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A Review of the Physiologic, Psychological and Therapeutic Effects of Yoga

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Rationale for Yoga as a Nursing Intervention

The World Health Organization defines health as a state of wellbeing, which includes physical, mental, social and spiritual dimensions and not simply the absence of disease or illness (Bhobe, 2000). Holistic nursing philosophy includes the understanding that a balance of mind, body and spirit is necessary for health (Dossey, Keegan, and Gussetta, 2000). As nurses are concerned with helping individuals attain optimized states of health, it is important to consider and use a holistic frame of reference, which includes all of the dimensions of health or state of wellbeing. Yoga is a method used for human development in order to attain higher physical, mental, intellectual, emotional and spiritual levels (Subhaviati, 2000). Thus, yoga may be a useful complementary intervention to achieve optimal health and fits within a holistic nursing philosophy.

The increasing popularity of yoga has been frequently referenced in the popular press in magazines such as *Time* (Corliss, 2001), *Newsweek* (Capouya, 2003), *Self* (Schneider, C., Luck Pearson, S., Marston, W., & O’Connor, A., 1998), *Shape* (Shelton, 2004; Sherman, 2004), and *Consumer Reports* (2004, September). In Northwest Ohio, local wellness and exercise facilities such as the YMCA have substantially increased the number of offerings of yoga classes to their members in the past to five years. La Forge (1997) notes the prevalence of health promotion programs in today’s health care arena with an increased focus on health risk assessment, smoking cessation, weight and stress management and physical fitness.

Acknowledging that many diseases are incurable and that there are limitations in the current health care system and modern medicines’ effectiveness in treating many chronic
illnesses, alternative therapies such as yoga may offer benefits and provide some symptomatic relief (Bhobe, 2000). Yoga may be an effective intervention, not only for the treatment of chronic conditions, but also for the prevention of illness and the maintenance of health and wellness.

Some of the long-held claims of health benefits of yoga practice expressed by yoga instructors and practitioners have been examined in a variety of research studies. Many studies on yoga have come from India, where yoga has been practiced for centuries. Despite the increase in the practice and use of yoga in the United States, there have been few studies from the U.S.

Different reported psychological, physiologic and somatic effects have been observed with the practice of different forms of yoga. There are several different types of yoga as well as multiple components or variables involved with yoga practice (i.e. meditation, breathing, body postures or exercises). This adds to the complexity of evaluating studies on yoga thereby, making it difficult to evaluate and separate the specific reasons for, and the rationale behind, those observed effects. While yoga has been studied in a variety of settings, similar findings have also been observed in studies of different independent and related components of yoga, such as: meditation (Wallace, 1970, Woolfolk, 1975), biofeedback (Lehrer, 2003), and rhythmic and slow breathing (Joseph et al 2005; Bernardi et al., 1998).

Nursing literature has very limited references promoting the benefits of yoga practice as an aid for stress management and promoting health. Pettinati (2001) notes the use of yoga as a method of primary and secondary prevention for cardiovascular disease. LaForge (1997) identifies methods of mind body fitness, which include yoga as encouraging prospects for promoting wellness, with implications for primary and secondary prevention of cardiovascular
disease. In the case of cardiovascular disease, mind body exercises as a form of complementary therapy may have merit, but no clinical practice guidelines currently exist (La Forge, 1997). Likewise, Pandya, Vyas and Vyas (1999) describe yoga practice as a valuable noninvasive method for management of heart disease, but little research has been published on yoga’s application in this patient population.

Much of the published literature in nursing consists merely of anecdotal remarks and simplistic explanations of yoga practice techniques and does not examine the claimed health benefits through controlled studies (“Discovering Yoga”, 2001; Allen, 2000; Collins, 1998; Fields, 1995) LaForge, 1997; Wanning, 1993). While controlled studies are lacking in nursing literature; the physiologic, psychological and therapeutic effects of yoga have been examined in controlled research studies by other disciplines.

Purpose

The purpose of this review is to analyze and synthesize the literature to describe the physiologic, psychological and therapeutic effects of yoga. There are several reasons to undertake such a review. First, the very large number and variety of studies that have been conducted on yoga make generalizations from the results difficult. Second, most of the studies have been conducted using small sample sizes, and the pooling of similar results may potentially offer more power and support of some of the study findings. Third, by using explicit, well defined and controlled criteria for inclusion and review of studies, it will be possible to decrease bias and improve the reliability of any conclusions drawn from the review.

Significance to Nursing. In order for nurses, advance practice nurses (NPs, CNS, and Midwives) and health care providers to understand and use yoga as an intervention to promote, maintain and attain holistic health, it is necessary to determine the physiologic, psychological
and therapeutic effects of yoga. Yoga has been examined and studied in various settings and clinical areas, but is not well described in nursing literature. Nor has it been studied in any extensive manner within the context of management of disease and altered health states.

The benefits of conducting an extensive review of the literature on yoga include identifying what beneficial effects may be achieved for individuals who practice yoga. Nurses and primary care practitioners may gain a better understanding of the physiology and theoretical basis of those potential beneficial effects. In addition, understanding terms and concepts related to yoga practice will be helpful when describing and recommending the use of yoga as a therapeutic modality. Issues with morbidity in individuals with chronic medical conditions as well as potential hazards associated with the practice of yoga may also be identified.

Additionally, nursing researchers, other health care providers, and public health professionals will be able to identify and prioritize new and additional questions that need further examination in relation to the effects and impact that yoga may have on health and treatment outcomes. Finally, once the effects of yoga are more clearly understood, practitioners will be better able to identify which individuals may benefit from the use of yoga as a complementary therapy. As a result of this review, an additional aim is to develop a beginning practice protocol on the application of yoga as an intervention or therapy for use by advance practice nurses and other primary care providers.

*Complementary Therapies.* Complementary therapies, also sometimes referred to as alternative medicine, can be defined as methods that exist or have evolved outside the biomedical or traditional mainstream of modern medicine as it evolved in industrialized and western societies (Bodeker & Kronenberg, 2002). Commonly viewed complementary therapies include methods for relaxation such as meditation, biofeedback, relaxation therapy, imagery or
hypnosis; other modalities such as chiropractic, acupuncture, homeopathy, massage; energy and spiritual modalities such as healing touch, Reiki and religion; as well as interventions such as music therapy, aromatherapy, and reflexology (Freeman, 2004). Nutritional supplements and herbal remedies also fall into the category of complementary or alternative therapy.

The use of complementary therapies has been steadily increasing. Eisenberg and his colleagues (1998), in a study of the trends and use of alternative medicine in the United States from 1990 to 1997, found a substantial increase in the utilization of alternative therapies. The study identified that relaxation methods are frequently used as complementary therapy. They also identified the conditions most frequently treated with the use of alternative therapies, which include chronic conditions such as back pain, anxiety, depression, and headaches.

Saper, Eisenberg, Davis, Culpepper, & Phillips, (2004), in an additional analysis of Eisenberg’s (1998) data further describe the prevalence and patterns of the use of yoga. These data about yoga use were collected, but not included in the initial report of study findings. With a 60% weighted response rate, 154 individuals from a sample of 2055 reported using yoga at least once in their lifetime for a rate of 7.5%. Current use, as defined by practice of yoga in the past 12 months, was 3.7% of the total survey respondents. Using weighted results and estimates for the US adult population of 200 million in 1998, an estimated 15 million were yoga users, of which 7.4 million would be considered current users. Yoga was used by individuals for both wellness (63.7%) and for common health conditions (47.9%). Common health conditions that yoga was used for included: back and neck pain (21%), anxiety (8.2%), arthritis (6.8%), depression (6.6%) and fatigue (4.0%). Of those using yoga for health conditions, 96% felt that yoga was very or somewhat helpful for their health condition. The authors note that yoga use
may be underestimated in the study since the data was collected 5 years previous to the publication of the analysis.

Using data from the 1996 Medical Expenditure Panel Survey which had 16,038 initial respondents, Druss and Rosenheck (2000) examined the use of complementary modalities and found that those individuals with self reported mental conditions, especially those with transient distress, had an increased use of complementary therapies. A noteworthy limitation in this study was that the mental conditions were self reported and not diagnosed by a trained health care provider. Thus, it appears that some individuals who recognize their own mental stress use complementary therapies to help deal with their stress.

Druss and Rosenheck (2000) noted that the boundaries between traditional medicine and alternative medicine are in flux, what was previously considered unconventional or complementary has sometimes been accepted in into mainstream medical theories and treatments. This factor is important for making inferences and interpretations from the data collected from different studies. Less distinction should be made between what is considered a complementary or alternative practice, and what is considered traditional. Instead, the emphasis should be on the scientific evidence that a therapy, whatever its kind, is effective and cost efficient (Druss & Rosenheck, 2000; Fontanarosa & Lundberg, 1998). Practitioners need to be knowledgeable of complementary therapies and the possible benefits as well as the limitations of such treatments (Fontanarosa & Lundberg, 1998). Likewise, Bodecker and Kronenberg (2002) discussed the importance of a public health agenda for not only traditional, but also for complementary and alternative medicine. Safety, efficacy and quality of complementary interventions; cost factors, financing and insurance coverage for those interventions; as well as regulation of practitioners need to be examined and studied.
Stress. Recall that the purpose of this review is to analyze and synthesize the literature to describe the physical, psychological and therapeutic effects of yoga. Many research studies measure the effects of yoga on stress physiology or conditions that have stress as a symptom. Therefore it is important to define and describe stress, the physiology of the stress response, and how it plays a role in numerous acute and chronic disorders.

Stress is both the perception of a threat to one's being and a perceived inability to cope (Dossey, Keegan & Guzzetta, 2000). Stress is any response, whether physiologic, psychological, or behavioral that occurs as a result to exposure to an evocative agent or stressor (Levi, 1972, as cited by Freeman, 2004). Stressors can be either or both psychological or physiologic in nature. Stress produces physiological and or psychological disequilibrium and may result in physical, psychological, behavioral and/or spiritual changes. The perception of stress can vary from one individual to another.

In response to stress the mind and body communicate and respond via the nervous, endocrine, and immune systems. The sympathetic-adrenal-medullary (SAM) axis, a primary and direct communication pathway within the body, activates the autonomic nervous system (ANS) using neurotransmitters and neuropeptides to regulate many physiological processes. Concomitantly and indirectly, the hypothalamic-pituitary-adrenal cortex (HPA) axis controls and regulates endocrine and hormone secretion. The hypothalamus is an important gate keeper in regulating both ANS and endocrine activities. Not only does the hypothalamus regulate commonly considered stress hormones, but it also releases hormones that influence emotions and behavior such as enkephalins or endorphins which produce pleasure. It also regulates basic biological drives such as thirst, hunger and sex. In response to stress, hypothalamus activation stimulates the posterior pituitary secretion of antidiuretic hormone affecting water retention,
vasoconstriction and subsequently blood pressure (McCaffrey, Ruknui, Hatthakit, and Kasetsomboon, 2005). The hypothalamus also has close links with the limbic system. The limbic system represents brain structures including the medial wall of the cerebral hemisphere which consists of the hippocampus, amygdala, and fornicate gyrus along with their connection to the septa area and reflects the emotional part of the brain influencing mood and motivation. The limbic system also influences endocrine and autonomic motor systems with the most simple example being the flight or fight response (Freeman, 2004).

The interactions between the nervous and immune systems have more recently been revealed and are beginning to be better understood which help explain the influence of emotional and psychosocial factors on the development of, and response to, illnesses such as infectious, autoimmune disorders, and neoplastic diseases (Ader, Cohen & Felten, 1995). The brain and the immune system are linked by the autonomic nervous system and the neuroendocrine system. Lymphoid tissue and organs have noradrenergic postganglionic sympathetic nerve fibers that release neurotransmitters to act on immune cells such as lymphocytes, monocytes, macrophages and granulocytes that all possess receptors for these neurotransmitters. As a result, the neurotransmitters can affect immune responses such as inhibiting thymocyte mitogenesis or enhancing expression of cell surface differentiation antigens. Antibody responses, complement activation and natural killer cell activity also have been observed to be influenced by neurotransmitters and neuropeptides (Ader, et al.,1995; Pert in Freeman 2004, p16-17). Thus it is easy to understand that “all immunoregulatory processes take place within a neuroendocrine environment that is sensitive to the influence of the individual’s perception of and response to events in the external world” (Ader, et al., 1995, p 100).
Physiologically, stress, either as a direct physical insult, as might occur as an invasion of an infectious organism, or as perceptual/cognition form, such as the case with worry or pessimistic attitudes, causes a series of biochemical reactions in the body in order to deal with the stress invasion. The central nervous system is key in initiating and regulating stress responses via sympathetic nervous system reactions that increase heart rate, blood pressure, respirations, muscle tension, blood glucose, coagulation times and galvanic skin responses (i.e. sweating) (Freeman, 2004).

In contrast to the sympathetic nervous system role in mobilizing the body’s energy and resources in emergent and stressful situations, the parasympathetic nervous system acts to inhibit the body’s responses to stress allowing the body to unwind or relax and conserve energy. Thus interventions that induce the parasympathetic responses have healing effects on the body (Dossey et al., 2000).

Common behaviors or symptoms observed with stress include anxiety, fear, increased mental activity, dyspnea, hyperventilation, gastric irritation, diaphoresis, tremors, restlessness, muscle tension and agitation. The psychological effects of stress include negative mood states, including depression, anxiety, hostility, and anger (Dossey, et al. 2000).

Behavioral effects of stress influence social interactions and often result in individuals reverting to less effective and sometimes unhealthy coping behaviors such as smoking, eating, drinking alcohol or using illegal drugs. Stress can also influence spiritual wellbeing by resulting in disconnection from one’s own beliefs, understanding and perceptions of life’s meaning (Dossey et al., 2000).

Mood states have been associated with morbidity and mortality rates in those with hypertension, and other cardiovascular diseases. As well, people with diseases associated with
immune dysfunction and other conditions have been shown to benefit from methods used to reduce stress. Spirituality, religion and health have been positively correlated in many studies. Because all systems are interconnected, holistic interventions contribute to health and healing (Dossey, et al., 2000, p. 82).

In contrast to the immediate responses to stress that occur, individuals who are chronically stressed often exhibit increased muscle tension, decreased peripheral skin temperatures and hyperactive responses to stress (Freeman, 2004). Having a chronic disease may be viewed itself as a major stressful life event (Heijman et al., 2004).

Patients with different chronic diseases were examined by Heijman et al., (2004) to identify the way stressors are experienced. Eleven chronic disease stressors were examined and described as: life threatening, progressive deterioration, intermittent character, control by self care, pain, fatigue, visible body changes, physical disability, social disability, and mental disability. Although many common stressors exist within the chronic conditions examined, the degree and type of stress differed according to the extent to which the disease was perceived controllable by either the medical care used to treat the condition or by oneself; by the perceived pain associated with the illness; and by the physical consequences or physical disability that occurred with the illness. In addition, personal environmental factors such as age, gender, marital status, level of education and length of illness were found have some correlation with perceived control and level of disability.

Defining yoga. Yoga is an ancient practice originating thousands of years ago in India and is described in Vedic scriptures around 2500 BC (Tran, Holly, Lashbrook, & Amsterdam, 2001). The word “yoga” comes from the Sanskrit term meaning union. While some describe yoga as a type of physical and mental exercise (Ripoll & Mahowald, 2002), yoga is also viewed
as the union of the mind with the spiritual dimension of a divine or universal intelligence (Raub, 2002). Despite the spiritual dimensions associated with yoga practice and its origins in Eastern cultures, yoga itself is not a religion.

Bhobe (2000, p. 42) describes and defines yoga as “a science of holistic living,” where physical, psychological and spiritual dimensions bring harmonious development of the mind, body and soul of humans. Yoga is both a traditional and scientific system that alters the brain and body chemistry with benefits of induced states of mental and physical relaxation (Khasla, 2003). Yoga’s ancient beginnings and teachings claim a variety of effects from yoga practice on the mind, body and the internal organs. There are many different dimensions to the practice of yoga and many different types of yoga. Teachings of yoga vary, but consistent to most descriptions is that from a central core come eight limbs of yoga (Farhi, 2000). Two limbs, Yamas and niyamas, are 10 ethical principles to live by, such as telling the truth and having compassion for all living things. The limb of Asanas, or body postures, helps keep the body flexible, strong, and relaxed as well as strengthens the nervous system and improves the ability of inner perception. Pranayama, or breathing practices, focuses on breath and prana or life force. Pratyahara deals with drawing attention toward silence. Dharana focuses on inner perceptual awareness. Dhyhana is the sustaining of awareness, and Samadhi returns the mind into original silence.

Yoga is complex in that it is a holistic practice that incorporates several components: relaxation, meditation, controlled breathing and assuming different body postures. The differences in the type of yoga practiced may vary on the amount of integration of these different components. The four mainstreams of yoga practice include: Jnana, Raja, Bhakti and Karma (Bhobe, 2000). Hatha yoga is one part or dimension of Raja yoga and is the form most frequently
practiced in the United States and in Western societies. Hatha yoga emphasizes exercise aspects or postures and movements called “asanas” along with breathing, known as “pranayama” and meditation or “chanda.” Other types of yoga practices may focus more on meditation, chanting mantras, different controlled breathing techniques, and spiritual dimensions, as well as asanas or body postures. Dietary practices, often vegetarian based, and body cleansing procedures are also considered in different types of yoga.

Yoga can be practiced in a classroom setting or at home. Yoga is usually taught in a classroom setting by an instructor; however, there is no universal or standardized certification or training method for becoming a yoga teacher. The Iyengar form of yoga is one of the few forms of yoga that has an extensive training and certification method. During the practice of yoga, participants are directed and guided through different sequences of body postures and movements known as asanas, which are incorporated with breathing and relaxation. Yoga is noncompetitive, with a focus on body awareness and recognition of individual differences and abilities. Participants are told to listen to their bodies and instructed in various postures along with modifications for the postures to incorporate into practice based on each individual’s own ability, flexibility and strength. In performing the asanas and relaxation, specific controlled breathing patterns and breath awareness are sometimes incorporated. Meditation is also often integrated into practice. Because yoga is very individualized, the length of time one practices can vary. Frequently classes last an hour, but can be adapted to whatever time is available. The difference between yoga and other forms of exercise is that in the practice of asanas one develops more body, as well as inner awareness along with muscle strength and flexibility. With yoga a deeper awareness brings about balance in body and spirit (Smith, Hall, & Gibbs, 2004).
Holistic principles of health are an essential part of many nursing conceptual models. Theorists such as Orem, Neuman, and Rogers all use holistic perspectives in their models of nursing practice (Donnelly, 2003). The meaning of holistic health has evolved with more mainstream use of complementary and nontraditional modalities to treat illnesses, improve chronic health conditions, and to promote and maintain health. Betty Neuman’s Systems Model is a nursing theory that can be utilized to guide nurses’ use of complementary therapies such as yoga to promote, attain and maintain health. Neuman’s theory embraces and is easily aligned with beliefs and understanding of holistic health principles. The model defines nursing interventions to be ‘prevention as interventions’ that are directed toward different stressors (Neuman, 1995). Thus, the use of yoga as an intervention against stressors is congruent with Neuman’s model.

Three importantly held beliefs in Neuman’s model include: (a) wholism, where both philosophical and biological relationships and dynamic processes arise from wholeness, and adjustments are made to stresses in the internal and external environments; (b) reality, formed by the client’s own perception of wellness and defined in terms of interrelationships of available energy, the client’s created environment, and the nurse or caregiver’s clarification of the client’s health perception; and (c) wellness, an experienced energy based reality that is illusive and is defined and negotiated between the client and the nurse (Neuman, 1995).

An assumption in Neuman’s Systems Model is that the individual or client system is composed of five different interacting variables, including: physiologic, psychological, sociocultural, developmental and spiritual dimensions, which are all viewed as part of the whole (Neuman, 1990a, p.129). The five interacting variables make up the core of the client system are
represented by the center of a concentric design (See Appendix A, Figure 1). Because yoga is believed to promote wholeness through physical, psychological and spiritual dimensions; the variables described in Neuman’s model fit in well with the assumed effects of yoga. Likewise, Neuman’s theory incorporates beliefs of holistic health with human wellbeing encompassing not only physical dimensions, but mental and spiritual dimensions as well.

One of the core concepts to understand with Neuman’s model (1995) is the environment. Neuman describes three different environments; internal, external and created environments influence the client either positively or negatively. The created environment, which is developed unconsciously by the client’s own perception, plays an important role in determining the response to stress. The client system is in dynamic and constant exchanges of energy with the environment. For health or wellness to be present, a stable yet dynamic state must be established. This state of health exists when the amount of energy stored or used is in balance and is related to the client’s own wellness. The balance of energy described by Neuman can easily be correlated with many of the dimensions of balance and energy associated with yoga. Yoga promotes a balance of mind, body and spirit, through the practice of breathing, asanas and meditation. Asanas are practiced by performing different stretches and postures equally on each side of the body. Contrasting stretches which incorporate both extension and flexion are performed to balance the body. Energy use in yoga practice is also controlled and balanced with a focus on breathing, awareness of body position and areas of tension, and the conscious release of that tension with promotion of relaxation. Yoga likely serves to conserve and increase available energy within the core and the flexible line of defense through the reduction of sympathetic nervous system activity and increase in parasympathetic activity achieved through relaxation, breathing and practice of asanas. Most importantly yoga’s focus on self awareness,
balance, and heightened and realistic perceptions may help form a more balanced and realistic
created environment, as well as better awareness of internal and external environments.

Neuman’s model (1995) is based on assumptions of stress and the client systems reaction
to stress. In Neuman’s Systems Model, stressors are considered neutral, but the client’s
encounter determines whether there is a beneficial or noxious outcome to the stress. This
assumption aligns well with beliefs that yoga helps one balance the stresses experienced in daily
life and helps put life’s failures and disappointments into perspective. Therefore, events seem to
be less stressful and not necessarily connected to one’s own sense of self-worth. In yoga, the
mechanisms of relaxation, deep breathing and physical training and control likely contribute to
an individual’s ability to deal with stress.

In Neuman’s model (1995) stressors are described as intrapersonal, interpersonal or
extrapersonal, and nursing is concerned with reducing actual or potential stressor reactions.
Within this context, nursing’s goal is to promote optimal client stability by applying
interventions to reduce actual or potential stress reactions. Betty Neuman explains that the
function of nursing interventions is to retain, attain and maintain an optimal level of wellness.
Nursing interventions are defined as prevention as intervention and include three levels: primary
prevention, secondary prevention, and tertiary prevention.

Assessing potential or actual stressors, different prevention strategies, the level of health,
and the client system stability are part of nursing’s involvement in use of prevention as
intervention (August- Brady, 2000). Within the context of prevention as intervention, yoga
could be implemented as any of the following three described prevention interventions. Primary
prevention would involve the use of yoga to retain health by practicing before a stress occurs. A
primary prevention acts to decrease potential encounters with, or negative reactions to, stress.
Wellness retention through the use and application of yoga would serve to strengthen the flexible line of defense. Appendix A, figure 2 is a substruction diagram of the Neuman Systems Model that provides an example of the use of yoga as primary prevention.

Secondary prevention would use yoga as an intervention to attain wellness or health after a reaction to a stressor has occurred. In this application, yoga’s function would be to strengthen the internal lines of resistance and reestablish stability in the normal line of defense. At this level of prevention, yoga would be used to treat some symptoms that have altered the state of health (i.e., treatment of chronic back pain, mild depression, or hypertension). In Neuman’s model, effective lines of resistance act to reverse the reaction to stressors and allow the client system to reconstitute toward wellness (Neuman, 1995). An intervention such as yoga applied after a reaction to stressors has occurred, would strengthen the internal lines of resistance and help reestablish the normal line of defense.

Tertiary prevention involves maintenance of optimal wellness following treatment of a stressor reaction. It comes full circle in the final attainment of health after intervening and responding to a stressor. Tertiary prevention easily evolves into primary prevention once wellness is attained. Continuation and incorporation of yoga in daily life exemplifies yoga’s application as a tertiary prevention.
Methods

Design

This research design is a systematic analysis of the published literature on yoga and the effects of yoga practice. A comprehensive search of potentially relevant studies conducted on this topic is included. Just as with any retrospective and observational study, the review is subject to systematic and random error (Meade, 1998). Thus, criteria are used to determine a study’s merit and eligibility for review to minimize these potential errors. This review is qualitative with no meta-analysis or combination of statistics. The search for appropriate studies for review occurred over a 12 month period in order to assure that all potentially eligible studies were identified, accessed, and included in the review.

Methods

Primary research related to yoga is examined in this systematic review. Studies were included if they are published in any refereed scientific journal published in English. The selected journals cover a variety of disciplines including medicine, psychology, biophysics, physical therapeutics, pharmacology and nursing cited in the computer based electronic databases of: CINAHL, Pubmed, MEDLINE, the Cochrane Library, and Psych Lit as recommended by Hunt and Kibbon (1998). The National Center for Comprehensive and Alternative Medicine website and database was also searched. The Yoga and Research and Education Center and the Swami Vivekananda Yoga Research Foundation have compiled extensive listings of published research papers on yoga that were used to identify potentially eligible studies. Finally, manual searching through the bibliographies and reference lists of the published articles added to the sample of research articles.
Key words used for searching electronic databases included yoga, yogic, hatha yoga, raja yoga, effects of yoga, complementary therapies and yoga, and alternative medicine and yoga. In addition, medical conditions for which yoga has claimed to benefit were also searched, specifically arthritis, chronic back pain, musculoskeletal disorders, depression, headaches, asthma, COPD and heart disease. For ease and facilitation of reproducibility, non-published works were not included in this review.

Sample Selection

All scientific research studies on the effects of yoga were considered for review regardless of the date of publication. Dates of publication were not restricted for three reasons. First, there are many studies published on yoga, but a majority are greater than 10 years old with many from the 1970’s and 80’s. Despite being dated, the results derived from those studies still provided meaningful data within the boundaries of this systematic review, and helped answer research questions. Second, older studies of sound design provided data on important variables and comparisons with control groups. Third, many of the studies measuring physiological effects were described in some of these early and classic studies. They were important in establishing the reasoning behind the believed benefits of yoga. Raub (2002) noted that one of the benefits of older studies is that negative findings were more frequently reported and published due to different editorial policies. Indeed, if more studies with negative findings were reviewed, less bias in the systematic review of literature would exist (Thacker, 1990).

The number of subjects included in each study was not a factor for inclusion or exclusion in the systematic literature review. Many of the studies have small samples, which are recognized as an important and expected limitation of this review. It is for that reason that a
systematic review is beneficial in aiding the interpretation of limited data by potentially analyzing the effects of an intervention from several small but similar studies.

Studies included a variety of designs, including experimental, controlled comparative, open and descriptive categories. Single case studies and anecdotal reports were eliminated. Also excluded were studies dealing with yogic cleansing, studies examining only the spiritual dimensions of yoga, or studies dealing only with chakras. Duplicated study reports were identified and eliminated so that each study is only reported once.

**Conceptual Definitions**

Yoga is a broad term used to describe a variety of different specific yoga practices. This is a variable that is only sometimes described and defined in more specific terms in the studies reviewed. For the purposes of the systematic review, the type of yoga was not considered a factor for exclusion, but was another variable examined in the analysis of each study. Therefore, the definition of yoga is any yoga practice that incorporates the main components of hatha yoga, which is most familiar in the western interpretation of yoga. The three main components of hatha yoga implied in this definition include: asanas (body postures), pranayama (breathing) and chanda (meditation) (Feuerstein, 1996). The type of yoga used in a study or the focus of yoga practice, such as a breathing focus, an asana focus or a meditation focus, were recorded and incorporated in a part of the organizational structure of the systematic review.

**Materials/Tools and Data Collection**

A tool to collect and organize data was derived from the components in the research process and the research review processes. Resources describing similar tools were reviewed (Burns & Grove, 2001; McQuay & Moore, 1998) and adapted to create a data collection tool for this systematic review. The tool was reviewed by peers and faculty for appropriateness of its
purpose, and revisions were made after initial articles were reviewed to ensure comprehensive collection of the data and the multiple variables. The data collection tool was designed for use in a table format and included recording of: 1) author, 2) date, 3) journal, 4) study purpose, 5) sample size, 6) age and gender, 7) type or focus of yoga, 8) length of yoga intervention, 9) physical condition or illness, 10) conceptual framework, 11) study design, 12) variables, 13) instruments, 14) results, 15) implications reported by author, and 16) any comments related to study limitations including the number of and reason for dropouts from the study. (See Appendix B)

Once data were collected, each study was reanalyzed and compared to the table to assure accuracy. Data were then displayed in table format and grouped according to different categories of research studies. Different groupings were examined and analyzed to identify both common and/or conflicting themes and methods. Demographic characteristics were compared and contrasted as well. Data were cleaned by re-reviewing inclusion and exclusion criteria for each study to assure stringent standards were maintained. Each study included is treated as a single datum.

Analysis

Methods of analysis for each research study incorporated the use of Evans and Shreves’ (2000) ASK method. Using The ASK method, studies were assessed for applicability, science and knowledge. Applicability of each study to the questions the literature review is trying to answer was assessed. In this systematic review, the question is: what are the physiologic, psychological and therapeutic effects of yoga? The science of each study was examined by identifying problem statements, research questions and the purpose of the study. Science was validated by critically reviewing the literature used to support the study as well as the theoretical
and conceptual frameworks, the methods, design, data collection, reporting of findings, and the analysis of the outcomes of the study. Knowledge of each study was determined by examining the findings of each study and analyzing how those findings fit in with the existing knowledge base of yoga and human physiology and psychology.

In addition, Counsell (1998) identified four important variables for answering clinical questions. Consideration of these variables was also used in the analysis of each study and included examination of: 1) the specific population and setting; 2) the condition of interest; 3) exposure to treatment, which in this case is exposure to yoga; and 4) the specific outcomes.

Studies were categorized according to the results of the study and the type of conditions or patient populations the study examined were and grouped as follows:

- Physiological and biochemical effects of yoga
- Cardiovascular, pulmonary and breathing effects of yoga
- Psychological and mood effects of yoga
- Musculoskeletal effects of yoga

Once the studies were categorized further analysis and summary were organized to include:

- Results
- Analysis and Summary of biochemical parameters
- Analysis and summary of cardiovascular effects
- Analysis and summary of respiratory and pulmonary effects
- Analysis and summary of neurological effects
- Analysis and summary of mood/mental status effects
- Analysis and summary of musculoskeletal effects
- Yoga methods/styles/techniques
• Duration of frequency of yoga intervention
• Injuries and adverse events

Assumptions and Limitations

Publication bias occurs due to the preferential reporting of studies that have positive results (Thacker, 1990). This bias can be limited by including unpublished studies. However, searching for unpublished work is difficult and would likely be incomplete given the time frame and resources available for this systematic study. Therefore, unpublished work was excluded from the review.

A large number of studies in the review were conducted in India. The presentation of findings in these studies is fairly complete and many studies conform to international standards for conduct, which brings arguments for the validity of the findings. An important limitation in several of the studies is lack of discussion of the validity and reliability of the tools used to measure the different variables that were being evaluated. In addition, the cultural differences between two very different countries such as the United States and India need to be considered. Different cultural backgrounds and belief systems may influence the interpretation of study findings (Kim & Han, 2004). The differences in the dates of the studies is such that different day to day activities in today’s society is a significant variable that differs from when many of these studies took place 15 to 30 years ago. Sample size is another important limitation in many of the studies included in this systematic review. Convenience samples were frequently used, and many times studies were conducted in healthy subjects with narrow age ranges where groups often consisted of young adults or healthy yoga practitioners. Generalizing findings of studies in such narrow and specific groups can not often be justified (Burnes & Grove, 2001); thus, results must be interpreted with caution.
Just as important as identifying limitations, it is also important to identify any potential adverse effects with any therapy, whether it is with a prescription medication or an alternative therapy. In the case of yoga, there are potential adverse effects in the form of musculoskeletal injuries from performing more difficult body postures or asanas. Unfortunately, adverse effects were rarely reported in the findings of most of these studies. Despite this limitation, any dropout or injuries reported in the studies were tracked so injuries due to yoga practice could be identified. The identification of such adverse effects may lead to the formulation of other important questions about the practice of yoga and implications for nursing and health care professionals. Finally, one of the biggest challenges was organizing studies with so many variables. Studies in yoga often record physiologic as well as psychological responses and the interrelated effects are difficult to place into one specific category. Thus, in the literature review, although an attempt was made to organize the studies, overlap in the variables measured and the findings were noted.

Review of Literature

Physiologic and Biochemical Effects of Yoga

General physiologic effects of yoga were first described in the context of Western medicine when Udupa & Singh, (1972) reported in a letter to the editor of the *Journal of the American Medical Association (JAMA)* a study conducted in India to assess the value of the claimed benefits of yoga. In the study, 12 healthy males, average age 23 (+/- 3.36) years, participated in a 6 month training course of Hatha yoga. Physiologic, metabolic, endocrine, and neuropsychological effects of yoga were evaluated. The specific details about the design, methods and controls used in this study were not presented in *JAMA*; however, the study findings were more thoroughly described elsewhere (Udupa, Singh, & Settiwar, 1971; Udupa, Singh, &
This sentinel study was a controlled, non-randomized study with pre-study, during treatment and post study comparisons of several variables. Study results suggested respiratory system benefits with slowing of the respiratory rate, and increases in chest expansion, lung vital capacity and breathe holding time. Reported metabolic effects included: enhanced adrenocortical activity with increased urinary excretion of 17-hydroxycorticosterioid, a decrease in urinary 17 ketosteroids and a trend for rising urinary catecholamines over the 6 month study. According to Udupa et al. (1971), these adrenocortical hormone changes were the most important observation from the study and explain why individuals may be more resistant to stress responses because of enhanced adrenocortical activity. Also, there was a significant decrease in serum cholesterol and blood sugar levels, and an increase in serum proteins and in urinary testosterone secretion. No significant changes were noted in cardiovascular functions in regards to heart rate and blood pressure. Psychological and biochemical evaluations showed significant changes following yoga practices when compared to pre-study measurements. Lowered neurohormonal activity claims were supported with scores indicating lower mental fatigability, increased performance and improved memory quotients, as well as a significant decrease in the neuroticism index. Using the Cornell Medical Index subjects reported a decrease in physiologic complaints from 125 pre study to 64 at six months, and a similar reduction in psychological complaints from 67 to 30 was recorded. Plasma acetylcholine and serum cholinesterase both had significant declines. Electroencephalogram (EEG) recordings showed prominent alpha waves and fewer spikes, representing a less irritable nervous system. Reductions in body weight were also reported in this study. The Hatha yoga participants practiced one hour daily with a specific course outline of yoga interventions providing gradual development of skills and incorporation of specific asanas or postures.
Udupa et al. (1971) explained the belief that yoga postures support and rehabilitate vital organs and endocrine glands without requiring excessive muscular activity to consume more energy, thereby making yoga a physiologically efficient practice. This effect on the organs is postulated to occur due, in part, to improved microcirculation. Improved performance and memory quotients and less fatigability that were observed may be secondary results to the neurophysiologic changes that occur after Hatha yoga practice.

Later, Udupa, Singh and Settiwar (1975) did a comparative study with ten healthy male volunteers to examine different yoga practices, each with a different sequence of asanas. Group I (n=4) performed shirshasana (headstand), bhujangasana (cobra), shalabhasana (locust), and mayurasana (peacock). Group II (n=4) practiced sarvangasana (shoulder stand), matsyasana (fish), halasana (plough) and paschimattana (sitting forward bend/head to knee); and Group III (n=2) did a more physically exertional series of power stretch poses called surya namaskar (sun salutations). Basal evaluations were taken pre-study and again after 6 months of intervention, with measurements being much the same as noted in their previous study. Both yoga Groups I and II showed decreases in cholinesterase and catecholamines, increases in plasma mono-amine oxidase (MAO), diamine oxidase (DAO), cortisol and protein bound iodine (PBI) (a very old test for circulating thyroid hormone), and a fall in fasting blood sugar (FBS) with a rise in serum protein. Both yoga Groups I and II also had decreased blood pressures. Although the presented information stated that yoga Group I experienced weight loss, and Group II and III participants had slight weight gains, conflicting data were presented in the tables, and mean weight differences for each group was 2 kg or less. Increases in blood pressures and in vital capacity and vital index were noted in Group III. Group II participants, performing an asana or posture called sarvangasana (shoulder stand), had more pronounced increases in PBI and plasma cortisol.
According to Udupa and his colleagues, this indicates improved thyroid and adrenocortical function that likely occurred from the specific asana.

Group III had contrasting findings with an increase in cholinesterase, and catecholamines and a decreased MAO and DAO. Plasma cortisol was unchanged and PBI was slightly decreased. The FBS fell, but protein levels were unchanged. Results suggest notable differences in the effects of different yoga postures or asanas. Group III exhibited a more stressed state, which is supported by the increase in neurohormones and enzymes.

Unfortunately the studies by Udupa and colleagues (1972, 1973, 1975) had very small samples, prohibiting the forming of any real conclusions. In addition, the studies are limited to healthy males from India and are further restricted without a control group. None the less, they are some of the first studies of the effects of yoga published in the context of evidence based validation. They suggest and offer some of the reasoning for possible effects of yoga and provide the basis for many studies conducted since. Many of the claims in these early studies are beginning to be examined more closely.

Prior to the published work by Udupa and his colleagues, Wenger and Bagchi (1961) from the University of California at Los Angeles and the University of Michigan, spent five months in India doing exploratory work with the purpose of conducting psychophysiological studies in yogis. Data was collected on 45 different individuals (43 male) who were either proficient yogis or students of yoga.

In data collected from EEG and EKG recordings, measurements of finger temperature, and palmar skin conductance on 14 subjects engaged in 25 different meditation sessions ranging from 14 to 148 minutes, the following observations (without statistical consideration) were made. Sympathetic nervous system (SNS) activity was greater during mediation than during
relaxation. Relaxation produced a slower heart rate, finger temperature was higher, palm-palm skin conductance was less, and both systolic and diastolic blood pressures were lower. Older, more experienced yogis had faster heart rates, lower finger temperature, greater palmar conductance and higher blood pressure during meditation than did the less experienced students, suggesting that for these more experienced yogis, the meditation process was an active one and not a passive one. Additional mean standard scores for physiologic tests on 15 students and 8 advanced yoga practitioners were compared to means from population-estimated data from India and the US Airforce using t-tests. Yoga groups had lower finger temperatures, higher diastolic pressures and lower pulse pressures than the comparative data from the American Airforce, suggesting that the yoga group appeared to have a dominance of SNS function. Final conclusions made from this exploratory study noted that yoga exercises may have produced marked changes in autonomic functions, and possible changes were observed with meditation, supporting the need for further investigations. Also, it was noted that racial differences in autonomic nervous system function may exist (Wenger & Bagchi, 1961).

Gopal, Bhatnagar, Subramanian and Nishith (1973) did a study comparing the cardio-respiratory efficiency in yoga-trained individuals to a control group of normal healthy subjects. This comparative controlled study was not randomized, but inclusion and exclusion criteria were clearly defined and groups were similar in height, with each group having 14 healthy males, ages ranging 20-35 years. Although demographic and health history data were collected, they were not reported to determine if the groups differed in other ways. Conditions for resting and fasting states were the same for each testing day. Physiologic measurements using spirometry for lung function as well as blood pressure and pulse were recorded before and after a standard physical exercise of 20 jumps and 20 sit-ups. Statistical differences between means were observed with
yoga practitioners having increased tidal volume and vital capacity and decreased pre and post exercise respiratory rates. Differences in the tidal volume were attributed to the controlled rhythmic pranayamic breathing and the associated deep inhalation and deep exhalations both involving bandhas. “Pranayamic breathing involves fixation of the thoracic and abdominal cages in the positions of either inner retention at the end of deep inspiration or outer retention at the end of deep expiration by bandhas” (p. 274). Bandha translated to English means bondage, and in yoga, it is a posture where certain organs or parts of the body are contracted or controlled.

The yoga group had lower respiratory rates both before and after the exercise. A lowered respiratory rate with high tidal volumes helps preserve a normal minute volume at a lesser cost of muscular energy expenditure. Although not to a significant degree, the pulse was lower and this may have been due to an increased parasympathetic tone similar what is observed in athletes. Likewise, the blood pressure (BP) was generally lower in the yoga group and may reflect decreased sympathetic tone and peripheral vascular resistance.

Another study conducted in India with 10 healthy subjects evaluated the effect of yogic training on some autonomic, physiologic, and biochemical responses (Joseph et al., 1981). Participants were male Indian soldiers, age 24-29 years, who had no prior yoga experience. They were placed on a regimented protocol, which included a controlled diet, activities and yoga. Yoga training was conducted by qualified instructors, and a specific practice schedule consisting of prayer, asanas, pranayama, and meditation was followed. Specific asanas were listed with a sequential order of practice. A month spent learning the different asanas was not considered in the 3 month long practice protocol. Comparing measurements taken pre-study and after 3 months of the intensive yoga protocol, the findings showed a significant decrease in heart rate and blood pressure, as well as an elevation in mean skin temperature and in the alpha index of the EEG,
with the occipital lead showing a predominance of alpha rhythm being present after the yoga intervention. There was no reduction in oxygen consumption. Significant reductions in fasting blood glucose, plasma cholesterol, and the $\beta/\alpha$ lipoprotein ratio were observed. A significant dopamine-$\beta$-hydroxylase decrease associated with an increase in MAO was purported to reflect a decrease in adrenomedullary hormone production as well as an increase in the rate of degradation. There was also a significant increase in plasma cholinesterase.

Physiologic changes, such as a reduction in pulse, blood pressure and changes in the alpha index of the EEG suggest changes in autonomic functions. Likewise, reduced dopamine-$\beta$-hydroxylase activity and increased plasma cholinesterase suggest predominance of the parasympathetic system with yoga practice (Joseph et al., 1981). Although this was a strictly controlled study, some important variables, such as the vegetarian diet may have influenced the results and hinder the interpretation of the findings.

Another report from India on the effects of yoga training on physiological parameters measured before and after 12 weeks of yoga training in twenty seven 18-21 year old male medical students was reported by Madanmohan, Balakumar, Nambinaryanan, Krishnamurthy and Chandrabose (1992). Mean scores from before and after yoga training were evaluated. Reaction times for both light and sound decreased significantly, and lung function measurements of maximum expiratory pressure (MEP) and maximum inspiratory pressure (MIP) both increased significantly. Significant increases were also observed for breath hold time after both inspiration and expiration (BHT insp., BHT exp.) and in hand grip strength (HGS). There was a 46% increase in the 40mmHG test. In this test, subjects took a deep breath and blew against a mercury column to the pressure of 40 mm Hg and maintained it for as long as possible while the time in seconds was recorded. Improvements in these breathing tests may reflect improvements in
cardio-respiratory function and endurance. The increase in MEP and MIP suggests that yoga training improves the strength of expiratory and inspiratory muscles. Bellows type breathing, which involves repetitive forceful deep inhalation and exhalation, was also a part of the yoga intervention and may have contributed to the increases in respiratory muscle strength. Conscious and consistent control of respirations during the practice of yoga and subsequent overriding of the respiratory center’s normal stimuli might also contribute to the prolongation of BHT; or yoga training might alter the responsiveness of the medullary and/or systemic arterial chemoreceptors, resulting in prolongation of BHT (Madanmohan et al., 1992).

Further, improved sensorimotor performance, reflected in the decreased reaction times, could be due to an enhanced processing ability of the CNS. Madanmohan et al. (1992) suggest that these effects of yoga practice are possibly a result of greater arousal and faster rates of information processing and/or improved concentration and ability to ignore or inhibit extraneous stimuli. Subjects reported feeling more alert and fresh with better concentration. In this comparative study, the sample was larger than those noted in many studies; however it lacked randomization and a control group. In addition, some of the methods of measurement for breathing parameters may not be standardized methods and could be subject to error. This study does, however, demonstrate additional physiological changes one can evaluate in order to assess the effects of yoga.

Schell, Alloio, and Schonecke (1994) evaluated the influence of yoga on heart rate, blood pressure, release of stress hormones and psychological changes. This German study enrolled 25 healthy females; 12 were proficient in yoga and were compared to 13 subjects who had no prior experience with yoga or relaxation. Data were collected during experimental sessions that occurred the same time of the day on different days. The individuals in the yoga
group practiced Hatha yoga with a specific series of asanas the first 30 minutes, followed by 30 minutes of different breathing and meditation techniques including 10 minutes of Kapalabhati (a fast and superficial breathing with rates up to 120/min), 10 minutes of lluijayi (a slow rhythm breathing with partially closed glottis at rate of 5/min) and 10 minutes of meditation. The control group read while sitting comfortably for the experimental period. Blood samples for cortisol, prolactin and growth hormones, as well as pulse and blood pressure were taken every 30 minutes over a two hour testing period. Psychological assessments using the Freburger Personality Inventory, a Stress Coping Questionnaire, and an Adjective check list were completed by all participants following the experimental session.

Both groups showed a slow decrease of plasma cortisol with greater, but not significant decreases observed in the yoga group. Significantly different levels in both groups were observed for prolactin levels, with lower concentrations in the yoga group throughout the experiment. In contrast, the control group started with higher prolactin levels, which decreased during experimental period, and then rose again. The yoga group had higher concentrations of plasma growth hormone prior to the experiment with a significant decrease during yoga when compared to the control group, which had no decline and lower pre-experiment levels. The heart rate in the yoga group decreased during and directly after yoga and returned to almost baseline at the end of the experiment. Subjects in the control group showed a slow, continuous decrease in heart rate, but no significant differences were found. Blood pressures showed little variation and no significant differences. Psychological parameters for the yoga group showed significantly higher life satisfaction and significantly less excitability, aggressiveness, openness and emotional labiality. Controls had higher scores in somatic complaints and extraversion, but differences failed to be significant; a significantly higher tendency to react with aggression and self pity did
occur. The yoga group more often downplayed their situation in comparison when responding to stress. Statistical differences in mood between the two groups existed, with the yoga subjects recording higher levels of high spirits and extroversion, while the control subjects were more irritable and less activated. A tendency in the control group towards more vexation, excitation and numbness was also observed, but these tendencies failed to be significant (Schell et al., 1994).

In Schell et al.’s study (1994) a more pronounced decrease in heart rate was observed, especially during active yoga at the 30 and 60 minute observations. It may be that yoga proficiency may improve vagal tone. Hormones were not influenced by exercises, but in general were lower when compared to the control. The differences in the mood and lack of differences in hormones status may indicate that hormones have limited use as markers for mood states. Hormones were also not influenced by exercise. Yoga practice seemed to induce different emotions and mental states when compared to the control group. Notable was the yoga group’s higher level in extrovertedness and state of activation in the mood assessments, yet the personality inventory showed lower rates of extraversion and achievement orientation. The yoga group had a more euphoric state of mind with low rates of negative emotions, and the personality inventory showed significantly higher satisfaction in life and lower levels for excitability, aggressiveness, emotional labiality and somatic complaints, reflecting a calmer and stable state of mind. In addition, the self reflection induced by yoga practice and the use of more self supporting strategies (i.e. minimizing, attempts to control the situation, turning away and positive self instruction) were probably related to higher life satisfaction according to Schell et al. In contrast, the controls tended towards more destructive and negative reactions, i.e. aggression, self pity, resignation, tendency to flee, self accuse, taking drugs, and continuous intellectual
engagement. Because endocrine parameters did not change, the possible stress reduction may have been due to increased vagal tone and changed mental processing of stressors. Delmonte (as cited in Schelle et al., 1994) noted that certain personality traits are associated with compliance and the practice of meditation; thus, a similar influence must be considered with those who practice yoga. It can not be determined then if the mood states were a result of the study or if they were due to personality traits of those who seek out yoga or similar mindful meditation practices. The results support the need for further research, and the psychological findings support the concept of using yoga techniques in conjunction with other therapies of psychosomatic disorders.

The impact of stress and its role in cardiovascular disease was the basis for a pilot study to examine the effects of an 8 week mindfulness-based stress-reduction program on the resting levels of stress hormones, physical functioning, and sub-maximal exercise responses in 18 women with a history of heart disease (Robert-McComb, Tacon, Randolph, & Caldera, 2004). The mean age of the subjects was 60 (+/-6.3) years. They were recruited for this randomized control trial through various medical settings. The subjects were randomized to either an eight week wait list control group or an eight week Kabat-Zinn’s Mindfulness-Based Stress Reduction Program which included body scan, sitting mediation breathing exercises, and Hatha yoga in a two hour weekly class. Pre and post submaximal exercise testing evaluations for oxygen consumption (V02), heart rate, breathing frequency, ventilation, and tidal volume were made. Participants also completed the Physical Component Summary Measure, a 36 item short form health survey to analyze physical function, and resting samples for serum cortisol and catecholamines were collected. There were no significant main effects or interactions for resting levels of stress hormones, physical functioning, or submaximal exercise responses. Although
there was not a statistical change in cortisol levels, it is important to note that the prestudy levels were not elevated in either of the groups and that following intervention, a there was a notable decrease in the resting levels in the yoga group and no change in the control group (Robert-McComb, et al.). Likewise, non-significant improvements were reported in the mean scores of Physical Component Summary for the yoga group while scores declined in the control group. A medium to large effect size was determined for both these variables; thus, a larger sample size may have found a significant difference. Significant differences for breath frequency were noted, but other parameters did not show significant differences. It is thought that through the mindfulness stress reduction program with conscious awareness and deliberate control of breathing patterns, higher brain centers are influenced resulting in the changes of breathing frequency. A longer intervention of therapy might have shown a larger impact on levels of stress hormones. This study was limited not only by the small sample size but also because of the characteristics of an all white, middle income, older female sample.

A study to investigate the effects of Hatha yoga and African Dance on psychological and biological markers of stress was conducted by West, Otte, Geher, Johnson and Mohr (2004). The purpose of the study was to see if changes in physiologic variables, such as arousal and demand, or psychological variables, such as perceived stress and affect, influence acute hormonal responses measured via salivary cortisol using different behavioral approaches such as African Dance and Yoga. Sixty-nine undergraduate students participated from different college classes they had enrolled in. Twenty one were in African dance, 18 in hatha yoga, and 30 from biology lecture. The sample was 65% female (n=47) and 35% male (n=22), with a mean age of 19 (range 17-24). Controls for time of class, time point in semester, lunch intake, and no drugs or medication use on day of experiment were applied. Psychological measures included analog
versions of a 14 item Perceived Stress Scale (PSS) and a 20 item Positive Affect and Negative Affect (PANA) Schedule. Marginally significant gender differences in the biology class were noted when compared to the other 2 classes and there were no demographic or lifestyle correlations identified. African Dance any Yoga showed significant reductions in PSS and in negative affect when compared to biology which had no changes. There was no difference in PSS or negative affect between African Dance and Yoga. There was a significant decline in positive affect in the biology class, and significant increase in African Dance and no change in Hatha Yoga. African dance and Hatha yoga significantly decreased perceived stress and negative affect compared to biology class. Salivary cortisol significantly increased for African Dance, significantly decreased for Hatha yoga and did not change for biology. West et al. (2004) note the findings of cortisol level changes do not correspond with previous studies that suggest that salivary cortisol is a reliable biological marker of changes in perceived stress and affect, with previous studies reporting that manipulations in perceived stress and affect were positively correlated with cortisol levels (West et al). Yet Schell et al. (1994) also found decreased cortisol secretion in the yoga practitioners with improved life satisfaction, mood and stress coping measures, and observed that hormones may not be good markers of mood states. Most literature suggests that cortisol responds to changes in negative affect. Yet the positive affect change in hatha yoga had an inverse correlation with cortisol secretion. This supports the premise that affective changes may influence cortisol levels, although the slow concentrated breathing and behavioral postures of Hatha yoga may also decrease cortisol levels regardless of changes in mood or perceived stress (West et al.). Psychological manipulations of perceived stress and mood do have an effect on hormonal responses to physical training. Findings underscore that, although cortisol can be influenced by perceived stress and distress, under some circumstances
these subtle changes can be overwhelmed by the role of cortisol in regulating arousal as was observed in the African dance group. The different effects on cortisol levels for this study were attributed to the different physiological arousal states (West et al.).

There were important limitations in the study, the groups were not randomly assigned and influence of personality traits resulting in the preference for the different classes may have impacted the outcome variables. This study only examined the acute affects of the Hatha yoga and African dance classes and can not represent any accumulated effects that might be observed with practice over time. This was a homogenous group of healthy young college students and results can not be generalized to a larger or characteristically different population. Behavioral factors influence on hormone production and the hypothalamic, pituitary and adrenal glands are complicated and difficult to sort out in the presence of different controlled variables and methods of physiological arousal (West et al).

Cardiovascular, pulmonary and breathing effects of yoga

Several of the studies on the effects of yoga, focus on the evaluation of the breathing component of practice, and its physiologic effects on lung and cardiovascular function as well as the associated effects on the nervous system. Some studies look specifically at the physiologic effects of yoga and controlled breathing methods in healthy humans who have no previous experience with either yoga or deep breathing techniques, while other studies have examined the effects in individuals who practice yoga regularly. Still, other studies have evaluated the effects of yoga and breathing practices in individuals with cardiovascular and lung conditions such as hypertension, asthma and chronic obstructive lung disease.

Telles et al. (2004) conducted a study to assess if yoga training can influence the ability to reduce the heart rate voluntarily in novices to yoga at the end of 30 day yoga program, and
compared to them to control group. Each group consisted of 10 males and 2 females with ages ranging 20 to 40 years. Participants in the yoga group were novices who joined a 30 day yoga program. The control group consisted of people who worked in an institution close to the yoga center and were selected to match the yoga group for gender and age. The 30 day yoga program was a structured lengthy course with 6.3 hours of practice, including 60 minutes of lectures on theory and philosophy of yoga each day. Heart rates measured by limb lead ECG were recorded at baseline, at the start of each testing period and again by recording the lowest heart rate observed during a 6 minute testing period on days 1 and 30. The baseline heart rates did not differ between the two groups. Following the intervention, the yoga group displayed statistically significant decrease in the baseline heart rate on day 30 compared to day 1 and a significant decrease in lowest heart rate achieved on day 30 compared to day 1. Both groups used similar strategies for attempting to reduce the heart rate which included conscious slowing the breath and relaxing the muscles. The study limitations including the limited sample size and the self selected yoga participants restrict any generalizability of the study, but results may support of the idea that training in yoga facilitates voluntary heart rate reduction and possibly the conditioning of visceral responses by autosuggestion. Telles et al. (2004) note that a similar earlier study using biofeedback in the form of visual (colored light) clues in novice yoga practitioners found similar significant reductions from baseline in the yoga group compared to a non yoga group, suggesting that yoga adds to the effect of biofeedback. The study findings may have implications for the use of yoga practice in the management of stress.

Sung, Roussanov, Nagubandi and Golden (2000) published results of a study examining hemodynamic changes associated with mental stress when comparing classical music, sounds of nature, yoga in the form of controlled breathing, and a non-intervention control group. Twelve
healthy normotensive volunteers, age range 22-55 years made up this crossover, comparative study sample. Baseline resting state blood pressures and heart rates were record on each subject followed by 5 minutes of mental stress in the form of serial subtraction using different combinations of 3 digit numbers. Hemodynamic measurements of heart rate, respiratory rate and blood pressure were recorded every one minute during the entire study testing period. Following application of 5 minutes of mental stress, one of the interventions (classical music, nature sounds, yoga breathing or control no intervention) was applied. The testing occurred on 4 different occasions for each subject. Significantly increased systolic blood pressure (12%), diastolic blood pressure (9%), and heart rate (7%) occurred with mental stress when compared to baseline measurements. The average time in minutes to reduce SBP to baseline level was 2.7 for yoga, 2.9 for classical music 3.0 for nature sounds and 3.7 for no intervention. The only statistical significant reduction in time for return of the systolic blood pressure was with the yoga breathing intervention, which also, when compared to the non intervention group, significantly decreased the diastolic blood pressure at measurements taken at 4 minutes in the relaxation period. Heart rate did not show differences in the recovery rates for any of the interventions. Sung et al. (2000) concluded that the most effective method for recovery from mental stress, measured hemodynamically, was yoga breathing. This was a small sample and limited data were provided in the published abstract. It is not clear if the study used a randomized sample and where the sample originated from. The specific yoga breathing methods were not explained nor was the order or sequencing of the different interventions outlined.

Shavasana, a yoga relaxation method was evaluated in relation to its possible influence on blood pressure by Sundar et al. (1984). In this controlled study, comparisons in blood pressure were made in hypertensive patients before and after a 6 month regimen of twice daily shavasana.
The sample, 25 subjects with essential hypertension, was divided into two groups based on need for oral antihypertensive therapy at the study baseline. Five were placed on antihypertensive therapy (group B) to stabilize severe elevations in blood pressure during a 6 week pre study stabilization period. The other 20 (group A) did not require medications. This study used independent observers to record supine at rest blood pressures weekly during the first 6 months and specific instructions on how to perform shavasana were given to subjects. For both groups there was a significant drop in systolic and diastolic blood pressures, group A had a 65 % and group B an 80 % (4 of 5) reduction. For those on antihypertensives (group B) there was also a reduction in medication doses ranging between 33.3 to 80%. In follow-up evaluations ranging from 6 months to 3 years, 11 subjects in group A continued to practice shavasana and did not have a significant change in mean SBP or DBP from the reduced level observed at 6 months. Six patients from group A did not continue with shavasana, but did returned for follow up and significant rises in the BP were noted. Of the 5 subjects in group B, 1 was lost to follow up and the 4 remaining patients continued the use of yoga and had no significant change or increase in blood pressures from those observed after the initial 6 months of intervention. It is widely accepted that psychosomatic factors play a role in hypertension and various relaxation methods (i.e. biofeedback, transcendental mediation and yoga) have been tested and shown to influence blood pressure and perceptions of stress. Yoga in the form of shavasana is simple to perform, convenient and does not require any additional equipment and may play an important role in management of hypertension.

A randomized controlled study conducted in USSR by Aivazyan, Zaitsev, Salenko, Yurenev, and Patrusheva (1988) compared the effectiveness of various relaxation therapy techniques in the treatment of mild essential hypertension. One hundred seventeen male
outpatients with ages ranging 20-45 years were enrolled in this study and were divided into two groups. The relaxation treatment group (N=70) was sub-divided according to three different relaxation treatments, 23 received autogenic training (AT), 24 training in biofeedback (BFB), and 23 breathing- relaxation training (BRT). The control group of 47 was divided with 24 having no treatment and another 23 receiving a psychological placebo treatment. Relaxation training was held in group meetings twice a week for 6 weeks, then once monthly for 12 months. Subjects were instructed to practice daily. Physiologic parameters with measurements of blood pressure and cardiovascular function were recorded before and after each class session. As well, data from psychological evaluations and a calculation of the number of sick days of leave per year due to hypertension were collected. Yoga was not specifically used but Jacobson’s (1938) progressive muscle relaxation combined with breathing and mediation concentrating on the words “in” and “out” with the respiratory cycles was used. Subjects also had measurements recorded before and after laboratory induced stress. Analysis of the data showed 66% from the treatment group and 32% in the control group had reductions in blood pressures. Of those, the relaxation treatment groups had significantly greater declines in systolic and diastolic blood pressure which continued to be observed at the one year follow-up. Systolic blood pressure declined by 10.3 mm Hg (+/- 0.8) and diastolic blood pressure decreased by 8.0 mm Hg (+/- 0.7) in the relaxation treatment group. A lesser decline was observed in the control group with the systolic pressure reduced by 3.2 mm Hg (+/- 1.2) and the diastolic pressure by 2.8 mm Hg (+/- 0.9). Additionally, the control group values returned to pre study levels at 1 year follow-up. During induced stress there was a significant reduction in SBP response and a more rapid restoration to initial pre-stress levels in the relaxation group when compared to the control
A comparative analysis showed that BFB and BRT produce the greatest reductions in blood pressure (Aivazyan et al., 1988). Psychological evaluations at 6 weeks and at 1 year also revealed some reduction in anxiety, and significant decreases in the level of interpersonal conflicts, and improved quality of life scores for the treatment group. The average number of sick days per year differed with the relaxation treatment group missing 4.5 (+/- 1.5) days and the control group 10.7 (+/-2.4) days.

Results of this study underscore the importance of relaxation and breathing. The fact that the breathing/meditation method was nearly as effective as biofeedback shows the usefulness and ease of utility in using these techniques by nurses and primary care providers who may not be trained or have the equipment necessary for biofeedback.

Patel et al. (1985) conducted a randomized controlled study in 34-64 year olds with 2 of 3 cardiovascular disease risk factors (i.e., hypertension, elevated cholesterol, and current smoking.). One hundred ninety two were enrolled with 99 randomized to the relaxation group and 93 randomized to the control group. Breathing, meditation, and progressive relaxation were taught in 1 hour sessions for 8 weeks. Home practice of 20 minutes daily was encouraged. The purpose of the study was to examine the effects of relaxation training in individuals with mild hypertension or other cardiac risk factors. Data were collected on heart rate, blood pressure, serum cholesterol, number of cigarettes smoked, along with morbidity data in the 4 year follow-up period. In the group taught relaxation and breathing there was significantly greater declines in systolic and diastolic blood pressure at 8 weeks, 8 months and at the 4 year follow-up when compared to controls. Cigarette reduction at 8 weeks and 8 months were observed in the relaxation group but this was not maintained at the 4 year follow-up evaluation. More individuals from the control group had angina and possible MI at the 4 year follow-up. Only 14 of 81 in the
relaxation group continued practice of relaxation. Those who were relaxing regularly showed
greater reductions in the mean systolic and diastolic BP than those who did not practice. Blinded
ECG evaluations showed that new ischemic events were significantly more common in the
control group as well. The study findings note that behavior modification for treatment of mild
hypertension and individuals with CVD risk factors may be cost effective (Patel et al.)

An important investigation of the effects of breathing rate on oxygen saturation and other
respiratory indices in individuals with chronic heart failure was conducted in a comparative,
controlled 2 part study by Bernardi et al. (1998). Fifty subjects with congestive heart failure
(CHF) (39 males, 11 females) and 11 healthy controls, mean age 62, were studied with the aim to
establish the optimum breathing rate based on SaO2. Then, using that established optimum
controlled breathing rate, yoga derived breathing instructions were given to a sub-group of CHF
patients in order to examine the objective and subjective changes.

In the first part of the study volunteers were evaluated during spontaneous breathing, and
then during controlled breathing practices at 15, 6 and 3 breaths per minute. Each time oxygen
saturation and ventilatory breathing characteristics (instability of tidal volume and instability in
breathing rate) were measured. Levels of perceived fatigue and dyspnea were recorded using the
Borg scale. ECG, blood pressures, lung volume and minute ventilation by Respitrace and SaO2
recordings were all recorded. Following the establishment of these baseline measurements and
observations another evaluation was conducted in 15 CHF subjects who were assigned to either a
rest group (N=6) or a breathing group (N=9) receiving yoga based breathing instructions to
practice 1 hour daily. Motivation to practice the controlled breathing methods was assessed at
the beginning, at completion and at 1 month post training. Maximal symptom limited exercise
testing was conducted prior to and at the end of the month long breathing intervention using an
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The mean SaO2 was lower and SaO2 instability was greater in CHF patients than controls during spontaneous breathing. During each different controlled breathing rate the SaO2 was significantly increased in both the CHF and the control groups. Of 15 patients with SaO2 < 90% during spontaneous breathing, only 4 during the 15 breaths per minute (BPM), 2 during the 6 BPM, and 3 from the 3BPM continued to have SaO2 levels below 90%. SaO2 instability was significantly decreased with controlled breathing and became similar to control group at 3 BPM. Minute ventilation increased with spontaneous breathing and at 15 BPM, didn’t change at 6 BPM and decreased at 3 BPM in both groups. In both CHF and controls the alveolar ventilation significantly increased at controlled 15 and 6 BPM. It was determined from this first part of the study that 6 BPM was the optimal rate for SaO2 and symptoms. Continuing then to the second part of the study, yoga breathing training at 6 BPM was given to 9 of 15 CHF patients who reported that slow breathing became easier with practice. Spontaneous breathing rates decreased from 13.4 to 7.6 per minute, and resting SaO2, peak oxygen consumption and exercise time increased, as well perceived dyspnea was significantly reduced. The subject’s motivation to practice the breathing techniques improved during the study. There were no significant changes in measurements from the 6 in the resting group.

Slowing the respiratory rate improved pulmonary gas exchanges, resting SaO2 and exercise performance while at the same time reduced the sensation of dyspnea. Motivation to continue the breathing practices were maintained after the study. Findings support the benefits from decreasing respiratory work and the use of training of respiratory muscles and physical
training in CHF and show that slowing the breath rate is possibly another method to enhance oxygenation and reduce dyspnea in this population (Bernardi et al., 1998).

Spicuzza, Gabutti, Porta, Montano and Bernardi (2000) conducted a study to see if chemoreflex response to hypercapnia and hypoxia are affected by the practice of yoga or by the response to slow breathing. Chemoreflex involves chemoreceptors such as those sensitive to blood oxygen and carbon dioxide levels which stimulate neurohormonal responses effecting cardiovascular system changes. Chemoreflex stimulation to oxygen and carbon dioxide levels result in increased heart and respiratory rates. Supporting this study was Bernardi and colleagues’ work (1998) describing the effects of yoga breathing practices on the sensation of dyspnea in patients with congestive heart failure. They hypothesize that yoga breathing, by reducing the chemoreflex response, might improve clinical symptoms. The study aim was to determine if chemoreflex changes were a result of yoga or if they were related more specifically to slow breathing, which is one component of yoga practice.

The controlled comparative study examined two different groups of individuals. One group of 10 had practiced yoga for an average of 7.9 years and a control group of 12 had no previous yoga experience. The two groups were compared for ventilation and oxygen saturation levels, as well as ventilation and CO2 end tidal volumes for 3 different breathing rates. Findings suggest that for both the yoga and the control group, when breathing was slowed to 6 breaths per minute, the chemoreflex response decreased substantially and similarly (Spicuzza et al. 2000). During spontaneous breathing assessments hypercapnia and hypoxia were substantially lower in the yoga group. The yoga group also had lower breathing frequency, lower respiration rates and higher end tidal CO2 measurements compared to the control group when at rest. When breathing rates were increased to 15 breaths per minute, the yoga group had only a slight increase in
chemoreflex sensitivity whereas the control group had increased sensitivity much like what was observed with their spontaneous breathing. The hypoxic and hypercapnic chemoreflex responses associated with yoga breathing are likely caused by the slower breathing rate that is a part of yoga practice. However, it also noted that slower breathing is not the only factor to consider and that the long term effects of yoga may also independently reduce sensitivity of the chemoreflex.

In another study of rhythmic breathing practices’ influence on cardiovascular rhythms and baroreflex sensitivity, Bernardi et al. (2001) performed a comparative study examining rosary recitation in Latin, known as the Ave Maria, and the practice of yoga mantra. Twenty three healthy adults with no previous yoga knowledge were included in the study. Data were collected both during spontaneous breathing, and at a 6 breaths per minute (BPM) control rate while talking and again during recitation of yoga mantra or during recitation of the Ave Maria. Study findings revealed that reciting both the Ave Maria and the yoga mantra were similar in that they slowed respirations to an average of 6 BPM and had a marked affect on cardiovascular rhythms and synchronization. Interesting in the discussion of this study is the historical development of the rosary during the middle-ages and its possible distant link to Tibetan Monks and the yoga masters of India. The repetition associated with the recitation of the rosary induces a fixed slow and controlled respiratory rate. Bernardi and colleagues note that heart rate variability and baroreflex sensitivity was enhanced by a slowed respiratory rate due to synchronization of inherent cardiovascular rhythms, and that reduced variability in heart rate and baroreflex sensitivity were independent and strong predictors of heart disease prognosis. In applying the study findings in light of this knowledge it was concluded that rhythmic forms of prayer or chanting a mantra, where breathing is slowed to 6 BPM, likely induce favorable
physiological and psychological effects that may have positive health benefits (Bernardi et al., 2001). Yet further study is required in order to validate this theory.

These studies (Spicuzza et al., 2000; Bernardi et al., 1998, 2001) support physiological benefits of controlled breathing patterns through slowing the respiratory rate to 6 breaths per minute. While this breathing pattern is frequently used in yoga practice, it is also achieved through other methods including reciting the rosary. The findings support utilization of methods that control and reduce respiration, but may also offer insights about the effects and reasoning for benefits described with different spiritual and religious practices.

Telles, Reddy, and Nagendra (2000) compared oxygen consumption and respiration after practicing a cyclical mediation (CM) method or supine rest in shavasana (SH) in order to explore an ancient yoga theory that a combination of both calming and stimulating measures, such as achieved with cyclical meditation, help one reach a better state of mental equilibrium and relaxation. Mental equilibrium is a state between mind inactivity and mind agitation. Cyclical meditation was practiced for 22½ minutes and included repeating a verse, isometric muscle contraction, supine rest, standing at ease (tadasana), bending to the right and to the left (ardhacakrasana), bending forward (padahastasana) and bending backward (ardhacakrasana) followed by supine rest. Supine rest occurred over the same length of time. Each posture was performed slowly lasting over a minute with gaps or pauses before moving into the next bend. Self and body awareness and relaxation were stressed during and after each asana. Forty healthy males, ages 20 to 47 with 3 to 72 months of previous yoga experience participated in this comparative, crossover, study. Half the subjects did CM the first day and the other half did SH with the sessions reversed on the following day. Measurements were made before and after the practices, but not during them. Closed circuit benedict-Roth apparatus was used for measuring
oxygen consumption with the subject sitting erect. There were no differences in the values of the two types of sessions, both CM and SH groups had significantly decreased O2 consumption, respiratory rate, and minute ventilation and increased breath amplitude. Because CM did have higher activity level compared to SH, the findings support the idea that CM which combines both stimulating and calming techniques may reduce physiologic arousal and promote relaxation. However, the question of whether CM is better than SH was not answered and requires further study with more controls.

A study in healthy elderly subjects comparing the effects of a 6 week aerobic exercise program to a yoga program was conducted by Bowman et al. (1997). The question under consideration for this study was if age related reduction in baroreflex sensitivity could be altered with exercise. Yoga in this study was picked to serve as a control for the aerobic exercise group so that subjects in both groups would have similar contacts with instructors and classroom environments. The yoga group performed only stretching and static yoga postures with no repetitive muscle contractions, and relaxation in the horizontal position, thereby not inducing any aerobic type of activity.

Oxygen uptake as measured by VO2, blood pressure, α-index (a measurement of baroreflex), and heart rate variability were measured at the baseline period and then at the end of the 6 week study session. Data from 14 individuals in the aerobic group and 12 individuals in the yoga group were paired and analyzed and the findings were surprising for the aerobic group in that baroreflex sensitivity was not changed, however the α-index at high frequency, which is a measurement of baroreflex reflecting parasympathetic activity level was significantly increased following 6 weeks of yoga. Heart rate was also reduced in the yoga group which was postulated to be the result of increased vagal activity. For the aerobic group the only significant finding was
a 25% increase in VO2 max, where as the yoga group had only a 12% increase (Bowman et al. 1997). Although the purpose of the study was not to evaluate the benefits of yoga, the study offers additional support for the cardiovascular and respiratory effects that have been reported by others.

Another study examining the breathing component of yoga was conducted in 12 male yoga practitioners, ages 18 to 30, in order to examine the energy costs of nadisodhana, a form of pranayama in which breathing is through alternate nostrils (Prasad, Venkata Ramana, Raju, Venkata Reddy & Murthy, 2001). In this controlled, comparative study, subjects each performed four types of activities; 30 minutes each of nadisodhana, treadmill walking, field walking and a graded maximal exercise test. During nadisodhana oxygen consumption and heart rate were lower than for field and treadmill walking. Perceived exertional ratings using the Borg scale were lower for nadisodhana than for the walking groups. Blood lactate and pyruvate samples collected prior to and immediately following each of the activities showed significantly lower lactate levels in the yoga group and pyruvate levels were significantly higher. When comparing these levels to those observed in treadmill and field walking, it appeared that yoga produced low fatigability and efficient conditioning of aerobic metabolism mechanisms. Findings also supported that the energy costs associated with nadisodhana were significantly less when compared to the energy expenditure with other forms of activity. The study supports the notion that yoga practice, which may include nadisodhana form of pranayama, does not induce additional physiological stress thereby offering benefits of yoga for individuals who may not tolerate increased cardiovascular and oxygenation demands commonly found in other forms of exercise.
Interpretation of study findings is limited, because of the small sample size and any generalizability is restricted, because the sample was comprised of individuals proficient in yoga practice. Results need to be validated in individuals with no previous yoga experience and those afflicted with conditions that affect cardiovascular and lung function. Yet, the findings are in line with Udupa and Singh’s (1972) discussion of the decreased oxygen and energy demands associated with yoga practice.

Cardiopulmonary function as well as physical fitness parameters were assessed in a pilot study to evaluate the effects of hatha yoga practice on health related physical fitness variables including pulmonary function was undertaken by Tran, Holley, Lashbrook and Amsterdam (2001). Ten healthy adults, 9 female and 1 male ages 18-27, with no prior experience with yoga were enrolled from the University of California. The eight-week Hatha yoga program consisted of a 1½ hour class 4 times weekly with 10 minutes of breathing that included alternate nostril breathing (nadisodhana), 15 minutes of warm up stretches consisting of frog pose, dynamic lunges, shoulder and arm circles, neck rolls and standing forward bend (parsva uttanasana), and 2 to 3 cycles of sun salutation (surya namaskar). The warm up was followed by 50 minutes of asanas including: spinal twist (vakrasana), cat (vidalasana), forward bend (pasccinmottanasana), head to knee (maha mudra), tree (vrksasana), warrior (virabhadradasana), triangular (trikonasana) variations one and two, superman, partner bridge, and pigeon (eka pada rajakapotasana) and concluded with 10 minutes of relaxation (savasana). Not all the poses were practiced with each session. Subjects were evaluated prior to and following the eight-week course for muscle strength, endurance, and flexibility as well as cardio-respiratory endurance, body composition and pulmonary function. In treadmill tests, the total time, maximal heart rate, respiratory exchange ratio and ventilation did not change, but the absolute and relative VO2 max increased
by 7 and 6%. Pulmonary function and body composition changes were not significant. Increases in muscular strength by 31% for elbow extension, 19% for elbow flexion, and 28% for knee extension were recorded. Muscular endurance only increased in knee flexion by 57%. Significant increases in all flexibility measurements were noted including ankle flexibility (13%), shoulder elevation (155%), trunk extension (188%) and trunk flexion (14%). There were no adverse musculoskeletal injuries reported.

The increased range of motion observed in these subjects was attributed to static stretching of asanas, resulting in elongation of connective tissue and muscles. The increased V02 max showed improved cardio-respiratory and large muscle exercise performance and endurance. Tran et al. (2001) noted that the lack of change in pulmonary function was consistent with other athletic training studies, but was in contrast to other yoga studies. The average class attendance was 21.5 classes out of the 32 available sessions. Limitations included a small sample size and a self selected group of healthy young, primarily female subjects, as well as lack of a control group. It is also important to note that differences in pulmonary function test results from other studies may be related to different breathing techniques with alternate nostril breathing.

Findings related to respiratory and lung function contradict the findings reported by Udupa (1972), where subjects participated in a 6 month study, and were also in contrast to the findings from Visweswaraiah and Telles (2004) where subjects with pulmonary tuberculosis showed improved lung function. In consideration of these findings, one must be aware that the subjects from Tran et al’s study (2001) were healthy young adults rather than those afflicted with a chronic lung condition.

Shannahoff-Khalsa, Sramek, Kennel and Jameison (2004), investigated the hemodynamics of a yogic breathing technique that claimed to “help eliminate and prevent heart
attacks due to abnormal electrical events in the heart and enhance the performance of the central nervous system (CNS) and to help eliminate the effects if traumatic shock and stress to the CNS” (p. 757). Evaluated in this study were four healthy middle age experienced yoga practitioners, 3 male, and 1 female. A breathing technique involved one breath per minute with 20 seconds of inhalation, 20 seconds of breath holding, and 20 seconds of exhalation. The theoretical framework for this technique is based on the role of the autonomic nervous system in sudden cardiac death. With this technique, the respiratory pattern shows a controlling effect of ejection phase contractility during one part of the 1 BPM cycle, while vasoactivity is essentially unchanged. When this method is practiced over a long period of time, it appears to produce a state where the one breath per minute hemodynamic modulator cycles are maintained post exercise (Shannahoff-Khalsa et al).

Only one of the subjects who had extensive practice with the breathing method showed attainment of such a sinusoidal effect in the post exercise phase. This suggests that the brainstem cardio-respiratory control center has been altered after long term practice. This resetting of the pacemaker function of the brain stem cardiorespiratory control center may be why this 20-20-20 second breath cycle had the claimed beneficial effects. Differences in practices of the four yogis were not well examined and it is not clear if all individuals practiced at same frequency and intensity. Practical application is very limited as only one well trained individual was observed to demonstrate these effects.

In a randomized trial of individuals with pulmonary tuberculosis yoga was compared to breath awareness practice to evaluate the effects on lung capacity and bacteriological status (Visweswaraiha & Telles, 2004). Based on the literature, the rationale behind the study is the
belief that yoga, by promoting relaxation and stress reduction, may help reduce susceptibility to infections, because stress can diminish resistance to infections.

In this trial 73 subjects were alternately allocated to one of the two groups. Forty-eight subjects completed the study with the numbers remaining equally distributed between the two groups. Inclusion criteria required all subjects to be receiving and compliant with anti-tuberculosis medication regimens. None of the study subjects had previous experience with yoga. Both groups practiced for 60 minutes per session for a total of 6 hours a week over a period of 2 months. Two important factors were controlled for in this study. First, both groups had interaction with an instructor, thereby reducing any influence that may have resulted from the amount of personal contact during the intervention. The second was that a blinded investigator performed and evaluated the assessments and measurements, and chest x-rays were independently evaluated by three different radiologists (Visweswaraiah & Telles, 2003).

Assessments and measurements recorded on day 1 were compared to those from day 60 for each of the two experimental groups. Both groups had statistically significant changes in all measurements except for FVC, which was not improved in the breath awareness group. The difference in the percentage of change for the yoga group was remarkably quite high. Increases in the yoga group were 10.9% for weight gain, 64.7% for FVC and 83.6% for FEV1, as well, there was an 88.1% decrease in symptom scores \( P = 0.001 \) for all. In comparison, increases for the breathing group were 2.1% for weight gain, and 63.8% for FEV1 with a 16.3% reduction in symptom scores. Noteworthy in this study too was the number of sputum conversions, although the sample size for sputum evaluations was smaller and the reason for this was not articulated. Despite this, considering all subjects in both groups had positive sputum cultures at the beginning of the study, conversion to negative cultures at day 60 occurred in 10 of 13 for the
yoga group compared to only 4 of 19 in the breath awareness group. Chest X-ray was improved in 16 of 25 for the yoga group and in only 3 of 22 for the breath awareness group.

The findings of improved lung function were consistent with Udupa’s (1972) findings. Because of the decrease in microbiological counts and clearing of sputum cultures, this study supports the theory that yoga, either through stress reduction or through other unknown mechanisms, may influence immune function. Findings from this study also support the use of yoga as a complementary therapy for patients with tuberculosis in providing benefit in lung function and bacteriological responses (Visweswaraiah & Telles, 2004).

The effect of yoga in patients with mild asthma was investigated by Singh, Wisniewski, Britton and Tattersfield (1990). The purpose of this study was to examine the effects of yoga breathing (pranayama) on lung function, as well as symptom scores and medication use. This was a double blind, controlled, crossover study where pranayama, breathing in a 1:2 ratio, was practiced with the use of an apparatus called the Pink City Lung (PCL) exerciser. A placebo breathing device with the same appearances the PCL, but without the internal control valves, was used in similar fashion to serve as a control for comparison. The selection of this study design and method of intervention was chosen to provide a blinded control for examining the differences in the breathing techniques which is often a threat to study validity in many studies that examine the effects of yoga.

The PCL was described in detail, but evidence of testing for validity of the device was not presented. Measurements of pulmonary function, FEV1 and FVC without and then with histamine induction, were obtained at pre-study and at weekly time points during the study. Subjects also measured morning and evening peak expiratory flow rates (PEFR) and kept a diary
record of daytime and night time symptom scores as well as β2 metered inhaler use. Of 22 subjects enrolled 18 completed the study (Singh et al.).

Although there were increases in FEV1 and both morning and evening PEFR, as well as decreases in symptom scores and inhaler use with the PCL exerciser compared to the placebo device, the changes were not statistically significant. According to Singh et al. (1990), one reason that the difference was not statistically significant may be attributed to the participants being mild asthmatics with nearly normal lung function thereby limiting any improvement that could have been recorded. What was significantly changed with PCL exerciser was airway reactivity as measured by the histamine induced pulmonary function test. The amount of histamine to induce a 20% reduction in pulmonary function scores increased substantially in the PCL group. In providing rationale and discussing the study findings support is related to the theory that yoga practice increases autonomic control and decreases vagal outflow, which would affect the lung by causing bronchodilation and may also have a small influence on bronchial reactivity. There also is a possible increase in endogenous corticosteroid release with yoga practice which might contribute to decreased airway reactivity (Singh et al.).

A study to assess the effect of yoga on patients suffering from perennial asthma included a sample of 30, 20 males with a mean age of 32, and 10 female with a mean age of 25 (Murthy et al., 1984). Specific yoga breathing practices (pranayama) performed through alternate nostrils included emphasis on exhalation (rechaka) and inhalation (puraka) with retention (kumbhaka) for 30 minutes daily for 75 days. This open, comparative study included evaluations at prestudy, day 15, 30, 45, 60 and 75 recording measurements of spirometry (FEV1, FVC, and FEV1/FVC%), and peak expiratory flow rates (PEFR), as well as collecting symptom scores and the number and amount of different asthma medications used.
There was a significant increase in the mean FEV1, FVC and PEFR for men starting at 15 days, however, the FEV1/FVC% remained essentially unchanged during the study. For women a significant increase in FVC on day 15, FEV1 at day 30 and PEFR at day 57 were observed. Like men the FEV1/FVC% was not significantly changed. A significant reduction in symptom scores began at day 15 for men and day 45 for women. For men the drug scores of patients using oral bronchodilators reduced significantly, but those on steroids as well as bronchodilators did not show any significant reduction in their dosage schedules. There was no decrease in either steroid or non-steroid medication use in females. Although FEV1, FVC, and PEFR improved, the ratio FEV1/FVC% remained constant thereby indicating that there was no significant reduction in airway obstruction (Murthy et al, 1984). The study demonstrates the usefulness of this practice on patients with moderate to mild symptoms and can supplement conventional drug therapy.

Nagendra and Nagaratha (1986) conducted a long term controlled study with pre and post treatment comparisons in individuals with bronchial asthma to determine the effects of yoga. There were 570 subjects, of which 408 were males, ages ranging from 7 to 78 years. Explicit entry criteria for both seasonal and perennial forms of asthma using Crofton, Douglas, and Shivpuri criteria were applied, and the average duration of asthma was 23.22 years (+/- 19.44 years). Yoga training consisted of a specific sequence of breathing for 10 minutes, postures or asanas for 25 min, savasana, or relaxation for 10 min, pranayama 10 minutes, and mediation for 15 minutes. Kriyas (a form of nasal and sinus cleansing using saline solution) was practiced once weekly or more often for those with blocked nasal passages. Training also included devotional sessions with lectures and discussion about yoga philosophy and relaxation, sessions lasted 2.5 hours a day for the first two weeks, then reduced to 1.25 hours daily for 4
weeks. After the initial interventional phase, the subjects were followed for an extended period which ranged from 3 to 54 months during which time subjects were given the option to practice yoga at home or to continue in a classroom setting. Multiple mechanisms were used to facilitate follow-up with monthly meetings, clinic visits for periodic checkups and annual follow-up camps lasting 1 to 3 weeks for reinforcing the initial training. Subjects recorded symptoms in diaries that were collected at each visit.

Multiple variables were evaluated during the study. In relation to asthma attacks the number per week, duration, and severity were monitored, as well as the amount of medications used each week and use of both oral and injectable steroids. Specific information on the number of months during the year which the person suffered symptoms, if nasal allergy was present, and trigger factors such as dust, smoke, vapors, scents were evaluated; as well, emotions, anxiety, tension, unusual distress; weather, food, and exercise were all monitored. General parameter assessments included: cough, sputum production, fever, sore throat, breathlessness, or other symptoms. Pulse, respiratory rate, BP, chest expansion, breath holding time as well as physical examination for the presence of wheezing, ronchi or crepitations, and measurement of peak expiratory flow rate (PFR) were evaluated.

The yoga groups were later classified during follow-up visits according to their level of participation and compliance: 1) regular - practice of at least 16 days per month, 2) irregular practice- fewer than 15 days per month, 3) discontinued on own after varying periods of regular practice after initial training. Analysis of these groups indicates that those who practiced irregularly had the least improvement. Even so, those who practiced irregularly did have some significant changes in important parameters such as reduction in the number, severity and duration of attacks, as well as medication use, and an increase in PFR. Those who had
discontinued practice after practicing regularly for varied periods of time after training continued to have improvements much like those individuals who practiced regularly.

For all subjects enrolled, highly statistical improvements were recorded on all but a few of the variables examined. No statistical differences were observed for the number of steroid injections per year (mean average per year was 6.4 prior to yoga and 3.92 after). Nor was there a difference in exercise triggering of asthma attacks. The number of sore throats per year, the presence of crepitations on exam as well the cardiac parameters of BP and pulse were likewise unchanged (Nagendra & Nagaratha, 1986).

An analysis of medication use showed that 69% reduced or stopped their oral medication, 72% stopped or reduced their injectable medications, and 66% stopped or reduced cortisone therapy. All three levels of yoga practice resulted in significant reductions in use of oral medication. PFR values were significantly improved in all patients despite level or regularity of practice, however, the irregular practitioners although reaching some level of significant improvement, did not, using statistics of repeated observations, improve significantly in this area. Data indicated the long term requirement of oral medication decreases with all levels of compliance with yoga practice. However, study findings indicate that in order to reduce the acuteness of attacks requiring parenteral medication, patients must be regular with their yoga practice (Nagendra & Nagaratha 1986).

Nagendra and Nagaratha (1986) further explored the pathophysiology related to hypersensitivity and extrinsic and intrinsic defects that result in asthma attacks and an association with an ANS imbalance. The premise for the study is that an integrated approach to yoga therapy appears to work at various levels in correcting the airway hyper-responsiveness. First, the calming and stress reduction of yoga may help decrease efferent vagal discharges
thereby decreasing stimulation of the receptors on the surface of airway smooth muscles which, when stimulated, initiate the afferent efferent arch reflex and lead to hypersensitivity. Second, through diminished bronchial β-2 receptor responsiveness which is achieved by reducing norepinephrine systemically and in the hypothalamus which, when increased, can inhibit corticotrophin releasing factor and cause reduced cortisol levels. Yoga Kriyas act to desensitize the end receptors by systematic exposure to nonspecific graded irritants. Following this cleansing procedure with deep relaxation may reduce the stimulation threshold of the vagal end receptors. Although this study had a much larger sample to give additional validity to the data, without a control group, it is not known how many changes was actually the result of the yoga intervention. Additional data in regards to biological and chemical responses might help validate the pathophysiological theories of the responses to yoga in this patient population. Yet while this study has limitations its sample size is much larger than other studies and it does provide evidence of significant clinical improvements for these asthma patients.

Another study examining yoga in lung conditions was conducted by Tandon (1978) who examined if yoga breathing exercises and postures produced any improvement in pulmonary function or exercise tolerance in patients with severe irreversible chronic obstructive lung disease when compared to patients trained in a physiotherapy breathing exercise to improve stamina. This was a randomized study with a blinded evaluator. Enrolled were twenty four older males, ages ranging 52-65 years, who were both smokers and nonsmokers. They were divided into two groups of 12, with one group instructed on yoga breathing exercises and 10 specific postures chosen to produce improvements in the respiratory system. The other group was instructed on physiotherapy relaxation exercises for accessory respiratory muscles, lateral costal and diaphragmatic breathing exercises and general leg and trunk exercises to improve stamina.
During the first month, patients attended 1 hour classes three times a week; the second month classes were reduced to 2 times per week, and after that point, classes were held once a week.

Values for FEV1, FVC, PaO2 and PaCO2 after training in either yoga or physiotherapy breathing exercises did not significantly change from baseline measurements. The yoga group experienced significant increases in maximum work tolerance occurring with increases in heart rate, but there was not a significant increase in tidal volume. Exercise tolerance in the physiotherapy control group deteriorated but the decrease was not statistically significant (Tandon, 1978).

The subjective symptoms reported for the two groups indicated that yoga participants had a significant improvement in exertion tolerance, recovered more quickly after exertion, could control an attack of severe shortness of breath without having to seek medical help through the use of breathing techniques, and felt a definite improvement in their lung condition. In rare reporting of adverse events, it was noted that one subject from the yoga group dropped out of the study due to the development of a cervical disc injury while practicing a yoga posture at home and was advised to stop yoga. Also, a patient dropped out of the physiotherapy group due to vertigo and chest pains that he attributed to the breathing exercises.

*Psychological and mood effects of yoga*

Yoga has also been evaluated in relation to its affect on mood, mental stress, and some psychological disorders. Berger and Owen (1992) conducted a study to assess and compare the mood alterations associated with Hatha yoga and swimming. For this study there were 87 subjects completing the study out of 101 college students from Brooklyn College of the City University of New York. A comparative convenient sample used 2 beginning swimming classes (N=22 and 17), one yoga class (n=26), and one control of a lecture science class (n=36), Classes
were held for 14 weeks with swimming classes lasting 40 minutes 2 times per week (25-30 minutes of swimming), yoga class 80 minutes once per week (60 min yoga exercise) and the control science class meet for 50 minutes 3 times per week. The specific asanas or postures used in the Hatha yoga class were not described. Yoga and swimmers were encouraged to practice on their own in between classes. Mood was measured before and after classes with the Profile of Mood States questionnaire administered on second day of class and at week 6, and week 12, and the State Trait Anxiety Inventory on day 2, and at week 12.

Both swimmers and yoga participants reported benefits, but gender differences existed. Female swimmers and yoga participants benefited differently with women swimmers reporting greater increases in vigor and yoga participants having larger decreases in fatigue. Males practicing yoga noted greater benefits for tension, fatigue and anger than swimmers. Results suggest that the breathing and stretch sequences from yoga have equal if not greater affects on mood when compared to aerobic type exercise (Berger & Owen, 1992). Similarities for the swimming and yoga may be in relation to slow deep breathing and this may be a factor that influences the mood changes that occur with both forms of exercises. Mood changes in the exercisers were inversely related to absences from class, stressing the positive relationship of class participation and prolonged mood improvement. Although gender differences were noted in the findings the breakdown of the number of men and women in each class was not provided. Limitations due to the convenience and nonrandomized self selected sample as well as the differences in the class sessions of each group prohibit generalization of study findings.

The mood alterations associated with different modes of exercise were explored by Netz and Lidor (2003). In this study a secondary objective was to examine those mood alterations when comparing mindful modes of exercise with more aerobic type activities. The study was
conducted in Israeli middle aged, female teachers of both general curriculum and physical education, who were voluntarily involved in a 1 year enrichment program. Participants were not involved in any organized or routine physical activity programs prior to study participation and were offered the choice of participation in a small number classes of either aerobic dance, yoga, Feldenkrais, swimming, or a computer class which served as the control. Measurements of anxiety, depression, mood, well being, personality, and social desirability were recorded at baseline during the second class and at week 14 with both pre and post intervention assessments. All tools of measurement which included State and Trait Anxiety Inventories, (STAI) (STAI-Y2-trait anxiety) and (SATY1-state anxiety), State and Trait Depression Adjective Checklist (DACL) [(S-DACL) (T-DACL)], Subjective Well-Being Scale (The Ladder Scale), Eysenck Personality Inventory (EPI), and The Lie Scale were converted into Hebrew and validation of translation was addressed.

Different numbers of participants participated in the baseline (N=193) verses the week 14 pretest (N=173), and post test (N=156), with only 87 of those at week 14 being participants in baseline week 2 assessments. Because there were differences in the baseline and the week 14 participants, data from 60 additional individuals who were present at week 14 was included under the assumption that the 60 did not differ from the 87 who participated in both week 2 and week 14 classes. Baseline equivalence of the classes was confirmed and participants did not differ in any measures except the Ladder scale which was positively skewed. In the pre-post test evaluations it was noted that significantly older women participated in the swimming class when compared to the other classes. Participants in the swimming, yoga and Feldenkrais classes had lower STAI-YI scores than the aerobic dance or computer class in post test scores. S-DACL scores measuring depression were lower in the post test phase compared to pretest. Post
intervention values for the Ladder Scale were higher in swimming, Feldenkrais and yoga class in comparison to dance aerobics and computer class (Netz & Lidor).

The findings are similar to those found in previous studies indicating that mindful low exertion activities are able to enhance mood in one single session of exercise. Results from this study show that more pronounced mood improvements may result from low-exertion rhythmical movements that are cognitively based than high intensity aerobic activities that are not cognitively focused. Similar study findings of improvements in mood with swimming (Berger & Owen, 1992) also agree with this study. However, it is not clear whether the affective change observed with swimming is a result of the aerobic effect, the relaxing water environment, or possibly due to some inherent mindfulness aspect of the act of swimming, such as the stroke and breath regulation and movement against resistance (Netz & Lidor). Aerobic dance was not associated with mood benefits in this study and it was assumed this was because the participants in this study were older than those in previous studies of aerobic exercise. Limitations to this study are the self selected volunteers who may have had prior expectations related to the benefits of their chosen exercise and the gender of the sample.

Ghonchen and Smith (2004) compared the psychological effects of progressive muscle relaxation (PMR) with hatha yoga exercises in regards to physical relaxation as measured by “R states”. Forty healthy adults, 15 male and 25 females, working as bank customer service representatives were recruited for this study and randomly assigned to participate in weekly in sessions employing progressive muscle relaxation or Hatha yoga, immediately after work for 5 weeks. Subjects were instructed not to practice at home. Class instructors used scripts to ensure consistency in techniques. The Smith Relaxation Inventory was given weekly at pre-practice, post practice and on two other testing days as an after test (3 min following post test).
ABC relaxation theory was employed in this study and is based on hypothesis that different approaches to relaxation have different positive psychological effects. Ghonchen and Smith (2004) cite earlier work by Smith on the psychological based *Attention Behavioral Cognitive Relaxation Theory* (ABC) which proposes that different approaches to relaxation have different effects. Smith identified 15 different relaxation or “R” states which include: Sleepiness, Disengagement, Physical Relaxation, Mental Quiet, Rested/Refreshed, At Ease/Peace, Childlike Innocence, Energized, Joy, Thankfulness and Love, Mystery, Awe and Wonder, Prayerfulness, Timeless/Boundless/ Infinite, and the 15th R-state, “Aware,” is a meta-state that can either exist alone or in combination with other states. A passive focus is universal to each different relaxation method. For PMR the focus is tensing up and letting go whereas yoga in this study involves focus on creating and maintaining a stretch while concentrating on breathing and self awareness. Both approaches involve sustained passive focus, but under the ABC theory each technique differs in what R state they invoke (Ghonchen).

In Ghonchen and Smith’s study (2004) those who practiced progressive muscle relaxation scored significantly higher on R states of Disengagement and Physical Relaxation at week four, and Joy and Mental Quiet on the week 5 after test. Yoga practitioners scored higher on R the state of Physical Relaxation at the week 1 post test. The groups did not differ significantly on R states Energized or Aware at either the beginning or end of the interventions. This study demonstrates that adequate time must be provided for the interventions to produce major effects and that single session studies may fail to report the potential cumulative benefits of different relaxation therapies. It also suggests the value of supplementing the assessment of relaxation with psychological measures of relaxation states. Techniques that appear the same at
the somatic level may display significant psychological differences (Nagendra & Nagaratha, 1986).

In a pilot study Waelde, Thompson and Gallagher-Thompson (2004) explored whether individuals who are undergoing severe chronic stress associated with providing care to family member with dementia would respond positively to Inner Resources method of mediation and yoga. Fourteen female caregivers of which 8 were Latina and 6 Caucasian with ages ranging from 36 to 69 years were enrolled. Six were spouses and 6 were daughters of a dependent dementia patient. During the study 2 individuals dropped out prior to the study completion.

The Inner Resources method includes a concentrative form of meditation, gentle stretching in the form of hatha yoga, breathing, guided imagery, and mantra repetition (Waelde, et al., 2004). Formal class sessions were held once weekly for 6 weeks with the first session lasting 3 hours and subsequent sessions lasting 90 minutes. Participants were encouraged to practice at home at least 30 minutes each day. Measurements for depression, self-efficacy, anxiety, care giving burden, treatment adherence, subjective improvement, and a usefulness of intervention assessment were all recorded. Tools for measuring depression, self-efficacy, anxiety, care giving burden, treatment adherence, and subjective improvement, included the Center for Epidemiological Studies Depression Scale (CES-D), the Self efficacy for Controlling Upsetting Thoughts about Caregiving subscale of the Revised Scale for Caregiving Self Efficacy(SEC), the State Trait Anxiety Inventory (STAI), the Revised Memory and Behavior Problem Checklist (RMBPC) and a weekly practice log, as well as follow up usefulness of intervention assessments were completed at the end of the study.

Pre-intervention scores showed that Latina and Caucasian participants were similar and moderately depressed, mildly anxious, and only confident in their ability to control negative
caregiving thoughts 50% of the time. Following intervention depression and anxiety were significantly less, and perceived self efficacy was also significantly improved. No difference or change was observed for subjective or objective caregiver burden. Treatment effect size was large for depression and medium for anxiety and self efficacy. In a 1 month post treatment follow-up evaluation 70% reported feeling somewhat or much better than before the study in terms of activity level, physical pain, sleep problems, depression, frustration, energy level, and overall well being (Waelde et al., 2004).

This pilot study appears to be the first study examining yoga and meditation as an intervention for stress experienced by family caregivers of those with a chronic debilitating illness. Interpretation of the findings is limited by the small sample and the lack of a comparative control group. According to Waelde et al. (2004) the findings suggest that the Inner Resources intervention program may significantly reduce depression and anxiety and increase self efficacy in chronically stressed women who are primary caregivers of persons with dementia. The process of detachment, as a result of this intervention using yoga and meditation may help improve caregivers ability to control distressing cognitions and thoughts and reduce depression and anxiety. The Inner Resources method may be a feasible and effective program to reduce symptoms of stress and depression among those in the role of being a caregiver, and may enhance affect, self efficacy, physical well-being and stress management (Waelde et al., 2004), however further study is required.

Two different publications report work done by Naga Venkatesha Murthy, Janakiramaiah, Gangadhar, and Subbakrishna (1997, 1998) which describe an open comparative study involving patients with two different depressive conditions, dysthymia (DY) and depressive melancholia (DM), using Sudarshan Kriya Yoga as treatment and measuring EEG
P300 event related potentials (ERP) as well as depression inventory scales to assess responses. The first publication presented a study objective to compared P300 ERP in DY and DM to normal controls (Naga Venkatesha Murthy, et al., 1997) and the second publication examined whether pretreatment P300 amplitude predicts or is related to antidepressant response to SKY yoga. For this study there were 15 subjects with DY (8 males, 7 females) and 15 with DM (6 males, 9 females). In addition, the initial study report included 15 matched controls for determining normal P300 comparison values (Naga Venkatesha Murthy et al., 1998).

Sudarshana Kriya Yoga employs 3 successive breathing techniques interspersed with periods of normal relaxed breathing with the eyes closed. The specific breathing techniques used in this method were not described in either report, but was later published elsewhere (Brown, 2005). SKY yoga has four breath components: three stages each of slow ujjayi, bhasrika, and chanting of OM; each separated by cyclical breathing. All breathing is done sitting with an erect spine, the legs are either folded under, crossed, or sitting in a chair. The eyes are closed with mind focused on breathing through nostrils. SKY breathing is then followed by meditation and rest (Brown, 2005). Training with a certified trainer occurred the first 10 days and was followed by 30 minutes of daily practice for 3 months. Auditory oddball P300 ERP recording via EEG for DY and DM were conducted with the average mean of 2 initial recordings used as baseline with repeated measurements at 1 and 3 months. The Hamilton Rating Scale for Depressions (HRSD), Becks Depression Inventory (BDI), and the Clinical Global Impression Scale (CGI) were used to measure depression and were administered at the same time points. Baseline levels of severity and duration of depression differed, as would be expected between the dysthymia and melancholia groups, but both groups were comparable in pretreatment assessment of P300 ERP amplitude and latency. There were significantly smaller P300 amplitudes at baseline in both
groups compared to the controls, but there was not a difference in P300 latency within or across the groups (Naga Venkatesha Murthy et al., 1997). Following intervention based on CGI scores at 1 and 3 months, 10 dysthymics and 12 melancholics were classified as responders and 8 patients were considered non responders. Responders at one month had significantly lower HRSD and BDI scores than non-responders (Naga Venkatesha Murthy et al.,1998).

Depression improved significantly following SKY with 22 out of 30 showing a reduction in both HRSD and BDI scores. The P300 ERP amplitude appears to be a non-specific state marker which normalizes with clinical recovery, but it is not predictive of response to SKY therapy (Naga Venkatesha Murthy et al.,1998) Many variables were controlled to avoid confounding factors, and although illiterates were excluded there was a significant difference in the educational levels with the control group having a higher level of education. It was however, determined to not likely affect the interpretation of the study results as both experimental groups improved to normal control group levels following intervention. Findings were comparable with earlier studies where depressed P300 amplitudes were observed in those with depression and improved with clinical resolution of symptoms. The earlier presentation of the study (Naga Venkatesha Murthy et al.,1997) primarily contributed information on the changes in P300 amplitudes observed in the different forms of depression, DM and DY, and the improvement observed with successful treatment, thereby supporting the theory that specific brain wave changes occur with depression and can serve as a means of assessment. There was little discussion of the benefits or application of SKY yoga intervention and it was noted this was part of an open study of SKY as the sole treatment of their depressive condition.

The therapeutic efficacy of SKY was also compared with 2 standard antidepressant treatments, including electro convulsive therapy and imipramine, for the treatment of
melancholia (Janakiramaiah et al., 2000). Forty-five inpatients, received 4 wks of therapy consisting of either 45 minutes of morning SKY sessions at least 4 days per week, electroconvulsive therapy (ECT) three times weekly (mean no. of sessions 8.9 +/- 3) given until HRSD score of 7 or less was achieved for 2 consecutive tests, or imipramine (IMN) 150mg daily at HS. The Beck Depression Inventory (BDI), and Hamilton Depression Rating Scale (HDRS) were used to measure depression. At baseline there were significant reductions in BDI and HRSD scores in all 3 groups, but there were no differences between them. Mean scores at weeks 3 and 4 were lowest for the ECT group, and scores for SKY and IMN groups appeared to be similar. At weeks 3 and 4 there was also between-group differences in the mean BDI score for SKY, though not different from IMN group, it was significantly higher than the ECT group. Remission rates at the end of the 4 week trial based on HRSD scores showed ECT the most effective at 93% followed by IMN at 73% and SKY at 67% (Janakiramaiah et al).

Although the response to SKY was not as good as ECT, it was comparable to IMN. With the small effect size a larger sample may have demonstrated some differences (Janakiramaiah et al). Results should be interpreted with caution in view of potential rater bias, limited size and inability to have a placebo control in this patient population. No clinically significant adverse effects (e.g., seizures, confusion, cardiovascular accidents, or hypomanic switch) occurred with the practice of SKY, and were not discussed for the other groups.

A more recent pilot study examining the effects of a short-term Iyengar yoga course in 28 mildly depressed young adults was conducted in California by Woolery, Myers, Sternlieb and Zeltzer (2004). Thirteen were randomized to the yoga group and 15 to the wait list control group. Five individuals dropped from the study, 3 from yoga and 2 from the control group. The Iyengar method recommends certain postures for aiding depression and asanas that consist of back bends,
standing postures and inversions were incorporated into a 5 week program with participants attending two 60 minute classes per week. The Beck Depression Inventory, State-Trait Anxiety Inventory, Profile of Mood States, and morning cortisol levels were monitored during this study. The yoga group demonstrated significant decreases in self reported symptoms of depression and trait anxiety. Decreases in negative mood and fatigue were noted following yoga classes. Although not statistically different, there was a trend at end of the 5 week course of increased morning cortisol levels in the yoga group, ($t(17)=1.83, P=.08$) (Woolery et al., 2004).

The majority of participants were females (79%) and students (82%), and other study limitations include the small sample size and the wait list control group. The need for other controlled measures for future studies was also suggested, such as comparisons against aerobic exercise or more pronounced depression, and use of broader array of measurements of depression (Woolery et al., 2004).

The results of 2 different year long clinical trials testing the efficacy of Kundalini yoga (KY) meditation techniques as an effective modality for treatment of obsessive compulsive disorder (OCD) both for chronic treatment and as a rapid intervention were presented by Shannahoff-Khalsa (2003) and Shannahoff-Khalsa, Srameck, Kennel, and Jameison (2004). Kundalini yoga (KY) applies specific breathing practices and chanting different mantras to induce certain mental benefits and does not use asanas or postures. All breathing techniques are done sitting in a chair or on floor with spine erect. Some of the specific methods involve forward bending, others have very specific hand placements or movements incorporated with the breathing techniques. There are 16 different techniques described (Shannahoff-Khalsa, 2003), and each one has a specific role or application to affect different mood or anxiety states. The different methods are directed toward such things as vitality, anxiety, tension, stress, fears,
challenges, OCD, changing negative thoughts to positive ones, focus, helping understand, clearing consciousness, quiet the mind, nervous disorders, balance energies, and inducing normal and extra-normal brain function.

The first study (Shannahoff-Khalsa, 2003; Shannahoff-Khalsa et al., 2004) was an open, uncontrolled pilot study enrolling 8 individuals suffering from OCD. Five of the 8 were stabilized on fluoxetine 20-40 mg for 3 months prior to the initiation of the study. Participants were trained and practiced KY for 60 minutes daily for 12 months. Evaluations using the Yale-Brown Obsessive-Compulsive Scale (Y-BOCS), and the Symptom Checklist 90- Revised, using both the Obsessive- Compulsive Scale and Global Severity Scales (SCL-90-R OC, SLC-90-R-GSI) were made at baseline and then every 3 months through the 12 month study. Three of the 8 subjects dropped out after the first three months of intervention, these three were not on any medications at the start of the study. Comparisons of baseline and 12 month measurements showed significant improvements in the Y-BOCS scores by 55.6 %, (baseline score 19.8; EOT score 8.8)., SCL-90-R OC by 53.2% and SCL-90 GSI by 52.7%. Prior to end of 12 mo study 3 patients were no longer using medications and the other 2 had reduced their medication dosage by 50%. The 3 who dropped out of the study early did have their three month evaluation also showing improved mean Y-BOCS scores going from a baseline score of 23.3 to 19.6 at 3 months. Despite the significant improvements observed conclusions can not be drawn from this pilot study due to the size and lack of a control.

In follow-up to the pilot study, a randomized controlled trial of 21 subjects with OCD, with groups matched for age and gender, was conducted having 11 assigned to the KY group and 10 assigned to a relaxation /mindful meditation (RM) group (Shannahoff-Khalsa, 2003, Shannahoff-Khalsa et al., 2004). Five individuals from the pilot study were rolled over into the
controlled study. The control group practiced relaxation response plus mindfulness meditation each for 30 minutes to compare for the time required for KY protocol. In addition to the measurement tools used in the pilot study, the Profile of mood States (POMS), Perceived Stress Scale (PSS), and Purpose in Life (PIL) questionnaires were also employed (Shannahoff-Khalsa., 2003).

Only 7 from each group completed the first 3 months of therapy. Those in the KY group experienced greater and statistically significant improvement in Y-BOCS, SCL-90R OC, SCL-90R GSI, and POMS scores. They also had non-significant but, still greater improvements in PSS and PIL scales. Within group statistics showed that the KY group had significantly improved on all 6 scales where as the RM group had no improvements. The KY group improved by 38.4% (mean score 24.6 to 15.1) verses the RM group 13.9% improvement (mean score 20.6 to 17.7). After the first 12 months those in the RM group were rolled over to receive KY therapy and Y-BOCS scores improved by 44% at their first 3 month evaluation. When merging the data from the individuals who continued KM after the first 12 months (n=11), at month 15 the mean scores showed an improvement of 70.1% (Y-BOCS), 58.8% (SCL-90-R OC), 60.6% (SCL-90-R GSI, 70.1% (POMS), 48.3% (PSS), and 19.7% (PIL test). All tests were highly significant at (p≤ 0.003) using an analysis of variance. Of the 12 patients on OCD medication at study enrollment 6 completed the study and of those 3 were able to discontinue medications a minimum of 6 months prior to the study completion. The 70% mean group Y-BOCS improvement was noted as an unusually high percentage rate for clinical change when compared to other treatment modalities (Shannahoff-Khalsa et al., 2004). Although the psychological scales used in the study show how much improvement patients had on negative symptoms they do not show the immediate and positive effects and feelings of wellbeing that patients practicing KY expressed.
Compliance and ability to perform the techniques are vital to success of the intervention. Experience shows that different patients require different amounts of practice to gain long term benefits (Shannahoff-Khalsa et al., 2004). As has been demonstrated with other studies, those who practice consistently, either daily or nearly daily, achieve the most significant benefits.

It is not clear if other variables were controlled in this study and it is noted that in the second trial 5 of the patients started therapy with trichotillomania during the study, an agent that is not currently available or well known in the United States. Further studies are needed with this intervention in order to validate its effects and usefulness.

*Musculoskeletal Effects of Yoga*

A limited number of studies have been conducted in individuals with various musculoskeletal disorders. Galantino et al. (2004) conducted a pilot study to evaluate a 6 week modified hatha yoga protocol for those suffering chronic low back pain (CLBP). Twenty two adults recruited through newspaper ads and referrals from health care providers were randomly assigned to yoga (n=11) or control group (n= 11, of which 6 did not return for follow-up). Evaluations using Oswestry Disability Index (ODI), Beck Depression Inventory (BDI), Sit and Reach Test, and Functional Reach Test were measured at baseline and at end of study. Participants recorded experiences and answered 4 qualitative questions in journals and completed a 3 mo follow-up questionnaire. Pre study analysis noted that the BDI was significantly higher in the control group. Post study assessments found that participants were less disabled by 46% and 40% for yoga and control groups, respectively, as measured by the ODI. BDI scores were 54% lower for the yoga group verses 20% the control group. Improvements in functional reach by 64 % and sit reach by 90% were noted in the yoga group. In diary entries 90% of the yoga group indicated they were motivated by group intervention and
all believed that yoga fostered relaxation and new awareness. At the 3 month follow-up 54% of yoga participants reported improved low back pain, 63% believed that benefits of the yoga intervention were still present, and 72% would recommend yoga to others with low back pain. However it was noted that none of the yoga group continued to participate in yoga classes after the study.

Although the study was not designed or powered to measure efficacy of the intervention, findings suggest that yoga intervention may improve balance and flexibility. Depression symptoms also seemed to improve, but the differences in the depression scores between the groups at baseline further limits the interpretation of those findings. The level of disability did not appear to be affected by yoga. The study does offer validation that changes in disability, depression, and flexibility are good outcomes to monitor; and that pain and discomfort scales would add more important data to future studies. Arms examining other types of interventions such as physical therapy would also be helpful comparisons. The fact that the control group received no contact with an instructor may have impacted the results of the study as well.

Also examining yoga effects in chronic back pain, Jacobs et al. (2004), conducted a 12 week pilot study using 90 minute Iyengar yoga classes held twice weekly. This pilot study was a randomized, two-arm, open label, wait list, controlled study. Measurements were made using tools which included: a Global Assessment of Effectiveness, Visual Analogue Pain scores, and functional status was measured by Roland-Morris Back Disability Questionnaire and the Oswestry Scale. Pharmaceutical drug usage for back pain was monitored as well. Biological markers of stress and healthcare utilization (number of back pain related outpatient visits) were measured as secondary outcomes. Variables were assessed at baseline, and at 1, 3, and 6 months and at follow-up. Data collection also included measures of potential covariates such as patient
expectations, general health, insomnia, depression, anxiety, and adherence to class and home based practice.

Unfortunately findings of the study were not provided, and only a discussion about the feasibility of conducting the study and the preliminary work involved with this pilot study were presented. The methodology of the study was discussed and included recruitment and randomization results, baseline demographics and group characteristics in the 52 subjects who were enrolled. The Iyengar method was chosen for use because it is the most commonly practiced form of Hatha yoga, and it has national credentialing of instructors. It also incorporates the use of props and adapts asanas according individual limitations and disabilities. The specific postures chosen for this study and the method for instruction were outlined. Although no results were reported, it was noted that there was moderate adherence to the yoga intervention; thus issues of adherence should be considered with future studies.

Haslock, Monro, Nagarathna, Nagendra and Raghuram (1994) completed controlled comparative pilot study to explore the ability of patients with severe Rheumatoid Arthritis (RA) to participate in a yoga program and observe any possible benefits. Twenty subjects were enrolled, 10 were assigned to yoga and 10 to a control group with ages ranging from 5-72, (mean of 52.2 for yoga and 57 for the control group). The yoga program was not well defined, but included asanas, pranayama and meditation with lectures and discussions on yoga philosophy. The asanas employed were modified to avoid strain on inflamed joints. Yoga sessions were attended 2 hours daily 5 days per week for the first 3 weeks, then were held once a week for 3 months with home practice encouraged.

Parameters for functional disability, joint swelling, morning stiffness, psychological assessments, and a disability index were measured. Following the 3 month intervention, the left
hand grip strength significantly increased in the yoga group when compared to the control. The right hand strength also improved relative to the controls, but the difference was not significant. Also, nonsignificant levels of improvement were observed in the Stanford Health Assessment Questionnaire Disability Index (HAQ) scores and left hand ring sizes in the yoga group when compared to control. In contrast to findings from other studies, depression, measured by the General health Questionnaire (GHQ), did not differ between the groups (Haslock et al., 1994). Although the study was small and again not powered for interpretation of the results, or drawing conclusions, it can be noted that patients with even moderate to severe RA are capable of participating in and may derive some benefit from yoga. In the future a larger trial using an appropriate control group and examining other conventional relaxation techniques would provide more information about the use of yoga in this population of patients.

Two studies examining the application of yoga in patients with osteoarthritis have been conducted. First, Garfinkel, Schumacher, Husain, Levy and Reshetar (1994), in a preliminary randomized controlled study, examined the effect of a supervised health education intervention based on Iyengar yoga and relaxation techniques in patients with osteoarthritis of the hands. The study was conducted in two phases where the control group from phase 1 was offered yoga therapy in phase two. Phase one enrolled 17 subjects (9 yoga, 7 control) and phase two enrolled 25 (14 yoga, 11 control) with ages ranging from 52 to 79. Yoga sessions lasted 60 minutes and were offered once weekly for 8 weeks. Outcome measurements were recorded for range of motion using a goniometer, hand grip strength via JAMR hydraulic hand dynamometer, finger joint tenderness using an instrument dolorimeter, circumference of finger joints with a jewelers ring sizer, hand pain using a visual analog scale, and hand function determined by Stanford Hand Assessment Questionnaire.
For both groups the scores improved for all variables for each hand except for hand function in the control group, however, none of the improvements in the control group were statistically significant (Garfinkel et al., 1994). The greatest improvement in the yoga group was for tenderness of the finger joints for both hands. Range of motion for each hand improved more with the right hand showing significant difference. There were no significant differences between the treatment group and the control group for hand grip strength or circumference of the finger joints, although the yoga group tended to show greater improvement. Combining the data on both hands the yoga group improved significantly more than the control group for hand pain during activity. Improvements at rest and in hand function were also observed in the yoga group, but they were not statistically significant.

Besides the small sample size, the study is also limited by the fact that the control group received no intervention or contact with an instructor. There were no reported adverse events or exacerbations of pain or discomfort in the treatment group as a result of participation. Study findings provide initial evidence of a potentially valuable approach in the management of OA of the hands and support the need for further study (Garfinkel et al, 1994).

Another study, this time involving subjects with osteoarthritis of the knee, was conducted by Kolasinski et al. (2005). The pilot study to assess the feasibility of using modified Iyengar yoga to treat the symptoms of osteoarthritis of the knee enrolled 11 and resulted in 7 subjects completing the study (i.e. they attended at least 5 classes). The sample consisted of obese females suffering from osteoarthritis of the knee with a mean age 58 and a body mass index (BMI) ranging from 28.7 to 39.1. Participants received instructions in a modified Iyengar hatha yoga program using 15 specific asanas in 90 minute classes once weekly for 8 weeks. Before and after the 8 weeks of yoga, assessments were made using the Western Ontario and McMaster
Universities Osteoarthritis Index (WOMAC), the Arthritis Impact Measurement scale 2 (AIMS2) for social and psychological subsets (Affect, Symptom, Social Interaction, Role), the Patient Global Assessment (GA) using 100 mm visual analog scale, the Physician Global Assessment using 100 mm visual analog scale, and a 50 foot walk test.

Pre and post measurements showed statistical improvements in level of pain and disability (WOMAC). The amount of stiffness also declined but failed statistical significance by a small margin ($p=0.06$). Affect (AIMS2) was the only statistically improved psychological variable observed, and although improvements were demonstrated in the other variables measured, they were not to the level of significance. The 50 foot walk test did not change and no adverse events reported by any of the subjects (Kolasinski et al. 2005).

Results suggest that an 8 week course of yoga can be beneficial for those with osteoarthritis of the knee in reducing pain and disability and improving affect. Yoga might also improve stiffness. Limitations, again because of the small sample size and lack of a control or comparative group exist. Future studies should include larger sample size and compare yoga to other interventions such as quadriceps strengthening, walking or swimming. Identifying subsets of patients who benefit, or whom yoga would not be appropriate would also be of interest in future work.

Garfinkel and colleagues (1998) also conducted a study to determine the effectiveness of a yoga based regimen for relieving symptoms of carpal tunnel syndrome. In this randomized, single-blind, controlled comparative trial 400 potential subjects were recruited through newspaper ads and posted notices, of which 51 met criteria and consented to participate, and 42 were used in the analysis. Subjects were randomized to either a yoga ($n=22$) or control ($n=20$) group. A Iyengar based yoga program used 11 specific asanas with emphasis on upper body to
stretch and improve flexibility and focus on correct alignment and joint position especially for
the wrists, arms and shoulders. The yoga group received 8 weeks of instructions lasting 60 to 90
minutes twice weekly. The control group used standard wrist splints. Baseline and end of
treatment evaluations were made assessing grip strength, pain intensity, sleep disturbance,
Phalen sign, Tinel sign and median nerve motor and sensory conduction times. In order to
measure distal latency of the median nerve an electroneurometer was used.

Comparisons in pre-test and post-test results identified that those in yoga group had
significant improvement in grip strength and pain reduction. There were also trends for
improvement, although not statistically significant, in nerve conduction time, Phalen sign, Tinel
sign and sleep disturbance. Both groups also showed trends toward improvement in sensory and
motor conduction times but no significant differences between pre and post test values were
found. Although yoga may offer some relief of pain and improvement in wrist strength the small
sample size prohibits generalizing the findings to others.

In four letters to editor in JAMA(1999), critical appraisals of the study identified several
limitations and design flaws for this study. By not reporting bilateral wrist responses in those
with bilateral CTS, it is noted that in analyzing responses as independent observations for each
extremity, the clinical significance may be overstated. Also, issues of the placebo effect,
especially since the yoga participants had weekly contact with an instructor and the control group
did not, can not be overlooked. Sex differences in grip strength may also affect the interpretation
of the data analysis for this variable. Other unanswered questions and missing information about
variables such as work exposure risk factors, the history of or current use of splints in the yoga
group, and the specific type of splints that were used were identified. Variables such as loss of
work, medications used and patient compliance with splint or other therapies should be included in future research.

Twenty-one elderly women (mean age 75, range 63.3 – 86) with hyperkyphosis were the subjects in a study by Greendale, McDivit, Carpenter, Seeger, and Huang (2002) to evaluate the effects of a 12 week yoga intervention on anthropometric and physical function. The yoga program used a series of 4 modified poses targeting the shoulders, spinal erectors, abdominal, and neck muscles in 60 minute classes held twice weekly. The group was divided into two classes to allow for individual attention and modifications according to constraints from the kyphosis. Anthropometric measurements were assessed at baseline and at follow-up and included height, distance from tragus to wall (a measurement of forward curvature) and Debrunner kyphometer angle (an estimate of degree of thoracic spinal curvature), as well, timed performance for activities such as standing and sitting down from an armless chair, functional reach, picking up a penny, or placing a book on a shelf and an 8 foot walk were recorded. Spinal x-rays were also obtained at the start of the study in order to document presence of vertebral fractures (43 % without and 57% with) which was later used to stratify subjects for analysis.

Nineteen subjects completed the study and attendance averaged 80 %. Mean and median scores were calculated and changes were compared. Measured height increased and the distance from tragus to wall diminished. No changes in kyphometer angle were apparent. Improvements were observed with faster timed chair stands, faster penny test and longer functional reach. Journal entries indicated 63% having increased awareness and improvement in postural as well as improved well being. Fifty eight percent perceived improvements in physical functioning such as improved balance and increased energy. As is evident in the radiological findings not all hyperkyphosis is a result of vertebral fractures and can also be attributed to muscle weakness and
poor posture. Despite study limitations this pilot study suggests that the use of yoga among women with hyperkyphosis is safe and may produce better posture. The mechanism through which this was achieved using yoga is likely because of increased strength and flexibility, and increased awareness of body alignment. An enhanced sense of well being, reported by a majority of the study participants may be the result of the contemplative mind-body intervention (Greendale et al, 2002).

Bastille and Gill–Body (2004) presented a preliminary descriptive study to investigate the effects of a yoga based exercise program on balance, mobility and quality of life for people with chronic (>9mo) post stroke hemiparesis. The study used a single case, single subject design to describe the experience of using yoga therapy in 4 post stroke patients. Subjects included three females, ages 49, 59 and 61, and one male age 71, Specific yoga instructions based on each individual’s abilities and limits in mobility were provided by an instructor certified in Integrative Yoga Therapy. Classes were 90 minutes twice weekly for 8 weeks, in each subject’s home, with written instructions left with the patient in order to help encourage daily practice at home.

Measurements for balance, using the Berg Balance Scale (BBS), and mobility, using Timed Movement Battery (TMB), were the primary outcome measurements. The Stoke Impact Scale was a secondary outcome. Data was collected at baseline, pre intervention, once weekly and after the yoga intervention phase. Enrollment criteria was established and baseline impairment criteria for moderate lower extremity impairment as determined by the Fugl-Meyer Sensiomotor Assessment. Exclusionary criteria was based on ambulation abilities, presence of significant medical conditions and Folstein Mini Mental Status Examination, as well as receptive aphasia or conditions that prohibited following 2 step instructions (Bastille & Gill–Body).
Each subject was analyzed independently with discussion about each patient’s unique abilities, concurrent conditions, and experiences. Subject 1 did not adhere to the daily independent yoga activities. Although he had improvement in total TMB SS scores, the baseline TMB SS was not stable and there was no improvement in BBS or TMB MM scores. Subject 2 experienced the greatest number of changes compared to the other subjects and reported consistent adherence to the daily independent yoga practices. She had demonstrated a commitment to self improvement prior to the study, evidenced by exercising on her own after her post stroke rehabilitation ended. This was believed to be a factor in the observed improvements between baseline and pre-intervention scores. A 14 second improvement in both TMB MM and TMB SS scores were recorded in this subject.

Subject 3 did not show improvement in any movement task of TMB. Of all the subjects she had the most impairments, limited mobility, and co-morbid conditions and was taking the most prescription medications. She participated less in the asanas portion of the program because of complaints of pain and fear that getting into some of the more challenging yoga postures would cause her pain to increase. She did continue with the less physically demanding aspects of the daily yoga activities. During contacts with her yoga therapist she expressed emotional and spiritual issues of frustration, feelings of isolation, fear and uncertainty about her future and questions concerning meaning and purpose of her life. Bastille and Gill–Body (2004) citing work from Britton Murray and Theorell, as well as work by Duncan, Sansa and Weinverger et al. related that “Emotional dysfunction has been strongly associated with health related quality of life and limitation in physical functioning, work, and leisure pursuits in people after a stroke.”(p 45); and that the empathy and support given by the Integrative Yoga Therapist when an individual expresses emotional and spiritual feelings is believed to facilitate healing of
the person’s body, mind and spirit. Despite the patient’s limited participation in the asanas portion of the intervention, clinically meaningful improvement in BBS scores after the intervention was believed to have occurred and was postulated that yoga activities may have enhanced her attention and concentration and decreased her physical impairments enough to affect her postural stability and control while performing BBS tasks.

Subject 4 did not adhere to the independent yoga practice and because of her aphasia it was difficult to determine if she understood all the instructions for the independent yoga practices. She was able to perform all the asanas with the presence and guidance of the yoga instructor, and indicated that she understood what to do, but she did not do the activities routinely giving reasons of time constraints, fatigue from performing daily household chores and frequent social outings. Despite the limited practice there were some clinically meaningful improvements in balance observed (Bastille & Gill–Body). The SSI results indicated a meaningful improvement in perception of memory, emotion and social participation after the yoga intervention although it was noted that validity of the SSI had not been established in individuals with communication difficulties. There was little change in the physical domain.

All subjects in the study demonstrated some positive effect in primary and secondary outcome variables. Not all of the subjects had similar responses to the yoga intervention and there were several differences among the subjects that may have contributed to the variance in the results. The most improvements were observed in those who adhered to the daily practice of the yoga program. Those who practiced less frequently showed some improvement, but may have needed a longer duration for the intervention in order to show more significant changes. Results suggest that yoga may be beneficial to people who have had a stroke. Further investigation is warranted to examine the effects of yoga in this population. In addition, the BBS
may not be sensitive to detect changes that may occur in some people with high level balance
deficits. Suggestions for future studies recommend using measures sensitive to changes in
postural stability or measures of postural sway. Also important to note was that no determination
of meaningful changes in TMB scores has been established and additional impairment measures
would clarify the relationship between changes in impairments and changes in speed of
performing movement tasks (Bastille & Gill–Body).
Analysis and Summary

Results

In all 60 articles were reviewed. Of these, there were 14 randomized controlled studies, 29 quasi experimental studies, and 6 explorative and/or descriptive studies. The remainder of literature was not clinical trials, but reviews, anecdotal and theory based articles of different applications of yoga. The categories of individuals involved in studies included healthy adults, either those with no prior yoga experience or yoga experienced practitioners. Experienced yoga practitioners had a wide range of practice history ranging from months to years. Twenty five studies examined yoga in specific clinical conditions and the number of trials, number of subjects and design of the study for each condition is noted in Table 1.

One study by Jain, Uppal, Bhatnagar and Talukdar (1993) in 149 non insulin dependent diabetics was not included in the review because the yoga intervention had a strict restrictive vegetarian diet and many visceral cleansing techniques practiced either daily or weekly. Another study incorporating visceral cleansing procedures and vegetarian diet by Jain and Talukdar (1993) in treatment of moderate to severe asthmatics was also not included in the review. The dietary changes and visceral cleansing practices were judged to be variables that may have greatly influenced the outcomes that were measured in these studies.
Table 1
Summary of Studies of Yoga in Specific Health Conditions and Illnesses

<table>
<thead>
<tr>
<th>Illness/Condition</th>
<th>Number of Studies</th>
<th>Number of Subjects (cumulative)</th>
<th>Experimental Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congestive Heart Failure</td>
<td>1</td>
<td>61</td>
<td>RCT</td>
</tr>
<tr>
<td>Hypertension</td>
<td>2</td>
<td>142</td>
<td>Quasi</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>1</td>
<td></td>
<td>Anecdotal or descriptive</td>
</tr>
<tr>
<td>Asthma</td>
<td>2</td>
<td>600</td>
<td>2</td>
</tr>
<tr>
<td>COPD</td>
<td>1</td>
<td>24</td>
<td>1</td>
</tr>
<tr>
<td>TB</td>
<td>1</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>Carpel Tunnel</td>
<td>1</td>
<td>43</td>
<td>1</td>
</tr>
<tr>
<td>Osteoarthritis</td>
<td>2</td>
<td>32</td>
<td>1</td>
</tr>
<tr>
<td>Low back pain</td>
<td>2</td>
<td>22</td>
<td>1 (pilot)</td>
</tr>
<tr>
<td>Hyperkyphosis</td>
<td>1</td>
<td>21</td>
<td>1</td>
</tr>
<tr>
<td>Rheumatoid arthritis</td>
<td>1</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>Stroke</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Chronic idiopathic Tinnitus</td>
<td>1</td>
<td>52</td>
<td>1</td>
</tr>
<tr>
<td>Cancer/lymphoma</td>
<td>1</td>
<td>39</td>
<td>1</td>
</tr>
<tr>
<td>Depression</td>
<td>3</td>
<td>113</td>
<td>2</td>
</tr>
<tr>
<td>Obsessive compulsive Disorder</td>
<td>2</td>
<td>26</td>
<td>1 (pilot)</td>
</tr>
<tr>
<td>Stress in caregivers</td>
<td>1</td>
<td>12</td>
<td>1</td>
</tr>
<tr>
<td>Insulin Dependent diabetes</td>
<td>1</td>
<td>37</td>
<td>1</td>
</tr>
</tbody>
</table>

RCT – randomized controlled study, Quasi- quasi-experimental study, COPD – Chronic obstructive lung disease, TB – tuberculosis

Analysis and Summary of Biochemical Parameters

Six of the studies reviewed included evaluations on hormone secretions, primarily examining adrenalcortical activity as an attempt to demonstrate physiologic stress responses.

Enhance adrenocortical activity was noted by Udupa et al. (1972) with increased urinary
excretion of 17-hydroxycorticosteroid, a cortisol metabolite, and decreased excretion of 17 ketosteroids, metabolites from testosterone and other androgenic hormones. Later Udupa and colleagues (1975) noted more pronounced increases in cortisol levels with postures that included shoulder stands. Whereas, Joseph et al. (1981) and Schell (1994) both noted decreases in plasma cortisol levels. Likewise, West et al. (2004) noted decreased salivary cortisol levels in those practicing Hatha yoga, and increases in those performing African Dance. Robert-McComb et al. (2004) did not find a statistical difference in cortisol levels, but did note a decrease in those individuals who practice yoga when compared to the control. Studies examining biochemical changes are reviewed in Table 2.

Interpretation of cortisone levels is difficult and single samples are of limited use because of circadian fluctuations and other influences. Cortisol levels are known to increase with stress, depression, anxiety, alcoholism, acute illness and other clinical conditions. West et al. (2004) pointed out that although cortisol can be influence by perceived stress and distress the subtle changes can be overwhelmed by cortisol’s role in regulating different arousal states. Other hormones were measured by Schell (1994) noting lower prolactin and increased plasma growth hormone in those practicing yoga. Joseph et al. (1981) recorded decreased dopamine β hydroxylase and increased monoamineoxidase levels which they believe to indicate decreased adrenomedullary hormone production as well as an increased degradation rate reflecting predominance of the parasympathetic system.
### Table 2

**Biochemical Changes of Yoga**

<table>
<thead>
<tr>
<th>Sample size</th>
<th>Duration of yoga</th>
<th>Hormone Secretion</th>
<th>Neurotransmitter enzyme for biosynthesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=12 healthy adults</td>
<td>6 mo</td>
<td>Enhanced adrenalcortical activity</td>
<td>↑ urinary catecholamines, ↓ plasma acetylcholine, ↓ serum cholinesterase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ urinary 17 hydroxycorticosteroid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>↓ urinary 17 ketosteroids</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>↑ urinary testosterone</td>
<td></td>
</tr>
<tr>
<td>N=10 healthy males</td>
<td>6 mo</td>
<td>↑ cortisol Gp 1 and 2 (more pronounced in Gp 2)</td>
<td>Gp 1 and 2↓ cholinesterase, ↓ catecholamines</td>
</tr>
<tr>
<td>3 groups (GP)</td>
<td></td>
<td>↓ cortisol Gp 3</td>
<td>Gp 2↑ PBI</td>
</tr>
<tr>
<td>each with different series of asanas</td>
<td></td>
<td></td>
<td>Gp 3↑ Cholinesterase, ↑ catecholamines</td>
</tr>
<tr>
<td>N=10 male soldiers</td>
<td>3 mo 1 hr class</td>
<td>↓ Plasma cortisol</td>
<td>↑ plasma cholinesterase, ↓ dopamine β hydroxylase, ↑ MAO</td>
</tr>
<tr>
<td>N=18 older females with heart disease</td>
<td>8 wks 2 hr class</td>
<td>No statistical change in cortisol or stress hormones (a ↓ in resting levels in yoga group noted)</td>
<td></td>
</tr>
<tr>
<td>n=9- tx group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=9- control</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N=50</td>
<td>NA experienced Yogis one day test</td>
<td>↓ plasma cortisol (more pronounced in yoga group)</td>
<td></td>
</tr>
<tr>
<td>n=12 exp in yoga,</td>
<td></td>
<td>↓ prolactin levels</td>
<td></td>
</tr>
<tr>
<td>n=13 control w/no exp</td>
<td></td>
<td>↑ plasma growth hormone</td>
<td></td>
</tr>
<tr>
<td>N=69</td>
<td>14 weeks</td>
<td>↓ salivary cortisol w/yoga</td>
<td></td>
</tr>
<tr>
<td>n=18-yoga</td>
<td></td>
<td>↑ salivary cortisol w/ Af Dan</td>
<td></td>
</tr>
<tr>
<td>n=21-African Dance (Af Dan)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=30-Biology class control</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

17 hydroxycorticosteroid is increased with adrenal hyperfunction
17 ketosteroids are metabolites of testosterone and other androgenic hormones
(The most common cause of decrease 17 KS is stress)

Cortisol tends to increase glucose by stimulating gluconeogenesis and inhibits the effects of insulin
MAO - monoamine oxidase
PBI- protein bound iodine (a very old test for circulating thyroid hormone)

Three studies examined blood glucose levels in healthy subjects and one study evaluated yoga in poorly controlled diabetics. Two early studies by Udupa et al. (1975, 1971) with 10 and 12 subjects enrolled and one study by Joseph et al. (1981) with 10 subjects each reported...
significant reductions in glucose and increased serum protein levels after 3 to 6 months of yoga practice. In contrast, Kerr et al. (2002), examining 37 poorly controlled insulin dependent diabetics, did not observe any improvements in glycemic control as measured by Hg A1C. Yet, after the 4 months of intervention in these diabetics the yoga group required no changes in insulin, whereas the control group required significant increases in their insulin doses (see Table 3).

Table 3

<table>
<thead>
<tr>
<th>Number of subjects</th>
<th>Condition</th>
<th>Blood Glucose</th>
<th>Serum Protein</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Healthy</td>
<td>Decrease</td>
<td>Increased</td>
</tr>
<tr>
<td>12</td>
<td>Healthy</td>
<td>Decrease</td>
<td>Increased</td>
</tr>
<tr>
<td>10</td>
<td>Healthy</td>
<td>Decrease</td>
<td>Increased</td>
</tr>
<tr>
<td>37</td>
<td>Insulin dependant diabetes mellitus</td>
<td>Not measured</td>
<td>HgA1c unchanged</td>
</tr>
</tbody>
</table>

Another study examined brain metabolism of glucose via PET scanning during meditation and noted elevated ratios of the cerebral metabolic rate in the frontal verses occipital regions during meditation. These findings were attributed to the reduction of input from the primary and secondary visual centers (Herzog, Lele, Kuwert, Langen, Kops, Feinendegen, 1990).

Thyroid function was only examined in Udupa Singh and Settiwar’s study (1975) where protein bound iodine levels were increased in those practicing shoulder stand type postures. No other studies examined thyroid function, thus conclusions about thyroid stimulation with yoga practice can not confidently be made.

The correlation between yoga and it’s affect on glandular and hormone activity is promising, but not enough evidence based criteria exists to draw any final conclusions. Studies
are limited and those studies examining stress hormones have conflicting results. The tests used to measure hormones and endocrine function failed to show substantial physiological evidence of stress responses in those who practice yoga. The limited observation of these hormones and the difficulty with interpreting results with wide variances in normal values prohibits any clear understanding of how hormone function might be influenced by yoga practice. Consistent methods of measurement were not used and reflect the different dates the research occurred. In order to assess hormonal and biochemical effects, new studies using larger samples and modern methods of measurements are needed along with the application of more strict controls.

*Analysis and Summary of Cardiovascular Effects*

The changes in cardiovascular function as a result of yoga are more apparent and supported in the findings of the studies reviewed with reductions in heart rate and blood pressure particularly noted and listed in Table 4.

Telles et al. (2004) looked specifically at the ability to reduce heart rates voluntarily after 30 days of yoga training with significant decreases noted from the baseline measurements. Wenger and Bagchi (1961), Joseph et al. (1981), and Telles et al. (2004) noted decreased blood pressures and pulse rates with yoga practice. Likewise Udupa et al. (1975) noted decreased blood pressure in two of the three groups practicing different yoga asanas. The group that had an increase in blood pressure was a group performing more vigorous exercise type sequences of yoga postures using repeated sequences of sun salutations.

Prasad et al. (2001) found that during nadisodhana (alternate nostril breathing) both heart rate and oxygen consumption were reduced when they were compared to field and treadmill walking. Sung et al. (2000) compared yoga to classical music and nature sounds as well as a
control group and found yoga to be the fastest and most effective method to reduce blood pressure after an induced stress.

Table 4
Cardiovascular Effects of Yoga

<table>
<thead>
<tr>
<th>Cardiovascular Parameter</th>
<th>Study Design</th>
<th>Direction of Response</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N (studies)</td>
<td>Increase</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heart Rate</td>
<td>RCT</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Quasi</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Anecdotal</td>
<td>1</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>RCT</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Quasi</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>Anecdotal</td>
<td>1²</td>
</tr>
</tbody>
</table>

RCT- Randomized controlled study, Quasi –Quasi experimental study

aStudies involved specific breathing maneuvers or vigorous asana sequences
²Observational study noted decreased SBP and increased DBP in yoga practitioners

In three studies in hypertensive patients, those practicing yoga (Sundar et al. 1984) and those using progressive relaxation, breathing and/or meditation methods (Patel et al., 1985, Aivazyan et al., 1988) had significant reductions in blood pressures. In the study by Sundar and colleagues (1984), not only was there a significant reduction in blood pressures, but the need for antihypertensive medications was reduced or eliminated in all 5 patients who were taking them when the study started. Aivazyan and colleagues (1988) observed significant systolic and diastolic blood pressure (BP) reductions which were maintained over 1 year in the treatment groups practicing either relaxation and breathing techniques or biofeedback when compared to
the control. They also found that with induced stress the BP in the treatment groups were significantly lower and the time required for restoration of BP was less than the control group, much like what was observed by Sung et al.,(2000). Aivazyan and colleagues (1988) found that both biofeedback and breathing and relaxation training both had an impact on BP reduction. Patel et al. (1985) also observed reduced blood pressures following 8 weeks of relaxation, breathing and meditation training in a study involving individuals with cardiovascular disease risk factors. The reduction in blood pressure was maintained at a 4 year follow-up evaluation.

The psychophysiological reactivity of patients undergoing relaxation therapy is reduced and likely leads to improved tolerance to stressful events. One reason for the observed antihypertensive effect of relaxation therapy involves reduction in sympathetic tone. Vempati and Telles (2002) noted significant reductions in heart rate and blood pressure in proficient yoga practitioners when applying either guided relaxation or supine rest. Recording measurements in heart variability, a reflection of sympathetic nervous system influence, revealed that with guided relaxation the low frequency component is reduced especially in those with higher baseline frequency ratios. These findings suggest that the practice of guided relaxation may be more effective than supine rest in reducing sympathetic tone. Bowman et al. (1997) found that heart rate decreased after yoga, but did not following aerobic training and attributed the difference to increased vagal activity induced by relaxation and breathing. No significant changes in the systolic blood pressure were noted with either yoga or aerobic exercises. In the yoga group there was an observed increase in the peak power values of heart rate variability in the mid-frequency range and to a lesser extent at the high frequency range. Mid frequency ranges may represent a quantitative index of the sympathetic control of the heart rate and vasomotor activity and high frequency ranges reflect respiratory component and parasympathetic activity (Bowman et al.).
No frequency changes occurred in the aerobic training group and no baroreflex sensitivity changes were noted in either group.

In contrast to studies reporting reduced heart rate or blood pressures are other study reports, such as Udupa et al.’s (1971), where after 6 months of yoga training, while noting a tendency of a lower pulse rate, neither changes in heart rate or blood pressure were statistically significant. Schell et al. (1994) found that the HR decreased during and directly after yoga and then returned to baseline. The decline was especially noteworthy during the active movement stage of yoga and was attributed to increased vagal tone in experienced yoga practitioners. However, like with Bowman et al. (1997) and Udupa et al. (1971), the blood pressure showed little variation. And, Gopal et al. (1973) noted that while the pulse and BP was generally lower in the yoga group, the difference was not statistically significant. When studying asthmatics Nagendra and Nagaratha (1986) noted significant improvement in all parameters except BP and pulse. Although some of the study findings did not show statistical significance they did show trends of decreased blood pressure and pulse and indicate that the observed reduction in sympathetic activity needs further validation.

In a more specific study Shannahoff-Khalsa et al. (2004) investigated the hemodynamics of a yogic breathing technique claimed to “help eliminate and prevent heart attacks due to abnormal electrical events in the heart and enhance the performance of the central nervous system…” (p 757). The theoretical framework is based on the autonomic nervous system’s role in sudden cardiac death. The study utilizes evaluation of the Mayer wave, a centrally regulated expression of autonomic activity mediated through the sympathetic and parasympathetic nervous system. Mayer waves are always slower and independent of the respiratory rate. The specific breathing technique used in this study was one breath per minute which reportedly induces
dramatic shifts in hemodynamic variables during the exercises and can produce changes in the post exercise resting period that remain in those who have long term practice with the technique. It is suggested that this breathing method may have an effect on the cardio-respiratory center in the brain stem which regulate the Mayer wave patterns of the cardiovascular system. The described respiratory pattern shows a controlling effect of ejection phase contractility during one part of the 1 breath per minute cycle, while vasoactivity is essentially unchanged. Only one of the 4 subjects who had extensive practice with the breathing method with three different experimental runs over a 9 month period showed attainment of a sinusoidal effect on the Mayer wave pattern in the post exercise phase. Although no conclusions can be made, the brain stem cardio-respiratory control center may be influenced after long term practice of yoga (Shannagiff-Khalsa).

In understanding human physiology it is clear that heart rate and blood pressure are impacted by the nervous system which responds to stress. Less sympathetic activity reduces the amount of stimulation and release of norepinephrine by the sympathetic nerves. As a result, there is less S-A and A-V node conduction, heart rate is slowed and less vasoconstriction results in a reduction of blood pressure. Parasympathetic or vagal nerve stimulation causes acetylcholine release at the vagal nerve endings and produces a decrease in S-A note rhythm and A-V node excitability. These combined effects, as they occur with yoga, relaxation, and controlled breathing, have a significant impact on the physiological responses to different types of stress.

**Analysis and Summary of Respiratory and Pulmonary Effects**

Eleven studies evaluated pulmonary, respiratory and/or lung functions. Significant improvements in lung volumes and vital capacity were noted by Visweswaraiah and Telles (2004), in their study of tuberculosis patients; in Murthy et al.’s. (1984) study involving asthma
patients; in Udupa et al.’s (1971) report of physiological changes in healthy adults, and by Gopal et al. (1973) in the study involving healthy experienced yogis practicing pranayamic breathing techniques. The only study measuring lung function with differing results was Tandon’s (1978) study in COPD patients, where there were no changes in FEV1, FVC, PaO2 or PaCO2 in either a yoga group or those in the physiotherapy control group. The lack of improvement observed in COPD was likely the result of irreversible permanent lung damage and not a failure to respond to the yoga intervention. Indeed, the individuals in the yoga group showed improved work tolerance and more rapid recovery from exertion, as well as improved ability to control an attack of shortness of breath without seeking medical help despite their lack of change in lung capacity or function.

Oxygen consumption was measured and found to be reduced in two studies. Both Prasad and colleagues (2001) in 12 healthy adults practicing nadiyodhana, and Vempati and Telles (2002) who examined guided relaxation and supine rest practices in 35 experienced yogis noted lower oxygen consumptions with nadiyodhana and guided relaxation. An increase in the VO2 max was observed in both yoga and aerobic exercises by Bowman et al. (1997) in their study examining baroreflex activity in 26 elderly sedentary adults.

Breathing frequency is generally reduced with yoga practice and was specifically noted by Udupa, Singh, and Yadav (1973), and Gopal et al (1973). Improvements in chest expansion were also noted by Udupa et al (1973) and an increase in breath amplitude was noted by Vempati and Telles, (2002). Table 5 provides a summary of the respiratory and pulmonary effects observed. Although consistent methods for examining respiratory or lung function were not used in these studies they collectively offer support for the positive pulmonary system effects of yoga and a variety of yoga breathing practices.
Table 5

Respiratory and Pulmonary Effects of Yoga

<table>
<thead>
<tr>
<th>Parameter Measured</th>
<th>Type of Study</th>
<th>Change in Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>RCT</td>
</tr>
<tr>
<td>Total Studies</td>
<td>N=11</td>
<td></td>
</tr>
<tr>
<td>Respiratory Rate/breathing frequency</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>FEV1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>FVC or VC</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>FEV1/FVC</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PEFR</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Chest Expansion</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Breath Amplitude</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>VO2 max</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>SaO2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>PaO2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Oxygen consumption</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Increased exercise tolerance 1 1*

RCT – randomized controlled trial
Quasi Exp.- Quasi-experimental study
Anecdotal or observational data
*Study in COPD patients

The only study measuring lung function that failed to show benefits was the study in COPD patients. Despite the lack of irreversibility of lung impairment in those with this condition they still achieved some benefit in practice. Thus, yoga would be an appropriate intervention for those afflicted with various lung disorders. Both conditions involving the lung which are chronic and those that are acute could benefit from the different breathing methods and intentional focus and awareness of the process of breathing.

Studies involving asthmatics also noted decrease reactivity to triggers and improved symptom scores following yoga intervention (Murthy et al., 1984; Nagendra & Nagaratha 1986).
Studies by Aivazyan et al. (1988), Sundar et al. (1984) and Sung et al. (2000) and Bernardi et al. (1998) all confirm that focusing on breathing and relaxation have significant impact on the physiologic responses to stress. Thus, breathing and relaxation components of yoga practice are essential variables that likely play an important role in achieving the full benefits of yoga intervention.

Analysis and Summary of Neurological Effects

Four different studies measured brain waves as a method of examining autonomic function. A prominence in alpha waves with fewer spikes indicates a less irritable nervous system and was observed by both Udupa et al. (1972) and Joseph et al. (1981). Kamei, Toriumi, Kimura and Kimura (2001) also noted increased alpha activity when examining the correlation between alpha rhythms and natural killer cell activity during yoga respiratory exercise. This study also found correlation of alpha activity and natural killer cell activity during pranayama exercises. A summary of studies examining neurological function is included in Table 6. In addition to EEG measurement of autonomic function, Bowman et al. (1997) in assessing baroreflex sensitivity, measured peak power values of heart rate variability via ECG to estimate the alpha index at high frequency (a reflection of parasympathetic activity) and at mid frequency (a reflection of sympathetic activity) levels. Findings in this study found increased alpha index at high frequency following yoga suggesting increased parasympathetic and autonomic control. Increased vagal activity that may be induced with relation and breathing techniques are purported to cause the reduced heart rates and resulting decreased sympathetic and increased autonomic activity (Bowman et al.)

Other than those findings note, there is a void in study information examining the effects of yoga on the nervous system. The inter-relationship of the neuromuscular system has an
important role in physical function. Stress reactions often are exhibited by muscle tension. Yoga not only affects the central nervous system, but also influences the peripheral nervous system and various reflexes (Coulter, 2001). The myotatic stretch reflex, the clasp knife reflex (activation of the Goldi tendon organs found near musculotendinous junctions aiding in activation of inhibitory interneurons to facilitate relaxation of muscles), the crossed extension reflex and other flexion reflexes can all be affected by activation and physical use of the muscles and tendons that they innervate. Muscle activity associated with yoga postures most likely influence peripheral nervous system function, but studies actually examining this phenomenon were not identified.

Table 6

<table>
<thead>
<tr>
<th>Neurological Effects of Yoga</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of subjects</td>
</tr>
<tr>
<td>N=12 healthy adults</td>
</tr>
<tr>
<td>N=10 male soldiers</td>
</tr>
<tr>
<td>N=8 Yogis</td>
</tr>
<tr>
<td>N=45 n=15 dysthymics n=15 depressive melancholia n=15 control</td>
</tr>
</tbody>
</table>

Analysis and Summary of Mood/ Mental Status Effects

There is strong evidence of positive effects resulting from various yoga practices in relation to changes in mood and improved mental states. Several studies employed tools to
examine mood, depression, anxiety, or perceived stress; additional assessments of mental abilities and fatigue were incorporated into a few trails as well. The Beck Depression Inventory (BDI) was frequently used and other tools for depression included the Hamilton Depression Rating, The Centers of Epidemiologic Studies Depression Scale and a Clinical Global Depression Rating.

Implementing yoga in actual depressive conditions, Janakiramaiah, et al. (2000), compared the therapeutic efficacy of SKY with 2 standard antidepressant treatments (electro convulsive and imipramine) for melancholic depression and noted significant reductions in BDI and HRSD scores in all 3 treatment groups. In addition, Naga Venkatesha Murthy et al. (1997, 1998) explored the use of SKY in two different depressive conditions, dysthymia (DY) and depressive melancholia (DM) using depression inventory scales as one method to assess responses to the therapy. The Hamilton Rating Scale for Depressions, Becks Depression Inventory, and the Clinical Global Impression Scale all indicated significant improvement in depression symptom scores following SKY.

Woolery et al. (2004) likewise evaluated a short term Iyengar yoga course in mildly depressed young adults and found that the yoga group demonstrated significant decreases in self reported symptoms of depression and trait anxiety and noted decreased negative mood and fatigue, following yoga classes.

In those suffering from obsessive compulsive disorder, Shannahoff-Khalsa (2003, 2004) reported the results of 2 different year long clinical trials testing the efficacy of Kundalini yoga (KY) meditation techniques both as a chronic treatment and as a rapid intervention. Kundalini yoga (KY) applies specific breathing practices and chanting different mantras to induce certain mental benefits and does not use asanas or postures. Improvements in measurements in the
Profile of Mood States (70.1%), Perceived Stress Scale (48.3%), and Purpose in Life (19.7%) were noted. In addition, the Yale-Brown Obsessive-Compulsive Scale (70.1%), and the Symptom Checklist 90- Revised, using both the Obsessive- Compulsive Scale and Global Severity Scales (58.8% and 60.6% respectively) were improved. Of the 12 patients on OCD medication at study enrollment 6 completed the study and of those 3 were able to discontinue medications a minimum of 6 months prior to the study completion. The 70% mean group Y-BOCS improvement was noted as an unusually high percentage rate for clinical change when compared to other treatment modalities (Shannahoff-Khalsa, 2004).

In Galantino et al.’s (2004) pilot study of a modified hatha yoga protocol in subjects with chronic low back pain there were lower BDI scores observed in the yoga group (54%) verses the control group (20%). However at pre-study the BDI was significantly higher in the control group, and 6 of the 11 in the control group failed to return for follow-up thereby limiting any specific conclusions about depression. In contrast, Cohen (2004), using patients with lymphoma examined the effects of Tibetan yoga practices that incorporate controlled breathing, visualization, mindfulness techniques and low impact postures. Although statistical improvements were reported in sleep, the measurements for depression, fatigue, state anxiety, avoidance or intrusion were not different than the control group. It was observed that the instruments used may not have been sensitive enough to detect changes in these variables for the patient population involved in the study.

Looking at the stress involved with being a caregiver to a family member with dementia, Waelde, et al. (2004) found significant reductions in depression and anxiety, and improvement in perceived self efficacy. Of the 12 participants 70% reported feeling somewhat or much better than before the study in terms of activity level, physical pain, sleep problems, depression,
frustration, energy level, and overall well being. Yet while these mood improvements occurred there was no difference in perceived subjective or objective caregiver burden.

Several studies showed improvement in mood and other mental and psychological measurements in healthy subjects, some of whom were experienced yoga participants and others were yoga naïve. Berger and Owen (1992) compared the mood alteration and anxiety associated with Hatha yoga, swimming, and a control group and noted benefits in both swimmers and yoga participants. Gender differences identified that female yoga participants had larger decreases in fatigue and male yoga participants had greater benefits for tension, fatigue and anger when compared the swimmers. Similar findings in another comparative exercise study using psychological markers of stress were reported by West et al. (2004) when they found that both African dance and Hatha yoga significantly decreased perceived stress.

Table 7

Measurements of Depression, Anxiety, Mood and Mental Status Effects of Yoga
(Symbol denote condition: * depression, OCD or stress; †chronic low back pain; ‡lymphoma; Δ healthy volunteer)

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<td>Becks Depression Inventory</td>
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<td>Hamilton Depression Rating</td>
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<td>Clinical Global Depression</td>
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<td>ANXIETY</td>
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<td>Profile of Mood State</td>
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</table>

Seven studies measured depression; five measured anxiety; four measured mood.
### Table 8

Measurements of Other Mental Status Effects of Yoga  
*(Symbols denote condition: * depression, OCD or stress; †chronic low back pain; ‡lymphoma; Δ healthy volunteer)*

<table>
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<th>OTHER-MENTAL STATUS</th>
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<td>Purpose in Life</td>
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<td>Mursley Personality Inventory</td>
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<td>Eysenck Personality Inventory</td>
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<td>Alexanders Passalong &amp; Kohs Block tests for Intelligence</td>
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<td>Memory Scale Wichsler</td>
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<td>Revised memory &amp; Behavior problem checklist</td>
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<td>Cornell Medical Index of Physical and Psychological health</td>
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<td>Smith Relaxation Inventory</td>
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<td>Mental fatigability after stress</td>
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<td>Digit cancellation mental fatigability</td>
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<td>Fatigue</td>
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<tr>
<td>Sleep disturbance and quality</td>
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<tr>
<td>Yale Brown obsessive compulsive scale</td>
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<tr>
<td>Symptom checklist for OCD and Global severity</td>
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</tbody>
</table>

Three studies assessed stress; three measured personality inventories; two measured memory; two measured mental fatigability; one measured fatigue; one measured sleep quality; and one measured relaxation.

Schell et al. (1994) also found similar improvements in healthy females when evaluating psychological parameters related to mood, stress and personality inventories. Yoga participants reported significantly higher life satisfaction, less excitability and aggressiveness, and less openness and emotional labiality. In coping with stress the yoga group tended to reduce stress by downplaying their situation comparison to others, whereas the control group showed higher tendency to react with aggression and self pity. Differences in mood between the two groups were observed with Yoga participants having significantly higher levels of high spirits, and being
extroverted. The controls were significantly less activated and irritable. The control group also
had a tendency towards more vexation, excitation and numbness as well as higher scores for
somatic complaints and extraversion, but these tendencies failed to be significant.

Udupa et al. (1971) also reported scores indicating lower mental fatigability, increased
performance and improved memory quotients, as well as a significant decrease in the
neuroticism index which may be secondary to the neurophysiologic changes that occur after
Hatha yoga practice. Tables 7 and 8 summarize the studies measuring depression, anxiety, mood
and other psychological and mental abilities.

Analysis and Summary of Musculoskeletal Effects:

Only 7 studies examined physical effects, primarily in those afflicted with different
musculoskeletal disorders, and are reviewed and listed in table 9.

Grip strength improved in individuals with carpal tunnel (Garfinkel et al., 1998) and
rheumatoid arthritis (Haslock et al., 1994). Those with osteoarthritis of the hand experienced
improvement in range of motion as well as decreased finger joint tenderness (Garfinkel et al.,
1994). Pain was also reduced in those with carpal tunnel and osteoarthritis of the knee, and in 54
% of yoga participants with chronic low back pain (CLBP) (Galantino et al., 2004). Those with
CLBP had significant functional improvements and improved scores on the BDI, although the
baseline levels differed between the yoga and the control group. Yet, for those with CLBP, the
level of disability did not appear to be affected by yoga.

In Kolanski et al.’s (2005) Study, assessing a modified Iyengar yoga program to treat the
symptoms of osteoarthritis of the knee, affect was the only statistically improved psychological
variable observed. Participants also reported that the amount of stiffness declined, and this
finding failed statistical significance by only a small margin (p=0.06).
Table 9

Musculoskeletal Study Summary

<table>
<thead>
<tr>
<th>Condition</th>
<th>Intervention</th>
<th>Statistical Improvement</th>
<th>Trend of Improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpal tunnel</td>
<td>Iyengar, upper body asanas 60-90 min 1/wk 8wks</td>
<td>• Grip strength</td>
<td>Nerve conduction time</td>
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<tr>
<td></td>
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<td>• Pain reduction</td>
<td>Phalen sign</td>
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<td></td>
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<td></td>
<td>Tinel sign</td>
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<td></td>
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<td>Sleep</td>
</tr>
<tr>
<td>Osteoarthritis of the hands</td>
<td>Iyengar based 60 min, 1/wk x 8 wks</td>
<td>• Finger joint tenderness</td>
<td>ROM</td>
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<tr>
<td>Phase 1 N=17</td>
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<td>Hand pain during activity</td>
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<tr>
<td>(Y-9,C-7)</td>
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<tr>
<td>Phase 2 N=25</td>
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<tr>
<td>(Y-14,C-11)</td>
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<tr>
<td>Osteoarthritis of the knee</td>
<td>Iyengar yoga modified 15 asanas 90 min once/wk 8 weeks</td>
<td>• level of pain and disability</td>
<td>Decline in stiffness (p=0.06)</td>
</tr>
<tr>
<td>N=7</td>
<td></td>
<td>• affect</td>
<td>Symptoms</td>
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<tr>
<td>Rheumatoid Arthritis</td>
<td>Asanas, pranayama mediation, lectures 120 min, 5/wk for 3 wk, 1/wk for 3 mo</td>
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<td>Social interaction</td>
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<td>N=20</td>
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<td>Role</td>
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<tr>
<td>Y-n=10</td>
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<td></td>
<td>Global assessments</td>
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<tr>
<td>C-n=10</td>
<td></td>
<td></td>
<td>Arthritis impact scale</td>
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<tr>
<td>Chronic low back pain</td>
<td>Hatha modified for chronic low back pain 60 min twice/wk 6 weeks</td>
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<td>N=20</td>
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<tr>
<td>Y-n=11</td>
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<tr>
<td>C-n=11</td>
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<tr>
<td>Stroke</td>
<td>Integrative Yoga Therapy 90 min twice/wk 8 weeks</td>
<td>All subjects in the study demonstrated some positive</td>
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<tr>
<td>N=4</td>
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<td>effect in primary and secondary outcome variables.</td>
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<td>The was variability in all subjects baseline BBS and</td>
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<td>TMB baseline scores</td>
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<td>• BBS scores improved in 2 subjects.</td>
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<td>• Three of 4 subjects improved in total TMB SS scores</td>
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<td>• SIS scores revealed the following improvements:</td>
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<td>o Pt #1, physical, emotional and participation domains</td>
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<td></td>
<td>o Pt #2 physical and memory domains.</td>
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<td>o Pt #3 participation domains</td>
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<td></td>
<td></td>
<td>o Pt #4 memory, emotion and participation domains.</td>
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<tr>
<td>Healthy Volunteers</td>
<td>Hatha Yoga 90 min 4/wk 8 weeks</td>
<td>Significant increase in range of motion attributed to</td>
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<td>static stretching.</td>
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<td>As well as statistical improvements in:</td>
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<td></td>
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<td>• Increased muscular strength in elbow extension and</td>
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<td>flexion and knee extension.</td>
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<td>• Increased flexibility in ankle, shoulder elevation,</td>
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<td></td>
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<td>and trunk extension and flexion</td>
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</table>
A pilot study in patients with severe rheumatoid arthritis found that following 3 months of yoga intervention, not only was there improvement in hand grip strength, but the Stanford Health Assessment Questionnaire Disability Index scores and left hand ring sizes were also improved in the yoga group when compared to control (Haslock et al., 1994). Consistent with psychological variables measured in osteoarthritis of the knee, depression, measured by the General Health Questionnaire, did not differ between the yoga and control groups. These findings are in contrast with findings reported in some healthy volunteers and those with depressive conditions where there were marked improvements in psychological mood and depression symptoms.

Elderly women with hyperkyphosis had an increase in height and improved posture with decreased distance from tragus to wall measurements, but no changes in kyphometer angle (Greendale et al., 2002). Yoga participants also had significant functional improvements, as well as improved balance and increased energy; their journal entries indicated an increased awareness of and improvement in posture, as well as improved sense of well being. The mechanisms through which the improvements were achieved were attributed to increased strength, flexibility, and awareness of body alignment.

Jacobs et al. (2004) conducted pilot study using Iyengar yoga classes, but unfortunately findings of the study were not provided. Only a discussion about the feasibility of conducting the study and the preliminary work describing methodology, recruitment and randomization with baseline demographic and group characteristics were outlined, along with the rationale for choosing to use Iyengar method of yoga. Although no results were reported, it was noted that there was moderate adherence to the yoga intervention, again pointing out that issues of adherence should be considered with future studies.
In Bastille and Gill–Body’s (2004) preliminary descriptive study investigating the effects of a yoga based exercise program on balance, mobility and quality of life for people with chronic post stroke hemiparesis, subjects experienced some positive effects in primary and secondary outcome variables, but there were several differences among the subjects that may have contributed to the variance in the results. Most of the improvements were observed in those who adhered to the daily practice of the yoga program.

The small number of studies and sample sizes used in to examine the musculoskeletal effects of yoga limit the formation of any definitive conclusions. The lack of control groups in some of the studies further limit the interpretation of the study findings. Future studies should include larger samples and compare yoga to other interventions such as quadriceps strengthening, walking, swimming and other exercises and activities recommended for arthritis and other musculoskeletal disorders. Identifying subsets of patients who benefit, or whom yoga would not be appropriate, would also be of interest in future work.

A modified yoga program may be beneficial for those with osteoarthritis of the knee and may reduce pain, disability, and improve stiffness and mood affect. Yoga practice can also improve posture, flexibility and balance. Although the study in RA was small and again not powered for interpretation of the results, or drawing conclusions, it can be noted that patients with even moderate to severe disease are capable of participating in and may derive some benefit from yoga. Yoga is a form of low impact exercise which is often recommended therapy for individuals with arthritis. It was also noted that no adverse events or exacerbation of arthritis or joint symptoms were reported by any of the subjects in either study involving individuals with osteoarthritis.
In a meta-analysis of studies examining strategies for exercise therapy to treat chronic low back pain Hayden, van Tulder and Tomlinson (2005) found that stretching and strengthening exercises, much like those used in yoga, were the most beneficial. The effects of yoga on muscle function, strength and flexibility as well as the effects on connective tissue and other neuromuscular reactions have not been thoroughly researched. Studies using adequate tools for measurement and comparison groups need to be conducted. Furthermore, it is uncertain if those with immune modulated conditions such as rheumatoid arthritis, and multiple sclerosis can benefit from the effects of yoga on the muscular and peripheral nervous systems. The potential for benefits from yoga in patient populations with various musculoskeletal disorders supports the need for further research.

Analysis and Summary of Yoga Methods/Style/Techniques

Information on specific yoga techniques was collected when available and is presented in Table 10. The description of the yoga techniques varied. Some studies used specifically defined postures and series of asanas, while in other studies the description of yoga was not defined. Hatha yoga was applied in 13 studies, which is a broadly defined method incorporating the application of asanas, breathing and meditation according to the experience and skill of the instructor. The Iyengar method is one type of Hatha yoga that includes certification with training and was implemented in 5 of the studies. For each of these studies a specific Iyengar regimen was used focusing on asanas and postures for the particular condition. Four of the studies were musculoskeletal conditions including carpal tunnel, osteoarthritis and chronic back pain, and one study was in mild depression. The Iyengar method has a very strong emphasis on proper body alignment and individualized application using, when needed, props or support measures to assure correct application of the postures thereby limiting any potential harm.
A number of studies focused on specific breathing practices sometimes alone or combined with meditation, chanting mantras or relaxation techniques. Specific yoga practices such as Sudarshan Kirya Yoga (SKY), Kabat-Zinns Mindfulness Meditation, Kundalini Yoga and Inner Resources were used in some of the studies and were placed in groups or categories according to the focus of the practice such as breathing and meditation. There was variation in how well yoga was explained or defined, and specific yoga postures or breathing techniques were not described in every study reviewed. It is important to note that the difference in the types of yoga practiced and the variability in applying breathing, asanas, relaxation and meditation limits the interpretation and pooling of the study results. Thus the efficacy of the yoga as an intervention can not be correlated to any specific yoga techniques.

Table 10

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<th>Type of Yoga</th>
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<td>Hatha Yoga</td>
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<tr>
<td>Relaxation</td>
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</table>

*One study did not report results only design of pilot protocol using Iyengar method

It is also important to note that breathing and meditation techniques have been successfully used to induce relaxation with similar physiological effects (Woolfolk, 1975; Wallace, 1970; and Joseph et al., 2005), much like those observed with yoga. Benson (2000)
labeled the response to breathing and meditation the *Relaxation Response* after examining practitioners of Transcendental Meditation. His observations showed that regular practice of the “Relaxation Response” resulted in reduced blood pressure levels not only during relaxation, but that those individuals had lower blood pressures in general. Benson identified four basic elements needed in order to elicit the Relaxation Response which include: 1. A quiet environment, 2. An object to dwell on, 3. A passive attitude, and 4. A comfortable position. The two most important elements are mental focus and passive attitude. Mental focus might be achieved through repetition of a word, sound, phrase, prayer or muscular activity. Passive attitude is accomplished by disregarding everyday thoughts that come to mind and returning to mental focus or repetition (p. xvii-xviii). Benson further explains his belief that other mental processes and methods have been used by various different cultures and religions for centuries to induce the same type of physiologic responses as observed with inducing the relaxation response. Those methods are often associated with different religious practices that involve reciting prayers or phrases and focusing attention away from thinking about events outside ourselves. Reciting prayers or words used in variety of different religions may also add meaning and help induce the relaxation response. The following are suggestions for words or prayers used in the most common religions practiced (p. xix-xx).

- Catholics—“Hail Mary”
- Jewish—“Sh’ma Yisrael”
- Protestants—“Our Father”
- Muslims—“Isha’allah”
- Hindu—“Om”
- Secular or nonreligious individuals could use words such as one, love, peace, or calm
One benefit of using the Relaxation Response is that it is a self administered therapy and as a part of self care, it may impact health and reduce the cost of health care.

The following is Benson’s (2000) protocol for eliciting the Relaxation Response:

- Sit comfortably and maintain quiet
- Close eyes
- Deeply relax. Progressive relaxation of the body beginning with the feet and progressing up to the face.
- Focus attention and breathe – with conscious breath awareness, focus on one word or prayer
- Continue with focus breathing and repetition for 10-20 minutes.
- Maintain a passive attitude, if other thoughts come into mind return to focusing on breathing and repeating the word or prayer. Do not dwell on distracting thoughts or worry about the ability to achieve deep relaxation.
- Following relaxation sit quietly a few minutes before getting up.

Analysis and Summary of Duration and Frequency of Yoga Intervention

A wide variety of frequencies, durations, and length of yoga sessions were used in the studies and are summarized in table 11. The Length of yoga sessions varied from 30 minutes to 6 hours. Some studies examining the effects of yoga in experienced yogis did not discuss their practice regimens and are listed as not applicable or NA in table 10. Most of the literature did not discuss the reasons for the choice in duration or length of time for the yoga sessions. A few of the more recently published works discussed reasons for choosing the specific type and length of yoga classes and the specific postures or asanas used in relation to the focus of practice or the condition that was being targeted. Only a limited number of studies discussed issues with class
attendance and adherence to yoga practice. Lack of adherence, especially with at home practice, was noted and is a significant weakness in both determining the benefits or therapeutic effects of practice, as well as the ability to maintain those benefits once the study is concluded.

Table 11
Duration, frequency and length of time of yoga intervention

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**FREQUENCY**

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( ) denotes length of time of each yoga class or session in minutes (m) or hours (h)

*study did not provide any results, only explained design and feasibility of a protocol, in addition to class it also called for home practice 5/wk.

** 120 m class 5/week for 1st 3 weeks followed by 1/week for 2 months with home practice encouraged.

¹Ten 2 hour sessions, duration and frequency were unknown ²Session of 60 m classes 3/wk for the first month followed by 2/wk the second month and then 1/wk for the remainder of the 9 month study. ³Option to attend either 150 m classes daily for two weeks, or 75 m classes daily for 4 weeks.

When examining the data on the type duration and frequency of therapy a consensus or pattern can not be clearly discerned. Jacobs et al. (2004) coordinated meetings with a panel of yoga instructors and Iyengar experts to design a protocol for use in chronic back pain. That study incorporated 90 minute classes twice weekly along with daily practice at home for 12
weeks as an intervention for chronic low back pain. An important observation in this review is that an ideal or consistent yoga protocol has yet to be defined and evaluated.

YMCA affiliates in Northwest Ohio primarily have instructors trained in Yoga Fit® method of yoga. This method, developed in 1994, combines some elements of Hatha yoga along with traditional exercise and stretching (Shaw, 2001). The program is geared to athletes and fitness minded individuals and incorporates a routine that involves more exertion. Instructors are generally individuals with a health or fitness background who completes training which can be accomplished in an intensive weekend session. This method appears to have less emphasis on breathing and meditation with fewer adaptations of postures. None of the studies in this review reported using this method of yoga, but it is important to be aware that this method of instruction is frequently being used, and that the benefits reported with the use of more traditional yoga practices may or may not achieved by those who practice yoga using this method.

Injuries / Adverse Events / and Precautions

In Tandon’s (1978) study involving subjects with COPD, one subject from the yoga group dropped out of the study due to the development of a cervical disc injury while practicing a yoga posture at home. Another patient in this study randomized to the physiotherapy group was dropped due to the development of vertigo and chest pains he attributed to the breathing exercises.

Four common yoga injuries were identified and explained by Heaner (2003). Pain in the knees with extreme bending or simultaneously bending and twisting can occur and are associated with positions that include lotus (sitting with legs crossed) or other severe knee bending poses like pigeon, hero pose or child’s pose. Straining the wrist, elbow or shoulder joints can be caused by poses that require supporting your weight on your hand or cause overextension of the arms or
shoulders such as with the downward dog position, the plank, upward facing dog or handstands. Inversion poses provide another source for injury or pain occurring primarily in the neck and shoulder regions. Herniated discs, chronic arthritis and degenerative disc disease in the neck and lower back have been observed in those who do yoga. Finally prolonged forward bends or spinal twisting poses can cause low back pain and can potentially rupture discs or overstretches spinal ligaments.

Individuals with certain injuries or medical conditions should be advised to avoid certain postures (Farhi, 2000; Shaw, 2001). Those with hypertension, glaucoma, eye problems, and ear congestion should avoid breath holding, breath retention and inverted postures. Individuals with back and neck injuries should also avoid inverted postures. In those with low back injuries or sciatica problems advice should be given to keep the knees bent slightly with all forward bending positions to reduce strain on the lower back. Individuals with knee problems should be advised to place extra padding under knees and avoid quadriceps stretches and extensive knee flexion poses.

Yoga as an Intervention: Implications for Nursing Theory, Research Education and Practice

The objective of this review is to describe the physiologic, psychological and therapeutic effects of yoga. Important limitations for this review include the small sample sizes, incomplete and inadequate reporting, poor quality of trials and loss to follow-up. As well, publication bias and lack of heterogeneity of the groups exist. Validity and reliability of the tools and methods used for measurement of different variables were often not discussed in the published studies. The application of everyday practice of yoga is not reflected in the clinical studies and randomized controlled trials that were reviewed. Despite these factors, this review provides additional useful information for nurses and clinicians on the effectiveness of yoga as a therapy.
and its possible application as an intervention in a variety of clinical conditions. Of course, clinical judgment is needed when interpreting and applying these study results.

The physiologic changes that occur with yoga practice provide evidence of increased autonomic system control and decreased sympathetic influences regulating heart rate and blood pressure. This has been particularly observed with controlled slow breathing methods incorporated into different yoga practices. Psychological adaptations and altered mental states are also supported in many study findings and in general provide evidence of overall improvements in mood and perceived stress for many people with a variety of different conditions or personal situations. The noted change in brain wave function during various yoga breathing practices provides additional evidence of yoga’s ability enhance autonomic function and to induce the relaxation responses.

Yoga practice helps to produce a sense of calm through decreased mental stimulation, focused breathing and heightened self awareness to produce a stress free state. In this stress-free state, physiologic changes occur resulting in a shift to parasympathetic control of autonomic functions. While some of these changes have been clearly observed such as with the reduction of heart rate and blood pressure, other physiological changes like hormonal and chemical responses to stress, although likely occurring, have been more difficult to clearly measure and demonstrate.

An increased understanding of psychoneuroimmunology and the complexity and interconnectedness of the nervous, endocrine and immune systems also supports an understanding of the effectiveness of mind-body interventions. Stress plays an important part in illness and disease. Any intervention to reduce the stress response may contribute to the prevention of or limit one’s reaction to illness.
Although there are several different limitations present in the literature reviewed, there are trends and effects that can be identified and put into context for the use of yoga as an intervention to maintain or achieve a state of health or wellbeing. Stress is a factor in human lives that influences the occurrence of many illnesses and affects the severity of many chronic conditions. Yoga is a complementary therapy that can be used as an intervention for stress related conditions. There is clearly supporting evidence that yoga practice produces a decrease in the physiological signs and symptoms of stress. In applying Neuman’s theory, yoga can serve as an intervention against stressors that affect the core of an individual. Yoga can be an intervention of primary prevention to strengthen the flexible lines of resistance; thereby maintaining a balanced state of energy and an optimal level of health by preventing invasion of stressors. As an intervention of secondary prevention, yoga serves to strengthen the internal lines of resistance and reestablishes balance to the core after the invasion of a stressor has occurred. In addition, because stressors are influenced by one’s created environment or perception of reality, individuals are likely affected by the practice of yoga which focuses on increased awareness and detachment from outside influences. The result of this focus and detachment may help bring more a balanced perspective of internal and external influences. By influencing the internal, external and created environments, yoga acts to strengthen the flexible lines of resistance and maintain the normal line of defense.

The type and design of studies reviewed have primarily focused on yoga’s effects on the physiological and psychological structures or variables of the client’s basic core. However, using a holistic framework and Neuman’s Systems Model, one can not exclude the other variables, or the interactions occurring among all the variables making up the core of individual. Although not demonstrated in the results of the studies, yoga likely influences spiritual, socio-cultural and
developmental dimensions of the core as well. Indeed, the increasing understanding of psychoneuroimmunology and the influence of stress on illness lends further support of this assumption.

Many of the limitations in the studies reviewed lead to questions that should be posed and addressed in future studies. Improved methods to measure the sensitive hormonal changes that may be occurring with the practice of yoga need to be used in future studies. The cultural and social differences between the studies conducted in India over the past 30 years need to be evaluated with studies conducted in more diverse and varied samples and populations including Americans.

Because the practice of yoga has many component or variables, further studies comparing yoga as a holistic method to each of the independent variables are needed. Yoga needs to be compared in controlled studies to independent practices of deep breathing, meditation and stretching exercises. This is a particularly important area for research as each component of yoga (i.e., deep breathing, and meditation) has been shown to be beneficial on their own accord. Thus, such comparison studies would help identify if there is a greater accumulated benefit from the holistic practice of yoga over other methods. In addition, the many different styles and types of yoga practice need to be compared so that individuals and health care providers can be directed to the practices that are safest and most effective.

Further studies are also needed in the specific patient populations where yoga is believed to be beneficial. Individuals with clinical conditions and illnesses where yoga seems to be helpful need to be duplicated to validate if yoga is truly effective intervention. It is important to duplicate the studies to further validate that yoga indeed has an influence on the physiological and psychological functions even in those with altered states of health. Chronic health
conditions that affect immune and musculoskeletal function, as well as mood and anxiety are especially important areas for further research.

Finally it is also important to examine the occurrence of adverse effects that result from the practice of yoga. This is an especially important area for research as the practice of yoga has been steadily been growing in the United States. Studies of adverse effects may provide more information on who should and should not be encouraged to practice yoga.

From the results of this review the intervention of yoga would likely benefit a large variety of people and individuals with illnesses or conditions that are affected by stress. The conditions include but are not limited to: cardiovascular diseases such as coronary artery disease, angina, congestive heart failure, and hypertension; pulmonary and lung disorders including asthma and chronic obstructive pulmonary disease; autoimmune illnesses encompassing rheumatoid arthritis, lupus, multiple sclerosis, HIV, and chronic fatigue; musculoskeletal disorders especially chronic low back pain, neck pain from muscle tension or spasm, osteoarthritis, carpal tunnel, hyperkyphosis; mood disorders and mental condition including depression, dysthymia, obsessive compulsive disorders, anxiety states and stressful life events; and other conditions such as diabetes mellitus, cancers or lymphomas, and chronic infections such as tuberculosis. Yoga is contraindicated in those with known spinal injuries including significant herniated discs, cervical neck injuries, and severe degenerative disc disease.

Nursing education needs to include complementary therapies and practices especially those that show evidence of benefit. Yoga, breathing and relaxation methods have significant evidence of benefit directed toward the physiologic responses of stress. Nursing needs to incorporate the use of such interventions. Basic nursing education should include the use of
interventions to promote relaxation and reduce stress responses such as techniques that include slow controlled deep breathing, relaxation, meditation and yoga.

In order to implement yoga into nursing practice the following two protocols are suggested for nurses to use in a variety of settings and are also detailed as a practical handout in Appendix C. In order for nurses to encourage, facilitate and promote yoga as an intervention a referral network of skilled yoga instructors could also be developed.

_Yoga as a Therapeutic Intervention: A Practice Protocol_

Rationale for selecting a yoga technique is subjective based on lack of evidence correlating a specific program to therapeutic benefit. Factors to be considered are if the program is low impact, safe, easy to learn and master, and conductive to patient schedules. For long term benefits a program of yoga practiced a minimum of twice weekly for 60 to 90 minutes is an appropriate intervention. Incorporated into this regimen should be time focused specifically to breathing, relaxation and focused attention or meditation, as well as performing asanas with attention to proper body alignment and each individual’s own abilities and limitations. Enrollment and participation in group classes with guidance from a qualified instructor should be encouraged to help promote proper technique and adherence to practice regimen. Although the style of yoga may not be know or promoted at various yoga studios or health and wellness facilities, a noncompetitive program that stresses and adapts asanas and postures according to individual’s unique needs and limitations should be encouraged. Clients should be instructed to make sure the yoga class includes instructions and time dedicated to breathing (pranayama), body postures (asanas) and meditation (chanda). The Iyengar method is one form of yoga that especially focuses on proper body alignment and adaptations to individual’s different abilities and limitations using props when appropriate. Caution clients to be watchful and avoid classes
where instructors do not explain postures well or if they do not show how to adapt asanas for those who have limited mobility. In addition it is very important that instructors explain, discuss and practice proper breathing techniques with sufficient time directed toward relaxation or meditation.

Health-care providers should also discuss with the client the benefits of incorporating various yoga techniques into daily life, and the importance of adherence to practice and attending classes. For example, encouraging the use of controlled slow breathing when distressed or at different time points during the day or focusing attention and meditating at specific time points or prior to bed might be suggested. Stretching or practicing simple opposing asanas after prolonged periods of repetitive or sedentary activities such as working at the computer or sitting could also be encouraged.

*An Intervention for Immediate Stress and Promoting Relaxation*

Individuals should be taught to focus and practice breathing with conscious effort to control and reduce the rate of breathing and engage the entire lung by using full abdominal breathing. Striving for a respiratory rate of 6 breaths per minute or less offers benefits of facilitating relaxation and reducing the SNS activity. This breathing rate can be maintained for 5-10 minutes with periods of rest and normal breathing if symptoms of dyspnea or light headedness occur. Instructions on abdominal breathing as well as concentration and focus on the breathing process should be given to the individual. Mental imagery to promote relaxation may add to the benefits of breathing. One example of such focus and use of imagery could be repeating “inhale energy, exhale tension”. Concentration on breathing is an easy and effective method of focusing thought to help reduce anxiety; it also affects autonomic nervous system
function leading to reductions in heart rate and blood pressure as well as promoting alpha brain waves which are associated with relaxation.

For some use of a religious word or prayer, or for others the use of a secular nondenominational word or sound to focus on with each breath and exhalation may facilitate slow breathing and relaxation. Imagery may also be helpful in producing relaxation by promoting detachment from everyday thoughts and concerns. In promoting wellness and using mind-body interventions to improve health, nurses should assess the patient’s past experiences with relaxation techniques or their ability to initiate a Relaxation Response.
References


Figure 1
Neuman Systems Model

- **Stressors**
- **CORE**
  - Flexible Line of Defense
  - Normal Line of Defense
  - Lines of Resistance
  - Basic Structures
    - Interacting Variables
    - Physiologic, psychological, socio-cultural, developmental and spiritual
    - Energy
    - Resources
  - Primary prevention
    - Strengthens flexible line of defense
  - Secondary Prevention
    - Tx of symptoms
  - Tertiary prevention
    - Readaptation
    - Reeducation
    - Maintenance of stability
### Conceptual Model

#### Primary Prevention

- Yoga practice which includes controlled breathing will induce relaxation. Improve lung function, reduce airway reactivity and improve sense of self worth and control over ones life.

#### Stressors

- 1. Internal environmental
- 2. External environment
- 3. Created environment

#### Lines of Defense

- Flexible line of defense is strengthened.

#### Impact of Stressors

- Environmental stressors unable to penetrate flexible line of defense.

### Empirical Indicators

#### Yoga practice which includes controlled breathing, Asanas, and meditation performed 60 minutes twice weekly

- 1. Mild depression
- 2. Asthma triggers
- 3. Anxiety and worry associated with everyday living, caring for small children and ailing parents and working

#### Lines of Defense

- 1. Mood is elevated with less feelings of depression
- 2. Histamine response to asthma triggers is reduced
- 3. Feeling of calmness and acceptance with less anxiety and reduced feelings of worry

#### Impact of Stressors

- Positive effects from yoga practice experienced by client brings balance and improved sense of wellbeing and health

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**Figure 2**
Neuman Systems Model
Substruction diagram
## Appendix B

### Data Collection Tool

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<th>Variables</th>
<th>Instruments</th>
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<table>
<thead>
<tr>
<th></th>
<th>Results</th>
<th>Implications</th>
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<tr>
<th></th>
<th>Comments / Notes</th>
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</thead>
</table>
Who can benefit from yoga?
Those with illnesses or conditions that are affected by stress including but not limited to:

<table>
<thead>
<tr>
<th>Cardiovascular diseases</th>
<th>Musculoskeletal disorders</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD, Angina, CHF, Hypertension</td>
<td>Chronic low back pain, Osteoarthritis, Carpal tunnel, Hyperkyphosis</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Pulmonary and Lung disorders</th>
<th>Mood Disorders and Mental conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asthma, COPD</td>
<td>Depression, OCD, Stressful life events</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Autoimmune illnesses</th>
<th>Other conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rheumatoid arthritis, Lupus, Multiple Sclerosis, HIV, Chronic Fatigue</td>
<td>Diabetes mellitus, cancers or lymphomas, and chronic infections such as TB</td>
</tr>
</tbody>
</table>

| Those with immediate stress or anxiety |

Contraindications:
- Known spinal injuries including significant herniated discs, cervical neck injuries, and severe degenerative disc disease.
- Severe hypertension
- Glaucoma

Yoga as a Therapeutic Intervention
- Yoga practice once or twice weekly for 60 to 90 minutes
- Incorporated into the yoga regimen should be time focused specifically to
  - Performing asanas with attention to proper body alignment and individual abilities and limitations
  - Awareness of breathing,
  - At least 10 minutes of relaxation and/or focused attention or meditation
- Enrollment and participation in group classes with guidance from a qualified instructor to help promote proper technique and adherence to practice regimen.
- A noncompetitive program that stresses and adapts asanas and postures according to individual’s unique needs and limitations.
- Caution clients to be watchful and avoid classes where instructors do not explain postures well, if they do not show how to adapt asanas for individuals with limited mobility, or if the class does not include instructions or discussion about proper breathing or time for relaxation or meditation.
  - The Iyengar Method is one form of yoga that especially focuses on proper body alignment and adaptations to individual’s different abilities and limitations using props when appropriate.
- Discuss the benefits of incorporating various yoga techniques into daily life, and the importance of adherence to practice and attending classes. For example, encouraging the use of controlled slow breathing when distressed or at different time points during the day or focusing attention and meditating at specific time points or prior to bed might be suggested. Stretching or practicing simple opposing asanas after prolonged periods of repetitive or sedentary activities such as working at the computer or sitting could also be encouraged.
Breathing Intervention / Relaxation Response
For Immediate Stress and Promoting Relaxation

Based on evidence and Relaxation Response developed by Dr. Benson of Harvard Medical School

Concentration on breathing is an easy and effective method of focusing thought to help reduce anxiety associated with stressful events. It affects autonomic nervous system function leading to reductions in heart rate and blood pressure as well as induces alpha brain waves which are associated with relaxation.

- Conscious slow breathing with full abdominal breathing.
- Abdominal breathing is achieved by engaging abdominal muscles to initiate inhalation deep in the lower lungs filling the lower lungs and alveoli first followed by mid and upper chest expansion. Exhalation occurs with relaxation of abdominal muscles and the diaphragm and passive release of air (much like letting air out of a balloon.)
- Inhaling and exhaling each to the count of 6 achieves a respiratory rate near 6 breaths per minute.
- Breathing rate should be maintained for 5-10 minutes with periods of rest and normal breathing if symptoms of dyspnea or light headedness occur.
- Breathing in this fashion is a learned process and sometimes does not feel comfortable at first. A passive and relaxed approach is required.
- Mental imagery to promote relaxation may add to the benefits of breathing. (i.e., repeating “inhale energy, exhale tension” or visualizing a relaxing place)
- Maintaining a passive attitude in relation to the control of breath and thoughts should be encouraged
- A quiet environment and comfortable position help facilitate relaxation but are not required.
- Focusing on a single word helps control thoughts. Many single words can work but for clients who relate to spiritual practices each religion has a word or phrase that my be helpful for producing relaxation and focusing attention.
  - Catholics - Hail Mary Prayer, Lord have mercy
  - Protestants – Our Father, Jesus
  - Jewish – Sh’ma Yisrael
  - Muslims – Isha’ Allah
  - Hindu – Om (the universal sound)
  - Nondenominational – one, love, peace, calm