), 56.
[62] Clifton Ware, *Basics of Vocal Pedagogy: The Foundations and Process of Singing* (Boston: McGraw-Hill, 1997), 85.
[63] McKinney, 56-9; David, 25-6.

(86%-89%) of persons demonstrating functional dysphonia (impaired vibration of the vocal folds) employed a clavicular method of breathing.[64]

BREATHING STRATEGIES OF THE ASTHMATIC

Clavicular breathing, which uses the accessory muscles of the neck and upper chest to assist in the breathing process, is very common among asthmatics and can create severe phonatory issues. Elevation of the chest and shoulders during inhalation, typical of clavicular breathing, generates heightened muscular tension throughout the entire upper torso. Voice therapists report that breathing in this manner spreads tension throughout the throat, elicits constriction,[65] and potentially damages the vocal folds. Additionally, breathing clavicularly for extended periods of time can permanently distend the thoracic cage,[66] often resulting in the hunched posture common to the asthmatic.[67]

Permanent distention of the rib cage reduces the mechanical capabilities of the diaphragm, due to the shortening of its muscle fibers, and diminishes its ability to create negative pressure during inhalation.[68] Medical studies indicate that persons afflicted with asthma commonly lack the necessary respiratory muscle strength to overcome increased respiratory loads.[69] Breathing that is more vigorous, as in singing, requires the primary respiratory muscles to take active roles in the process. For the asthmatic, functional weaknesses in these muscles may result in incorrect mechanical coordination of the musculature, directly contributing to

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[64] David, 25-6.
[65] Ibid., 26.
[66] Paul Sorvino, *How to Become a Former Asthmatic* (New York: William Morrow and Company, Inc., 1985; Signet Books, 1986), 3-9.
[67] Firshein, 21-2.
[68] Paltiel Weiner et al., "Inspiratory Muscle Training in Patients with Bronchial Asthma," *Chest* 102, no. 5 (1992): 1358-9.
[69] Thomas H. Shaffer, Marla R. Wolfson, and Vinod K. Bhutani, "Respiratory Muscle Function, Assessment, and Training," *Physical Therapy* 61, no. 12 (1981): 1711-3.

asthmatic complications. For example, the flattening of the diaphragm may directly result in lung hyperinflation, permanently placing the rib cage in a raised position. This position increases muscular tension and further negates the ability of the diaphragm to provide inspiratory pressure, thus requiring the accessory muscles of the head, neck, and upper thorax to assist in inhalation. Lung hyperinflation is further exacerbated by this expiratory muscle weakness, reducing the lung's ability to exhale carbon dioxide and increasing its measurements of residual volume.

Breathing techniques common to modern vocal pedagogy can be severely compromised by the mechanical aspects of lung hyperinflation. Miller, in writing of the *appoggio* method of breathing, states:

> The sternum must initially find a moderately high position; this position is then retained throughout the inspiration-expiration cycle. Shoulders are relaxed, but the sternum never slumps. Because the ribs are attached to the sternum, sternal posture in part determines diaphragmatic position. If the sternum lowers, the ribs cannot maintain an expanded position….[70]

Brown writes of intercostal-diaphragmatic breathing in this way:

> [T]he diaphragm tends to exert a lateral pressure which assists in expanding the lower ribs…. Your rib cage is expanded by the external intercostal muscles and contracted by the internal intercostals. When your ribs expand, you have the greatest mechanical advantages to support phonation.[71]

Due to the physiological consequences of lung hyperinflation, the breathing process becomes exceedingly more complex for the singer with asthma. The concept of the raised sternum and expanded lower ribs--a methodology taught in most modern vocal studios--complicates the breathing process for the singer with asthma, as it can directly contribute to lung hyperinflation. Additional efforts to increase the size of the thorax in order to gain a mechanical

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[70] Richard Miller, *The Structure of Singing: System and Art in Vocal Technique* (New York: Schirmer Books, 1986), 24.
[71] O. Brown, 26-8.

advantage in phonation can create significantly increased levels of muscular dysfunction in the singer with asthma. The perceived increase of respiratory control is completely negated by the heightened workload--reducing airflow, increasing airway resistance, and potentially precipitating an asthmatic episode.

DIAPHRAGMATIC MUSCLE TRAINING

Respiratory training can enhance airway function levels and reduce lung hyperinflation in asthmatics. Exercise programs that re-train the respiratory musculature improve the physiological factors of pulmonary function, strength, endurance, and tolerance to exercise. Training of the diaphragm, similar to methodologies utilized in vocal training, is commonly recommended in subjects with respiratory or pulmonary dysfunction. Studies show that respiratory training exercises designed to increase the power curve of the diaphragm also increase lung pressure available for the phonatory process, resulting in increased strength and heightened endurance of all respiratory muscle groups.[72] Such increases in pulmonary efficiency enhance the mechanical capabilities of the respiratory muscles, improve the functional measurements of the pulmonary system and enhance the performance attributes of the singer.[73]

Respiratory muscle strength and endurance is decreased in singers with asthma due to the increased breathing workload caused by lung hyperinflation and the inefficient position of the diaphragm. Medical studies prove that respiratory muscle training is safe and effective in subjects with asthma.[74] These findings demonstrate that increasing respiratory fitness positively

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[72] Shaffer, Wolfson, and Bhutani, 1716-7.
[73] Stefanos Volianitis et al., "Inspiratory Muscle Training Improves Rowing Performance," *Medicine & Science in Sports & Exercise* 33, no. 5 (2001): 805-8.
[74] Paltiel Weiner et al., "Specific Inspiratory Muscle Training in Patients with Mild Asthma with High Consumption of Inhaled ß$_2$-Agonists," *Chest* 117, no. 3 (2000): 722-6.

affects pulmonary function levels,[75] reduces daily consumption of inhaled medication, significantly increases breathing comfort, and improves respiratory function regardless of gender and severity of the disease.[76]

BREATHING EXERCISES FOR THE SINGER WITH ASTHMA

Breathing exercises utilized for the reduction of asthmatic symptoms emphasize use of the diaphragm, keeping it fully involved throughout the breathing process. As the singer concentrates on the diaphragm during inhalation, the lungs expand fully, giving the sensation of a complete, relaxed breath.[77] Diaphragmatic breathing assists the asthmatic by improving chest-wall motion, oxygen distribution, breath-energy loss, and respiratory efficiency during exercise or singing. Additional benefits of diaphragmatic breathing are reductions of lung hyperinflation and respiratory rate, with subsequent correction of residual volume, tidal volume, and breathing efficiency.[78]

For over fifty years, yogic forms of inspiratory breath training have been used to treat subjects with asthma. Studies demonstrate that yogic breathing relaxes the muscles of the lungs and allows physiological changes that stabilize bronchial activity in the asthmatic.[79] Specifically, yogic breathing focuses on the proper mechanical function of the diaphragm, resulting in efficient oxygenation of the blood and maintenance of bodily function.[80]

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[75] Gavin Sturdy et al., "Feasibility of High-Intensity, Interval-Based Respiratory Muscle Training in COPD," *Chest* 123, no. 1 (2003): 142-9.
[76] Paltiel Weiner et al., "Influence of Gender and Inspiratory Muscle Training on the Perception of Dyspnea in Patients with Asthma," *Chest* 122, no. 1 (2002): 197-200.
[77] Hogshead and Couzens, 140.
[78] Gosselink, 28-30.
[79] R. Nagarathna and H. R. Nagendra, "Yoga for Bronchial Asthma: A Controlled Study," *British Medical Journal* 291 (October 1985): 1077-9.
[80] Barbara Brosnan, *Yoga for Handicapped People* (London: Souvenir Press, 1982), 43.

Diaphragmatic breathing exercises similar to those found in yoga are commonly utilized in the respiratory training of singers, making it is possible to determine regimens beneficial to the singer with asthma. Training methodologies that provide minimal benefit to, or negatively impact, the asthmatic condition are supplemented by modifications presented in the following discussion.

EVALUATION OF RESPIRATORY TRAINING EXERCISES

Respiratory training exercises are derived from the following sources:

Vocal Pedagogy:

Bunch, Meribeth and Cynthia Vaughn. *The Singing Book.* New York: W. W. Norton & Company, 2004.

McKinney, James C. *The Diagnosis and Correction of Vocal Faults: A Manual for Teachers of Singing and for Choir Directors*, revised ed. Nashville: Genevox Music Group, 1994.

Miller, Richard. *The Structure of Singing: System and Art in Vocal Technique.* New York: Schirmer Books, 1986.

Schmidt, Jan. *Basics of Singing,* 3d ed. New York: Schirmer Books, 1994.

Vennard, William. *Singing: The Mechanism and the Technic,* revised ed. New York: Carl Fischer, Inc., 1967.

Ware, Clifton. *Basics of Vocal Pedagogy: The Foundations and Process of Singing.* Boston: McGraw-Hill, 1998.

Asthmatic Respiratory Therapy:

Firshein, Richard N. *Reversing Asthma: Reduce Your Medications with this Revolutionary New Program.* New York: Warner Books, 1996.

Hogshead, Nancy and Gerald Secor Couzens. *Asthma and Exercise.* New York: Henry Holt and Company, 1990.

Sorvino, Paul. *How to Become a Former Asthmatic.* New York: William Morrow and Company, Inc., 1985; Signet Books, 1986.

Vocal pedagogy sources represent diverse ideologies in the respiratory training of the singer, while asthma-specific sources present medical and exercise physiological philosophies of non-pharmacological methods of disease treatment. Through the examination of individual breathing exercises from each source, their potential effectiveness in the respiratory training of the singer with asthma will be determined. Similar exercises are listed by pedagogical/training function and illustrated in Table 4.1 (p. 44). Respiratory exercises are numbered to indicate degree of difficulty and correspond with the appropriate training level of the singer. Exercise recommendations are as follows: Recommended for All Levels of Vocal Training (beginning students with 3 or fewer years of vocal training); Recommended for Intermediate to Advanced Level Students (students with 3 or more years of vocal training); Recommended for Advanced Level Students Only (students with 6 or more years of vocal training); and NOT Recommended. A listing of the exercises by pedagogical function and recommended training level is illustrated in Table 4.2 (p. 45). For the purposes of this study, exercises that utilize phonation are excluded from the discussion.

Existing research studies from the fields of vocal pedagogy and asthma respiratory therapy are essential in determining the appropriate number of years of study for each vocal training classification--beginning, intermediate, and advanced. A vocal pedagogy study by Gould and Okamura (1974) showed that respiratory capacity and consistency of muscle strength is highest in singers with more than six years of vocal training. The study also showed that singing students, whose training ranged from two to five years, showed increased respiratory capacity, but at lower levels than those of professional singers. Both groups demonstrated respiratory-function levels higher than the control group.[81] An asthma respiratory therapy study by Nagarathna and Nagendra (1985) showed that daily respiratory training, utilizing yogic deep

[81] Wilbur J. Gould and Hiroshi Okamura, "Respiratory Training of the Singer," *Folia Phoniatrica* 26 (1974): 277-9.

breathing methodologies, improved pulmonary-function measurements in asthmatics, but did not demonstrate consistent lung-function measurements for a period of 36 months.[82] These studies show that respiratory muscle strength and inhalatory consistency are enhanced through systematic respiratory training, and that the muscles involved in this process attain appropriate levels of strength and consistency over specific time frames.

Beginning Level Respiratory Exercises

In evaluating each respiratory exercise to determine its appropriate vocal training level, specific lung function criteria were used as a guideline, in combination with information from the previously listed studies. Beginning vocal students with asthma may have no previous respiratory training and may utilize compensatory breathing strategies--such as clavicular breathing--that are detrimental to phonatory quality and stamina, and present additional risk of disease exacerbation. These students are assumed to possess levels of respiratory muscle strength and coordination that permit performance of only the most basic respiratory training exercises. Appropriate exercises for beginning vocal students increase diaphragmatic usage, release tension in the external intercostals, reduce thoracic hyperinflation, strengthen the respiratory musculature, and enhance the muscular coordination of the breathing process.

Gould and Okamura's study, listed previously, showed that significant increases in lung function measurements occurred after approximately two years of vocal training. Singers with asthma, however, may require additional time in which to train the musculature, due to inadequate respiratory muscle-strength levels and the essential re-training of inappropriate compensatory breathing strategies associated with the disease. For the beginning singer with asthma, appropriate levels of respiratory muscle strength, coordination, and consistency should

[82] Nagarathna and Nagendra, 1078.

be possible after three years of daily respiratory training utilizing the most basic respiratory exercises. Some students may attempt to move too quickly through the beginning, as well as subsequent, levels of respiratory training. Caution is advised in this regard, as improper changes to the respiratory training regimen may result in phonatory problems that include loss of vocal quality and stamina, hoarseness, and utilization of accessory muscle groups, all of which can, given sufficient time, cause more severe laryngeal issues. As all individuals progress at different rates, it remains the responsibility of the teacher to care for the student's voice by ensuring that a proper respiratory training regimen is established and continued. Any modifications to the course of training must be carefully considered for the singer with asthma.

Intermediate Level Respiratory Exercises

An intermediate level of vocal study provides respiratory training exercises designed to specifically enhance the functional capabilities of the lungs and further assist in the development of the singing voice. Intermediate level respiratory exercises for singers with asthma--singers having studied between three and six years--should not be attempted until the basic concepts of diaphragmatic breathing have been mastered at the beginning level of training and appropriate levels of respiratory muscle strength and coordination have been established. Intermediate level respiratory exercises further enhance muscle strength, stamina, and coordination of the diaphragm and intercostal muscle groups. Exercises that increase expiratory muscle strength and expiratory duration--respiratory tasks accomplished by the abdominal muscles--are necessary for enhancing phonatory breath support and continuing the vocal progress of the singer with asthma. Care must observed with the application of expiratory training exercises, as their improper performance can lead to lung hyperinflation, respiratory muscle fatigue, and collapse of the

diaphragm. Utilization of the recommended exercise modifications will help to alleviate these potential problems and provide respiratory exercises that enhance the capabilities of the singing voice and reduce the risk of asthmatic inflammation for the singer with the disease.

Advanced Level Respiratory Exercises

Respiratory exercises for advanced level singers with asthma--singers having more than six years of study--require respiratory muscle forces that exhibit high levels of muscular strength, duration, and consistency. Singers at an advanced training level demonstrate the capabilities to perform vocal literature that requires continuous muscular support with minimal opportunity for rest. The rapid inhalation of air, extremes of range and dynamics, extended phrase lengths, and long periods of required vocal control (e.g.: major operatic roles) place strenuous demands on the respiratory musculature. Advanced level exercises enhance the singer's ability to perform properly under such physically demanding circumstances, and can quickly fatigue respiratory muscle groups if the level of respiratory training is insufficient for the vocal tasks. Advanced respiratory exercises, therefore, should be utilized only by singers demonstrating substantive levels of vocal training, consistency, and respiratory muscle strength.

Appropriateness of individual exercises should be considered on a case-by-case basis through consultation and agreement of both the vocal instructor and the student. Respiratory muscle strengthening requires daily practice to acquire the most significant benefit. As individuals vary, so will the time frame necessary to obtain the desired respiratory benefit from each individual exercise. Caution is warranted for the singer with asthma, as an improper training regimen can adversely affect the quality, range, and longevity of the voice. The author's recommendations in assigning exercises to specific training levels are intended solely to assist

vocal instructors in safely selecting respiratory exercises appropriate for the majority of singers with asthma.

EXERCISES FOR BASIC DIAPHRAGMATIC FUNCTION (BDF)

Recommended for All Levels of Vocal Training

Exercise BDF-1

> Imagine you have a large tube from your mouth to your lower abdomen that forms a channel for your air. This tube does not change shape during the breathing process and nothing in the upper chest is disturbed. There is no gasping and no noise comes from the mouth or throat and no extra movement of the shoulders or chest. Any visible action of breathing is seen in the lower abdomen and the lower ribs at the back.[83]

This exercise teaches proper coordination of the respiratory muscles, emphasizing diaphragmatic breathing to improve chest-wall motion, oxygen distribution, breath-energy loss and respiratory efficiency. Performed in a variety of positions--sitting, standing or leaning--this visualization of the breathing process slows the respiratory cycle, strengthening the diaphragm and intercostal muscles while relaxing the throat and chest.

Exercise BDF-2

> Pretend you are smelling a flower, even to the point of raising your hand to your nose; notice how the breath enters your body slowly and easily without any conscious effort on your part and how deep the breath goes.

Exercise BDF-3

> Pretend you are beginning a yawn, but do not actually go into a full yawn. Notice how your lower jaw drops free in its socket, notice the gently lifting feeling in the area of your soft palate, notice that your throat feels deeper, notice the cool air moving easily through your throat, notice how deep in the body your breath goes without any effort.

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[83] Meribeth Bunch and Cynthia Vaughn, *The Singing Book* (New York: W. W. Norton & Company, 2004), 9. (This exercise is identified in Bunch and Vaughn as "Deep Breathing").

Table 4.1
Frequency of Respiratory Exercises by Pedagogical Function
(Exercise numbers are assigned for purposes of this study)

Function	Basic Diaphragmatic Function	Strengthen the Diaphragm and Intercostals	Timed Respiratory Cycles	Increase Expiratory Duration	Respiratory Muscle Coordination (Panting)	Expiratory Pulsing	Expiratory Muscle Strengthening	Enhance Lower Back Expansion
Vocal Pedagogy								
Bunch	BDF-1							
McKinney	BDF-2, 3, 4, 5			IED-1			EMS-3	
Miller	BDF-6	SDI-4	TR-3	IED-3	RMC-2, 6	EP-1, 2		
Schmidt					RMC-1			
Vennard	BDF-7, 13		TR-4	IED-2	RMC-5			
Ware	BDF-8		TR-5		RMC-3, 4		EMS-4, 5	LBE-1, 2
Asthmatic Respiratory Therapy								
Firshein	BDF-9, 12, 14, 16	SDI-5, 6	TR-1				EMS-6	
Hogshead/Couzens	BDF-10, 15	SDI-1, 2, 3	TR-6					
Sorvino	BDF-11		TR-2				EMS-1, 2, 7	

Exercise BDF-4

> Pretend that you are drinking a glass of water, raising your hand to your mouth; observe how easily the jaw drops open, how deep and spacious the throat seems, the lifting of the soft palate. If you breathe in this position, the breath will enter the body easily and noiselessly, and will go deep without any effort.[84]

Each of these previous exercises provides an excellent benefit to the singer with asthma, as their primary purpose is to teach proper diaphragmatic contraction. Diaphragmatic forms of

[84] McKinney, 49.

Table 4.2
Respiratory Exercise Recommendations
(Exercises are ordered to reflect difficulty and recommended individual vocal training levels.)

Respiratory Exercise Recommendations for Singers with Asthma	Basic Diaphragmatic Function	Strengthen the Diaphragm and Intercostals	Timed Respiratory Cycles	Increase Expiratory Duration	Respiratory Muscle Coordination (Panting)	Expiratory Pulsing	Expiratory Muscle Strengthening	Enhance Lower Back Expansion
Recommended for All Levels of Vocal Training	BDF- 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	SDI- 1, 2	TR- 1, 2		RMC- 1			LBE- 1
Recommended for Intermediate to Advanced Level Students	BDF- 12	SDI- 3	TR- 3, 4, 5	IED- 1, 2	RMC- 2, 3, 4		EMS- 1, 2	LBE- 2
Recommended for Advanced Level Students Only	BDF- 13, 14, 15	SDI- 4, 5, 6	TR- 6	IED- 3	RMC- 5	EP- 1, 2	EMS- 3, 4, 5, 6, 7	
NOT Recommended	BDF-16				RMC- 6			

breathing are common in the rehabilitation of asthma, as they increase inspiratory muscle strength, reduce lung hyperinflation, and diminish contraction of accessory respiratory muscles.

Additional benefits of this type of exercise include reduced severity of asthmatic symptoms and diminished need for asthma medications, resulting in increased lung-function measurements and improved respiratory efficiency for the singer with asthma.[85]

[85] Weiner et al., 200.

Exercise BDF-5

> Place your hands on your back in such a way that they touch the lowest ribs and the area just below them. Breathe in as if you are smelling a rose; you should feel some expansion beneath your hands. Now place your hands on your sides in such a way that they rest on the lowest ribs and the part of the abdomen just below them. Smell another rose; you should feel some expansion under your hands. Now place your hands on your upper abdomen with your thumbs touching the lowest ribs, your little fingers near your waistline, and your middle fingers touching each other. You should feel more expansion here than in the back and sides.[86]

This exercise is similar to the three previous ones in teaching proper coordination of the respiratory muscles, particularly in its encouragement of the full descent of the diaphragm, which is extremely important to both the singer and the asthmatic. Diaphragmatic breathing improves chest-wall motion, oxygen distribution, breath-energy loss, and respiratory performance. Additional benefits include reduction of lung hyperinflation and respiratory rate, with subsequent correction of residual volume, tidal volume, and breathing efficiency. This exercise should provide great benefit to vocal training of the singer with asthma and reduce asthmatic symptoms.

Exercise BDF-6

> Recline on a flat surface. Be certain the head is not tilted backward with elevated chin (head and shoulders should be in line). Usually, depending on how the head sits naturally on the shoulders, it will be necessary to place a book under the head to avoid backward tilting. Breathe quietly through parted lips, the flat hand bridging the epigastric and umbilical regions (the area between the navel and the sternum). Observe that the epigastric-umbilical area moves outward but that the lower abdomen (hypogastric, or pubic area) does not, unless purposely pushed outward. (For a moment, move out the lower abdominal wall; notice the inward collapse of the rib cage when one thrusts out the lower abdomen. The falseness of low abdominal distention as a part of inhalation will be apparent at once.) The chest neither rises nor falls during the breathe cycle (or only slightly), because of the postural alignment of the body in this expulsion. Maintaining this relationship of head, neck, and shoulders, rise to a "noble" standing position. Although the diaphragm is not in exactly the same position in standing and lying, the axial alignment of the body is similar in both positions.[87]

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[86] Ibid., 49-50.
[87] Miller, 30. (This exercise is identified in Miller as "Exercise 2.2")

This exercise is excellent for the singer with asthma, as it promotes relaxed usage of the diaphragm. The singer with asthma must be careful not to crowd the lungs with breath or utilize accessory inspiratory muscles throughout this exercise. The risk of asthmatic inflammation from this exercise is minimal, and the singer with asthma will find this exercise effective as the diaphragmatic action promoted is beneficial in reducing lung hyperinflation and helpful in restoring the mechanical advantage of the diaphragm.

Exercise BDF-7

> One simple exercise for developing the right coordination is performed while lying flat on the back on some rigid surface, like the floor or a table. A weight, such as a few large books, is placed on the abdomen near the ribs. When the person inhales, he should raise the weight, and when he exhales, the weight should go down. It is good psychology to imagine that the pressure of the weight expels the breath, and that the only muscular action is for inhalation.[88]

Similar to previous exercises, this exercise promotes usage of the diaphragm in a relaxed manner. The only caution is that the singer with asthma must be careful not to crowd the lungs with breath or utilize accessory inspiratory muscles throughout this exercise. Due to a lack of resistance, the risks of asthmatic inflammation from this exercise are minimal and the singer with asthma will find this exercise beneficial in reducing lung hyperinflation and helpful in restoring the mechanical advantage of the diaphragm.

Exercise BDF-8

> Lie flat on the floor on your back and place both open hands over your entire abdominal area. Breathe in and out in a slow, relaxed manner, observing the rise and fall of your abdominal area with each breath you take. Continue the exercise with the addition of a weight (such as a large book) placed on the upper abdominal (epigastrium) area. Next, try lying on your stomach while breathing slowly and deeply.[89]

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[88] Vennard, 29. (This exercise is identified in Vennard as a "Belly Breathing Exercise").
[89] Ware, 87. (This exercise is identified in Ware as "Exercise 5-2 Lying Flat")

This exercise is virtually identical to example BDF-6, promoting correct function of the diaphragm during inhalation. This version of the exercise contains a variation of lying on the stomach, a modification that may prove highly beneficial in extending diaphragmatic usage into the lower back area, potentially deepening diaphragmatic contraction and increasing its strength through enhanced respiratory mechanics.

Exercise BDF-9

> Sit in a comfortable chair. Let your whole body relax. Place both hands palms down on your sides so that the index fingers of your hands are up against the lower ribs in the front, and your thumbs are in the back. Feel your hands move forward as you inhale, and return to their original position when you exhale.[90]

This exercise is beneficial to the asthmatic in training the diaphragm and relaxing the thoracic musculature. The relaxed usage of the respiratory musculature reduces lung hyperinflation and helps restore the natural mechanical motion of the diaphragm. Due to minimal risk of asthmatic inflammation associated with this exercise, significant benefit is provided to the singer with asthma.

Exercise BDF-10

> The easiest way to practice diaphragmatic breathing is to sit, stand, or lie on your back and hold the palm of your hand against your stomach between your navel and rib cage. Breathe in deeply. If you are using your diaphragm to breathe, your stomach will push out against your hand. Now, exhale, and you should be able to feel your stomach go down as your hand moves in toward your stomach.[91]

Similar to many previous versions, this exercise promotes proper diaphragmatic function with a minimum of physical and asthmatic risks, making it desirable in the respiratory training of the singer with asthma.

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[90] Ibid., 254-5. (These exercises are identified in Firshein as "Simple Belly Breathing").
[91] Hogshead and Couzens, 141.

Exercise BDF-11

> The first part of the exercise is done lying comfortably on your back. Once in this position, place your hands at your sides at the bottom of your rib cage, thumbs pointed downward, fingers up. Start to take an easy breath with your mouth closed. Do this while mentally counting to four. As your progress you should begin to feel some pressure of the incoming air on your hands. Don't let the sternum rise while you are breathing. Exhale. Relax.[92]

This exercise, like those that precede it, emphasizes basic diaphragmatic utilization in breathing, benefiting the asthmatic through improved respiratory muscular coordination, reduced crowding of the rib cage, and increased respiratory effectiveness. Performing the exercise in a lying position provides for relaxation of the spine and other skeletal postural muscles, allowing the asthmatic to easily monitor the consistency of the breath cycle. Breathing with the mouth closed, especially in cold, dry environments, is beneficial to the singer with asthma, as air inhaled through the nose is warmed and humidified, minimizing the risk of asthmatic exacerbation.

<u>Recommended for Intermediate to Advanced Level Students</u>

Exercise BDF-12

> Lie down on a mat or blanket on the floor, so that you feel comfortable. Keep your legs slightly apart. Place a hardcover book on your stomach, with the binding just touching the bottom curve of your ribcage. Breathe in through your nose, unless you find it difficult to do so because of a cold or chronic sinusitis. Yet, while breathing through your nose, imagine that you are actually drawing air in from the back of your throat, not just your nostrils…. As you inhale, try to lift the book as high as you can with your stomach muscles. At the same time, try to keep your chest muscles relaxed and motionless. Imagine that you are filling your belly with oxygen, which is then flowing from your stomach up through your chest. Your chest will expand somewhat toward the end of your inhalation. As you exhale, use the same belly muscles to squeeze every last drop of air out of you lungs. Your exhalation should be longer than your inhalation. As you try to

[92] Paul Sorvino, *How To Become a Former Asthmatic* (New York: William Morrow and Company, Inc., 1985; Signet Books, 1986), 14-17.

> completely and fully contract your diaphragm muscles and push air out, the book will lower. When you've nearly reached the end of your breath, begin to hum.[93]

This diaphragmatic exercise contains many elements similar to those that precede it, and now adds the element of humming at the end of the respiratory cycle. As the primary purpose of the exercise is to develop proper respiratory function, its phonatory element does not automatically negate it from the study; however, humming at the end phase of expiration can cause tension in the neck and laryngeal muscles, resulting in improper vibration of the vocal folds. Consequently, this final aspect of the exercise should be excluded for the singer with asthma.

Recommended for Advanced Level Students Only

Exercise BDF-13

> Another exercise, similar to one [previously] described, but much more strenuous, requires the use of a small object about the size and shape of a pint milk bottle. Hold the object against the "breathing muscle," between the ribs, and lean so that the other end of the object presses against a wall. Stand on tiptoe, with feet far enough back so that a good deal of weight is converted into pressure on the epigastrium. Release the breath, but do not exhale abdominally; rather, let the bottle, or whatever is being used, expel the air by pushing in below the ribs. Inhale, pushing the weight of the body away from the wall.[94]

This exercise may be problematic for the singer with asthma due to the amount of lung pressure required. As respiratory muscle strength is reduced by disease, the singer with asthma is forced to utilize accessory muscles to create sufficient phonatory pressure within the lungs. Of additional concern are gravitational forces that may exceed the resistance capabilities of weakened or fatigued abdominal musculature. Exercises such as this can cause the asthmatic to employ muscles of the head, neck, and upper chest, causing the vocal folds to adduct with

[93] Firshein, 252-3. (This exercise is identified in Firshein as "Getting to Know Your Belly").
[94] Ibid., 29. (This exercise is identified in Vennard as a "Belly Breathing Exercise").

excessive force. This sequence of events/scenario presents a significant risk for the singer with asthma: Vocal folds could be damaged due to inefficient muscular tension and increased pressure within the thoracic cavity.

Exercise BDF-14

> Lie on your back as above. Swing your knees to your chest as you inhale, and then lower them back to the starting position when you exhale.

This exercise is beneficial in developing diaphragmatic muscle strength, particularly in the lower back. Raising the knees while inhaling promotes deep respiration, while lowering the knees during exhalation assists in developing the abdominal muscles, benefiting both breath and postural aspects of singing. Fatigue of the back muscles, due to improper muscle tone or previous injury, may occur with this exercise variation; therefore, caution is recommended during its performance.

Exercise BDF-15

> A variation on the diaphragmatic breathing exercise is to lie on your back and place about five pounds of weights on your diaphragm. A five-pound barbell plate, a bag of rice, a few books, or two bricks will do nicely. Suck in deeply with your diaphragm and exhale slowly as before. Repeat the exercise ten to twenty times.[95]

The amount of resistance applied in this variation is greater than previous versions and may provide significant benefit to the singer with asthma by requiring higher levels of respiratory muscle coordination and strength. With proper exhalatory pacing, inspiratory muscle training is significantly enhanced, benefiting lung-function measurements and respiratory endurance factors for the singer with asthma. However, weight recommendations of the exercise should be considered carefully, as excessive amounts of muscular resistance may be problematic for asthmatics who do not possess appropriate levels of diaphragmatic strength.

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[95] Ibid., 141-2.

NOT Recommended

Exercise BDF-16

> Lie on your back with your knees raised, feet about eight inches apart on the floor, and rock gently on your coccyx, the bone at the base of the spine. You can use an exercise mat or blanket for comfort. Rock in rhythm with your breathing, so that you arch your back off the floor slightly as you inhale, and roll your back into the floor as you exhale.

This exercise is capable of reducing tension in the intercostal muscles and decreasing the risk of lung hyperinflation, yet can be detrimental to diaphragmatic strengthening because excessively distending the abdominal area collapses the diaphragm. Arching of the back can also be problematic in the respiratory training of the singer with asthma and is therefore not recommended.

EXERCISES TO STRENGTHEN THE DIAPHRAGM AND INTERCOSTAL MUSCLES (SDI)

Recommended for All Levels of Vocal Training

Exercise SDI-1

> With knees slightly bent, lift your arms over your head while inhaling as deeply as possible. Stretch and reach for the sky, looking up without arching your back. Try to feel your rib cage move away from your spine. Bend over as far as comfortable while exhaling, hands pointed toward your feet. Don't force the stretch. It should feel good, not painful. Exhale all the way. Stand up slowly while inhaling deeply.[96]

This exercise benefits coordination of the respiratory musculature, isolation of the diaphragm during inspiration, and reduction of asthmatic symptoms. Bending at the waist stabilizes the rib cage in one position throughout the exercise and provides significant diaphragmatic strengthening, thus making it beneficial for the singer with asthma.

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[96] Hogshead and Couzens, 143.

Exercise SDI-2

> With knees slightly bent, arms straight out from your sides and parallel to the ground, inhale as slowly and deeply as possible. Exhale while twisting as far as possible to the right. Let your body positions help you exhale and inhale. As you return to face forward, inhale slowly. Twist to the left, exhaling as you make the move; inhale as you return to face forward.[97]

Movement of the rib cage provides considerable benefit in this exercise, reducing muscle tension and providing deeper diaphragmatic function during inhalation. Additionally, raising the arms engages muscles of the chest, shoulders, and back, lifting the rib cage, which allows for relaxation of the external intercostal muscles and provides significant benefit for the singer with asthma by reducing the thoracic tension and lung hyperinflation commonly associated with the disease.

<u>Recommended for Intermediate to Advanced Level Students</u>

Exercise SDI-3

> With knees slightly bent, hands together directly in front of you and arms parallel to the ground, exhale. While bringing your hands back to the sides of your body, elbows tucked in and behind you, inhale slowly. See how far you can expand your rib cage.[98]

This exercise may prove problematic for the asthmatic because the increased muscular tension, caused by excessive expansion of the rib cage, reduces the mechanical effectiveness of the diaphragm, contributes to lung hyperinflation, and exacerbates asthmatic symptoms. Eliminating excessive rib-cage expansion facilitates proper functioning of the respiratory musculature, thus negating asthmatic risk and providing significant benefit to the singer with asthma.

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[97] Ibid., 144.
[98] Ibid., 144.

Recommended for Advanced Level Students Only

Exercise SDI-4

> Raise the arms above the head. Return the arms to the sides while retaining the moderately high chest posture of the sternum and rib cage. If the chest, at this point, cannot be raised somewhat higher with an upward thrust of the sternum, the basic thoracic posture is too high; if the chest sinks during either inspiration or expiration, the initial thoracic posture was not sufficiently high. Breathe in and out, easily and silently, making certain that the sternum does not fall and that the rib cage does not collapse. The epigastrium and the umbilical region, as well as the rib cage, move outward with inspiration. At commencement of expiration, a slight inward movement is experienced in the umbilical area, but neither the sternum nor the ribs should change position. The exercise should be accomplished by breathing through the nose. Following several inspiration-exhalation cycles of nose breathing, the same cycle should then be practiced by breathing through the mouth. It is essential that the structural support (posture) and the quiescent vocal tract remain unchanged, whether breath is taken through the nose or through the mouth. There should be complete silence during both inhalation and exhalation.[99]

This is an excellent exercise for the singer with asthma through its improvement of diaphragmatic function, flexibility, and strength. Inhaling through the nose is preferred as this moisturizes the air, reducing the possibility of airway dryness and the associated increase of bronchial inflammation. Exhalation through the nose demands that the diaphragmatic musculature be actively employed without laryngeal tension. However, caution should be taken not to crowd the lungs or utilize accessory muscles of inspiration. Engaging these muscles will further raise the sternum and cause excessive tension, potentially exacerbating the asthmatic condition through increased workload and negating the efforts of the diaphragm. Closure of the glottis will increase tension in the muscles of the neck, shoulders, and upper chest, and should therefore be avoided. Nevertheless, this exercise allows for greater freedom during breathing by improving the mechanics of the respiratory system, thus benefiting the singer with asthma.

[99] Miller, 29-30. (This exercise is identified in Miller as “Exercise 2.1”).

Exercise SDI-5

> Stand with your feet about twelve inches apart, letting your arms dangle freely. Bend your head forward as far as possible to stretch the back of you neck. Inhale vigorously while letting the belly distend and stick out. Swing you arms freely to the right and then to the left as you inhale. Make sure your shoulders are relaxed. Exhale a belly breath. Inhale a belly breath. Then, on exhalation, lower your shoulders. Bring your head upward, and gently tilt it back as far as is comfortable, so that the front of your neck is stretched and your spine is straight. You should be exhaling forcefully through pursed lips while sucking in the lower abdomen. Swing your arms freely to the left and right as you exhale. On your next breath, bend your head forward as far as is comfortable to stretch the back of your neck. Inhale a belly breath, swinging your arms to the right and left as you exhale.[100]

This exercise is beneficial in restoring proper movement of the rib cage while also encouraging relaxed diaphragmatic breathing. Swinging the arms prevents tension of the thoracic musculature and allows greater freedom throughout the respiratory cycle. Tilting the head back during exhalation gently elevates the rib cage, prevents improper use of clavicular muscles, and emphasizes expiration that utilizes the abdominal musculature. Distention of the belly may be problematic for the singer with asthma, as extreme muscle tension can occur in the abdominal area, collapsing the diaphragm and negating the benefit of respiratory training during the exercise. With careful monitoring of the abdominal muscles and avoidance of improper muscle tension, this exercise should prove beneficial to the singer with asthma.

Exercise SDI-6

> Stand straight with your feet about ten inches apart. Lower and relax your shoulders. Shake your arms to relax yourself further. Let your hands dangle at your sides. Now inhale. Then exhale. As you exhale, stretch your head back as far as possible, while your stomach slowly deflates. As you inhale again, straighten up. Repeat this exercise.[101]

This exercise provides respiratory benefits to the singer with asthma through proper diaphragmatic function and relaxed thoracic musculature, promoting proper coordination of the

[100] Firshein, 256-8. (This exercise is identified in Firshein as the "Shoulder Drop").
[101] Ibid., 258-9. (This exercise is identified in Firshein as the "Chest Stretch").

abdominal, diaphragmatic, and intercostal muscle groups. Caution must be observed to maintain an open throat during exhalation, as glottal restriction of airflow may increase the levels of muscular tension and thus negate the effectiveness of the exercise.

EXERCISES WITH TIMED RESPIRATION (TR)

Recommended for All Levels of Vocal Training

Exercise TR-1

> Place one hand on your stomach. Place two fingers of the other hand on the pulse of the hand resting on your stomach. Let yourself relax. Now synchronize your breathing with your heart rate. For every seven beats, breathe in. For every nine beats, breathe out. Blow out through pursed lips until your air is gone.[102]

This exercise benefits the singer with asthma through the extension of the respiratory cycle and the subsequent contribution to expiratory muscle strength. Caution is advised when blowing out through pursed lips, as increased thoracic tension can result, negating the effectiveness of the exercise and creating potential risk of asthmatic exacerbation. If performed with proper diaphragmatic breath and appropriate expiratory pressure, this exercise should provide significant benefit to the singer with asthma.

Exercise TR-2

> Inhale on a count of four. Now exhale, but this time let the exhalation last as long as is comfortable for you. Continue to count until you exhaust the air in your lungs. In most cases, the exhalation will be longer than the inhalation.[103]

This variation of the exercise can provide significant benefit to the singer with asthma as extending the respiratory cycle increases expiratory muscle strength and coordination. Unlike previous exercises, this variation does not contain a suspension phase, which removes the risk of lung crowding and hyperinflation, and is therefore recommended for the singer with asthma.

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[102] Firshein, 261. (This exercise is identified in Firshein as "Heart Breathing").
[103] Sorvino, 19-20.

Recommended for Intermediate to Advanced Level Students

Exercise TR-3

> Inhale while mentally counting from 1 to 5 at a moderate tempo, maintaining absolute silence. Keep precise rhythm by tapping a finger or pencil. A metronome may also be helpful. Lips should be parted throughout the three parts of the exercise. Complete but unforced expansion of the ribs and of the muscles of the umbilical-epigastric area and of the lumbar area should be realized. Suspend the breath without any sensation of holding it, without any muscular tension in either the vocal tract or the torso. The position of the rib cage and the abdominal wall is retained while silently counting from 1 to 5 at the original tempo. Exhale silently, maintaining as far as possible the same posture of sternum and rib cage, counting 1 to 5. There should be rhythmic continuity between the three phases of the exercise (inhalation, suspension, and exhalation). Immediately following completion of the three-part breath cycle of 1 through 5, move without pause to a cycle of 1 through 6, passing through the three successive phases of the exercise; In this fashion, increase the numbers until 9, 10, or perhaps 12 counts have been achieved.[104]

Exercises such as these are commonly used to help strengthen the respiratory musculature of asthmatics and would appear to be appropriate for singers with asthma, particularly given their basis in the relaxation methodology of yoga and their premise of extending the relaxed breath over specific durations. However, this exercise, although common to vocal training, can produce negative effects for the singer with asthma, because the suspension phase can increase respiratory muscular tension, consequently crowding the lungs and contributing to hyperinflation and respiratory muscle fatigue. Increased use of the accessory muscles of the head, neck, and upper chest during the suspension phase can cause closure of the glottis, leading to potential issues of laryngeal tension. The suspension phase should be omitted for the singer with asthma, in order to create an exercise that develops the respiratory musculature without the risk of asthmatic complications.

[104] Miller, 31. (This exercise is identified in Miller as "Exercise 2.3").

Exercise TR-4

> Inhale slowly, while counting [to] five; hold the breath while counting [to] ten; exhale slowly, while counting [to] five; repeat indefinitely. This may be done while walking, a step for each count. Variations may be improvised, gradually increasing the length of time the breath can be held. However, the regular repetition is important.[105]

As in previous examples, exercises such as this are commonly used to strengthen the respiratory musculature of asthmatics. Performing the exercise while walking can reduce muscular tension of the abdominal-thoracic areas, providing for greater depth and relaxation of breath. This exercise may not be appropriate for singers with asthma, as the suspension phase can increase respiratory muscle tension, consequently crowding the lungs and contributing to hyperinflation. Removal of the suspension portion of the exercise is recommended for singers with asthma. With these modifications, the exercise should provide substantial benefit to the singer with asthma.

Exercise TR-5

> Take a slow deep breath while breathing through the nose for five seconds. Then sniff in extra air to fill the lungs completely and to reach your full lung capacity. Next, while maintaining the sensation of inhaling, hold your breath with expanded abdominal muscles (not at the larynx) for a count of five. Finally, release the breath on a hiss for approximately ten counts until all the air is expelled.[106]

As previously noted, breathing methodologies such as this are based on yoga, with the desired outcome of extending relaxed breaths over specific durations. Unfortunately, the suspension phase can increase respiratory muscular tension, consequently crowding the lungs and contributing to hyperinflation in the singer with asthma. Increased use of the accessory muscles of the head, neck, and upper chest during this phase may cause closure of the glottis, leading to potential laryngeal tension. Respiratory muscle fatigue may also be a concern. In

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[105] Vennard, 35. (This exercise is identified in Vennard as an "Exercise for breath control").
[106] Ware, 88. (This exercise is identified in Ware as "Exercise 5-8 Sniffing").

training the singer with asthma, it is recommended that the suspension phase be avoided, thus resulting in an exercise that develops the respiratory musculature with minimal asthmatic risk.

Recommended for Advanced Level Students Only

Exercise TR-6

> Begin by inhaling to a count of 4 – at each count take in a little air so that by the 4 count your lungs are fully inflated – and exhaling to a count of 8. Again, let the air out in short stages until it's all expelled by the 8 count. Practice this for several days, then begin to raise the exhale count slowly, keeping the inhale count at 4. Keep doing this, concentrating on letting the air out very slowly.[107]

The benefits of this type of exercise are considerable and have been noted previously. Incremental inhalation may be beneficial to the singer with asthma, as relaxation of the inspiratory musculature reduces fatigue and improves the mechanical capabilities of the diaphragm. The underlying concern in this variation is the possible length of the expiratory phase, because too long a time period can increase thoracic muscle tension, crowding the lungs and contributing to hyperinflation and respiratory muscle fatigue. By carefully monitoring the length of the expiratory phase of the exercise, the singer with asthma should receive significant respiratory benefit.

EXERCISES WITH INCREASED EXPIRATORY DURATION (IED)

Recommended for Intermediate to Advanced Level Students

Exercise IED-1

> Place your hand on your upper abdomen with your thumbs touching the lowest ribs, your little fingers near your waistline, and your middle fingers just touching each other. Breathe in deeply and easily until the expansion under your hands has caused your middle fingers to separate slightly. Hold this expanded position for a moment (suspension) before exhaling. Now start making a hissing sound by

[107] Hogshead and Couzens, 141.

> gently blowing your breath between closed teeth: keep the hiss as steady and even as you can, with a minimum of breath pressure; try to maintain your expansion and to keep your middle fingers from coming back together as long as you can without straining. Now repeat the experiment, but this time blow your breath out forcibly between protruded lips; notice how much more rapidly your expansion collapses. Return to the hissing exercise and repeat it several times always maintaining expansion as long as you can comfortably, and trying to analyze the associated feelings in your abdomen, ribs, and back.[108]

This exercise can be problematic for the singer with asthma due to the duration of the expiratory phase and suspension of breath in the lungs. Mechanical force imbalances such as these can result in thoracic hyperinflation and fatigue of the respiratory musculature in singers with asthma. Asthmatics are known to suffer from improper muscle mechanics, which during singing can cause a lack of coordination of the respiratory musculature, severe respiratory muscle fatigue, inflammation of the airways, and exacerbation of asthmatic symptoms.[109] Modification of this exercise, to accommodate the singer with asthma, shortens the duration of the expiratory phase and alleviates certain aspects of lung hyperinflation. With this modification, the exercise can provide respiratory training benefits to the singer with asthma with minimal risk of asthmatic complications.

Exercise IED-2

> Take the breath quickly and then spin it out through partially closed lips making the expiration as long as possible. This is more comparable to the singing situation.[110]

This exercise can be very beneficial to the singer with asthma, as it uses forceful expiration to elicit a training effect on the musculature. However, rapid inhalation can be problematic, due to the increased abdominal tension common to asthmatics. This variation may be possible with training, but it is not recommended for singers with asthma during the early

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[108] McKinney, 51-2. (This exercise is identified in McKinney as "Controlled Exhalation").
[109] Paltiel Weiner et al., 197-200.
[110] Vennard, 35. (This exercise is identified in Vennard as an "Exercise for breath control").

stages of vocal study. Reducing the speed of inhalation is a necessary modification to better enable the relaxation of the inspiratory musculature. If performed properly, this exercise can provide benefit to the singer with asthma through the relaxation of inspiratory muscles and the strengthening of the expiratory muscle groups necessary for phonation.

Recommended for Advanced Level Students Only

Exercise IED-3

> A "noble" chest posture should first be established. Following silent inspiration, breath is exhaled very slowly while sustaining a constant sibilant noise [s]. The sound should be barely audible. One hand is placed on the epigastric-umbilical region, the other hand on the flanks just below the rib cage. The abdominal wall gives no initial inward impulse nor does it move inward during the exercise until the last few seconds. The aim of the exercise is to maintain the rib cage and the abdominal wall near to the inspiratory position throughout most of the exercise. Eventually the abdomen must move inward, at the close of the expiration, but the rib cage remains longer in the posture of inspiration and the sternum does not lower.[111]

This exercise can be problematic for the singer with asthma due to the duration of the expiratory phase, contributing to lung hyperinflation. As previously noted, asthmatics suffer from a lack of coordination and improper use of the respiratory muscles, leading to respiratory muscle fatigue, airway inflammation, and increased asthmatic symptoms. An acceptable modification of this exercise for use by the singer with asthma shortens the duration of the expiratory phase, permitting a freer flow of breath without the occurrence of asthmatic symptoms. With modification this exercise can provide respiratory training benefits for the singer with asthma with minimal risk of asthmatic complications.

[111] Miller, 32. (This exercise is identified in Miller as "Exercise 2.4: Prolongation of the sibilant [s]").

EXERCISES FOR RESPIRATORY MUSCLE COORDINATION – PANTING (RMC)

Recommended for All Levels of Vocal Training

Exercise RMC-1

> At the rate of one exhalation per second, and using the "hoh" or "hah" syllable, speak the sounds while rapidly pulling in the abdominal muscles. It is important to allow the abdominals to relax (move outward) after each syllable.[112]

This exercise is similar to panting, but at a much slower pace, providing increased coordination of the respiratory muscles, advantageous movements of the diaphragm, and minimal asthmatic risk. A clear benefit of this exercise is the relaxation of the abdominal musculature following each exhalation. Also, performing the exercise in this manner negates the possibility of increased muscle tension and fatigue.

Recommended for Intermediate to Advanced Level Students

Exercise RMC-2

> Pant audibly, though gently. Supple, flexible, agile motion of the abdominal musculature is felt by the hand placed on the umbilical-epigastric region. The surface movement indicates rapid inhalation-exhalation patterns. If glottal adduction were introduced, rapid onset vocalizes would result.[113]

This exercise is particularly useful in the training of singers, developing the muscle coordination and the vocal and respiratory flexibility necessary to properly attain a balanced onset of breath during rapid, staccato singing. The exercise, however, can contribute to specific problems common to singers with asthma, as issues of muscle fatigue, lung hyperinflation, and respiratory gas imbalance can occur. Muscle fatigue, caused by an improper mechanical position of the diaphragm, can be exacerbated due to the minimal diaphragmatic movement associated

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[112] Jan Schmidt, *Basics of Singing,* 3rd ed. (New York: Schirmer Books, 1994), 15. (This exercise is identified in Schmidt as "Exercise 3.1").
[113] Miller, 32. (This exercise is identified in Miller as "Exercise 2.5: The audible pant").

with this exercise. The lack of diaphragmatic motion can trap air in the lungs, distend the rib cage and contribute to lung hyperinflation, further negating the action of the diaphragm. With exhalation affected through a lack of muscle coordination, the ratio of oxygen and carbon-dioxide in the lungs is severely altered, heightening the potential for asthmatic exacerbation. Panting slowly may be the alteration that best accommodates the singer with asthma: utilizing slower breathing cycles allows for advantageous movement of the diaphragm, increased coordination of the respiratory muscles, proper respiratory gas exchange, and minimized asthmatic risk. As diaphragmatic function and strength improves, the singer may be able to gradually increase the speed of the exercise without detrimental asthmatic effects.

Exercise RMC-3

> Pant like a dog at varying rates, from fast to slow, and notice the outward-and-inward action of the high-middle-low abdominal area. Let your tongue rest loosely on your bottom lip with the jaw dropped comfortably.[114]

This exercise, like those listed previously, can contribute to specific problems for singers with asthma, in spite of its potential benefit in vocal training. Issues of muscle fatigue, lung hyperinflation, and respiratory gas imbalance can occur, potentially exacerbating the asthmatic condition. However, panting at a slower pace allows for advantageous movements of the diaphragm, increased coordination of the respiratory muscles, proper respiratory gas exchange, and minimized asthmatic risk. As diaphragmatic function and strength improve, it may be possible to slowly increase the speed of the exercise without detriment to the singer with asthma.

Exercise RMC-4

> Sit erect on the edge of a chair with your legs spread comfortably and with your feet resting flat on the floor. Lean over slightly, and place your elbows on your knees. You should be facing the floor at about a 45º angle. Take slow and relaxed breaths at first, then pant at various rates, with your hands feeling the sensations of your body's mechanism in the lower torso.[115]

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[114] Ware, 87. (This exercise is identified in Ware as "Exercise 5-3 Panting").
[115] Ibid., 87. (This exercise is identified in Ware as "Exercise 5-4 Sitting and Leaning").

The singer with asthma can quickly establish proper coordination of the respiratory musculature through this exercise. Expiration while slowly leaning forward onto the legs provides the physical sensations of abdominal-wall contraction, limited suspension of the rib cage, and powerful exhalation of the breath. Benefits of leaning during this exercise include strengthening of the expiratory muscles, reduction of rib-cage tension, coordination of the respiratory process, negation of accessory muscle usage, and relaxation of the throat. This variation benefits the singer with asthma through increased FEV and VC, reduced airway obstruction, and heightened airflow consistency.

The panting element of the exercise constitutes the primary concern for the singer with asthma. As previously stated, rapid panting creates specific problems in the asthmatic that can contribute to increases in muscular tension, muscle fatigue, lung hyperinflation, and exacerbation of asthmatic symptoms. Modification of this exercise to include slow, deep breathing allows for proper respiratory muscle coordination and effective training of the expiratory muscle groups.

Recommended for Advanced Level Students Only

Exercise RMC-5

> The chest should be raised, the shoulders back and down, and the belly should move out and in causing inhalation and exhalation. Specifically, the diaphragm contracts, causing inspiration and forcing the belly out; and the belly contracts, forcing the diaphragm back up and causing expiration. The mouth should be open and the tongue should be forward, preferably lolling out, like a dog's when he is panting. The musculature must be kept under control. Do the exercise at a definite cadence, fast or slow, or even in rhythmic patterns, but do not let the exercise run away with the exerciser. Be sure that there is real inspiration for each expiration. It is not just a matter of taking a deep breath and then exhaling it in a series of puffs. The student should be able to continue panting indefinitely.[116]

[116] Vennard, 32. (This exercise is identified in Vennard as the "Panting Exercise").

This exercise is particularly useful in the training of singers, providing muscle coordination, vocal and respiratory flexibility, and attaining rapid onset of breath during staccato singing. However, this exercise can contribute to specific problems for singers with asthma, as issues of muscle fatigue, lung hyperinflation, and respiratory-gas imbalance can surface. Muscle fatigue, caused by an improper mechanical position of the diaphragm, can be exacerbated due to the minimal diaphragmatic movement associated with this exercise. The lack of diaphragmatic motion can trap air in the lungs, distend the rib cage, and contribute to lung hyperinflation, further negating the action of the diaphragm. Exhalation is also affected through a lack of muscle coordination, severely altering the ratio of oxygen and carbon-dioxide in the lungs, potentially heightening the likelihood of asthmatic exacerbation. Panting slowly may be the alteration that best suits this exercise to the singer with asthma, as utilizing slower breathing cycles allows for advantageous movement of the diaphragm, increases coordination of the respiratory muscles, facilitates proper respiratory gas exchange, and minimizes asthmatic risk. As diaphragmatic function and strength improve, it may be possible to slowly increase the speed of the exercise without detriment to singers with asthma.

NOT Recommended

Exercise RMC-6

> Pant silently and as rapidly as possible. Establish the pattern of umbilical-epigastric motion present in the audible pant, without sound, and without actual inhalation and exhalation taking place. Epigastric muscle action is now independent of the breath cycle.[117]

Removal of the inhalatory-exhalatory process negates the possibilities of lung hyperinflation and respiratory-gas imbalance that can be present in the previous exercise. Diaphragmatic muscle fatigue, however, remains a high probability, in addition to the laryngeal

[117] Ibid., 32-3. (This exercise is identified in Miller as "Exercise 2.6: The silent pant").

risk from improper closure of the glottis due to the suspension of breath within the lungs. If the loss of rib-cage movement is present in the singer with asthma, this exercise can lead to abnormal distention of the thorax, causing considerable pain. This scenario could lead to improper methods of breathing and negate the intended training benefits of the exercise; therefore, the exercise is not recommended for singers with asthma.

EXERCISES UTILIZING EXPIRATORY PULSES (EP)

Recommended for Advanced Level Students Only

Exercise EP-1

> One hand should be placed on the umbilical-epigastric region, the other just below the ribs and above the iliac crest (uppermost portion of the pelvis), at the side of the body. A quiet breath should be taken, paced over several seconds, followed by a series of rapid, labiodental fricative continuant noises, represented phonetically by the symbol [f]. Sufficient impulse should be given each fricative in the series so that abdominal motion is distinct. Yet the exit of the breath must be so controlled that a series of short expulsions can occur on one breath without any collapse of the rib cage, with no lowering of the sternum, and with minimal inward motion of the umbilical-epigastric region.[118]

This exercise and the similar one that follows offer obvious benefits for vocal training, by enhancing the muscular coordination of the respiratory process. The rate in which the [f] sounds occur can be problematic to the singer with asthma, through the incorrect usage of glottal articulation to produce the consonant, thus negating the purpose of the exercise. Such methods of articulation can increase pressure levels within the lungs, distend the thoracic cage, and lead to hyperinflation, further reducing the effectiveness of the exercise through diaphragmatic inefficiency and fatigue. Modifications suitable for the singer with asthma can be found in the following exercise.

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[118] Miller, 33. (This exercise is identified in Miller as "Exercise 2.7: Rapid execution of the voiceless labiodental fricative continuant [f]").

Exercise EP-2

> The singer is requested to "blow out six or eight candles successively with one breath, but with separate abdominal impulses." The exercise should be done in successive phases, perhaps four times in a row, with a deep and silent inhalation after each series:
>
> [f f f f f f]'[f f f f f f]'[f f f f f f]'[f f f f f f]'
>
> During the staccato execution of the phoneme [f], no part of the anterolateral wall should be drawn inward; an internal-external balance of the abdominal musculature should be the aim. Sternum and rib cage remain stationary.[119]

This exercise provides increased muscle coordination, improved respiratory flexibility, and enhanced onset of breath during staccato singing. While vocal technique is clearly benefited by this type of exercise, it can be negated for the singer with asthma. Of primary concern is the abdominal thrust against a rigid diaphragm, as this may increase tension levels in the rib cage musculature, leading to hyperinflation of the lungs. As muscle tension increases, pain levels may begin to rise, causing the muscles to collapse due to mechanical insufficiency. Under these conditions, the muscles will fail to function properly, thereby negating any training benefit.

Variations utilizing slower pulses can provide greater advantage to the singer with asthma. The reduced pace of impulses facilitates a reduction of tension in the diaphragm and intercostal muscles, and the brief period of relaxation enhances muscular recovery, promotes improved strength and reduces fatigue within the muscles, thus providing a more effective exercise for the singer with asthma. Keeping the diaphragm in a rigid, inhalatory position can contribute to muscle fatigue and mechanical weakness, making additional alterations necessary. Allowing for a progressive relaxation of the respiratory musculature will strengthen the diaphragm, prevent loss of breath energy, and reduce the risk of asthmatic symptoms. With

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[119] Ibid., 33. (This exercise is identified in Miller as "Exercise 2.8: Slow execution of the voiceless labiodental fricative continuant [f]").

alterations in place, this exercise may prove beneficial to singers with asthma at an advanced level of training, but may not be appropriate for those in the early stages of study.

EXERCISES FOR EXPIRATORY MUSCLE STRENGTHENING (EMS)

Recommended for Intermediate to Advanced Level Students

Exercise EMS-1

> Sit on a chair. Place your hands, palms down, on your knees. Take another moment to relax. Begin the same exercises you just completed on the floor. Four and four, six and six, six and eight, etc. Chest up. Drop the abdominal muscles. Inhale through the nose, then exhale through the mouth against the pursed-lips pressure. Finish the exercise by reversing the count. Inhale and exhale through the mouth only.[120]

The benefits of this exercise variation can be significant as inhalation through the nose warms, cleans, and moisturizes the air, thus reducing the risk of asthmatic exacerbation. The minimization of asthmatic triggers provides a more effective exercise, greatly benefiting the respiratory musculature. Exclusion of mouth inhalation creates an exercise variation with significant benefit to the singer with asthma.

Exercise EMS-2

> Sit erect on a chair with your hands placed comfortably on your knees. Take a deep breath (no counting needed) and begin your exhalation – but this time, start leaning forward from the waist very slowly. As you do this, consciously exert a steady pull on the front part of your diaphragm. The movement should last about ten seconds, at the end of which your head should be close to your knees and you should have exhaled most of the air in your lungs. At this point you will attempt to push the remaining air out of your lungs by exerting even more inward force with the diaphragm and changing the position of your lips so that you can make a hissing sound through your teeth. When you feel you have no more air to exhale, begin to rise from the waist. Inhale through the nose, slowly, mouth closed. When you arrive at the sensation that tells you no more air can be taken in, lean forward again from the waist – but this time, do it very quickly so that your head reaches between your knees in less than a second. As you push forward, exert a powerful inward force on your diaphragm area as if you were reacting to a sudden

[120] Ibid., 21-2.

> punch. If you are doing this correctly, the air will be rushing to escape – and it is at this time that the very strong pursed-lips position is extremely important. When your head is between your knees and you have exhaled most of the air, switch to hissing and force the last remaining bit of air from your lungs, even to the point of saliva escaping from your mouth. Now relax and sit up slowly.[121]

Exercises that train the expiratory musculature are commonly used in the respiratory rehabilitation of asthmatics, as forceful exhalation provides considerable benefits to lung function. This particular exercise employs a forceful downward thrust to aid in clearing mucus from the lungs, which benefits the singer with asthma through increased forced expiratory volume, reduced airway obstruction, and heightened airflow consistency. However, the downward thrust may be problematic for the singer with asthma because of increased muscle tension of the neck, reduced pharyngeal space, and extreme amounts of air pressure moving through the vocal folds. The singer with asthma should modify this exercise by keeping the mouth and throat in an open position during the downward exhalatory thrust. Removing the strong pursed-lip position reduces muscular tension in the neck, allowing for proper pharyngeal space and negating inappropriate pressure against the vocal folds. Due to the speed with which the lungs are emptied, it is also recommended that the hissing phase of the exercise be removed, since this could increase tension levels in the muscles of the chest and neck. If performed with these modifications, this exercise may provide significant respiratory benefits to the singer with asthma.

<u>Recommended for Advanced Level Students Only</u>

Exercise EMS-3

> Take a deep breath through your mouth; leave your mouth hanging open and blow your breath out; notice how quickly all your breath is exhausted from your body, because you are doing nothing to control the passage of the air. Now take another

[121] Ibid., 25-7.

> deep breath, but this time as you blow your breath out, shape your lips into a pucker as if you are about to whistle; notice how much longer it takes to blow the breath out of your body this way. This is because you have begun to control your breath through the use of your lips.[122]

This exercise can be very beneficial to the singer with asthma, as it uses forceful expiration to elicit a training effect on the musculature. Caution should be observed with the pursing of the lips, as intense embouchure maintenance contributes to tension in the jaw and neck that may not be released during inhalation. Strength of expiration should also be monitored, as this can lead to increased tension of the abdominal and thoracic muscles, contributing to premature collapse of the diaphragm and possibly negating the desired training effect. If performed properly, this exercise may prove beneficial to the singer with asthma.

Exercise EMS-4

> In the standing "singer's posture" – hands clasped behind your head, chest expanded and feet evenly spaced- begin by blowing out (exhaling as much air as possible). When air is expelled, hold for a few seconds (five to six) until you feel a strong need to breathe. Now let the air rush in, filling every nook and cranny of available space. Observe the physical sensations associated when performing this exercise.[123]
> A similar variation of this exercise was examined previously (Exercise TR-1, p. 52).

While this exercise can contribute to improvements in diaphragmatic function, flexibility, and strength for the singer with asthma, if performed improperly this exercise has the potential to exacerbate the asthmatic condition through an increased workload and negation of the efforts of the diaphragm.

Exercise EMS-5

> [Spread feet slightly, stand erect, then bend over at a 90º angle with hands on your ankles.] Hold your right (or left) index finger approximately 4 to 5 inches from your mouth and pretend you are trying to blow out an intense flame emanating

[122] McKinney, 54. (This exercise is identified in McKinney as an "Exercise for breath control").
[123] Ware, 87. (This exercise is identified in Ware as "Exercise 5-1 Blowing out").

> from your fingertip. Use a vigorous breath for three to four seconds. Observe the action of the abdominal area and rib cage.[124]

This exercise can be very beneficial to the singer with asthma, providing significant benefit in the reduction of asthmatic symptoms.[125] The strong exhalation of air strengthens the respiratory muscles, potentially opening the bronchial airways and lessening their sensitivity to inflammation. However, the strength of expiration must be monitored, as excessive tension of the abdominal and thoracic muscles contributes to the premature collapse of the diaphragm.

Bending at the waist is considered beneficial to the singer with asthma, as this promotes expansion of the lower back muscles and maximum contraction of the diaphragm. If performed properly, this exercise can greatly benefit the singer with asthma through its strengthening of the expiratory muscle groups necessary for phonation.

Exercise EMS-6

> [This exercise] may be done sitting, standing, or lying down. Draw in a belly breath. Upon exhalation, purse your lips firmly and exhale as forcefully as you can, as if you were blowing out candles on a birthday cake. By pursing your lips this way, you produce a controlled, powerful stream of air. It will sound a bit like a speeding train.[126]

This exercise, similar to exercise EMS-3, can be very beneficial to the singer with asthma, as strong exhalation of air strengthens the muscles, opens the bronchial airways, desensitizes them to inflammation, and reduces the severity of attacks. Strength of expiration should be monitored, as excessive pressure can lead to increased tension of the abdominal and thoracic muscles, contributing to the premature collapse of the diaphragm. If performed properly, this exercise provides considerable benefit to the singer with asthma.

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[124] Ware, 87-8. (This exercise is identified in Ware as "Exercise 5-7 Bending and Blowing out an intense flame").
[125] Paltiel Weiner et al., 197-200.
[126] Ibid., 256. (This exercise is identified in Firshein as "Blowing Out the Candle").

Exercise EMS-7

> Take a large breath by expanding your lungs from their bottoms up using the count of four. Now purse your lips firmly and exhale as if you were going to blow out a candle. The result should be a steady stream of air expelled to the count of four. While exhaling, the front part of the diaphragm will naturally want to pull in somewhat. This is natural and necessary.[127]

This exercise can be very beneficial to the singer with asthma, as forced expiration elicits a training effect on the respiratory musculature, reducing pulmonary muscle fatigue and the associated exacerbation of asthmatic symptoms. The utilization of brief, timed respiratory cycles provides benefit to the asthmatic through reduced risk of sustained pulmonary muscular tension. Strength of exhalation must be monitored in this regard; however, if performed properly, this exercise can provide considerable benefit to the singer with asthma.

EXERCISES TO ENHANCE LOWER BACK EXPANSION (LBE)

Recommended for All Levels of Vocal Training

Exercise LBE-1

> Stand erect with legs spread far apart as possible and with hands on waist in reversed position (thumbs forward). Like a "toy water bird" or mechanical toy, bend over slowly at a 45º angle from a fulcrum point at the bottom of the pelvic area (not at the waist). Breathe slowly, gradually increasing the breathing tempo as you pay attention to the action of the breathing mechanism.[128]

This exercise advocates bending the body in order to fully integrate the muscles of the lower back. Exercises such as this may prove beneficial in deepening diaphragmatic contraction and strengthening the respiratory musculature. Leaning forward is beneficial in the respiratory training of asthmatics, because this postural change suspends the rib cage, relaxes the external intercostal muscles, and reduces thoracic tension. Inappropriate respiration strategies, those

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[127] Sorvino, 18-9.
[128] Ware, 87. (This exercise is identified in Ware as "Exercise 5-5 Standing").

which emphasize intercostal and clavicular muscle groups, are negated, allowing the diaphragm to be fully utilized. Through the application of a slow breathing tempo that coordinates the actions of the respiratory musculature, this exercise may prove highly beneficial to the singer with asthma.

Recommended for Intermediate to Advanced Level Students

Exercise LBE-2

> Spread feet slightly, stand erect, then bend over at a 90º angle with hands on your ankles. Breathe as described above but be particularly aware of expanding a full breath; this will be evident by a sensation of tightness in the back below the ribs. This exercise can also be done by placing your forehead on your hands at the edge of a table while bending over in the same manner.[129]

Leaning forward can provide excellent benefit to singers with asthma as integration of the lower back musculature deepens diaphragmatic contraction, increases its respiratory mechanics, and relaxes the external intercostal muscles. Gravity suspends the rib cage, allowing it to relax and provide a complete diaphragmatic breath for the singer with asthma, without incorrect utilization of accessory muscles of the head and neck. However, the singer must be cognizant of breathing in a relaxed manner, as the use of accessory muscles creates tension during inhalation and negates the respiratory training benefits of the exercise. Extreme effort upon inhalation may indicate the use of incorrect respiratory musculature, provoking the onset of asthmatic symptoms. This exercise should provide significant benefit to the respiratory training of singers with asthma, if they focus on the depth of breath and expansion of the lower back.

[129] Ibid., 87. (This exercise is identified in Ware as “Exercise 5-6 Bending”).

SUMMARY OF RESPIRATORY EXERCISE OBSERVATIONS

Each of the exercises in this chapter demonstrates possible benefits for the respiratory training of the singer with asthma, with certain exercises providing greater benefit, as suggested by the preceding discussions of respiration, lung-volume capacities, function values, and expectations for singers with asthma (see chapters one and two). The primary objective of the exercises discussed in the chapter is to promote relaxed diaphragmatic respiration, thus facilitating significant strengthening of the respiratory musculature and resistance to muscular fatigue. Additional benefits to the singer with asthma include reduced thoracic hyperinflation, improved oxygen distribution, decreased bronchial-airway inflammation, and desensitizing of the airways, all of which are symptoms associated with asthma. Further benefit is obtained through exercises employing respiration over specific time intervals and with increased expiration requirements, as the application of these variables is known to enhance lung measurements of vital capacity and forced expiratory volume.

Caution is warranted for exercises requiring pulsed coordination of the diaphragm and the abdominal muscles, as this activity increases the risk of asthmatic exacerbation caused by lung hyperinflation, oxygen imbalance, muscle fatigue, and loss of mechanical function. Exercises that emphasize distention of the rib cage may further exacerbate this condition by increasing the pain levels associated with respiration. The suggested modifications to these exercises can provide appropriate respiratory benefit, with minimal health risks, to the singer with asthma.

CHAPTER 5

CONCLUSIONS OF THE STUDY

This study has focused on asthma's influence on respiratory function, while also observing what modifications to traditional vocal training methodologies are indicated for singers with the disease. Four questions were considered as the basis of research, and they also constitute the first topics in this chapter.

Lung Function Measurements of Asthmatics

The first question determines parameters of lung function in both singers and asthmatics, providing a comparison that might establish a range of expected respiratory function for the singer with asthma. This question is further divided for greater understanding of the evidentiary findings.

(1) How does asthma affect measurements of lung function; how do these levels of lung function in the asthmatic compare with those of non-asthmatic singers; and what differences in pulmonary efficiency should be expected by singers with asthma?

The vast majority of research regarding asthma comes from medical case studies, which find significant reductions of lung function during asthmatic episodes. These studies report measurements of *vital capacity*, one of the primary indicators of lung function and pulmonary efficiency, that average 30% –50% below normal in persons suffering from asthmatic symptoms. Significant limitations in forced expiratory volume--reductions ranging from 20% – 65% of

normal levels--are present during asthmatic attacks and demonstrate the asthmatic's physical condition. Subsequent increases in residual volume, caused by the diminished expiratory capabilities of the asthmatic, contribute to the trapping of carbon dioxide in the lungs, further exacerbating the severity of the symptoms through increased inspiratory muscle fatigue. Additional findings show *gender* as a significant factor in the reduction of pulmonary function, as indicated by higher levels of lung function and respiratory muscle strength in male asthmatics (p. 19). Research also demonstrates that the *type* of asthmatic "trigger" influences the severity of symptoms, as persons with allergy-induced asthma demonstrate higher pulmonary measurements than those found in persons with exercise-induced asthma. Recent evidence from long-term studies reveals that asthma progressively worsens over time, due to physiological changes within the lungs. Physiological changes associated with childhood asthma reduce lung growth and respiratory efficiency, diminish pulmonary function by 16% – 24%, and contribute to increased inspiratory muscle load in asthmatic adults. These effects of the disease are directly responsible for respiratory muscle weakness, reduced chest-wall movement, and oxygen-ratio abnormalities that significantly influence improper distention of the rib cage, incorrect posture, lung hyperinflation, and fatigue of the respiratory muscles.

Vocal scientists have completed minimal research regarding asthma and its effect on lung function of singers. Findings from one study within the field of vocal pedagogy demonstrate that singers with asthma experience reductions in pulmonary efficiency of more than 20%, a level of reduction that is similar to lung-function measurements commonly found in exercise-induced asthma and confirms asthma's negative effect on singers.

My examination of this research implies that the changes of lung function associated with asthma and their necessary physical accommodations affect the respiratory training of the singer

with the disease. By comparing the previously shown measurements for asthmatics with research of lung function in non-asthmatic singers, it is possible to establish a range of lung function for singers with asthma.

Lung-Function Measurements of Singers

An examination of lung-function studies on singers reveals higher than normal levels of respiratory efficiency and concludes that respiratory training positively affects pulmonary measurements and respiratory muscle strength. Research from the examined vocal pedagogy sources lists average vital capacity measurements ranging from 89% – 123% of normal, with differences primarily attributable to a diverse number of years of vocal training. The research conclusively demonstrates that coordination of the respiratory musculature is important to the efficiency of breath management and that vocal training positively affects respiratory function. Benefits to vital capacity, forced expiratory volume, residual volume, and total lung capacity are attained through the respiratory training methodologies commonly taught to singers. This evidence also reveals a correlation between parameters of respiratory function and the duration of vocal training, as singers with longer periods of study (six or more years) display markedly increased lung-function levels, while those with shorter periods of training (fewer than five years) register nearly normal measurements.

Expected Lung-Function Measurements for the Singer with Asthma

Findings from both the medical and vocal pedagogical fields reveal definitive evidence that asthma contributes to improper vocal production. Asthmatic inflammation within the lungs leads to inefficient coordination of the primary respiratory musculature and causes reactive

application of accessory muscle groups, increasing laryngeal tension and adversely affecting vocal function. Medical findings show that base-line measurements of lung function in asthmatics--reductions of 10% – 20% below non-asthmatic levels--can be reversed through application of respiratory training methodologies. Evaluation of vocal pedagogy studies suggests that the respiratory training methodologies commonly used in the singing profession also provide pulmonary benefit to the singer with asthma by potentially increasing the lung-function measurements of vital capacity, forced expiratory volume, and residual volume to levels approaching those found in non-asthmatic persons. Acute asthmatic exacerbations, however, potentially reduce the lungs' capabilities by more than 35% and hence negate the enhancement achieved through respiratory training. During acute attacks, of which allergy and exercise are the most likely causes, medications are normally considered the only viable option for restoring proper lung function. Side effects from asthma medications, however, are known to contribute to improper vocal function and are *not* recommended during singing. My examination of the medical evidence reveals that exercise provides additional benefit to lung-function measurements in asthmatics through reduced airway sensitivity to asthmatic "triggers" and should therefore be examined as a means of achieving the greatest pulmonary benefit for the singer with asthma.

Asthma and Exercise

Exercise regimens are commonly recommended by vocal pedagogues to enhance lung function and health parameters in singers. Medical doctors also advocate such exercise and respiratory training methodologies for asthmatics. Question two evaluates and compares exercises commonly recommended in the fields of asthma therapy and vocal pedagogy, in order

to determine those activities that provide the greatest respiratory benefit to the singer with asthma.

(2) Which exercise regimens are recommended for the singer and for the asthmatic; are there exercises for optimal efficiency common to both groups; and are there possible health concerns for singers with asthma?

Medical research on asthma shows that exercise positively affects the levels of pulmonary function in asthmatics and provides significant respiratory benefit as a result of corresponding reductions in airway sensitivity. However, these studies also demonstrate a direct correlation between exercise and the onset of asthmatic symptoms, resulting in measurable deterioration of lung function as exercise levels and duration increase. To improve lung-function parameters in asthmatics, the examined asthma sources commonly recommend aerobic activities such as swimming, running, walking, and cycling, even though running is known to be highly capable of triggering asthmatic episodes. Instances where recommendations contradict research findings illustrate the necessity of carefully evaluating physical activities for the asthmatic in order to determine those exercises that provide the greatest benefit while simultaneously ensuring minimal risk of disease exacerbation.

Singers and Exercise

Vocal pedagogues concur that good physical health, muscular coordination, and postural balance are important to the act of singing and that well-chosen fitness regimens can improve respiratory function without tiring the voice. Studies show that fitness levels improved through regular exercise can enhance musical attributes during vocal performance and are therefore recommended for the singer. In controlled studies by vocal scientists, research shows increased measurements of vital capacity, vocal power, and duration in singers who exercise regularly.

The findings from these studies verify that singers who are physically fit maintain greater control over the voice, while singers who do not maintain appropriate muscle tone compensate by using inappropriate muscle groups that tire the voice and contribute to vocal dysfunction.

Recommended Fitness Regimens and their Health Concerns

After examination of each exercise in the specified sources (see Introduction), a list of recommended activities and conclusions were presented. The chart on page 26 illustrates the frequency with which specific exercises are recommended and includes a brief synopsis of the advantages, disadvantages, and suggested modifications of each exercise, in order to identify and further develop those activities best suited to the singer with asthma.

My examination of the research found that the most beneficial exercises are aerobic in nature: swimming, walking, and jogging. Among these, I found walking to be the least problematic for the singer with asthma, as the reduced pulmonary demands of walking minimize the risk of respiratory inflammation while still providing mild cardio-vascular benefit due to greater exercise duration. Additionally, fitness level is not an important factor in walking and its training effects can be enhanced with simple modifications. Altering this exercise by breathing over specific time intervals provides a training effect on the respiratory muscles and reduces asthmatic sensitivity within the lungs. Specific climatic/atmospheric conditions during exercise can heighten asthmatic risk, however, even for lower intensity exercises such as walking. While exercising in cold, dry weather, nasal breathing is recommended as it warms and moisturizes the air, diminishing the potential for airway inflammation. Walking on a treadmill, with previous modifications in place or on days with increased air pollution, is recommended for the singer with asthma.

Even though research shows that medical professionals recommend swimming as the most beneficial exercise for the asthmatic, swimming is usually discouraged by vocal pedagogues due to risks of sinus problems and water retention in the ears. The potential benefit of swimming is significant for the singer with asthma, since this exercise provides excellent cardio-vascular benefit with minimal risk of asthmatic symptoms, due to the warm, humid environment of water. Based on these observations, I recommend that singers with asthma should modify swimming activities by using ear and nose plugs, thus counteracting the possibility of water retention in the ears and sinuses.

To the contrary, jogging is one of the most common exercises recommended by vocal pedagogues, but the increased risk of airway inflammation while jogging can negate its potential benefit for the singer with asthma. Numerous medical studies show that jogging requires respiratory intensity and duration levels capable of aggravating the asthmatic condition. Supplemental evidence indicates that brief periods of intense exercise, interspersed with periods of reduced activity or rest, minimizes the risk of airway inflammation and, with sufficient exercise duration, provides superior pulmonary benefits to the asthmatic. My recommended alternative is a modified form of jogging, one combined with walking, that is better suited to the singer with asthma. This alteration includes shorter periods of intense exercise, lowers pulmonary demands, and lengthens exercise duration, thus providing superior training benefits to the singer with asthma.

Medical studies reveal that activities such as tennis, racquetball, handball, and squash are excellent aerobic exercises that require brief periods of intense activity. Each of these sports involves duration requirements that can provide significant respiratory-training benefits and can reduce airway sensitivity in singers with asthma. Based on my examination of the medical

research, I conclude that these activities should be carefully monitored during adverse atmospheric/environmental conditions that can heighten asthmatic symptoms. In addition, such exercises should be modified to avoid any potentially damaging usage of the vocal folds (e.g., grunting).

Weight training is a form of exercise commonly recommended by vocal pedagogues; however, only one medical source suggests it for asthmatic therapy. Vocal studies show that, while weight training benefits the singer by improving specific vocal performance criteria, it is an anaerobic form of exercise that provides minimal improvement toward pulmonary fitness and respiratory muscle strength desired by the singer with asthma. Additionally, lifting extreme amounts of weight can potentially aggravate the asthmatic condition and can also increase pressure on the vocal folds. Hence, my study suggests using lesser amounts of weight, reducing the risks of lung hyperinflation and vocal-fold pressure while still benefiting the respiratory training of the singer with asthma.

The chapter on recommended exercises and their health concerns concludes with my evaluation of the remaining forms of exercise suggested by the examined sources, makes recommendations regarding exercise effectiveness, and suggests modifications to the exercises in order to enhance their respiratory training potential for the singer with asthma.

Breathing Strategies of Asthmatics

Question three examines the breathing strategies of asthmatics to determine potential problems for the singer with asthma.

(3) Do asthmatics commonly employ methods of breathing or use compensatory breathing strategies that may contribute to problems of posture, muscle tension, and respiratory fatigue during singing?

The body of medical evidence demonstrates that the breathing strategy most often used by asthmatics employs the muscles of the upper chest and contributes to the physiological effects of asthma, including lung hyperinflation and respiratory muscle fatigue. Studies by vocal pedagogues show that clavicular breathing strategies adversely affect posture, breath management, and phonatory quality, and are therefore *not* recommended for singers. Both fields of study consider clavicular breathing strategies to be the most inefficient, and both also recommend that persons employing this form of respiration be re-trained to engage the diaphragm during respiration.

The research I compiled for this paper indicates that diaphragmatic breathing is utilized both in the training of singers and the respiratory rehabilitation and re-training of the asthmatic. Diaphragmatic breathing reduces asthmatic symptoms and provides significant potential for minimizing the long-term physiological effects of the disease. Strengthened respiratory musculature, reduced airway sensitivities, diminished lung hyperinflation, and increased respiratory measurements (i.e., vital capacity and forced expiratory volume) are all attributable to diaphragmatic breathing strategies. Additionally, diaphragmatic breathing is the form most often recommended by vocal pedagogues for improving respiratory duration, vocal power and agility, and laryngeal health. Based on the observation that the act of singing can exacerbate asthmatic symptoms, I hypothesized that certain respiratory training exercises can actually *contribute* to disease complications. After examining the recommended respiratory training exercises from both fields of study, I found similar methodologies that are capable of (a) improving respiratory function and (b) positively affecting breath management in the singer with asthma.

(4) Do healthy singers utilize respiratory training exercises that could be compatible with the training of singers with asthma; and what modifications, if any, may be necessary to adapt these exercises for vocal respiratory training of singers with asthma?

In question four, this study compares respiratory exercises from both the fields of vocal pedagogy and asthmatic respiratory therapy and, having found replication of many of the exercises in both areas, concludes by illustrating their similarities and differences. For the purposes of this study, I grouped the exercises into the following categories:

- Basic diaphragmatic function
- Strengthening of the diaphragm and external intercostal muscles
- Timed respiration
- Increasing expiratory duration
- Respiratory muscle coordination - Panting
- Expiratory pulsing
- Expiratory muscle strengthening
- Enhancement of lower back expansion

A listing of exercises grouped by similarity is found in table 4.1 (pg. 44), with a similar listing of exercises grouped by recommended training level found in table 4.2 (pg. 45). Exercises are grouped by pedagogical function to provide the clearest method of comparison. This methodology yields a clearer understanding of the benefits of respiratory training, the modifications necessary to improve less effective exercises, the appropriate amount of training best suited to each exercise, and the associated pulmonary risks for the singer with asthma. My conclusions in the study confirm that many of the exercises, or their modified forms, are beneficial for the development of diaphragmatic function and coordination, thus providing significant benefit to all levels of singers with asthma through increased diaphragmatic strength and muscular coordination, reduced muscular fatigue, and minimized sensitivity to asthmatic symptoms.

Basic Diaphragmatic Function

My findings reveal that the most prevalent form of breathing exercise promotes basic diaphragmatic function, enhancing proper inhalatory muscle movement and benefits the singer with asthma. Sixteen exercise examples, from the fields of vocal pedagogy and asthmatic respiratory therapy, demonstrate the importance of diaphragmatic movement in respiratory training. Exercises that promote diaphragmatic function are beneficial to the singer with asthma and pose minimal risk of asthmatic inflammation, while at the same time reducing lung hyperinflation and restoring the mechanical advantage of the diaphragm. Additionally, my findings showed that twelve of the sixteen examined exercises required little or no modification in order to achieve their intended pedagogical purpose. Inhalation through the nose is the only recommended alteration of these exercises, as nasal breathing warms and humidifies the air, reducing the risk of asthmatic triggers for the singer with asthma. By contrast, I found that the remaining four diaphragmatic-function exercises examined for this study require modifications in order to reduce extremes of lung pressure or weight resistance, because insufficient respiratory muscle strength can demand application of the head, neck, upper chest, and laryngeal muscle groups. Compensatory reaction by these muscles potentially increases laryngeal pressure and heightens the workload of the lungs, inflaming the bronchial airways and contributing to lung hyperinflation in the singer with asthma.

Strengthening of the Diaphragm and External Iintercostal Muscles

My findings for this portion of the study show that exercises designed to strengthen the diaphragm and external intercostals provide improved diaphragmatic function, flexibility, and strength to the singer with asthma. However, caution is recommended during the performance of

these exercises, as potentially harmful situations, including lung crowding, hyperinflation of the rib cage, extreme abdominal distention, and inappropriate closure of the glottis, can occur. Modifications to the exercises that are beneficial to the singer with asthma include swinging the arms or twisting the body to reduce thoracic tension, bending at the waist to isolate diaphragmatic function, tilting the head back to avoid clavicular muscle usage, and breathing through the nose to reduce potential airway inflammation. My observations show that application of the previous modifications reduces the asthmatic risks associated with diaphragmatic/intercostal strengthening exercises, making them suitable and beneficial for the singer with asthma.

Timed Respiration

The second most common form of respiratory exercise utilizes timed respiratory cycles and benefits the singer with asthma by strengthening the respiratory musculature. My findings further show that variations of this form of exercise, which employ pulsed respiration and walking during the exercise, significantly enhance the respiratory benefits for the singer with asthma through the increased mechanical capabilities of the diaphragm and improved respiratory muscle coordination. My observations reveal that exercises that include pulsed inhalation and exhalation can reduce the potential for respiratory muscle fatigue, while also increasing the mechanical capabilities of the diaphragm and improving respiratory muscle coordination. Additionally, my findings show that exercises that require either suspension of breath or extremely extended expiratory lengths (both of which were listed only in the vocal pedagogy sources) were the most problematic, as they potentially exacerbate asthmatic symptoms and require modification in order to benefit the singer with asthma.

Increased Expiratory Duration

This group of exercises--recommended only by vocal pedagogues for increasing expiratory muscle strength and duration--can be problematic for singers with asthma due to the length of expiration and the suspension of breath in the lungs. My findings show that the resulting mechanical force imbalances can result in hyperinflation of the rib cage, fatigue of the respiratory musculature, inflammation of the bronchial airways, and the exacerbation of disease symptoms in singers with asthma. These exercises are recommended for intermediate and advanced vocal students only, as these levels of vocal training demonstrate the necessary amounts of respiratory muscle strength and coordination. Regardless of the heightened training level necessary in utilizing these exercises, modifications are still required to provide the greatest benefit, with the least asthmatic risk, for the singer with asthma.

Respiratory Muscle Coordination - Panting

A second group of exercises recommended only by vocal pedagogues promotes proper coordination of both the inhalatory and exhalatory muscle groups. Panting exercises are particularly useful in the training of singers for attaining a balanced onset of breath during singing that requires precise vocal flexibility and control. My findings show, however, that exercises such as these can be problematic for the singer with asthma, as issues of muscle fatigue, lung hyperinflation, and respiratory gas imbalance can occur. The improper mechanical position of the diaphragm causes its premature weakening, subsequently trapping air in the lungs, distending the rib cage, and potentially exacerbating the asthmatic condition. I found that panting at a slower pace is the modification best suited to the singer with asthma. Utilizing

slower breathing cycles improves the movement of the diaphragm, increases coordination of the respiratory muscles, restores proper respiratory gas exchange, and minimizes asthmatic risk.

Expiratory Pulsing

This group of exercises--recommended by vocal pedagogues for the training of singers--are not utilized in the respiratory rehabilitation of the asthmatic. Each of these exercises presents significant risk to the singer with asthma by contributing to respiratory muscle fatigue, lung hyperinflation, and respiratory gas imbalances that are capable of triggering asthmatic symptoms. My research reveals that exercises that emphasize respiratory pulsing can severely alter measurements of respiratory function, consequently reducing muscular coordination and negating the training effects of the exercise. My personal observations further reveal that slowing the rate of expiratory pulses during these exercises increases diaphragmatic function and strength, and reduces muscular fatigue, thus providing respiratory benefit to the singer with asthma. Additional modifications, such as allowing for a progressive relaxation of the respiratory musculature, strengthens the diaphragm, prevents breath energy loss, and reduces the risks of asthmatic inflammation. Even with these modifications in place, these exercises are recommended only for advanced level vocal students.

Expiratory Muscle Strengthening

The final group of exercises common to both fields of study promotes strengthening of the expiratory muscles, contributing to respiratory muscle coordination and to diaphragmatic function, flexibility, and strength. Medical research shows that the strong exhalation of air, recommended in these exercises, provides significant benefit to the singer with asthma through

reduced sensitivities to asthmatic triggers and the possible removal of mucus buildup in the lungs. However, my conclusions reveal that caution is warranted during the performance of these exercises, as extreme lung pressures contribute to increases of abdominal and thoracic-muscle tension, application of accessory and laryngeal muscle groups, and improper diaphragmatic usage, thus negating the intended purpose of the exercise. I recommend modifying these exercises to include bending at the waist, breathing through the nose, and timing individual respiratory cycles, because these alterations provide greater diaphragmatic strengthening, reduce muscle fatigue, and minimize asthmatic risk for the singer with asthma.

Enhance Lower Back Expansion

These exercises require bending of the body in order to fully utilize the muscles of the lower back, providing a deep diaphragmatic contraction that strengthens the respiratory musculature. My findings show that leaning forward is beneficial for the singer with asthma, because this postural position suspends the rib cage, relaxes the external intercostals muscles, and reduces thoracic muscle tension. Additionally, this position negates inappropriate breathing strategies and allows for full utilization of the diaphragm. The singer with asthma needs to avoid extremes of inhalatory effort, as this is indicative of incorrect usage of the respiratory musculature and can provoke the onset of asthmatic symptoms. Focusing solely on the depth of breath and expansion of the lower back throughout these exercise provides the greatest benefit to the singer with asthma

Conclusions from the Examined Exercises

My observations conclusively demonstrate (a) that similar respiratory training methodologies exist in the fields of vocal pedagogy and asthmatic respiratory therapy and (b) that specific types of exercises provide superior benefit in the respiratory training of the singer with asthma. Exercises that develop basic diaphragmatic function, increase respiratory muscle strength and duration, and reduce asthmatic risks are deemed the most beneficial for the singer with asthma. Beginning, intermediate, and advanced levels of these exercises have been evaluated and are considered appropriate for persons that possess the required training criteria within each level. Exercises that demand extremes of lung pressure, breath duration, and muscle resistance or coordination can contribute to muscular tension, airway inflammation, lung hyperinflation, and inappropriate use of the vocal folds for the singer with asthma, and should therefore be utilized only by advanced level singers with asthma--those that have more than six years of vocal study. I recommend the modification or avoidance of specific exercises, as their unaltered application can present a significant respiratory risk for the singer with asthma. Recommended modifications can potentially lower asthmatic risks by lessening muscular tension and fatigue, even as they create new exercises that promote improved diaphragmatic function, increase respiratory muscle strength, and enhance vocal duration, all of which significantly benefit the singer with asthma.

RECOMMENDATIONS FOR FURTHER STUDY

The preliminary conclusions reached in this study, based on analysis and deductive reasoning, demonstrate a need for controlled clinical trials to ascertain their validity. A panel of researchers from the fields of cardiology, pulmonology, exercise physiology, pharmacology, and

vocal pedagogy could represent the primary areas of inquiry. However, my research suggests that supplementing these fields with qualified practitioners or instructors of the Alexander Technique, massage therapy, homeopathy, and herbal medicine could encourage substantial empirical investigation of these alternative methods of intervention, therapy, and rehabilitation.

The body of research concerning asthma, its causes and symptoms, is growing rapidly, yet there is little research on non-pharmacological methods of treatment beneficial to the singer with asthma. Medical research demonstrates improvement of asthmatic symptoms and lung-function parameters through nutritional supplements, with evidence concluding that specific vitamins and herbs may affect the asthmatic's biochemical profile, thereby reducing the frequency and severity of the disease.[130] Although vocal scientists recommend limited ingestion of specific vitamins, minerals, and herbs considered detrimental to phonation, these nutrients may be necessary for the improved health and respiratory function of the singer with asthma. Investigative studies to determine the benefits and/or limitations of nutritional supplements would be invaluable for singers with asthma, their healthcare providers, and vocal instructors.

Diaphragmatic strength studies utilizing devices that increase airflow pressure during inspiration show improvement in measures of lung function and resistance to muscular fatigue during physical performance.[131] Diaphragmatic muscle training that utilizes inspiratory training devices may provide enhanced benefit to the singer with asthma, demonstrating a significant need for further research in this area.

The research examined in this study illustrates that asthma may not be reversible in all cases, thus requiring the asthmatic to seek medical intervention to control the disease. Several studies have demonstrated specific problems for the singer with asthma as a result of inhaled

[130] Firshein, 134-47.
[131] Volianitis et al., 806-8.

asthma medications and their apparent side effects. Additional research may reveal new medical options for the singer with asthma, providing increased effectiveness in drug therapies without the current health and phonatory risks associated with inhaled steroids and their accompanying propellants.

Research in vocal pedagogy and related medical fields prove that the act of singing is a form of exercise capable of triggering asthmatic episodes, with both fields recommending drug therapy for the alleviation of disease symptoms. Due to the long-term physiological effects of these medications on the vocal folds, I propose that alternative, non-pharmacological methods of disease treatment are preferable for the singer with asthma. Controlled studies of lung-function measurements could significantly enhance respiratory-function measurements for the singer with asthma, without the risk of drug-induced side effects.

Vocal research demonstrates a relationship between medication for allergies and the occurrence of mild forms of vocal dysphonia, yet these oral medications may be necessary to the asthmatic for alleviating symptoms and reducing sensitivity to allergic triggers. Additionally, increased mucus levels in allergy-induced asthma necessitate the ingestion of medications that minimize mucus production and dry the sinuses, despite the adverse systemic effect of drying the pharyngeal and laryngeal tissues. Further research could benefit the singer with asthma by identifying medications that inhibit allergic asthma symptoms while also enabling proper vocal production.

Research into the connection between asthma and gastro-esophageal reflux disorder (GERD) requires more extensive study, as the detrimental effects of this disease on the voice are considerable. Increased levels of stomach acid are common in GERD, burning the vocal folds

and limiting their vibratory potential. Recent findings demonstrate a connection between these two diseases, revealing significant potential dangers to the singer with asthma.[132]

The limitations of current research concerning the respiratory function of singers, wherein subjects suffering from pulmonary dysfunction are excluded, suggest that greater study is necessary to establish scientific parameters regarding the effects of asthma on lung function in singers with this disease. Clinical assessment of singers with asthma will provide beneficial statistical data concerning lung-function parameters and training methodologies for enhancing respiratory measurements, the benefits of nutritional supplements to lessen disease severity, the identification of appropriate drug therapies for the singer with asthma, and a myriad of other possibilities.

The examination of asthma, as it affects the singing voice, presents many research possibilities yet to be determined. My intention in this study is to illustrate the possible differences between asthmatic and non-asthmatic singers with regard to lung-function measurements, and to demonstrate how commonly recommended exercises, both physical and respiratory, impact the training capabilities of the singer with asthma. It is my hope that this study provides greater understanding of the implications of the disease on vocal training, and that it leads to additional studies that further quantify the physiological effects of asthma on the singer.

[132] Cohn et al., 336.

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