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Systematic Review of Scientific Evidence Supporting Yoga as an Alternative Treatment for
Generalized Anxiety Disorder

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Thank you,

Alexandria Keller

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Abstract

Background: This study was a systematic review of scientific evidence investigating yoga as a treatment for GAD. Assessing the scientific validity of alternative health practices is necessary for proposals of inclusion in public health practices.

Methods: A comprehensive search for peer-reviewed biomedical research was conducted for literature describing interventions for GAD using yoga and its practices (e.g. physical postures, meditation, breathing exercises). Systematic research was conducted on academic literature databases available through Wright State University (Web of Science, PubMed, Cochrane Library) using search terms selected based on key words for *Diagnostic and Statistical Manual, 5th Edition* and the Sanskrit variation of yoga terms/names for different yoga styles (Anxiety OR anxious OR agoraphobia OR phobic disorder OR panic disorder AND meditation OR mindfulness-based stress reduction OR yoga OR yogic OR pranayama OR kriya OR Kundalini).

Results: Three randomized control trials reported that yoga intervention resulted in statistically significant decreases in stress scores and stress biomarkers. Decreases in stress hormones and inflammatory cytokines are evidence of positive effect on comorbidities including heart disease. There was also lower anxiety recidivism in yoga groups compared to yoga group with medication.

Conclusions: Clinical trial study limitations include small sample sizes and a majority of white participants. Further research is necessary to provide more evidence describing the potential efficacy of yoga intervention for mental health conditions such as GAD.

Keywords: Meditation, Mindfulness based Stress Reduction, Anxiety, Mental Illness, Public Health, and Evidence Based Practice.

Systematic Review of Scientific Evidence Supporting Yoga as an Alternative Treatment for
Generalized Anxiety Disorder

Yoga is a popular physical exercise discipline defined by the National Institutes of Health as a “meditative movement practice” (National Center for Complementary and Integrative Health [NCCIH], 2016, first paragraph) that includes physical exercises, meditation, breathing exercises, personal awareness, and emphasizes the mind-body connection (Yoga Journal Editors, 2010).

Practitioners and the popular press cite the physical benefits of yoga such as increased flexibility and decreased muscle tightness (American Osteopathic Association, 2017; Harvard Mental Health Letter, 2009; McCall, 2007).

There are several claims about the benefit of yoga on mental health, including decreased stress and tension, increased memory, concentration and decreased effects from traumatic experiences (Novotney, 2009; Harvard Mental Health Letter, 2009). These claims are often based on personal experiences and personal testimonials. People who practice yoga reported feeling better; there are even some claims that symptoms caused by diseases such as cancer, depression and osteoarthritis are reduced (Table 1) (Chang, Sklar, & Groessl, 2016; Cramer, Steel, Lauche, Dobos, & Zhang, 2016; Sharma, Lingam, & Nahar, 2016; Desveaux, Lee, Goldstein, & Brooks, 2016; Schumann et al., 2016). The purported association between yoga and increased health and wellness has become generally accepted in the American consciousness (NCCIH, 2013). According to Dr. Sanjiv Chopra and Dr. Alan Lotvin, “There are centuries of anecdotal evidence that yoga is beneficial for the mind and spirit even if the actual medical benefits haven’t been proven” (Chopra & Lotvin, 2012, p. 298).

Table 1

Purported Benefits of Yoga

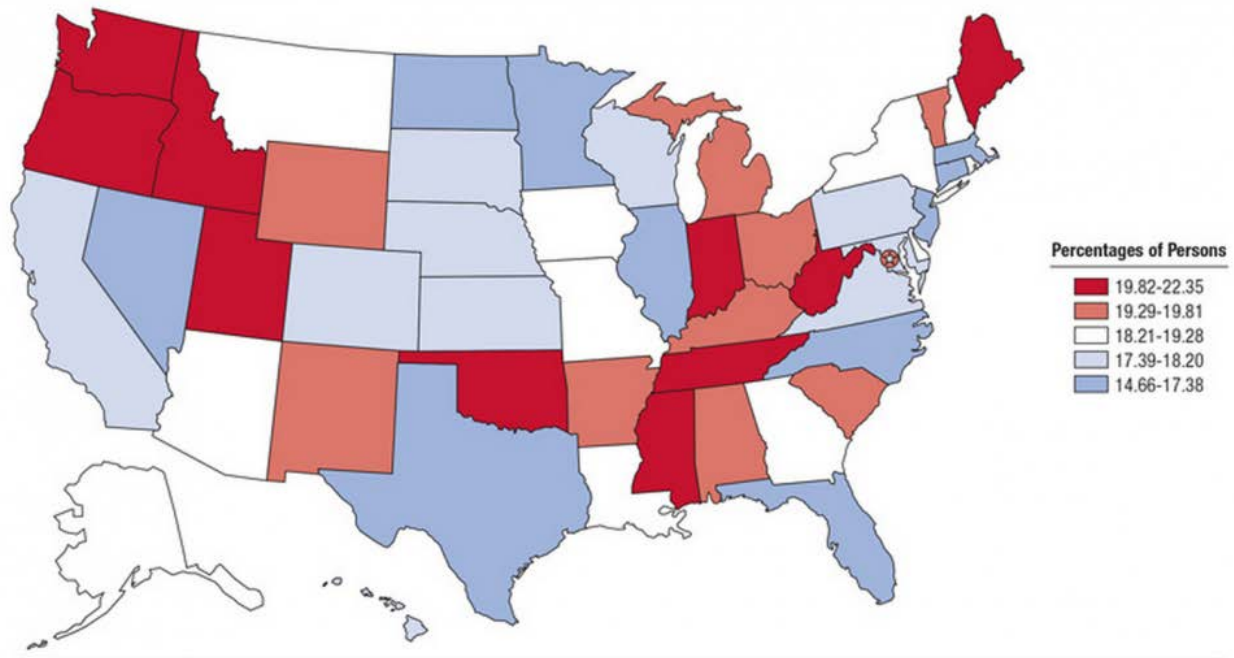
• Improved brain function	• Improved emotional resilience
• Improved mental health	• Improved ability to manage anger
• Decreased anxiety	• Improved stress-related imbalances in the nervous system
• Decreased attention-deficit-hyperactivity disorder (ADHD)	• Improved sleep
• Decreased depression	• Lo weight loss
• Decreased posttraumatic stress disorder (PTSD)	• Promotes good health

(American Osteopathic Association, 2017; Harvard Mental Health Letter, 2009; Yoga Journal, 2007; Monitor on Psychology 2009; Chang et al., 2016; Cramer et al., 2016; Sharma et al., 2016; Desveaux et al., 2016; Schumann et al., 2016)

Mental Illness, Anxiety, and Generalized Anxiety Disorder

Mental illness. Mental illness effects 43.8 million adults per year and 1 in 25 (10 million) adults in America live with a serious mental illness (National Alliance on Mental Illness [NAMI], 2016). Figure 1 represents American mental illness rates by state. Mental illness is “collectively... all diagnosable mental disorders and is characterized by sustained, abnormal alterations in thinking, mood, or behavior with distress and impaired functioning” (United States Department of Health and Human Services, 1999, Introduction, first line). There is a correlation between mental illness and the morbidity of multiple chronic diseases such as cardiovascular disease, diabetes, obesity, asthma and cancer (Kessler et al., 2008; Evans, Charney et al., 2005; El-Gabalawy, Katz, & Sareen, 2010; Lichtman et al., 2010). According to the World Health Organization (WHO), mental illnesses account for more disability in developed counties such as the U.S than any other group of illnesses such as cardiovascular disease (World Health Organization [WHO], 2004). The effects of mental illness cost the United States billions of dollars (Greenberg et al., 2003). Mental illness in 2002 to 2003 had an annual estimated cost of \$300 billion, and when partitioned, \$193 billion were from lost earnings and wages, \$24 billion

were from disability benefits (Greenberg et al., 2003), and \$100 billion were from health care (Mark, Levit, Buck, Coffey, & Vandivort-Warren, 2003).



Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Surveys on Drug Use and Health (NSDUHs), 2011 (revised October 2013) and 2012.

Figure 1. The Substance Abuse and Mental Health Services administration (SAMHSA) study shows mental illness rates by state. Image copied directly from SAMHSA, 2013.

Anxiety and generalized anxiety disorder. Anxiety is the most common mental illness in the U.S., affecting 40 million adults age 18 and older (National Institute of Mental Health, n.d.; Kessler, Chiu, Demler, & Walter, 2005). The clinical definition of anxiety and its subtypes (including Generalized Anxiety Disorder) receives further explanation later in this manuscript. Anxiety disorders are a category defined in the American Psychiatric Association's *Diagnostic and Statistical Manual, 5th Edition* (DSM-V); generalized anxiety disorder (GAD) is one of the clinical disorders within that category. GAD was chosen for study because it is common and affected individuals can recognize and report their own symptoms (American Psychiatric

Association [APA], 2013). Generalized anxiety disorder (GAD) is diagnosed in 6.8 million adults (National Institute of Mental Health, n.d.).



Figure 2. Yoga practitioner rates by state. Source: *Yoga Journal*, Yoga Alliance, & Ipsos Public Affairs (2016), *Yoga in America Study*, p. 22.

Yoga’s Potential as a Behavioral Health Intervention

Yoga could be utilized as a lifestyle intervention program, along the same lines of the function of the CDC’s National Diabetes Prevention Program (<https://www.cdc.gov/diabetes/prevention/index.html>), but addressing the public health crisis of anxiety. Yoga has many purported benefits to mental health, specifically with anxiety (see Table 1). If any of these purported benefits are valid, yoga could form the basis for new public health interventions and potentially decrease costs associated with anxiety.

Statement of Purpose

This study was a systematic review of scientific evidence investigating the efficacy of yoga as an alternative therapeutic treatment for GAD. Assessing the scientific validity of alternative health practices is necessary to evaluate proposals of inclusion in public health practices.

Background

In order to provide context for the systematic literature review the following section describes a brief history of yoga, and information detailing generalized anxiety as it pertains to mental illness.

A Brief History of Yoga

The history of yoga can be delineated back over 5,000 years. Tim Burgin (2015) divided this history into four periods: pre-classical yoga, classical yoga, post-classical yoga and the modern period. This summary follows his description of the periods of yoga, unless otherwise cited.

Pre-classical yoga was documented in Northern India over 5,000 years ago. The word *yoga*, meaning “yoke” or “union” (*Yoga Journal* Editors, 2010), was first used in the *Rig Veda*, the oldest written yogic text. The *Vedas* were a compilation of texts used by Vedic spiritual leaders as a manuscript for life. The practices of yoga were cataloged in the *Upanishads*, which contains over 200 scriptures. A notable *Upanishad* is the *Bhagavad-Gita*, which was written around 500 B.C.E. and contains teachings of karma yoga and of action and reaction, and *Jnana* yoga, defined as a path to wisdom.

Classical Yoga includes Patanjali’s *Yoga-sutras*. Patanjali codified these teachings into a text that is a life style guide, which strongly influenced modern yoga.

Post-classical yoga moved from mental teachings to physical teachings with an exploration of physical spiritual connections. The movement to body-centered yoga is taught in modern Western yoga known popularly as *Hatha* yoga.

Burgin (2015) states that modern yoga begins in the late 1800s and the early 1900s. Eastern yoga teachers began teaching in the West, such as Swami Vivekananda (Table 2), who taught yoga 1893 in Chicago's Parliament of Religions starting in 1893. In the 1920s, T. Krishnamacharya and Swami Sivananda both promoted Hatha yoga. Krishnamacharya's students B.K.S Iyengar, TKV Desikachar, Pattabhi Jois, and Indra Devi increased its popularity in the West, opening studios in California and New York.

Table 2

Yogis Who Introduced Yoga to the West and Their Styles

Founder	Style Name	Concentration
Krishnamacharya	Yoga	Mixed styles
Swami Sivananda	Yoga	Philosophy
B.K.S Iyengar	Iyengar Yoga	Low physical intensity alignment based
Pattabhi Jois	Ashtanga	Very physically demanding
TKV Desikachar	Yoga	Physical (range of intensity)
Indra Devi	Yoga	Low physical intensity
Swami Vivekananda	Yoga	Philosophy

The American physical fitness industry grew during the 1970s (Andreasson & Johansson, 2014). The Beatles, an iconic musical act of the 1960s, increased popularity of Eastern teachings when they travelled to Rishikesh, India to attend a transcendental meditation training at Maharishi Mahesh Yogi's *ashram*. The aerobics fad of the 1980s increased fitness-related injuries that increased interest in low-impact exercise programs such as yoga. Yoga videos were produced by fitness stars of the time and also popularized on PBS television show hosted by Liliias Folan called *Liliias, Yoga and You* (www.liliiasyoga.com), which aired from 1970 to 1999

for a total of 500 episodes. In the time since, yoga classes expanded to gyms, health clubs, and YMCAs all over the United States (www.yogaalliance.org).

Yoga continues to be a growing trend in the United States. With universal availability of yoga classes, magazines, conferences, clothing lines, and accessories, trend-conscious Americans wear the comfortable and fashionable, eco-friendly, fair-trade yoga pants and has possessed a recycled-plastic, name-brand yoga mat sometime in their life. A national survey was conducted by *Yoga Journal*, the field's self-proclaimed leading magazine, founded in 1975 and Yoga Alliance, an international non-profit association with a mission to "promote and support the integrity and diversity of the teaching of yoga." (Yoga Alliance, 2016a, Our Mission, second sentence). The survey showed that the number of American yoga practitioners increased from 20.4 million in 2012 to 36 million in 2016 (*Yoga Journal et al.*, 2016). There are 43,322 yoga instructors in the United States that have met Yoga Alliance instructional standards (Yoga Alliance, 2016b), and 3,632 yoga schools in the United States that have met the Yoga Alliance school standards (Yoga Alliance, 2016b). The *New York Times* had a monthly series entitled "Stretch" which reviewed everything yoga from studios to classes held in Central Park (https://cityroom.blogs.nytimes.com/author/lizette-alvarez/?_r=0). Even The White House has participated in yoga: First Lady Michelle Obama integrated yoga into her *Let's Move* campaign, a child exercise-initiative program, and there was a yoga garden with yoga sessions throughout the day in 2009 at the annual Easter Egg Roll, the largest public event held on the White House property (Broad, 2012).

The current teachings of yoga look very different from the texts written 5,000 years ago. Modern yoga embodies physical fitness and meditation, but rarely markets yoga as the lifestyle put forth by Patanjali's *Sutras* and other yogic texts. The question that drove this project was if

Western medicine had investigated the original tenants of yoga for application in wellness interventions for GAD. The efficacy of yoga in improving health conditions has been shown in some studies for medical conditions such as pain (Kim, 2016), cancer (Sharma et al., 2016), and irritable bowel syndrome (Schumann et al., 2016). A review of the evidence for yoga in depression showed that yoga could be an effective alternative mind-body treatment option (Cramer, Lauche, Langhorst, & Dobos, 2013) but concluded that anxiety (as a secondary outcome) had “limited evidence” (Cramer et al., 2013, abstract).

Generalized Anxiety Disorder

Anxiety disorders are subdivided into many subtypes, but all of them are center on an intense... fear for a defined period of time (Li & Goldsmith, 2012, background). According to *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; *DSM-5*; American Psychiatric Association, 2013) anxiety disorders are classified into types that include separation anxiety disorder, specific phobia, social phobia, panic disorder, agoraphobia, and generalized anxiety disorder. Generalized anxiety disorder diagnosis criteria are presented in Table 3.

Table 3

Diagnostic and Statistical Manual of Mental Disorders (5th ed.; *DSM-5*), *Criteria for Generalized Anxiety Disorder (GAD) Diagnosis*

Generalized Anxiety Disorder (GAD)

- A. Excessive anxiety and worry (apprehensive expectation), occurring more days than not for at least 6 months, about a number of events or activities (such as work or school performance).
 - B. The individual finds it difficult to control the worry.
 - C. The anxiety and worry are associated with three (or more) of the following six symptoms (with at least some symptoms having been present for more days than not for the past 6 months):
 1. Restlessness or feeling keyed up or on edge.
 2. Being easily fatigued.
 3. Difficulty concentrating or mind going blank.
 4. Irritability.
 5. Muscle tension.
-

Generalized Anxiety Disorder (GAD)

6. Sleep disturbance (difficulty falling or staying asleep, or restless, unsatisfying sleep).
D. The anxiety, worry, or physical symptoms cause clinically significant distress or impairment in social, occupational, or other important areas of functioning.
E. The disturbance is not attributable to the physiological effects of a substance (e.g., a drug of abuse, a medication) or another medical condition (e.g., hyperthyroidism).
F. The disturbance is not better explained by another mental disorder (e.g., anxiety or worry about having panic attacks in panic disorder, negative evaluation in social anxiety disorder [social phobia], contamination or other obsessions in obsessive-compulsive disorder, separation from attachment figures in separation anxiety disorder, reminders of traumatic events in posttraumatic stress disorder, gaining weight in anorexia nervosa, physical complaints in somatic symptom disorder, perceived appearance flaws in body dysmorphic disorder, having a serious illness in illness anxiety disorder, or the content of delusional beliefs in schizophrenia or delusional disorder).

(Verbatim from Locke, Kirst, & Shultz, 2015, Table 1; based on American Psychiatric Association, 2013)

Pharmacotherapy is the first line treatment for anxiety disorders (Anxiety and Depression Association of America, 2010-2016). Pharmaceuticals used to treat anxiety disorders include benzodiazepines, beta-blockers, monoamine oxidase inhibitors, and antidepressants (NIMH, 2010). The safety of these drugs has improved over the past 30 years but treatment efficacy and duration have not (Farach et al., 2012). Psychotherapy is another treatment option that includes cognitive-behavioral therapy, cognitive therapy, and applied relaxation (Powers, Becker, Gorman, Kissen, & Smits, 2015). Yoga as an intervention could help improve treatment. There is a need for more research on yoga treatments in order to evaluate its potential utility for evidenced-based practice. This manuscript is an inventory of randomized clinical controlled trials (RCTs) that would qualify as valid evidence for the evidence-based practice of yoga as a treatment for GAD.

Methods

A comprehensive search for peer reviewed biomedical research was carried out following Khan, Kunz, Kleijnen, and Antes 2003 study to identify literature describing associations

between yoga and its practices and GAD. Figure 3 illustrates the process of literature selection. Each step of the process is described in the following paragraphs.

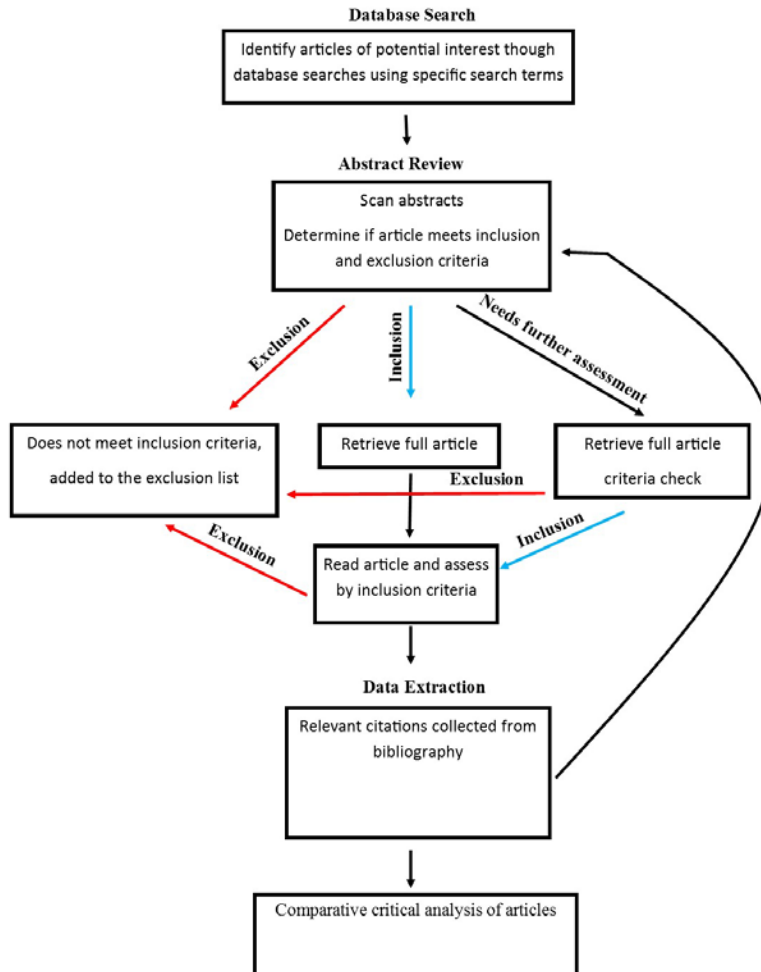


Figure 3. Flow chart of the literature search process

Database Search

A systematic literature search was conducted on academic literature databases available through Wright State University (WSU). Databases searched were Web of Science, PubMed, and Cochrane Library. Each search included the search terms for yoga and anxiety as follows:

(Anxiety OR anxious OR generalized anxiety disorder OR “phobic disorder*” OR “panic disorder”)

AND

(meditation OR “mindfulness-based stress reduction” OR yoga OR yogic OR pranayama OR kriya OR Kundalini)

The search terms were chosen based on the author’s professional background in yoga and review of academic literature conducted for this project’s literature review.

Abstract Review

The abstract for each article retrieved from the database search was screened and compared with inclusion criteria and exclusion criteria (see Table 4). In general, these criteria ensured external validity for adult populations and generalizability for the American public. If an article met the inclusion criteria, it was marked for retrieval and assessment (the next process step); if an article did not meet the inclusion criteria, it was excluded and added to the excluded article list. If the author could not determine if an article met the inclusion or exclusion criteria based on the abstract, the article was moved forward for retrieval and assessment.

Table 4

Inclusion and Exclusion Criteria for Articles from Data Search

Article Status	Criteria
Inclusion	Participants 18 years of age or older <ul style="list-style-type: none"> • Published in or after 2000 • Published in peer-reviewed journal based in the United States • Quantitative or qualitative design randomized clinical trial (RCT) • English language • Full text available through Wright State University (WSU) library services or Google • <i>Diagnostic and Statistical Manual of Mental Disorders</i> (5th ed.; <i>DSM–5</i>) diagnosis of Generalized Anxiety Disorder

Article Status	Criteria
Exclusion	<ul style="list-style-type: none"> • Participants included were younger than 18 years of age • Published before 2000 • Published in non-peer-reviewed journal or journal not based in the United States • Case report, observational study, or conference report • Study with concerns for external validity • Non-English language • Full text not available through Wright State University (WSU) library services or Google

Article Retrieval and Assessment

Articles that were marked for retrieval and assessment and were available for direct download from the Wright State University (WSU) library were downloaded. Articles that were not available for direct download through WSU were retrieved through Google or requested via Wright State University interlibrary loan. If a copy was not available through these resources, it was excluded from further consideration.

Articles that fully met the inclusion criteria were retrieved/downloaded, stored for data extraction, and added to the inclusion list. Articles that needed further assessment were retrieved and scanned for inclusion and exclusion criteria. If the study in question did not meet the inclusion criteria for this review, it was added to the exclusion list. If the study met the inclusion criteria, it was stored for data extraction and added to the inclusion list.

Data Extraction

The inclusion list was used to create an excel spreadsheet to organize the included articles and assist with analysis. From the articles authors, year, full citation, population, and methodology were recorded.

Additional citations were collected from the bibliographies of peer-reviewed articles assessed as part of this study. Relevant citations from the bibliography were then subjected to

the review process like the sources identified through the database search and evaluated accordingly.

Results

Selection Process Outcomes

A total of 2,640 records were retrieved by the literature search; 2,632 were excluded because they were not randomized clinical trials, did not include yoga as an intervention, or did not have participants older than 18 years of age. A large number of studies included children, many studies had excellent methodology but did not use DSM criteria for mental disorders diagnosis, and there were other studies that had valid results but did not pertain to anxiety. A very strong RCT design was published (Hofmann et al., 2015), but the publication was excluded because the trial was not yet implemented.

Six full text articles were assessed for eligibility: Streeter et al., 2010; Yadav, Magan, Mehta, Mehta, & Mahapatra, 2012; Doria, de Vuono, Sanlorenzo, Irtelli, & Mencacci, 2015; Hoge et al., 2013; Hoge et al., 2017; Fares & Fares, 2016. Three full text articles were excluded after review because they did not include a clinical evaluation for GAD for participants (DSM-5 criteria) (Streeter et al., 2010; Fares & Fares, 2016; Yadav et al., 2012).

Three articles met all criteria (Doria et al., 2015; Hoge et al., 2013; Hoge et al., 2017). They represent one stand-alone RCT (Doria et al., 2015) and one RCT (Hoge et al., 2013) with a follow-up study of a subsample with laboratory measures (Hoge et al., 2017). The RCT by Doria and colleagues (2015) included a sample with both anxiety and depression disorders. This study was included for review given the small number of available RCT descriptions that met the inclusion criteria, the relationship between depression and anxiety (Anxiety and Depression

Association of America, 2010-2016) and the use of DSM-5 criteria. The three RCTs are summarized in Table 5.

Table 5

Studies Examining Yoga Intervention for GAD: All Met All Inclusion Criteria

Author, Date	Sample Size	Intervention	Control Intervention	Intervention Results
Hoge et al., 2017	N = 70 57% Female 81% White 7% Black 10% Asian	8 weeks Yoga	Stress Management Education (SME)	↓ ACTH ↓ IL-6 ↓ TNF-alpha ↓ TSST
Hoge et al., 2013	N = 93 48% Female 83% White 6% Black 8% Asian	8 weeks Yoga	Stress Management Education (SME)	↓ HAM-A ↓ BAI
Doria et al., 2015	N = 39 100% White	10 weeks Yoga	Pharmaceuticals	↓ ZAI ↓ HAM-A

Note. ACTH = stress hormone; IL-6 & TNF-alpha = inflammatory factors; TSST = Trier Social Stress Test; HAM-A = Hamilton Anxiety Scale; BAI = Beck Anxiety Inventory; ZAI = Zung Anxiety Index.

Review of Studies that Met Criteria

The three articles identified by the selection process were subjected to critical literature review regarding yoga as an alternative treatment for anxiety. All three identified studies used validated assessment tool to measure anxiety: State-Trait Anxiety Inventory (STAI), Hamilton Anxiety (HAM-A) scale, the Beck Anxiety Inventory (BAI), and the Zung self-rating anxiety scale inventory (ZASI). Each of these is summarized in Table 6.

Table 6

Validated Scales of Anxiety Used in Included Studies

Scale	Abbreviation	Used By	Description
Hamilton Anxiety Rating Scale	HAM-A	Hoge et al., 2013 Doria et al., 2015	Assesses severity of cognitive and psychological symptoms of anxiety; 14 items
Zung Self-Rating Anxiety Scale Inventory	ZASI	Doria et al., 2015	Assesses severity of anxiety symptoms on an ascending numerical manner.
Spielberger State-Trait Anxiety Inventory	STAI	Hoge et al., 2013	40-item multiple-choice questionnaire to assess state anxiety.
Beck Anxiety Inventory	BAI	Doria et al., 2015	21-item self-reported anxiety questionnaire measure on 4-point scale.

In addition to psychological survey instruments, biometrics were also used as indicators of anxiety in one study: Hoge et al., 2017 used physiological indicators consisting of hormones and inflammatory markers. They are summarized in Table 7.

Table 7

Biochemical Indicators of Anxiety Tested in Studies

Indicator	Impact of Anxiety
<i>Hormones</i>	
Cortisol	Increase
ACTH	Increase
<i>Inflammatory indicators</i>	
TNF-alpha	Increase
IL-6	Increase

Note: ACTH= adrenocorticotrophic hormone, TNF-alpha = tumor necrosis factor alpha , IL-6 = interleukin 6.

Comparison of study methods and results. Three RCTs on yoga for participants with DSM-diagnosed anxiety were included in the comparative critical analysis (Doria et al., 2015; Hoge et al., 2017; Hoge et al., 2013). The sample sizes ranged from 69 to 93 participants. Doria and colleagues' sample ($N=69$) included those with anxiety ($n=39$), those with depression ($n=18$), and those with both ($n=12$). Hoge and colleagues (2017) had a sample size ($N=72$) with a GAD DSM-4 diagnosis. Hoge et al., 2013 had a sample size of ($N=93$) with DSM-IV diagnosis of GAD. One RCT was conducted in Italy (Doria et al., 2015) and two in the United States (Hoge et al., 2017; Hoge et al., 2017). Specificity of participant recruitment was stated in vague terms for all three RCT descriptions, but included health care referral and media advertisement.

All three RCTs used DSM-4 diagnostic criteria for GAD. There have been changes to anxiety and anxiety disorders between the DSM-4 and DSM-5, but there were no changes to GAD criteria (Grohol 2013; Cummings, 2013). While they all specified adult participation, participants' mean age ranged from 37 to 45. Ethnicity was reported in all three studies: 80% were Caucasian in the studies by Hoge et al., 2013 and Hoge et al., 2017, and 100% of participants were Caucasian in the study by Doria et al., 2015.

Intervention characteristics. All three RCTs used yoga intervention that included yoga postures, breathing exercises, meditation, and relaxation (Doria et al., 2015; Hoge et al., 2013; Hoge et al., 2017). One RCT (Doria et al. 2015) exclusively used *Surdashan Kriya* yoga, a style based on focused breathing practices, while the other two RCTs used Hatha yoga (physical practices) (Hoge et al., 2013, Hoge et al., 2017). Details regarding yoga intervention were not specified, such as what yoga postures and breathing exercises were implemented, how long the practitioner held the pose or how many repetitions of each posture. If poses were modified for

practitioners or if props were used to help practitioners access poses are another important factor not mentioned in any study.

For all RCTs, the yoga intervention was delivered by a combination of yoga teachers, audio recordings, and certified facilitators. The Doria and colleagues (2015) intervention used a “comprehensive program derived from yoga” (p. 311) including physical postures, breathing, meditation, and cognitive behavioral exercises for 10 sessions over the course of two weeks. The Hoge and colleagues 2013 and 2017 intervention utilized one weekend “retreat” (2013, p. 4) and a weekly group-based intervention of “gentle” (2017, p. 2) Hatha yoga, breathing exercises, and “body-scan awareness” (2017, p. 2), with daily home practices guided by audio recordings.

Anxiety measures. Doria et al., 2015 collected pre- and post-intervention Zung self-rating anxiety scale inventory (ZAZI) completed by subjects as well as pre- and post-intervention of Hamilton Anxiety scale (HAMA) that were assessed by a psychiatrist. The HAMA was implemented and re-assessed at two weeks, three months, and six months post-intervention.

Hoge et al., 2013 and 2017 collected pre- and post-intervention HAMAs, Beck Anxiety Index (BAI)s, and State-Trait Anxiety Inventory (STAI)s. In addition to these validated anxiety tests, they also conducted pre- and post-intervention evidence-based testing of social stress (Trier Social Stress Test [TSST]) and perceived illness severity (Clinical Global Impressions-severity of illness [CGI-S]) where the illness was GAD. The Hoge et al., 2017 study measured biomarkers for stress during the pre- and post-intervention TSST tests (stress hormones = adrenocorticotrophic hormone [ACTH] and cortisol; blood levels of inflammation = tumor necrosis factor-alpha [TNF-alpha] and interleukin-6 [IL-6]).

Outcomes. Doria and colleagues’ (2015) RCT compared yoga with pharmaceutical intervention (medicine arm, $n=37$) versus the same yoga without pharmaceutical intervention (no

medicine arm, $n=32$). Figure 4 shows the significant difference between pre- and post-intervention scores in HAMA for both intervention groups. (The period mean is the average of the two groups.) There was a statistically significant reduction in anxiety in both study arms (medicine, no medicine), indicating that yoga alone was an effective anti-anxiety treatment.

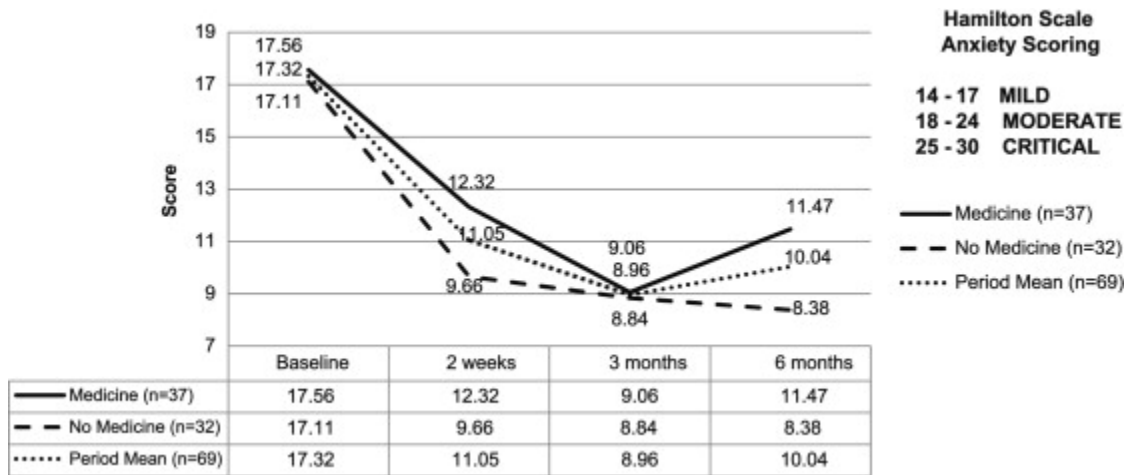


Figure 4. Doria et al. (2015) found that yoga alone (‘no medicine’ group) reduced GAD better than pharmaceutical treatment. This figure shows change in anxiety scores between the yoga-only group (dashed lines) and the yoga plus medicine group (solid line).

Hoge and colleagues’ (2013) RCT compared yoga in the form of mindfulness-based stress reduction intervention (MBSR), (yoga arm, $n=48$,) versus a non-yoga stress management education (SME) intervention (SME arm, $n=41$). The results are summarized in Figure 5.

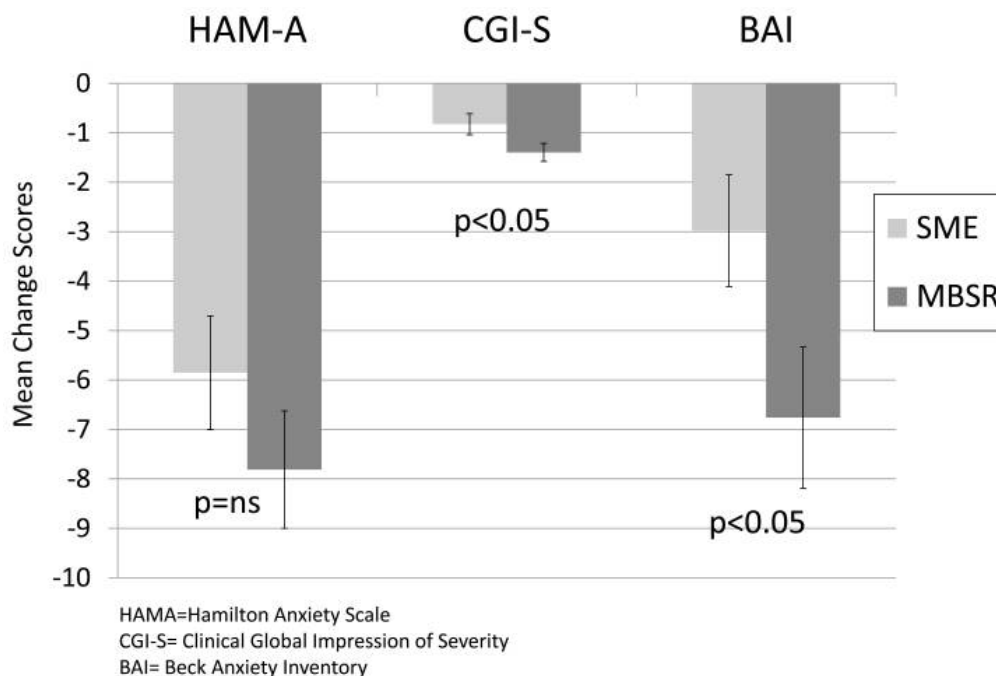


Figure 5. Change in scores that Hoge et al. (2013) reported between the yoga intervention group (Mindfulness-Based Stress Reduction, MBSR) and the control group (Stress Management Education, SME). Two measures (CGI-S, BAI) showed significantly greater decreases in the yoga group.

The changes from baseline to endpoint showed a significant decrease in anxiety scores measured by HAMA for both groups. The reduction for anxiety scores measured by the HAMA in the MBSR yoga group was significantly greater than the SME group ($p<.001$). The BAI scores changed for the better in both groups, but the difference was statistically significant only in the MBSR group. A greater percentage of the MBSR group (66%) reported feeling “improved” or “much improved” as opposed to the SME group (40%). MBSR intervention had a significantly greater average change in perceived improvement ($p<.05$). STAI-S scores decreased in both the control and intervention group, but this change was statistically significant only in MBSR group (data not shown).

Hoge and colleagues’ (2017) RCT compared MBSR and SME results in laboratory blood work, reporting on the association between attenuated stress response and external laboratory

stress test in GAD. They utilized the Trier Social Stress Test (TSST), a popular test used to induce psychological stress in human subjects (Kirschbaum, Pirke, & Hellhammer, 1993). Laboratory blood measures for stress hormones (ACTH, cortisol) and inflammatory markers (IL-6, TNF-alpha) were included and the results are summarized in Figure 7. There was a significant treatment/time interaction with the stress hormone ACTH over the course of treatment: the MBSR group had a reduction in ACTH, while the SME group had an increase. There was a decrease in inflammatory markers (IL-6 and TNF alpha) between pre-treatment and post-treatment TSSTs in the MBSR group, but not in the SME group. These findings suggest that the MBSR group had a greater increase in stress resilience.

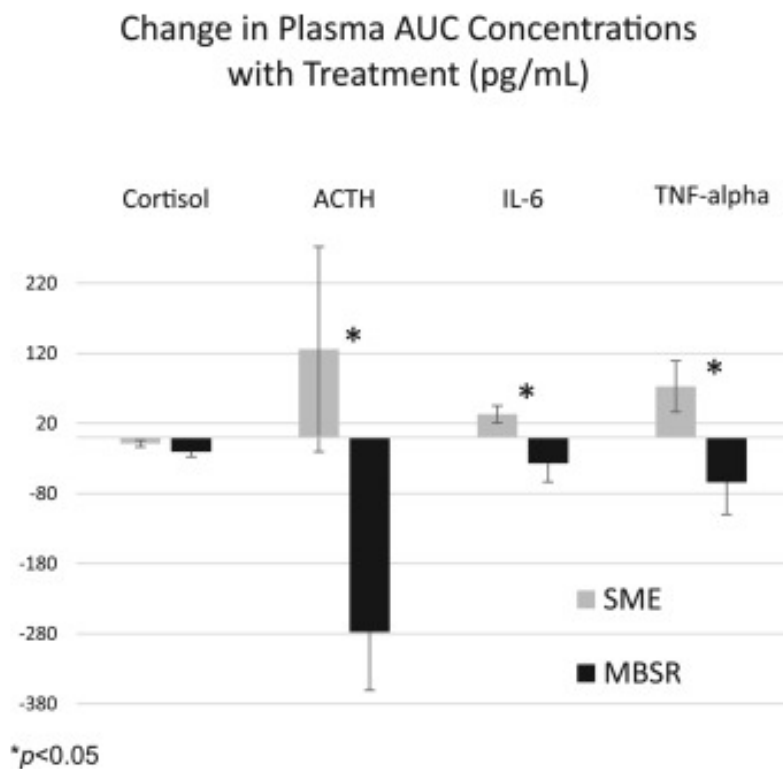


Figure 7. Hoge et al. (2017) results. The negative scores for the yoga group (Mindfulness-Based Stress Reduction, MBSR) indicate decreases in stress hormones (Cortisol, ACTH) and inflammatory factors (IL-6, TNF-alpha). The control group (Stress Management Education, SME) only showed decreased Cortisol and increased the other hormone levels.

Discussion

Out of 2,640 articles, only three RCTs were identified and met inclusion criteria. It was important to maintain strict inclusion criteria in order to show scientific validity through strength of scientific study design. Public health is an evidence-based practice (Brownson, Chiqui, & Stamatakis, 2009). Evidence-based practice uses evidence established through peer review or by a systematic review and demonstrates external validity (Brownson et al., 2009). There are hierarchical categories of scientific evidence according to Brownson et al. (2009), and RCTs are considered the “gold standard” of peer-reviewed scientific research (Victora, Habicht, & Bryce, 2004, p. 1). The low number of RCTs that met the inclusion criteria led us to include the Doria et al. (2015) study despite its inclusion of DSM-diagnosed depression as well as anxiety.

Summary of the Evidence and Limitations

The three RCTs received evaluation in this systematic review: comparable beneficial effects were found for yoga intervention groups compared to control groups. Yoga intervention was associated with decrease in anxiety scores in all three studies as well as stress biomarkers in the study by Hoge et al. (2017).

RCT study limitations include small sample sizes and narrow demographics. However, the Hoge et al. (2013, 2017) studies accounted for variation by age-, race-, and sex-matching. All of the studies had the inherent benefits of RCT, which include randomization of participants into control group and intervention group, a controlled intervention with measured doses, and a consistent intervention process across treatment groups. Doria et al. (2015) had limited ethnic representation and a narrow age range (25 to 63 years); therefore, their results might have lesser external validity. Hoge et al. (2013, 2017) had a broader ethnic representation that included Caucasian, Black, Asian, and “other” categories.

The evaluated studies did not detail any safety or other contraindications for yoga as an alternative treatment for GAD. This is an important aspect to consider when evaluating potential bias in participant recruitment.

Another limitation to Hoge et al. (2013, 2017) was that their MBSR intervention included physical postures, breathing exercises, and meditation without analysis of the effects of each individual aspect of the intervention. Individual practices may have different effects on GAD. The implications of the studies were based on a comprehensive analysis of multiple yoga elements, when a single yoga element may be sufficient and different individual yoga practices may be beneficial for different participant needs. For example, people with GAD and physical disabilities may not be able to participate in physical postures used these study interventions, but could benefit from the breathing exercises emphasized in Doria et al.'s (2015) intervention or the meditation aspects of yoga.

There is a possibility that other forms of exercise may be as effective (or more effective) an intervention for GAD as yoga: this should be included in future RCTs. There have been studies comparing exercise versus yoga and GABA responses regarding general measures of anxiety and stress. In anxiety disorders, γ -aminobutyric acid (GABA)-ergic activity is decreased. Streeter and colleagues (2010) tested whether GABA level increase is associated with yoga or physical activity alone. They found that the yoga group had greater improvements in GABA levels compared to the walking exercise group. The two groups worked at an equal metabolic expenditure in order to eliminate a confounding effect. These findings imply that yoga has a greater beneficial effect on stress and anxiety hormone GABA than exercise alone (Streeter et al., 2010).

None of the RCTs monitored program adherence. There was no data collected on whether the participants were practicing on their own and how this affected program outcomes. There are currently no studies regarding long-term compliance for yoga as a treatment for GAD, and there is a need for future studies should include long-term follow-up.

A limitation of this study is the small number of RCTs that met inclusion criteria. Further, there was one reviewer of the evidence; future studies should have a panel in order to minimize human error and subjectivity. Due to lack of early investigator and mentor familiarity of ICD–10 criteria and its correlation with DSM diagnostic criteria, studies were excluded that might have been acceptable. Future studies should be conducted with studies using ICD–10 GAD diagnosis criteria. Limiting it to GAD instead of all anxiety disorders may have been a limitation. However, GAD is common, easily diagnosed, and has easily self-reported symptoms. Anxiety diagnosis includes different subsets of mental disorders including post-traumatic stress disorder (PTSD) and agoraphobia. These subsets have different diagnostic criteria and treatment protocols, making it more difficult to determine if yoga works as an alternative treatment.

There are other empirically supported interventions that have components similar to yoga, such as deep diaphragmatic breathing, meditation, and other mindfulness-based interventions (Powers et al., 2013). Applied relaxation, a psychotherapy treatment, teaches patients a coping skill in order to counteract anxiety reactions better and is an effective method of treatment (Powers et al., 2013). Due to the parallels between these empirically proven treatments and yoga, it is important to continue the research regarding yoga as an alternative treatment with the ability to compare and contrast its elements.

Strengths of the study included the investigator's previous knowledge of yoga terminology generating a more comprehensive search for yoga interventions. Another strength

was following an established methodology (Khan et al., 2003). Databases available through Wright State University, OhioLink, and efficient no-cost interlibrary loan services were another strength for this project.

Advantages and Disadvantages of Yoga Intervention

Table 8 shows the advantages and disadvantages of lifestyle intervention programs such as yoga intervention garnered from the literature review conducted for this project.

Disadvantages of yoga interventions are high initial costs, lack of a large-scale medical organization qualified to oversee medical applications of yoga therapy, implementation challenges, program attrition, and post-program maintenance.

Table 8

Advantages and Disadvantages of Yoga as a Lifestyle Intervention

Advantages	Disadvantages
Overall cost	Initial cost
Risk to benefit ratio	Lack of governing body
Recidivism	Implementation
Reduction in comorbidity	Program participation
	Program attrition
	Post program maintenance

Lifestyle intervention programs can be costly in terms of administration, materials, location, and personnel. These obstacles make uniform program implementation difficult, and fidelity is important in the collection of consistent measurable outcomes. Based upon literature describing lifestyle intervention programs such as the National Diabetes Prevention Program (Diabetes Prevention Program Research Group, 2012), initial cost of behavioral program implementation is high compared to pharmaceutical interventions. The 10-year cost-effectiveness comparison of lifestyle intervention and pharmaceutical intervention for diabetes prevention, the cost of the lifestyle intervention program was more than the pharmaceutical

intervention. However, when the medical costs outside of the intervention such as comorbidity treatment were taken into consideration, the lifestyle intervention was more cost-effective in the long term (Diabetes Prevention Program Research Group, 2012).

There is a lack of an organization qualified to oversee medical applications of yoga therapy or any type of yoga intervention approved for treatment of medical conditions/ mental illnesses. Unless a yoga instructor is also a licensed or certified provider with appropriate credentials such as Medical Doctor (MD), Doctor of Osteopathic Medicine (DO), Nurse Practitioner (NP), Doctor of Psychology (PhD/PsyD), Yoga Alliance states that yoga schools and instructors cannot advertise as “yoga therapy” (Yoga Alliance, 2016, statement on yoga therapy). There is currently no yoga curriculum that is a medically recognized alternative treatment. However, there are training programs that focus on mindfulness based stress reduction (MBSR) that incorporate yoga into their training, for example, the MBSR training program developed at the University of Massachusetts Medical School (Kabat-Zinn, 2014).

Participation attrition is another obstacle to overcome. Some lifestyle intervention studies regarding physical activity and nutrition reported low retention rates, while other studies showed high retention rate but low attendance rate or inconsistent participation within the program (Lemacks, Wells, Ilich, & Ralston, 2011). Pharmacological intervention also has a low adherence rate; according to Cassil (2008), nearly 50% of people taking a chronic medication stop taking it in the first year. There needs to be research and implementation of best practices directed towards program retention rates, and more focus on methods used for programs reporting high retention rates.

Post program follow up in terms of continued positive reduction in GAD and maintenance of practice is important in understanding long-term effects of intervention. Doria

and colleagues (2015) completed a six-month follow-up post-intervention. They found that the non-medicated yoga group had a continued decrease of anxiety scores, whereas the medicated yoga group had gradual return of anxiety symptoms. This encouraging pattern for yoga intervention should be investigated for longer periods of time in order to amass more conclusive results.

Advantages for yoga as a lifestyle intervention for GAD include a lower overall predicted cost than pharmaceutical intervention, lower recidivism, and reduced inflammatory biomarkers with positive effect on comorbidities and chronic disease (see Table 7).

Anxiety patients often display physical symptoms and comorbid medical conditions. Every part of the body is susceptible to physical discomfort from anxiety (Arikian & Gorman, 2001). Therefore any system in the body can develop an anxiety related acute or chronic medical conditions widely divergent from diabetes, irritable bowel syndrome and heart disease (Kaufman & Charney, 2000; Kessler, Keller, & Wittchen, 2001, Kessler, Mickelson, Barber, & Wang, 2001; Noyes, 2001). The cumulative costs of anxiety, comorbidities and physical symptoms can be quite expensive for the individual and employers, as well as the health care system. *The Cost of Treating Anxiety*, a retrospective database analysis, reported that cost for treating anxiety patients from the multivariate analysis was \$6,475 US\$ per person in 1999, including all treatment and prescription costs (Marciniak et al., 2005). The annual cost of mental disorders in 2012 was \$467 billion (Insel, 2015). The cost of differentiating somatic symptoms of anxiety from an actual serious medical condition are impacted by untreated GAD, for example, this impacts the rate and cost of emergency department (ED) evaluation of chest discomfort because people with panic attacks may think they are having a heart attack (Locke, Kirst, & Schultz, 2015). The United States spends between \$10 and \$12 billion dollars annually on the healthcare

costs associated with diagnostic protocols associated with acute chest pain for emergency room visits (Priest, Schuffham, Hachamavitch, & Marwick, 2011). More than 6 million people visit the ED each year for chest pain (McCaig & Nawar, 2006). In 2006, 83.2% of people who visited the ED for chest pain were not diagnosed with acute coronary syndrome (Bhuiya, Stephen, & McCaig, 2010).

Yoga as an alternative treatment may provide some alleviation of GAD and impact on evaluating somatic complaints of anxiety disorder that may otherwise be contributed to a somatic medical condition.

Lower recidivism. There was a reported lower recidivism in anxiety regarding yoga intervention compared to pharmacologic intervention according to Doria et al. (2015). The study showed that three months after intervention there was a statistical decrease in the HAMA anxiety scores in both group, but between three months and six months post intervention the medication group experienced a relapse in anxiety and an increase in HAMA anxiety scores. This has important implications for health care costs, for quality of life for patients, and for reduction of comorbidities. Because this result is reported for only one study, further research is needed.

Reduction in metabolic factors of chronic disease. There are a number of physiological factors that play a critical role in chronic disease (Tabas & Glass, 2013; Mayo Clinic, 2016). Two of these, inflammation and stress hormones, were measured outcomes in one of the RCTs identified and critiqued in this project. Inflammation is a biological response to a stimulus that can be acute or chronic. Chronic inflammation and stress hormones are thought to play a role in chronic disease. Stress hormones are a natural biological response to a variety of stimuli. Acute increase of stress hormones is natural biological phenomenon: for example, we all experience an elevated level of cortisol in the mornings to help the human body awaken, and it then naturally

decreases in later in the day order to aid in sleep progression. However, chronically high levels of cortisol have negative biological effects and are associated with atherosclerotic heart disease (Whitworth, Williamson, Mangos, & Kelly, 2005).

The study by Hoge and colleagues (2017) investigated yoga effect on the inflammatory markers TNF- α and IL-6, and stress hormones cortisol and ACTH. Chronically higher levels of these biomarkers are associated with higher risk of chronic disease. They found a statistically significant decrease in TNF- α and IL-6 post yoga intervention. This is important because TNF- α is a key cytokine that deals with tumor immunity and immunity against infection and impaired response of TNF is harmful (Tosi, 2005; Riche et al., 2000). The body produces IL-6 when there is inflammation (National Center for Biotechnology Information, 2017). Chronically high levels of TNF and IL-6 production can lead to risk of type 2 diabetes as well as atherosclerotic heart disease (Diehl, 2004; Lutzky, 2001). IL-6, through multiple mechanical pathways, can cause cardiovascular disease in addition to atherosclerotic heart disease (Yudkin, Stehouwer, Emeis, & Coppack, 1999). With a decrease in the inflammatory markers, there is an implication of decreasing the risk of these comorbidities. Stress hormones cortisol and ACTH play an important role in human functioning, but chronically high levels can be detrimental to human health (Mayo Foundation for Medical Education and Research, 1998-2017). In response to stress cortisol is released, its function is to suppress the immune system, aid in the metabolism of macronutrients, and increase blood sugar (Hoehn & Marieb, 2010). ACTH affects the production and release of cortisol. Both of these hormones are an integral part in the hypothalamus pituitary axis: chronic over-activity of this axis can cause health issues such as depression, heart disease and autoimmune disease (MDBiosciences, 2017).

Conclusions and Recommendations

According to the American Medical Association (AMA), yoga practice is an alternative therapy referred to as “unproven treatments” the AMA also states “rigorous research to study safety” of these therapies are needed (Li & Goldsmith, 2012, quoting Landers, 2009). This project confirmed the lack of rigorous research regarding yoga interventions for GAD.

Based on the available RCT evidence, yoga does appear to decrease symptoms of GAD. The overall cost of treating people with GAD could be reduced if the results of yoga as an alternative treatment for GAD are reproducible and applicable to more diverse populations. Yoga could also have a positive effect on inflammatory responses, reducing the risk of comorbidities and chronic disease. There needs to be further studies focused on long-term management of initial yoga intervention costs, program attrition, and post-program evaluation. There also needs to be studies regarding the physical and mental safety of the yoga intervention for GAD and policies guiding intervention protocols. The safety of yoga intervention must be evaluated in order to conduct a risk ratio of yoga with other traditional forms of treatment.

Additional RCTs evaluating yoga intervention are needed. Hofman and colleagues (2015) offer the following design recommendations in their strong RCT trial design for testing yoga for GAD intervention relative to standard treatment.

- Evaluators should be blind to participant treatment assignment, independent from the study administration, and credentialed mental health professional and experienced in clinical interviews.
- A power analysis should be completed in order to determine the appropriate amount of participants for valid statistical analysis.

In addition to these, I offer the following recommendations.

- The yoga intervention must be described in detail including specific yoga postures practiced, the duration of each posture held, if props were used, and if modification were offered and used.
- Recording class participation and attendance for group classes as well as at-home practice, and the degree of completion.

There is a potential for yoga to have an impact on the economic burden of GAD in addition to its clinical and scientific implications. Further rigorous research is needed to provide more information to evaluate the efficacy of yoga intervention for mental health conditions such as anxiety. Public health will benefit from more evidence-based practices regarding yoga intervention for GAD.

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Appendix A: List of Competencies Met in CE

Wright State Program Public Health Competencies

Assess and utilize quantitative and qualitative data.
Apply analytical reasoning and methods in data analysis to describe the health of a community.
Communicate public health information to lay and/or professional audiences with linguistic and cultural sensitivity.
Address population diversity when developing policies, programs, and services.
Make evidence-informed decisions in public health practice.
Evaluate and interpret evidence, including strengths, limitations, and practical implications.
Demonstrate ethical standards in research, data collection and management, data analysis, and communication.

Concentration Specific Competencies

Health Promotion and Education	
Area 1: Assess Needs, Assets and Capacity for Health Education	
1.6	Synthesize assessment findings
Area 2: Plan Health Education Programs	
2.1	Use assessment results to inform the planning process
2.7	Organize health education into a logical sequence
Area 3: Implement Health Education	
3.5	Use evaluation findings to plan future training
Area 4: Conduct Evaluation and Research Related to Health Education	
4.1	Create purpose statement
4.2	Develop evaluation/research questions
4.3	Assess the merits and limitations of qualitative and quantitative data collection for research
4.4	Critique existing data collection instruments for research
4.6	Develop data analysis plan for research
4.9	Disseminate research findings through professional conference presentations
Area 5: Manage Health Education Programs	
5.10	Synthesize data for purposes of reporting
Area 6: Serve as a health education resource person	
6.4	Identify existing resources that meet training needs
6.8	Use a variety of resources and strategies
6.9	Evaluate impact of training programs