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Martine Delcroix March 28th, 2016

EFFECTIVENESS OF USING A DEEP BREATHING TECHNIQUE TO REDUCE THE STRESS OF INTERNATIONAL BACCALAUREATE 12TH GRADERS

BY

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to be awarded: M.P.H
Executive MPH

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BY

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Abstract

EFFECTIVENESS OF USING A DEEP BREATHING TECHNIQUE TO REDUCE THE STRESS OF INTERNATIONAL BACCALAUREATE 12TH GRADERS.

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Background: Teens identify school as a source of stress, but often are not aware of the impact of stress on their physical and mental health, and often do not know how to cope with stress.
Exploring coping techniques in school may ensure lifelong healthy behaviors for students. Students enrolled in challenging curricula such as the International Baccalaureate (IB) report more stressors.

Methods: This longitudinal pilot study assesses the effectiveness of a short, inexpensive course to train teachers to implement stress management techniques with students. We compared over six weeks, two 12th grade classrooms of International Baccalaureate students. One class practiced mindful breathing (n=8) for 5 minutes, 3-4 times a week, and the other class served as a control (n=3). The effectiveness of the intervention was measured by comparing level of stress as measured by both salivary cortisol and self-perceived stress, before and after intervention, within and between students. Correlations were calculated between level of stress and math score.

Results: Self-perceived stress and cortisol were correlated before two different exams ($r=.50$, $p=.12$, $r=.89$, $p=.0003$). Despite the small sample size, results showed that students in the Intervention group reported lower self-perceived stress and had a four-fold lower level of cortisol after intervention, while the control group's cortisol and self-perceived stress did not change appreciably. The cortisol drop in the intervention group (paired t-test of log cortisol was significant ($p=0.006$)). Finally, a moderate negative correlation was observed between stress level and math performance, as measured by both perceived stress ($r=-.51$; $p=0.11$) and salivary cortisol ($r=-.52$; $p=0.10$).

Conclusion: The study is innovative in using two measures of stress (biologic and behavioral). Results suggest that a five-hour course to train teachers to implement short and

simple coping techniques can substantially lower students' stress. In addition, this intervention may enhance the class environment by benefiting both students and teachers, who in turn may promote health within the school community. While we tested the intervention among relatively well-off students, findings are promising for schools with disadvantaged students and scarce resources, as it can support mental health of a large number of students for very little cost.

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Finally, I would like to dedicate this study to my daughter Adeline, who completed successfully an International Baccalaureate, at a time when I did not know yet how to support her to manage her own level of stress.

Contents

Introduction

While stressful situations are inevitable and some stress is good, the 2014 survey of Stress in America reveals a culture of unhealthy stress in United States and particularly among teens (Anderson et al., 2015). In this survey, teens report experiencing stress at a level higher than adults, with school being a main source of stress. Although, teens report that stress affects their academic and social performances, they are not very aware of the impact that stress can have on their physical and mental health. Furthermore, teens often do not know what to do to manage their stress (Anderson et al., 2015). In addition, high school students who are enrolled in academically challenging curricula in particular, such as the International Baccalaureate (IB), report more stressors and reduced academic functioning associated with increased academic requirements compared to non IB students (Shaunessy et al., 2010).

Research has shown that stress; a body-response to any demand for change (Selye, 1936), is a particularly salient construct in adolescence that is clearly related to mental health outcomes (Hagell et al., 2012). Exposure to high level of stress and/or unmanaged stress have been shown to have negative/deleterious effects on both physical and mental health (e.g. anxiety, insomnia, muscle pain, high blood pressure), to weaken the immune system (Hagen et al., 2014), and to impact cognition (Zenner et al., 2014).

Mental health disorders, or "serious deviations from expected cognitive, social, and emotional development" (Perou et al., 2013) among children and adolescents in the United States represent an important public health issue due to their prevalence, early onset, and economic burden. The prevalence of mental health disorders among

adolescents in the US is increasing (Perou et al., 2013). Today one in every four to five teens (22.2% between 13 to 18 year olds) is currently suffering, or has suffered from a severe mental disorder in the US (Heizomi et al., 2015). Adolescents are particularly vulnerable to mental health disorders, especially girls, and those who are poor and non-white (Anderson et al., 2015), as they experience normative and transitive, relationship, social, and academic stressors (Suldo et al., 2009). Furthermore, three quarters of mental health disorders appear in adolescence or early adulthood ages (Heizomi et al., 2015), and the onset for 50 percent of adult mental health disorders occurs by age 14 (Kessler et al., 2005). In addition, mental health disorders among adolescents in the US represent a critical economic burden as they have an estimated total annual cost of $247 billion, and are among the most costly conditions to treat in children (Perou et al., 2013). Finally, mental health disorders impact not only on the child but as well on his/her family and community (Perou et al., 2013).

Mental health disorders are associated with a high level of stress, role impairment and/or distress such as mood disorders (11.2 %), anxiety disorders (8.3 %), and behavior disorders (9.6 %) (Merikangas et al., 2010). Adolescents who suffer from mental disorders are at higher risk for substance abuse, social detachment, academic failure (Khalsa et al., 2012), and school dropout (Heizomi et al., 2015). In addition, most adolescents who report suicidal thoughts are depressed, and suicide is the third leading cause of death for youth between the ages of 10 and 14 (Center for Disease Control and Prevention, 2015c).

School is a critical place in which to prevent mental disorders and foster personal development and well-being of youth, because children spend much of their time at

school and emotional health among students is steeply declining (Lowe, 2011). If schools cannot be expected to be responsible for managing emotional health of students, neither can they ignore it. Academic success is not just about instruction; a growing body of research shows that physical/mental health, social/emotional competence, and academic achievement, are fundamentally interrelated (Center for Disease Control and Prevention, 2010; Zenner et al., 2014). In particular, a high level of anxiety among teens, such as mathematics anxiety (MA), has been shown to negatively affect math reasoning compared to teens with low level of MA (Passolunghi et al., 2016). Furthermore, anxious teens tend to develop negative beliefs regarding their own math abilities (Ashcraft et al., 2001; Lent et al., 1991).

Throughout the country, educators, major voluntary organizations, and researchers recognize both the enormous impact that health has on the academic achievement of students (Council of Chief State School Officers, 2004), and the need to foster students' health and well-being within the educational environment (American Cancer Society et al., 2007). As a result, schools and educators seek tools that will allow them to simultaneously provide prevention and education (Zenner et al., 2014) and to address a wider range of needs and skills that until recently were not the province of school (Rechtschaffen, 2014). By teaching students how to cope with stress, schools can reflect the importance of promoting the mental health of young people at their critical ages (Heizomi et al., 2015), propelling all students to achieve success, and ensuring a healthy and productive future adult population (McNeely et al., 2009).

Each school day in the United States provides an opportunity for more than 50 million students to learn about the dangers of unhealthy behaviors and to practice the

skills to establish lifelong healthy behaviors. However, with the decrease of public resources in recent years, school's resources have become scarcer and school's accountability to show achievement via testing and school performance has increased (Suldo et al., 2009). School leaders have focused in allocating resources toward academic achievement and budget effectiveness, rather than students' health and well-being. For example, according to CDC, only 29% of high school students have attended a daily physical education class in 2013 compared to 42% in 1991 (Kann et al., 2014).

To address the stress of students, schools use various interventions including yoga and a variety of Mindfulness-Based Interventions (MBIs), which consist of a training of the mind and/or body to steady the mind. Both yoga and mindful breathing have been shown to: reduce stress (Khalsa et al., 2012) and anxiety (Beauchemin et al., 2008), increase well-being, and strengthen immune functions (Zenner et al., 2014). In addition, yoga and MBIs are acceptable and feasible in a secondary school setting (Khalsa et al., 2012). However, resources and time are often a barrier for schools, and long training, such as for yoga or a the Mindfulness Based Stress Reduction (MBSR) program, may be expensive and challenging for teachers or schools to afford (Rechtschaffen, 2014). Although, hiring an outside experienced trainer to implement stress management interventions in school may overcome some barriers, it is not always sustainable in the long term (Shucksmith et al., 2007). For this reason, training the teachers themselves to teach their students how to cope with stress, may be a more promising approach. Furthermore, training teachers in paying close attention to inner stress may be conducive in taking better care of themselves and students, and in cultivating group cohesion for students to feel more safe and attentive (Rechtschaffen, 2014). As a result, offering stress

management techniques that are easy to implement and economically accessible has become critical to the whole classroom and the whole school, particularly for public schools that serve impoverished communities. In recent years, MBIs have become increasingly integrated into medicine, healthcare, and psychology (Rechtschaffen, 2014), and have been identified as a promising avenue for youth, particularly in relation to improving their cognitive performance and resilience to stress.

A growing number of studies have been published in relation to mindfulness in general, but little experimental research has investigated MBIs in school. While the enthusiasm about MBIs in school settings is growing, it remains difficult to assess their effectiveness due to the heterogeneity of measures, settings, and interventions. For instance, in their review Zenner et al. in 2014 report at least five outcomes of interest, factors of resilience being the most measured, then emotional problems, third person ratings, and surprisingly the least measured are cognitive performance and stress and coping. Furthermore, studies are often underpowered and small, and use self-reported measures (Zenner et al., 2014). Studies to date on stress in IB students, in particular, have used no control group, and only self-reported measure of stress. In addition, most school-based interventions to foster student learning and social-emotional well-being are designed for students, and are conducted by professional trainers rather than by the class teacher.

This study adds to the literature by assessing the effectiveness of a course to promote the use of MBIs that are easy to implement in the school-routine by the class teacher, and by measuring the level of stress and academic performances within students

compared to a control group. Finally, this study is innovative in combing two measures of stress: self-perceived stress and salivary cortisol among IB students.

The purpose of this study is to demonstrate the effectiveness of a course to be offered to IB teachers in reducing student stress when integrated into the school routine. The course is named "Coping strategies for balanced IB learning". The research question that guides this study is to explore if a deep breathing technique, taught to IB teachers as a stress management strategy for use with students decreases the level of stress of 12th grade IB students and improves their performance in math.

The theoretical framework of this study refers to both the Transactional Model of Stress and Coping (Lazarus et al., 1984) and the Health Realization/Innate Health Model (Sedgeman, 2005), as well as recent research in neurosciences (Davidson1 et al., 2012). These models support the assumptions that stress is not the direct result of a stressor, but that stress is controllable, and that coping strategies to control stress can be taught.

The results of this study are presented in an attached article to be submitted to the Society for Public Health Education (SOPHE) for publication in one of their Peer-Reviewed journal named "Pedagogy in Health Promotion: The Scholarship of Teaching and Learning" (PHP). SOPHE advocates for school and public health education issues. It is a non-profit professional organization which provides leadership through a code of ethics, standards for professional preparation, research and practice, professional development, and advocacy. This study was presented at GA SOPHE 2015, and at the annual SOPHE meeting in spring 2016.

The journal Pedagogy in Health Promotion: The Scholarship of Teaching and Learning (PHP) is the latest official journal created by SOPHE. The main purpose of the PHP is to advance “pedagogy through contributions in areas such as curriculum and course/program design, assessment, and administration relevant to teaching and learning” ("Guidelines for prospective authors," 2015). This article will be proposed as an “Original Research” which is a major scholarship article. The PHP’s format guidelines authorize 7,000 words. Articles must be typed double-spaced; page numbered; and written in Times New Roman, 12-point font. In addition, no more than 35 references and 4 figures (black & white, 1,200 dpi or better) are authorized.

Literature Review

Stress is inevitable and not necessary the result of traumatic events. We all encounter stress on regular bases, and particularly with multitasking. Furthermore, all stress is not bad and some stress is good. When in the face of stress, stress hormones flood our bloodstream initiating a red alert status commonly called "fight and flight", and our internal dynamic balance "homeostasis" shifts to survival mode. Once the source of stress passes, our bodies return to homeostasis where our bodies function best. Although, stress is not new, we tend today to experience stress more often, and for some people constant stress. As a result, our stress response system gets overloaded, and our body stops returning to homeostasis, our dynamic balance. Such consequence is even more concerning for youth, as how youth respond to stressors and cope with stress has been shown to impact their risk level for maladaptive developmental trajectories (Compas et al., 2001). This literature review brings some lights on what is stress and what may trigger one's response to stress in general, as well as the prevalence of stress among youth in particular, its consequences, and the role of school in relation to stress.

Theoretical models of Stress

Stress remains a highly subjective phenomenon that defies clear definition. Until today, the most recognized definition of stress is the 1936 definition of the Hungarian endocrinologist Hans Selye. Selye's definition of stress relies heavily on animal laboratory experiments rather than human subjects (Selye, 1936). Selye was interested in identifying hormones' effects on rodents. Selye noted that control rodents (injected with salt solution) exhibited identical negative outcomes as active rodents (injected with

different hormones such as cow's hormone). "Anything he injected the rats with made them sick, in exactly the same way" (McGonigal, 2015, p. 39). In addition, control rodents exposed to placebo or uncomfortable acute stimuli (e.g. extremes of heat or cold) also exhibited these same identical outcomes as well (e.g. stomach ulcerations, shrinkage of lymphoid tissue, enlargement of the adrenals). As a result, Selye deducted that the outcomes observed in rodents were not caused by what they were injected with or exposed to, but of what they were experiencing. Selye named this phenomenon stress, and defined stress as the "response of the body to any demand on it" (McGonigal, 2015, p. 39). First, Selye described stress for both what he was doing to the rodents (stressing them out) and how rodents' body reacted (response to stimuli) (McGonigal, 2015), before creating a new word "stressor" to distinguish stimulus from response. Along the years, Selye discovered that the symptoms observed in humans under stress (e.g. loss of appetite, fever, fatigue) were not specific to any disease, and that the outcomes observed in rodents under stressing conditions (e.g. heart attacks, stroke, kidney disease and rheumatoid arthritis) were similar to those observed in humans. From these discoveries, Selye hypothesized that the symptoms observed in humans exposed to persistent stress may result from the same process observed in animals. However, the negative nature of symptoms and outcomes observed in reaction to stressors placed stress in "a negative light and its positive effects be ignored" (The American Institute of Stress, 2016). Subsequently, Selye in the 1970s contended there is good stress (eustress) and bad stress (distress), and as "There is always stress, so the only point is to make sure that it is useful to yourself and useful to others" (McGonigal, 2015, p. 39).

Beginning in the 1960s and 1970s, stress was considered to be a transactional phenomenon dependent on the meaning of the stimulus to the perceiver (Antonovsky, 1979; Lazarus, 1966). The Transactional Model of stress and coping and the Health Realization/Innate Health model of stress illustrate the concept that stress does not necessary follow the presence of a stressor but rather that stress depends on an individual's reaction to the stressor. While those models provide us with an understanding of what may trigger a stress-response, each offers a different interpretation of what the transactions may depend on, such as one's appraisal based on perceived coping skills, or the person's nature of thought.

The **Transactional Model of Stress and Coping** was developed by Richard Lazarus and Susan Folkman in 1984. They suggested that stress may result from an "imbalance between demands and resources" or may occur when "pressure exceeds one's perceived ability to cope" (Lazarus & Folkman, 1984). The transactional framework is based on the belief that when facing a demand (a stressor) made by the internal or external environment, a person evaluates first (Primary Appraisal) the potential of threat of the stressor using his/her own judgment. The stressor will be interpreted as stressful, positive, controllable, challenging, benign or irrelevant, depending on the person and the person's coping skills at the time, as well as the situation in which the event/demand is occurring. If the pressure "exceeds one's perceived ability to cope" (Lazarus & Folkman, 1984), the demand will be perceived as a threat and the person will proceed to a second appraisal (Secondary Appraisal) to evaluate the efforts needed to cope with the demand and restore his/her balance between demand(s) and resources(s). The coping efforts are the strategies (negative and positive) used by the person to cope with a stressful situation.

They are aimed at mediating/regulating the emotional and functional effects of the Primary and Secondary Appraisals. In other words, external circumstances do not have the intrinsic capacity to produce stress, but instead the effect of these external circumstances is mediated by the person's perceptions, abilities, and understanding. Consequently, stress is not considered as an inevitable result of stressor(s) beyond the control of the person experiencing pressure(s), but stress is controllable, and coping strategies to control stress can be taught.

The **Health Realization/Innate Health (HR/IH) model** of stress was developed by Roger C. Mills and George Pransky in the 1980s. The HR/IH differs from the Transactional Model on the nature of the mediation applied between acknowledgments of the stressor(s) and response to the stressor(s). For Lazarus and Folkman, it is the person's appraisal of external stressors based on their own coping skills that will restore balance and determine whether or not stress will be the result. Stress results from a transaction between a person's coping skills and their external environment. In contrast, according to the HR/IH model, the experience of stress is an inside-out process originating within the mind and using the person's thoughts to determine the response to potentially stressful demands. Stressors are considered, in Sedgeman's words, "the moment-to-moment perceptions of a mind innocently caught up in negative, upsetting thinking, without recognition and understanding of the process that is driving the experience"(Sedgeman, 2005, p. 3). If the person experiences momentary insecure or negative thoughts, he/she will tend to experience the situation as stressful. However the HR/IH model teaches us that we have health and well-being already within us (innate health), and it can never be taken from us (Mills, 1995). Therefore, as soon as we quiet our minds, positive feelings

emerge, allowing us to connect with our intuition, our inner wisdom (innate health), to solve the problem. A strength of the HR/IH model is that each person is considered to have the power of the mind to help determine how external factors will affect him or her (Sedgeman, 2005).

Coping with stress

Coping, as the general process of negotiating internal and/or external stressors, may be effective or ineffective, depending on the individual's perception and response strategy. The Transactional Model of Stress and Coping suggests equipping individuals with coping skills to respond efficiently to stressors. The HR/IH model suggests teaching people how to maintain their peace of mind, regardless of what they experience in their lives, by acknowledging stressors rather than avoiding them or replacing them with more positive thoughts. For Sedgeman, stressors are a sort of barometric pressure of the mind that provide an indicator of our actual quality of thinking, and positive thoughts (optimistic) rather than negative thoughts (pessimistic) empower people (Sedgeman, 2005). Teaching people how to stay grounded in life and live their lives with greater presence will, in turn, allow them to experience external stressors with more resilience.

The idea that coping strategies may be taught is supported by recent research in the neurosciences and the concept of neuroplasticity. Davidson (2012) contends that the brain patterns that trigger one's stress response are not fixed, and they can be modified through a mental training (Davidson1 et al., 2012; Kabat-Zinn, 2005). Once modified, those patterns of brain activity have the power to change one's Emotional Style and to improve one's life. Davidson suggests that people have distinct emotional styles, what

Compas and colleagues (2001) had earlier referred to as temperamental style. These emotional styles, the result of both genes inherited from parents and early childhood experiences, influence how we learn to cope as well as the efficacy of the coping strategies used. One's emotional style is reflected as a specific pattern by our brain activity, which, in turn, triggers biological process in one's body to influence one's response to the stressor. Brain activity patterns are not forever fixed, according to Davidson, and they can be altered by new experiences, thoughts, or through the cultivation of specific mental habits. In other words, mental activity training has the power to alter the brain's response to stressors. Furthermore, McGonigal (2014) suggests that our perception of stress may interfere with our ability to use stress as a resource to build confidence and power when processing stressors. McGonigal builds on both Selye's dichotomy of stress, i.e., there is good stress (eustress) and bad stress (distress), and Davidson's findings to suggest that the stress response system is adaptive and the changes that may occur in response to stressors are strategic and receptive to the efforts of deliberating practice. Hence, the way one perceives stress interferes with one's ability to use anxiety as a resource. A positive attitude toward stress, in general, may influence positively how a person reacts to a stressor (McGonigal, 2015).

Stress in adolescence

The 2014 survey of Stress in America (Anderson et al., 2015) identified a culture of unhealthy stress in the United States, particularly among teens. Teens have reported experiencing a stress at a level higher than adults (5.8 vs 5.1 out of a 10-point scale), and girls at rates higher than boys. Teens have identified school, friends, and family as the most common source of stress, and have reported that stress affects their academic and

social performances. Often, teens do not know how to manage their stress, particularly girls (36% vs 27%), or report not doing enough to manage their stress (42%). They underestimate the impact that stress can have on their physical and mental health, while they report feeling overwhelmed (31%), tired (36%). Girls report having unhealthy behaviors as a result of stress such as affecting their relationship with food and feeling irritable, angry, or tired (Anderson et al., 2015). In addition, 31% of teens say their stress level has increased in the past year, and 34% estimate their stress level will increase in the coming year. Finally, three quarters of adult mental health disorders seem to appear in adolescence or early adulthood ages (Heizomi et al., 2015).

Research has shown that exposure to a high level of stress and/or unmanaged stress was associated with negative/deleterious effects on physical health (e.g. anxiety, insomnia, muscle pain, high blood pressure) (Hagen & Nayar, 2014). Other recent studies have found that stress has an impact on mental health and cognition (Hagell et al., 2012; Zenner et al., 2014), by affecting the brain, the key organ of stress reactivity (McEwen et al., 2010), and particularly the brain's structures involved in cognition and mental-health (Lupien et al., 2009). The most prevalent current diagnoses associated with stress are Attention Deficit Hyperactivity Disorder (ADHD), behavioral or conduct problems, and anxiety (Costello et al., 2011; Perou et al., 2013; Zenner et al., 2014).

As of 2015, more than 22% of adolescents (13 to 18 year olds) in the US were currently suffering or had suffered from a severe mental disorder (Heizomi et al., 2015), and the numbers are increasing (Perou et al., 2013). Under those circumstances, particular attention has focused on the prevalence of mental health disorders among adolescents. Adolescents are particularly vulnerable to mental health disorders as they experience

more daily stressors than are typical in childhood (McNamara, 2000). These include normative and transitive stressors (e.g. puberty, roles and responsibilities), relationship stressors (e.g. peer pressure, romantic relationships, and relationships with parents), and increased academic pressure (Suldo et al., 2009). Furthermore, research shows that adolescents and young adults who are African American, American Indian, or Hispanic, and especially those who are living in poverty, experience worse physical health outcomes (e.g. hypertension, heart disease), as well as mental health outcomes (e.g. depression to schizophrenia) (Wadsworth et al., 2012).

Adolescents who suffer from mental disorders are at higher risk for substance abuse, social detachment, academic failure (Khalsa et al., 2012), and school dropout (Heizomi et al., 2015). For this reason, Rechtchaffen (2014) describes adolescence as a dangerous time, during which teens start both exploring very adult experiences and withdrawing from positive adult role modeling. Studies of adolescent health have shown that risk-taking increases between childhood and adolescence, as youth are looking for more reward (Steinberg, 2008), and represents the main cause of mortality in adolescence (Barbalat et al., 2010). Such an increase in risk-taking in adolescence results from two main changes in hormonal processes: a brutal secretion of sex hormones and a delayed maturation of cognitive control (Barbalat et al., 2010).

Stress and school

Children and youth frequently experience stress in school (Zenner et al., 2014). However, if almost 40% of parents recognize that high-schoolers are under a lot of school

pressure (Neighmond, 2013), they often underestimate the impact of stress in school on youth (American Psychological Association, 2009).

High School students who are enrolled in academically challenging curricula such as Advanced Placement (AP) and International Baccalaureate (IB) face a multitude of stressors related to increased academic demands in addition to the developmental and biological challenges (Suldo & Shaunessy, 2008; Suldo, Shaunessy, et al., 2008). IB students have reported more symptoms of psychopathology and reduced academic functioning as they experienced higher levels of stress associated with academic requirements than non IB students; they have also manifested worse outcomes in the face of stress (Suldo et al., 2009). In addition, particular coping styles (e.g. frequent anger, infrequent positive appraisal) used by some IB students have been shown to exacerbate the impact of stress on IB students' social-emotional well-being and affect negatively their mental health (Suldo, Shaunessy, et al., 2008). The IB is a specific diploma, awarded upon completion of secondary school studies. It has been described as "a rigorous, off-the-shelf curriculum recognized by universities around the world" (Wallis et al., 2006), with challenging requirements far beyond those required by state for high school graduation (Suldo, Shaunessy, et al., 2008). "The International Baccalaureate (IB) aims to develop inquiring, knowledgeable and caring young people who help to create a better and more peaceful world through intercultural understanding and respect" ("What is an IB education?," 2013). In 2012, 3482 schools across 143 countries offered an IB program, and over one million students are currently enrolled ("What is an IB education?," 2013).

Stress in school may be related to a particular academic subject such as mathematics. For instance, studies have found that some students experience mathematics anxiety (MA), a feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of math problems in a wide variety of ordinary life and academic situations (Ashcraft & Kirk, 2001; Maloney et al., 2012; Vukovic et al., 2013). MA tends to increase with the degree of difficulty of the mathematical problem (Ashcraft et al., 2009). Furthermore, a negative loop has been observed among students with MA, in which, when they perform badly in standardized math tests (Ashcraft et al., 2007; Hembree, 1990), they then avoid arithmetic courses (Ashcraft & Moore, 2009; Hembree, 1990), they develop negative beliefs regarding their own math abilities (Ashcraft & Kirk, 2001; Lent et al., 1991), and they experience even more MA.

Stress management strategies in school

School is a critical place and a unique resource to prevent mental disorders, and foster personal development and well-being of youth because children spend much of their time at school (Weare et al., 2011); healthy students are better learners (Center for Disease Control and Prevention, 2015b; Langford et al., 2014); and emotional health among students is steeply declining, with the number of children living in poverty increasing (Lowe, 2011). Research has shown the importance of both promoting and preventing mental health issues in schools (Weare & Nind, 2011), which was not, until recently, the province of schools (Rechtschaffen, 2014). While schools cannot be expected to be responsible for managing the emotional health of students, schools can help solving the issue of mental health problems among students, particularly as academic success is not just about instruction. A growing body of research shows that

academic achievement, social and emotional competence, and physical and mental health are fundamentally interrelated (Diamond, 2010). A student has not only a cognitive and physical side, but also an emotional and social one. Therefore, the best and most efficient strategy to improve students' academic performances is to address the whole student (Diamond, 2010). Similarly around the country, educators, major voluntary organizations, and researchers emphasize both the enormous impact that health has on the academic achievement of students (Council of Chief State School Officers, 2004), and the need to foster students' health and well-being within the educational environment (American Cancer Society et al., 2007). By teaching students how to cope with stress, in the long run schools adopt a preventive approach (Heizomi et al., 2015) that reflects the importance of promoting the mental health of young people in this critical period to ensure a healthy and productive future adult population (McNeely & Blanchard, 2009). Furthermore, school can be a turning point for disadvantaged students and students at higher risk, among whom the impact of mental health interventions in schools has been shown to be stronger (Weare & Nind, 2011).

To address stress of students, schools around the world use various interventions. The United States is the world leader in terms of number of interventions generated, many of which were mentioned in the European Union Dataprev project, which reviewed studies on mental health interventions in schools (Weare & Nind, 2011). Among the most familiar interventions are yoga and a variety of Mindfulness-Based Interventions (MBIs). Yoga is the training of mind and body to bring emotional balance, and increase overall health and well-being through various postures (Hagen & Nayar, 2014). MBIs target attentional capacity (Zenner et al., 2014) and emotion processing (Bishop et al., 2004) to

steady the mind. The concept of mindfulness was defined by Jon Kabat-Zinn (1990) as nonjudgmental attention to one's experiences in the present moment (Kabat-Zinn, 2005). Kabat-Zinn introduced mindfulness into clinical research and practice, and in recent years, mindfulness and MBIs have become increasingly integrated into medicine, healthcare, and psychology (Rechtschaffen, 2014). Both yoga and MBIs have the potential, within non-clinical populations, to reduce stress (Khalsa et al., 2012) and anxiety disorders (Beauchemin et al., 2008; Crane et al., 2010), increase well-being, and strengthen immune functions (Chiesa et al., 2009; Davidson et al., 2003; Sedlmeier et al., 2012). Research on yoga for children has shown that yoga may have physiological benefits (e.g., neuromuscular, cardiopulmonary, and musculoskeletal) (Galantino et al., 2008) as well as physical and behavioral benefits. MBIs, in particular, have been identified as a promising avenue for youth to improve their cognitive performance and resilience to stress. MBIs not only enhance attentional and emotional self-regulation (Vickery et al., 2016), but also promote personal development such as self-compassion, empathy, creativity and problem solving skills (Birnie et al., 2010; S. Shapiro et al., 2007; S. L. Shapiro et al., 1998) , and increase attentional capacity (Jha et al., 2007; Tang et al., 2007). For example, a deep breathing technique as a MBI has been shown to reduce symptoms of stress, help to cope with exams, and promote wellbeing (Broderick et al., 2009; Burke, 2009; Kuyken et al., 2013) among students. Using the breath as an anchor to steady the mind is a simple way to start practicing mindfulness, as our breath is always with us and breathing can be practiced anytime, anywhere (Srinivasan, 2014). By breathing deeply, one can trigger one's nervous system to return to a more relaxed state of body and mind to reach the balanced stage of homeostasis (Srinivasan, 2014). In

addition, the practice of MBIs, in general, may enable youth to "deal with future challenges of the rapidly changing world, ideally becoming smart, caring, and committed citizens" (Zenner et al., 2014). Finally, yoga and MBIs are acceptable and feasible in the school setting with adolescents (Khalsa et al., 2012).

With the decrease of public resources in recent years, schools' resources have become scarcer while schools' accountability to achieve has increased (Suldo et al., 2009). As a result, teachers have been pressured to focus even more on preparing students for standardized tests, and students' mental health often has remained ignored (Rechtschaffen, 2014). Due to scarcer resources, training teachers in Mindfulness Based Stress Reduction (MBSR) or to become yoga instructors may be expensive for schools to afford (Rechtschaffen, 2014). Thus, schools often hire outside, experienced trainers to deliver MBIs or yoga in school. While this approach has been suggested to be effective in short-term stress and coping interventions, Shucksmith et al. (2007) found the use of specialist staff not to be sustainable in the longer term, particularly for larger-scale and universal interventions. As a result, attention has shifted back to using people routinely involved in the life of the school, including teachers, to become agents of transmission (Weare & Nind, 2011). Training the teachers themselves is envisioned as a more promising approach because teachers play a central role in creating a classroom climate that fosters student learning and social-emotional well-being (Flook et al., 2013). Teachers who have been trained through MBIs to pay close attention to their own inner stress may promote mindfulness in their students through teaching mindfully (Zenner et al., 2014), and may, thus, take better care of both the students and themselves (Rechtschaffen, 2014). In addition, this might provide good support for teachers' own

resilience, as well as preventing their burnout and increasing their teaching efficacy (Flook et al., 2013). However, the effectiveness of training the teachers rather than hiring out of school specialists has not been fully established yet, due to some contradictory evidence (Weare & Nind, 2011), and requires further investigation.

Research & MBIs in school

The enthusiasm about MBIs in school settings is growing, as well as the research on the effectiveness of these programs. Studies on MBIs have been conducted in different countries (e.g., United States, Spain, Germany, United Kingdom, Canada, Hong Kong, India, and Australia), in different settings (e.g. private & public, religious & secular, urban, suburban & rural, different socio economic status), and among different student populations (e.g., first to twelfth grade, with & without learning difficulties, with & without mental disorders). Studies have explored the impact of MBIs in reducing the level of anxiety, regulating emotions, promoting social skills, improving executive function, and improving academic performance among students. Specifically, the ability to regulate emotion, which includes the ability to modulate responses to stress, has been associated with higher levels of well-being, and learning outcomes (Barnes et al., 2003; Mendelson et al., 2010; Weare & Nind, 2011).

The first systematic review and meta-analysis on MBIs in schools has been recently conducted by German researchers. They have reviewed 24 studies of MBIs in schools, which involved a total of over 2,000 students, ranging in grade from first to twelfth (Zenner et al., 2014). While the researchers concluded that the available evidence certainly justifies the allocation of resources to implement and evaluate MBIs, they also

noted it remains difficult to assess their effectiveness due to the heterogeneity of measures, settings, and interventions. For instance, they reported that at least five different outcomes were measured, factors of resilience being the most measured, followed by emotional problems, third person ratings, with the least measured being either cognitive performance or coping with stress. Furthermore, studies are often underpowered and small, and use self-reported measures. Studies to date on stress in IB students have used no control group, and only self-reported measure of stress. Such findings led Zenner et al. (2014) to suggest that, as of today, enthusiasm about the integration of MBIs in schools surpasses the evidence.

Measuring stress

Measuring stress remains challenging, as the word stress is used loosely to define stressor or stress response. One can measure the level of stress perceived by participants using indirect measures such as self-report (i.e., measures that rely on the individual's own report of their symptoms, behaviors, beliefs or attitudes about stressful life-events) (Anoka-Ramsey, 2016). Self-reports are commonly used as diagnostic information, and have the advantages of being widely available, easy to implement, generally accepted, and making data collection simple. The main disadvantage of self-report methods is potential lack of accuracy due to response bias (Prince et al., 2008). For instance, when respondents report their own experiences, they may be consciously or unconsciously influenced by social desirability, and as a result, more likely to report experiences that are considered to be socially acceptable or preferred. Compared to indirect measures, direct measures are believed to remove many of the issues associated with response bias (Prince et al., 2008). Direct measures include procedures such as measuring changes in blood

pressure and galvanic skin response. Galvanic skin response uses a digital thermometer to evaluate changes in skin temperature, which can indicate activation of the fight-or-flight response via drawing blood away from the extremities. An additional direct measure, and one which is currently the most popular, is to measure the level of the cortisol, which is the main hormone released during a stress response. Cortisol plays a central role in organizing the body's response to physiological and psychological stressors. Cortisol, the primary glucocorticoid produced and secreted by the adrenal cortex, has for main functions to mobilize resources to turn them into energy, and inhibit inflammation, to improve our ability to respond to stressors. Cortisol can be measured using blood, saliva, and urine. The salivary technique, compared to blood sampling, avoids the risk of needle stress, and allows sampling beyond the laboratory setting (Jessop et al., 2008). Research has shown that salivary cortisol is a valid biomarker for stress (Hellhammer et al., 2009).

Building on these ideas

Together, these findings document a critical need for schools to consider students' needs beyond academic performance and to offer stress management strategies that are easy to implement and economically accessible, particularly for public schools that serve impoverished communities. As Norman B. Anderson, the CEO and Executive Vice President of APA, wrote: "In order to break this cycle of stress and unhealthy behaviors as a nation, we need to provide teens with better support and health education at school and home…" (Anderson, 2014).

Building on these ideas, I developed a short and inexpensive stress management course to be delivered in school to support IB teachers in addressing the stress of

students. The course aims to equip the teachers (rather than out-of-school instructors) to implement and practice with their students during class time, simple stress management strategies borrowed from MBIs (e.g., deep breathing). The objective of such practice is to support students in managing the stress of increased academic demands, and improving their academic performance (such as in mathematics). The course is based on the assumptions that stress is not the direct result of a stressor, and stress management strategies can be taught, as outlined by the Transactional Model of Stress and the Health Realization / Innate Health model. The effectiveness of the course will be assessed by combining direct and indirect measures of stress, pre- and post-intervention.

Data Collection, Analysis, and Results

Methodology

I conducted a study for the Center for the Advancement and Study of International School (CASIE, Atlanta). CASIE designs and implements training for IB teachers and is concerned with the increased level of stress faced by IB students compared to non-IB students. CASIE is interested in offering a new course on stress management. CASIE funded this study to develop such course, and demonstrate its effectiveness in reducing student stress. The course will be offered to International Baccalaureate (IB) teachers.

Participants

The study took place in a private international school, "Atlanta International School" (AIS) in Atlanta (Georgia). The school was selected as it volunteered after listening to the presentation of the potential study at a general Board Meeting of CASIE in late 2013. The Headmaster of AIS is a board member of CASIE. The AIS offers an International Baccalaureate program (IB). The IB is a diploma awarded upon completion of secondary school studies, and described as "a rigorous, off-the-shelf curriculum recognized by universities around the world" (Wallis & Steptoe, 2006).

The study's base population consisted of 12th grade IB students enrolled at AIS for the school-year 2013-2014. The sample population was drawn from the base population enrolled in IB math classes. Two IB math classes of 12th graders each were selected in concertation with the AIS Head of Curriculum and Professional Development. One IB math class had nine students (intervention classroom) and the other class had

thirteen students (control classroom). Both classes were taught the same IB math program, at the same math level, and students had a similar average level in math, based on their 2013 performance in mathematics. The math teacher of each class agreed to participate in the study.

Following Institutional Review Board approval at the Emory University, the study was presented to all potential participants by the AIS Head of Curriculum and Professional Development, along with the assent form, to be signed by students, and a consent form, to be signed by their parents, for them to participate in the study. The presentation included the identification of the class that was selected for intervention, and a discussion of the assent form.

At the end of the presentation, students were asked to take the assent form home and an additional copy was emailed to parents. Written informed assent was obtained from all participants, and consent from their parents, to participate in the study. There was no pressure upon the students from school staff to participate or not in the study, and students knew if they would be participating in the intervention group or the control group. Eleven students returned the consent form to participate in the study (intervention group n=8; control group n=3).

Study design

I conducted the study between March 18th and April 24th, 2014. The study consisted of a longitudinal intervention using a control group and a pre and post-intervention design (Figure 1). The objective that guided this study was to explore if a deep breathing technique, taught to IB teachers as a stress management strategy for use

with students, decreases the level of stress of 12th grade IB students and improves their performance in math.

I designed, taught, and tested the effectiveness of a five-hour course for the IB teachers named "Coping strategies for balanced IB learning". The purpose of the course was to prepare IB teachers to implement simple stress management strategies in their classroom. The main goal of the course was to raise teachers' awareness of the issue of stress, for them to gain knowledge of its symptoms and consequences, and for them to discover a sample of stress management strategies which could be integrated into the school-routine. The five-hour course was delivered in four sessions (2 sessions of 1.5 hour and 2 sessions of 1 hour) prior to the intervention. For this pilot study, I taught the course to the IB math teacher of the intervention classroom.

Two assumptions guided the study: 1) Students from the intervention and control groups were comparable at baseline, and 2) both an IB math mock test and an IB math final exam were sources of increased stress for students.

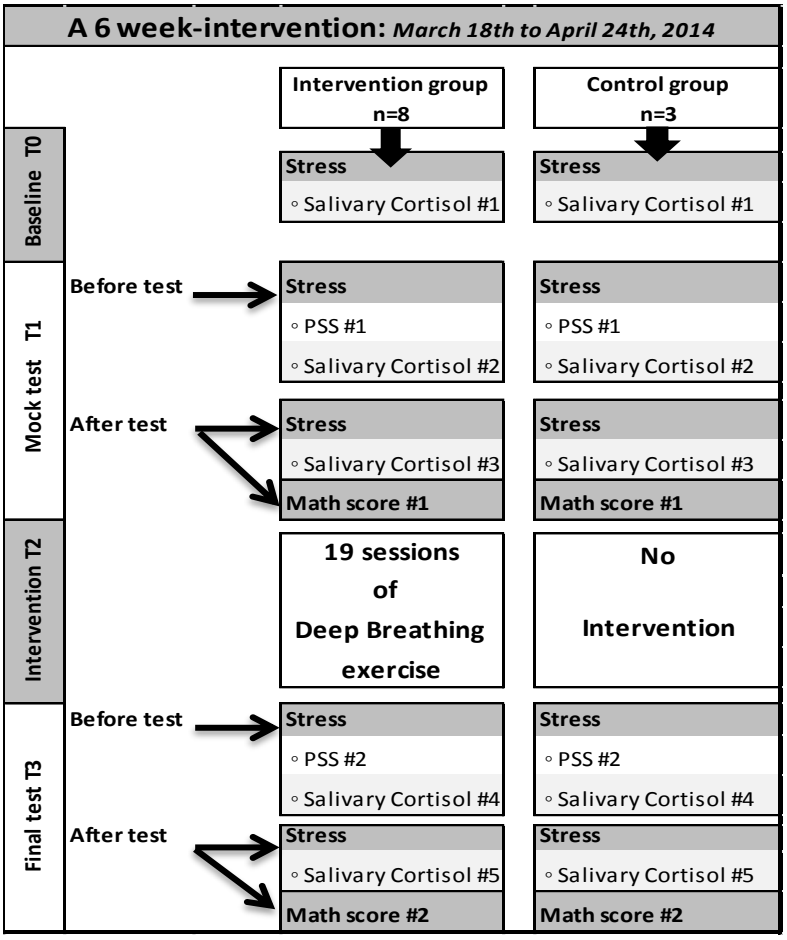
I tested two hypotheses: that,

1. students of the intervention group (I.G.) would have a decrease in stress level at the IB math final exam (after intervention) while the control group (C.G.) would not, and
2. students of the intervention group (I.G.) would have an increase in math scores at IB math final exam (after intervention) while the control group (C.G.) would not.

The effectiveness of the intervention was measured by comparing the change in level of stress of students of both classrooms within (before and after intervention) and

between (intervention vs control) students, as well as their performance in mathematics. The small size of the two groups (n=11), especially the control group, meant that our study must be considered a pilot study, for which the results will need confirmation in a larger sample.

Figure 1: Study Design



(PSS: Perceived Stress Scale)

Intervention

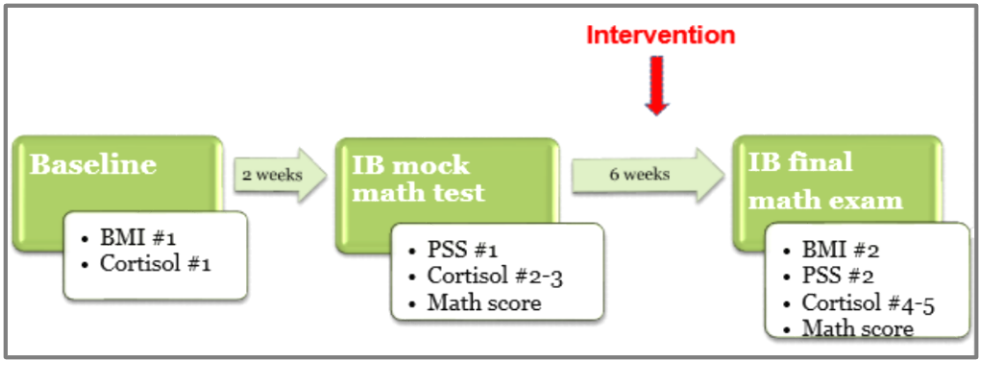
The intervention consisted of the trained IB math teacher implementing a "5 minute deep breathing exercise," inspired from Project UPLIFT (Thompson et al., 2010) and following a given protocol (see annex). The teacher conducted the exercise at the

beginning of the math class, over a period of 6 weeks, 3 to 4 times a week (19 sessions total). The control IB classroom did not receive any intervention and their math teacher was not trained in using stress management techniques. The time frame for the study was selected based on the academic schedule of Atlanta International School, and the 2014 International Baccalaureate worldwide schedule.

Data collection

Figure 2 shows the time-line of data collection. I collected measures of stress and math performance for all participants at two time points: before intervention (IB mock math test) and after intervention (IB final math test). In addition, I collected demographic data such as gender and date of birth at baseline; height and weight at baseline and post intervention to calculate the Body Mass Index; as well as food and beverage (including caffeine) absorbed before collection of saliva cortisol sampling at three time points: before baseline sampling, before and after IB mock math test and before and after IB final math exam. Caffeine has been shown to increase cortisol secretion in people undergoing mental stress (Lovallo et al., 2005).

Figure 2: Data collection



Measures

Measure of stress

I measured the stress level of students by using self-report and cortisol level. To measure the level of stress perceived by students, I used an easy to use self-reported questionnaire, the 10-item Perceived Stress Scale (PSS) (Cohen et al., 1983), a popular tool for measuring psychological stress (Lee, 2012). The reliability and validity of the 10-item PSS has been previously established with acceptable psychometric properties (Lee, 2012). The PSS was designed for use with a population with at least a junior high school education, to measure the degree to which situations in one's life are appraised as stressful (Cohen et al., 1983). The PSS items are of a general nature and ask respondents about their feelings and thoughts during the last month. Each question is rated on a 5-point scale ranging from never (0) to almost always (4). PSS scores are obtained by reversing responses (e.g., 0 = 4, 1 = 3, 2 = 2, 3 = 1 & 4 = 0) to the four positively stated items (items 4, 5, 7, & 8) and then summing across all scale items. The ratings are summed, with higher scores indicating more perceived stress. Scores around 13 are considered average, while scores of 20 or higher are considered high stress.

I used salivary sampling as a relatively non-invasive (Jessop & Turner-Cobb, 2008) and well-established technique for cortisol measurement both in adults (Al-Ansari et al., 1982) and children (Woolston et al., 1983). To measure the level of cortisol, the hormone of stress, in the saliva, I used a salivette prelabeled sampling kit (ESOTERIX, Inc.), which consists of a cotton swab designed to stimulate salivation. Under my supervision, participants rinsed their mouths with water to remove food particles and bacteria, then inserted the cotton swabs into their mouths and chewed on them for 3

minutes. The cotton swabs saturated with saliva were inserted back into the salivettes. I kept the salivettes in a biohazard cooler to transport them from the school to the laboratory of Dr. Dana Barr (Environmental Health, Rollins School of Public Health, Emory University) where they were analyzed.

A total of 5 saliva samples per participant were collected to measure the level of cortisol over the course of the study at three time points: one time at baseline (a morning in January, right after December's school break); two times the day of IB math mock test (thirty (30) minutes before and after the math IB mock test); and two times the day of the final IB math test (thirty (30) minutes before and after the math IB final test). The saliva sample collection took place at mid-day, and the exact time was recorded, as both diurnal slope and morning cortisol have been found to be associated with levels of psychological stress (Flook et al., 2013). Almost all students (n=10) did not drink caffeinated beverages before testing.

To analyze the collection of salivary samples, Dr. Dana Barr used a commercially available enzyme-linked immunosorbent assay named Cortisol ELISA kit (ELISA, Enzo Life Sciences, Farmingdale, NY). The analysis consisted of mixing the saliva samples using a vortex mixer, and then pipetting 100 µL of saliva into individual wells in a 96-well plate. Each sample was diluted with 50 µL Tris buffered saline, after which 50 µL of blue alkaline phosphatase conjugated cortisol solution was added. A yellow mouse monoclonal antibody solution (50 µL) was added to each well. The plates were incubated at room temperature on a plate shaker for 2 hours at 500 rpm. The contents of the wells were discarded and the wells were washed 3 times with a buffered saline solution and dried. The p-nitrophenyl phosphate substrate solution (200 µL) was added

to each well and allowed to incubate for 1 hour at room temperature without shaking. After incubation, a reaction stop solution (trisodium phosphate) was added (50 µL). The plates were read using a 96-well plate spectrophotometer at 405 nm wavelength with scatter subtraction between 570 and 590 nm. Using Beer's Law, the concentrations were proportional to the absorbance measurement. Concentrations were derived from a 7-point standard curve constructed at concentrations ranging from 156-10,000 picograms per milliliter (pg/mL)[1]. Blanks and positive controls were run concurrently with unknown samples to ensure proper performance of the immunoassay.

Measure of math performance

I compared the change in math scores at pre- (IB mock math test) and post- (IB final math test) intervention within students of both groups. The math scores were reported out of 100 (100 being the highest score).

Analysis

The primary outcomes were level of stress and performance in mathematics. I tested my hypotheses using different statistics.

I analyzed data using descriptive statistics (e.g. minimum, 1st quartile, mean, median, 3rd quartile, and maximum), *t*-tests, and correlation coefficients.

To validate the cortisol measure, I compared the level of cortisol before and after each math test (IB mock test and final test) for both groups combined (I.G. and C.G). I

[1] *A picogram is one-trillionth of a gram. A gram is about 1/40 of an ounce. The picogram refers to some type of substance dissolved in a solution which is represented by the milliliters. This is referred to as a "concentration".*

anticipated that the level of salivary cortisol would decrease after the test. These comparisons were done via paired *t*-tests on log cortisol using Excel. I used the log to reduce the influence of outliers.

To test my two hypotheses, that the change in both level of stress (salivary cortisol and PSS) and math score would be greater in the I.G. than in the C.G., I compared the mean difference of these variables at the time of both math tests (IB mock test and IB final test), for each group separately (I.G. and C.G), and before the test. I chose to compare the change within students in each group rather than the difference of stress level between both groups to avoid potential confounding. I used logged cortisol and PSS in my paired *t*-test, to have more normal distribution (e.g. cortisol distribution was skewed right). I used the software Excel for logging variables and conducting paired *t*-test.

To measure the strength and direction of the relationship between continuous variables, including perceived stress, math tests scores, and cortisol levels, I calculated correlation coefficients using Spearman's coefficient measures. I chose Spearman's coefficient (rank order) rather than Pearson's coefficient (linear relationship), due to having sparse data potentially subject to outliers (to which Pearson's is more susceptible), and to avoid an assumption of linearity in relationship between any two variables (which is what is measured with Pearson's coefficient). I used the software suite Statistical Analysis System (SAS 9.3) for correlation coefficient analyses.

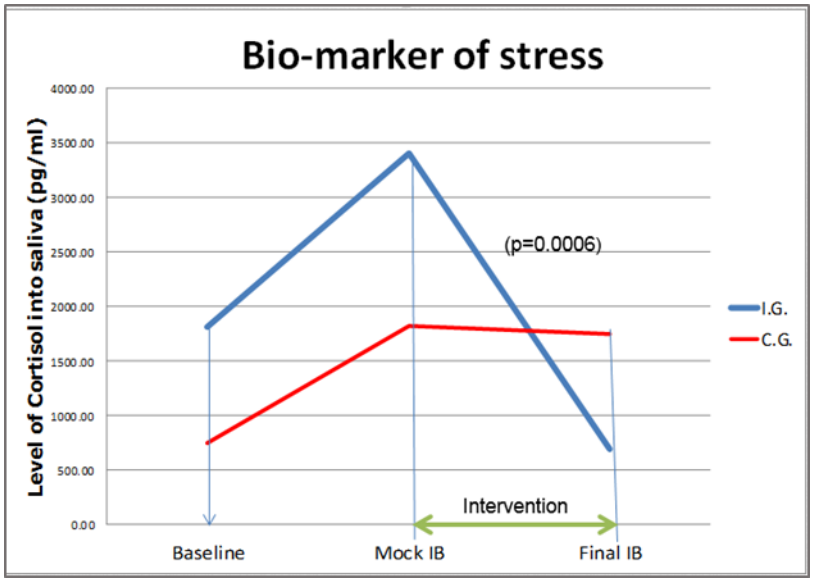
The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Stress measures

Figure 3 shows the results for change in stress, based upon the cortisol analysis, and for both groups: intervention (I.G) and control group (C.G.).

Figure 3. Level of salivary cortisol



At baseline, the salivary cortisol test indicated that students of the I.G. had a higher level of stress than the C.G. (Mean of cortisol concentration: I.G.=1806.13; C.G.= 742.43). **Before Intervention** (IB mock math test), students of the I.G. felt a higher level of self-perceived stress, as measured by the Perceived Stress Scale (PSS), than C.G. (PSS Mean: I.G.=20; C.G.=17). Higher PSS scores indicate a higher level of stress, and the maximum score is 40. The salivary cortisol test confirmed the students' self-perception of stress (Mean of Cortisol concentration: I.G.=3,403; C.G.=1,817). **After Intervention** (IB final math test), the I.G. group reported a lower level of Self Perceived stress than at mock test (PSS mean I.G.: IB mock math test=20, IB final math test= 17), while the C.G.

reported a higher level of self-perceived stress (PSS mean C.G.: IB mock math test =19, IB final math test = 21).

The salivary cortisol test (IB final math test) confirmed a great drop in the level of stress of students in the intervention group (I.G.: from 3,403 to 687), and that decrease in log cortisol was statistically significant (p=0.006). The salivary cortisol test did not confirm the perceived increased level of stress for the control group, indicating virtually no change in stress level (C.G.: from 1,817 to 1,750; p=0.54). The drop in cortisol was two times higher in the intervention group than the control group. After intervention, the intervention group had a four time lower level of stress compared to before the intervention (IB math mock test), and almost three times lower than the control group.

As expected, the level of salivary cortisol measured after test is lower than before test at both math mock (mean for paired difference of log cortisol = 1.28, p=0.0001) and math final exam (mean for paired difference of log cortisol = 0.36, p= 0.15).

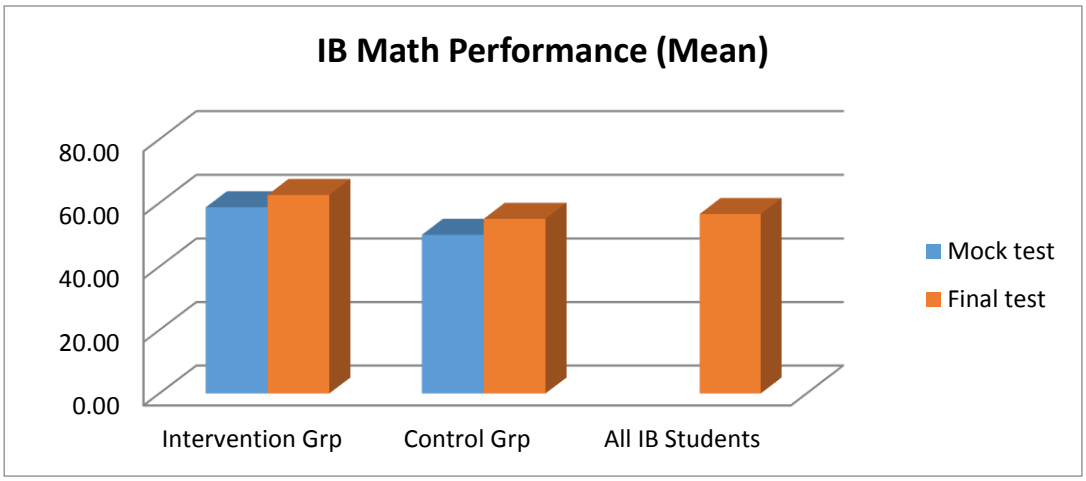
Correlation between both measures of stress

Results of Spearman's coefficient measures showed that PSS and Salivary Cortisol tests were correlated in both groups combined before both IB math mock test (r=0.50; p=0.12) and IB math final test (r=0.89; p=0.0003). These results suggest that the drop in stress as measured by the level of cortisol was perceived by the students themselves.

Math performances

Before intervention (IB mock math test), both groups showed differences in math performance. Figure 4 shows these differences were carried over after intervention.

Figure 4. Performance in math (scores out of 100)

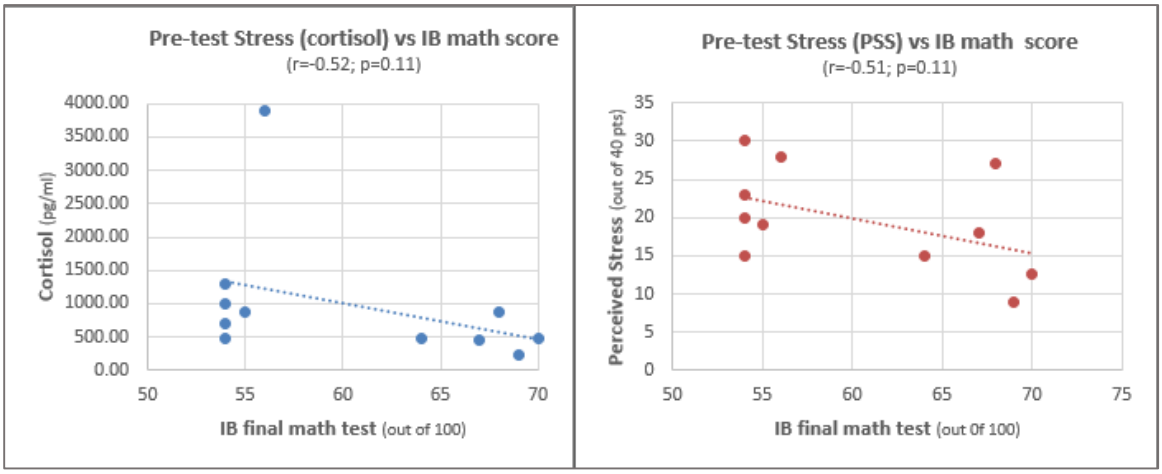


Before intervention (IB math mock test), students in the I.G. scored higher (score out of 100) (mean: I.G.=58.6) than students in the C.G (mean: C.G.=50). After intervention (IB final math test), the I.G. again scored higher than the C.G. (mean: I.G.= 62.5; C.G.= 55). However the magnitude of the change in group mean score between IB mock math test and IB final math test was lower for the I.G. (I.G.=3.9) than for the C.G. (C.G.=5.0). One student in the C.G. was an outlier, he gained 15 points from the IB mock math test to the IB final math test.

Correlation between performance in math and level of stress (cortisol and PSS)

Figure 5 presents the results of Spearman's coefficient for the correlations of both measures of stress with the math score at the IB math final test. These data show a moderate (close to significant) negative correlation between the level of stress (pre-test) and the math score at IB final math test for both groups combined, and as measured by both PSS (r=-0.51; p=0.11) and cortisol (r=-0.52 ; p=0.10). Similar negative correlations, but less strong, were found at the time of the mock test (PSS: r= -0.23, p=0.49; cortisol: r = -0.15, p=0.66).

Figure 5. Correlation between stress level and math score at IB final math exam



Post Hoc qualitative results

Although not formally assessed by our study, a few informal interviews were conducted after the intervention. I conducted two informal interviews, one with the trained teacher, and one the Head of Curriculum and Professional Development. The trained teacher asked her students at a few different times to share comments about the intervention. The Head of Curriculum and Professional Development added to the annual students' survey three questions about the intervention: 1) "What are the top three things

that bring stress to your life?", 2) "Could the 5-minute breathing exercise be an option to address some stressors present among the AIS community?", and 3) "Would the 5-minute breathing exercise encounter barriers to implementation at AIS?". Three surveys answering the questions were sent back. All these data combined suggest that training directly the teacher to teach his/her students how to cope with stress, rather than hiring an outside experienced trainer, is perceived by both the teacher and the Head of Curriculum and Professional Development as a good model. Such short breathing intervention was feasible in the school routine, and enhanced the class environment in a way that is conducive to learning. Both students and teacher shared that starting the class with a breathing exercise created an atmosphere of peace, encouraged genuine listening, strengthened relationships, and supported emotional self-regulation. In addition, this approach seems to have benefited both students and the teacher, as the teacher practiced the stress management strategy she taught to students.

Discussion

The results of this pilot study suggest that a short and inexpensive course to train IB teachers to implement a simple 5-minute coping strategy into their classroom activities may be effective in reducing students' stress. The decrease in level of stress within the students of the intervention group and as measured by cortisol was substantial, being four times lower after the intervention, while the level within the control group barely changed. Furthermore, the drop in stress level as measured by the cortisol was perceived by the students themselves as shown by the PSS results; cortisol and PSS were significantly correlated. In addition, measures of both stress and performance in math indicate that IB students who are under a higher level of stress may perform less well in math. However, I cannot exclude the reverse, that IB students who perform less well in math may experience a higher level of stress.

Our findings may contribute to the existing literature on IB students by suggesting an effective positive coping intervention for IB students under stress, as measured by both a subjective and objective measure of stress. As far as we are aware, this study is the first of its kind regarding IB students. Other studies carried out by Shaunessy and Suldo have investigated the relationships between stress, academic, and mental health (Suldo, Shaunessy, et al., 2008), stress and coping (Suldo & Shaunessy, 2008; Suldo et al., 2009), and more recently stress and resilience (Suldo et al., 2013). Those studies compared students' self-report of stress and coping strategies within IB students or with non-IB students, but none have used biomarkers of stress, nor a control group. In addition, our findings provide an example of a positive coping strategy (a strategy that encourages building relationships rather than blaming others), that IB teachers may encourage among

IB students. It is worth noting that Shaunessy and Suldo found positive coping strategies lacking among students. Importantly, documenting the positive impact of a deep breathing strategy for students enrolled in the IB program is relevant, as the program is receiving growing interest throughout the United States, in both private and public schools and among increasingly diverse populations.

Our findings may contribute, as well, to the existing broader literature on MBIs in school settings, by supporting the current enthusiasm about their use. Here we report results suggesting that a mindful deep breathing strategy can reduce the level of stress as measured by both self-report and salivary cortisol measures. Stress as an outcome has been surprisingly less often investigated than resilience and emotional problems (Zenner et al., 2014).

Post Hoc qualitative results concur with prior literature, which has found that teachers trained in mindfulness techniques create an atmosphere of calm that help students to relax (Shonin et al., 2014), that a classroom filled with peace becomes a conducive environment for learning (Srinivasan, 2014), and that relationships are fundamental to develop powerful connections between teacher and students (Srinivasan, 2014) and between students.

Students' connectedness to school is an important indicator of school climate (Langford et al., 2014), and a determinant of students' health. When students feel cared for by people and peers at their school, they are less likely to use substances, engage in violence, or initiate sexual activity at an early age (McNeely et al., 2002).

Furthermore, recent research recommends training the teachers to implement coping strategies in the classroom rather than hiring out-of-school instructors, so that the teachers practice what they teach, and when they teach (Shonin & VanGordon, 2014). In addition, as school is both a learning place for students and a worksite for adults (Center for Disease Control and Prevention, 2015a), training the teachers themselves may promote teachers' well-being, support teachers' resilience and prevent them from burnout (Zenner et al., 2014). In turn, healthy and happy teachers are more productive, and may support student's health and academic success by serving as role model for students (Center for Disease Control and Prevention, 2015a).

Moreover, practicing a simple coping strategy in school-routine such as a 5-minute deep breathing exercise, may facilitate the implementation of national health objectives standards (e.g. Common Core State Standards, United States National Health Education Standards and Benchmarks) that require students to develop social emotional skills (e.g. self-awareness, self-management), to practice health-enhancing behaviors to avoid or reduce risky behaviors, and to set personal goals to enhance their health (American Cancer Society et al., 2007). Importantly, the use of a deep breathing exercise in school does not violate the Constitution's separation of church and state, and thus, should not prompt parent concerns about secularity of education. Deep breathing is a universally beneficial practice that has its roots in humanity, and is not what some proponents of mindfulness have named a Buddhist practice in secular clothing (Santorelli, 2016).

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Our findings support as well the idea that school's interventions should not necessarily be placed on reducing stress, but rather on managing the stress of students. While stress has been widely recognized to have negative impacts on learners' cognition and performance, a growing body of research argues that a certain degree of stress can be positive, even increasing students' performance. The belief is that negative beliefs about stress interfere with the students' ability to use anxiety as a resource (McGonigal, 2015). In contrast, a positive mindset toward stress can influence positively how a person reacts to stressor, because when a person's perceptions change, his/her body's response changes (Crum et al., 2007). Furthermore, students who embrace stress feel more confident in their abilities, and improve their performance (Jamieson et al., 2012).

Although our findings are encouraging, the small sample size (n=11) is an important limitation. Moreover, the interpretation of our findings is complicated by the even smaller size of the control group (n=3). Other limitations include the observational nature of the study. Both these limitations could be addressed in future research with a

larger sample, and by randomizing the classes or the students. A randomized design in a large sample would randomize classes within a school, and preferably across schools.

While in our observational pilot study we limited the risk for confounders, by comparing the changes pre- and post-intervention in variables (e.g. stress level, math scores) within students in each group, rather than comparing between both groups, we have not eliminated the risk for confounders in each paired *t*-tests. For instance, some factors in relation to each students' environment could have changed between the mock & final test and influenced the variables observed.

In addition, the correlation between level of stress and math scores may raise a question about temporal relationship due to its cross-sectional nature. It is unclear without further measures to determine between stress and score in math, which one happened first.

Finally, it is possible that students' mindset, or "belief that biases how one's think, feel, and act" (McGonigal, 2015, p. 11), about the impact of both stress and the intervention have influenced how students appraised their own level of stress, and/or how they performed in math, but that the specific intervention itself was irrelevant to their better performance. For instance, students of the intervention group could have believed that the intervention would help them, and were more confident entering the test and performed better. Similarly, those in the control group might have similarly believed they would perform less well due to not having the intervention.

Therefore, the results of our study, while suggestive, remain tentative. Nevertheless, given the level of interest in, first, addressing the level of stress of students,

and second, training the teachers in mindfulness, this pilot study can set the foundation for a larger and more definitive study to explore the feasibility and effectiveness of training teachers in different school settings (e.g. private, public), different educational tracks (e.g. IB, non-IB), and teachers who interact with populations that are more socially diverse.

On the whole, this pilot study suggests that school may support the mental health of students by training teachers to implement short, simple and inexpensive coping strategy in classroom. While this intervention was tested among relatively well-off students, it may represent a promising avenue for schools with vulnerable populations, and disadvantaged students who face greater obstacles to health, and as a result experience multiple physical and mental health disparities (Huang et al., 2013). While addressing the mental health of youth in school requires new policies and practices, additional resources and expertise, and strong partnerships among schools' stakeholders and communities, teaching coping skills to students will nevertheless be a small step in the right direction. As proclaimed by the 19th Surgeon General, United States should move from a culture of treatment to one of prevention (Murthy, 2015), and big issues may often be addressed by a succession of small solutions rather than commensurately big solutions (Heath et al., 2010).

Journal Article

Effectiveness of using a short simple breathing exercise to reduce stress of International Baccalaureate 12th graders.

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Key words: Mental Health, IB students, Stress, Coping strategies, Mindfulness in school

Abstract

Background: Teens identify school as a source of stress, but often are not aware of the impact of stress on their physical and mental health, or know how to cope with stress.

Methods: We studied a short inexpensive course to train teachers to teach students stress management strategies. We compared over a 6-week period, two 12th grade classrooms of International Baccalaureate students, known to have high stress. One class practiced mindful breathing for 5 minutes, 3-4 times a week, and the other class served as a control. The effectiveness of the course in reducing stress of students was assessed using self-report and salivary cortisol.

Results: Despite the small sample size, we found a statistically significant drop in stress ($p=0.006$) as measured by salivary cortisol in the Intervention group. Students in the Intervention group had a four-fold lower level of cortisol after intervention, while the control group's cortisol and self-perceived stress did not change appreciably. In addition, both measures of stress were correlated before two different exams ($r=.50$, $p=.12$, $r=.89$, $p=.0003$). Finally, a moderate negative correlation was observed between stress level and

math performance, as measured by both perceived stress (r=-.51; p=0.11) and salivary cortisol (r=-.52; p=0.10).

Conclusion: This intervention is promising for schools as it may enhance the class environment by benefiting both students and teachers, and in particular for schools with scarce resources that serve disadvantaged students, as it can support mental health of a large number of students for very little cost.

Introduction

While stressful situations are inevitable and some stress is good, the 2014 survey of Stress in America reveals a culture of unhealthy stress in United States, particularly among teens. Teens report experiencing stress at a higher level than adults (5.8 vs 5.1 out of a 10-point scale), with school being a main cause. High School students who are enrolled in academically challenging curricula in particular, such as the International Baccalaureate (IB), report more stressors and reduced academic functioning associated with increased academic requirements compared to non IB students (Suldo et al., 2009). Moreover, teens are not very aware of the impact that stress can have on their physical and mental health, and often do not know what to do to manage their stress (Anderson et al., 2015).

Research has shown that stress, defined by Selye (1936) as the body's response to environmental to any demand for change, is a particularly salient construct in adolescence that is clearly related to mental health outcomes (Hagell et al., 2012). Exposure to high level of stress and/or unmanaged stress have been shown to have negative/deleterious effects on physical and mental health (e.g., anxiety, insomnia,

muscle pain, high blood pressure), to weaken the immune system (Hagen & Nayar, 2014), and to impact cognition (Zenner et al., 2014).

Mental health disorders among children and adolescents in the United States represent an important public health issue due to their prevalence, early onset, and burden on society. The prevalence of mental health disorders among adolescents in the US is increasing (Perou et al., 2013), and today one in every four to five teens (22.2% between 13 to 18 year olds) is currently suffering, or has suffered from, a severe mental disorder in the US (Merikangas et al., 2010). Adolescents are particularly vulnerable to mental health disorders as they experience normative and transitive, relationship, social, and academic stressors (Suldo et al., 2009). Three quarters of adult mental health disorders appear in adolescence or early adulthood ages (Kessler et al., 2005). Adolescents who suffer from mental disorders are at higher risk for substance abuse, social detachment, academic failure (Khalsa et al., 2012), and school dropout (Heizomi et al., 2015). In addition, suicide is the third leading cause of death for youth between the ages of 10 and 14, resulting in 4,513 deaths in 2008 (Center for Disease Control and Prevention, 2015c). Finally, mental health disorders among adolescents in the US represent a critical economic burden as they have an estimated total annual cost of $247 billion (Perou et al., 2013).

School is a critical place where programs to prevent mental disorders and foster well-being of youth can be implemented, because children spend much of their time at school and emotional health among students is steeply declining (Lowe, 2011). Schools should accept some responsibility for managing the emotional health of students; they must acknowledge that instruction is not the only contributor to academic success. A

growing body of research shows that physical/mental health, social/emotional competence, and academic achievement, are fundamentally interrelated (Center for Disease Control and Prevention, 2010; Zenner et al., 2014). As a result, schools and educators seek tools that will allow them to address a wider range of needs and skills that until recently were not the province of school (Rechtschaffen, 2014). By teaching students how to cope with stress, schools will promote the mental health of more than 50 million students each day, at their critical ages (Heizomi et al., 2015).

To address stress of students, schools around the world use various interventions. The most often used are yoga, the training of mind and body to bring emotional balance (Hagen & Nayar, 2014), and a variety of Mindfulness-Based Interventions (MBIs) that target attentional capacity (Zenner et al., 2014) and emotion processing (Bishop et al., 2004) to steady the mind. Both yoga and Mindful breathing have been shown to: reduce stress (Khalsa et al., 2012) and anxiety (Beauchemin et al., 2008), increase well-being, and strengthen immune functions (Zenner et al., 2014), and are acceptable and feasible in a secondary school setting (Khalsa et al., 2012). However, resources and time are often a barrier for schools, and long training, such as for yoga or a Mindfulness Based Stress Reduction (MBSR) program, may be expensive and challenging for teachers or schools (Rechtschaffen, 2014).Therefore, offering coping strategies that are easy to implement and economically accessible has become increasingly important.

In recent years, MBIs have become increasingly integrated into medicine, healthcare, and psychology (Rechtschaffen, 2014), and have been identified as a promising avenue to improve the cognitive performance and resilience to stress of youth. Despite a growing number of studies being published, little experimental research has

investigated MBIs in school, and surprisingly few only measure cognitive performance, stress, and coping (Zenner et al., 2014) . Studies to date on stress in IB students have used no control group within IB students, and reported only self-reported measure of stress. In addition, most school-based interventions to foster social-emotional well-being are designed for students only, and are conducted by professional trainers rather than by the class teacher. Finally, as high level of anxiety in mathematics among teens has been shown to negatively affect their math reasoning (Passolunghi et al., 2016), this study explores whether a deep breathing technique, taught to IB teachers as a stress management strategy for use with students, decreases the level of stress of 12th grade IB students and improves their performance in math. This study combines both self-report and salivary cortisol measurement of stress, and uses a control group, among IB students.

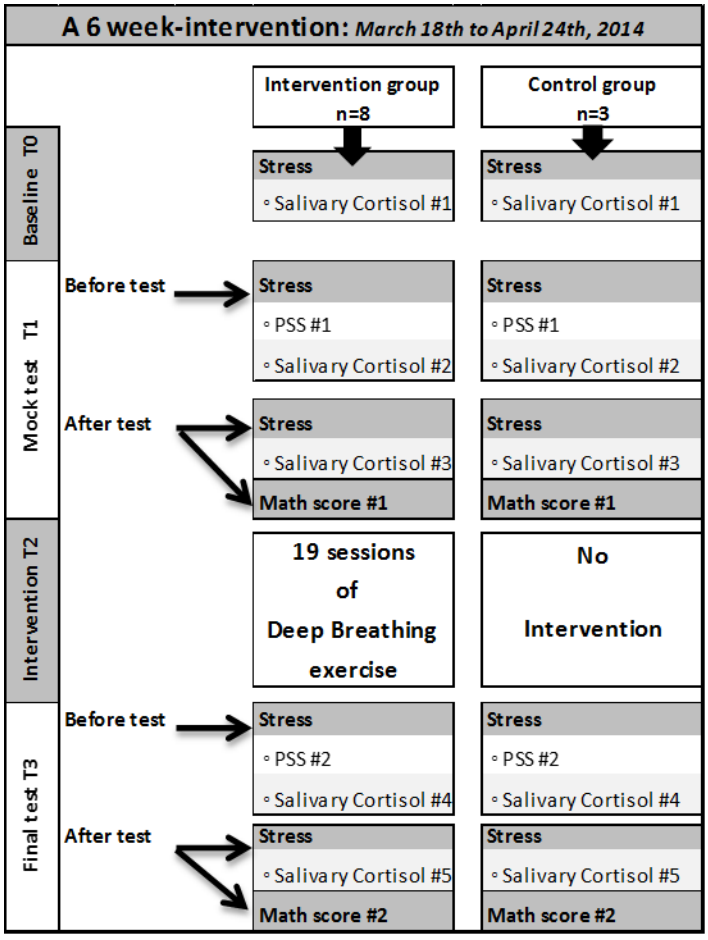
Methods

Study design and participants

We conducted a longitudinal study from March 18th to April 24th, 2014 to test two hypotheses; that 1) students of the intervention group (I.G.) would have a decrease in stress level at IB math final exam (after intervention) while the control group (C.G.) would not, and 2) students of the intervention group (I.G.) would have an increase in math score at IB math final exam (after intervention) while the control group (C.G.) would not. That is, the study compared the level of stress within students of both classrooms (I.G. and C.G.) (before and after intervention), as well as their performance in math. The small size of the two groups, especially the C.G., meant that our study must be considered a pilot study, for which the results need confirmation in a larger sample.

The design of this pilot study is presented in Figure 1. As depicted, salivary cortisol was measured three times before the intervention: at baseline, and before and after the Mock IB test. After the intervention it was measured two more times, once before and once after the IB test. Perceived stress was measured once before and once after the intervention.

Figure 1. Study design



The study participants were students in a private international school (Atlanta, Georgia), which offers an International Baccalaureate program (IB). The IB is a diploma awarded upon completion of secondary school studies, and described as "a rigorous, off-the-shelf curriculum recognized by universities around the world" (Wallis & Steptoe,

2006). The study invited students in two 12th grade IB math classrooms to participate: one for intervention (n=9) and one for control (n=13), in coordination with the school's Head of Curriculum. Both classes, were taught the same IB math program at the same math level, and students had a similar average level in math, based on their 2013 performance in mathematics. The math teacher of each class volunteered to participate in the study. Following Institutional Review Board approval at the Emory University, participants were recruited after a scripted verbal explanation of the study conducted by the school's Head of Curriculum. Students were aware of whether their class was the intervention or the control class. Written informed assent was obtained from all participants with parental agreement. A total of eleven students agreed to participate in the study (intervention n=8; control n=3).

Intervention

We designed, taught, and tested the effectiveness of a five-hour course to be offered in four sessions (2 times 1.5 hour and 2 times 1 hour) to IB teachers. The main goal of the course was to raise teachers' awareness of the issue of stress, and for them to gain knowledge of its symptoms and consequences, and to discover a sample of stress management strategies which could be integrated into the school-routine. Two assumptions guided the study: 1) Students from both groups (I.G. and C.G.) were comparable at baseline, and 2) both tests (IB math mock test and IB math final exam) were sources of increased stress for students.

The intervention consisted of a trained IB math teacher implementing a "5 minute deep breathing exercise" inspired from the Project UPLIFT (Thompson et al., 2010) and following a given protocol (see Annex). The teacher conducted the exercise at the

beginning of the math class, over a period of six weeks, 3 to 4 times a week (19 sessions total). The control IB classroom did not receive any intervention and their math teacher was not trained in using stress management strategies. The time frame for the study was selected based on the school's academic schedule, and the 2014 International Baccalaureate Worldwide Schedule.

Data collection

Participants in both classrooms had their level of stress measured by both a self-reported measure using the Perceived Stress Scale (PSS) (Cohen et al., 1983) and a bio-marker of stress collecting salivary cortisol. The PSS is a 10-item Likert scale with response options going from 0 (never) to 4 (very often). The PSS was administered at two time points: before intervention (before the IB mock math test) and after intervention (before the IB final math exam). A higher score on the PSS indicates a higher level of stress, and the maximum score is 40. A total of 5 saliva samples per participant were collected to measure cortisol over the course of the study at three time points: one time at baseline, two times the day of IB mock math test (30 minutes before and after IB mock math test), and two times the day of the IB final math test (30 minutes before and after IB final math test). The after-test measure allowed controlling for the validity of cortisol measure. The saliva samples collection took place at mid-day under the researcher's supervision. Salivary samples were then transported in a biohazard cooler to a laboratory at Emory University where they were analyzed using Cortisol ELISA kit (ELISA, Enzo Life Sciences, Farmingdale, NY). Other data such as the beverages consumed in an hour before collection of saliva cortisol sampling were noted; almost no student (n=10) drunk

caffeinated beverages before testing which could increase the level of cortisol (Lovallo et al., 2005).

We compared math scores at pre (IB mock math test) and post (IB final math test) intervention.

Analysis

The primary outcomes were level of stress and performance in mathematics. Data on self-reported stress, and math performances were analyzed using descriptive statistic such as: minimum, 1st quartile, mean, median, 3rd quartile, and maximum. Cortisol as a measure was validated by comparing cortisol before and after each math test (IB mock and final test) for both groups combined (I.G. and C.G), via a paired *t*-tests of log cortisol (logged to reduce the influence of outliers and assure a normal distribution). We hypothesized that there would be a drop in cortisol just after each exam, compared to before the exam).

Paired *T*-tests were used to compare I.G. and C.G. groups at different points in time, for self-perceived stress, log cortisol, and math scores. Paired sample *t*-tests were conducted to examine change over time in log cortisol levels from before to after the intervention, for the intervention and control groups separately. Correlation coefficients between continuous variables, including math tests scores, perceived stress, and cortisol levels were calculated using Spearman's coefficient (less influenced by outliers, does not assume a linear relationship, in contrast to Pearson's coefficient). The Statistical Analysis System (SAS 9.3) was used for correlation analysis.

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Change in stress measures

Figure 2. Level of salivary Cortisol

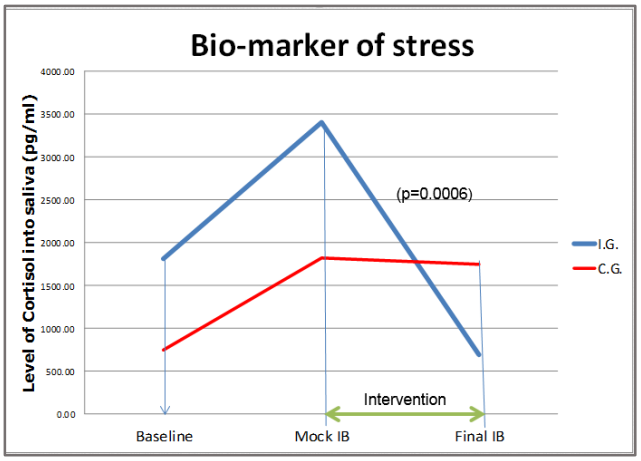


Figure 2 shows the results for change in stress, based upon the cortisol analysis. **At baseline,** the salivary cortisol test indicated that students of the intervention group (I.G.) had a higher level of stress than the control group (C.G.) (Mean of cortisol concentration: I.G.=1806.13; C.G.= 742.43). **Before intervention**, at the time of the mock IB test, the salivary cortisol found that students in the I.G. experienced greater stress than those in the C.G. (Mean of Cortisol concentration: IG=3,403; CG=1,817). **After intervention**, at the time of the final IB test, the salivary cortisol test demonstrated large drop in the level of stress of students in the I.G. from 3,403 to 687. This decrease in log cortisol was statistically significant (p=0.006). In contrast, there was a small reduction in stress level for the C.G. (C.G.: from 1,817 to 1,750; p=0.54). The drop in cortisol was two times greater in the I.G. than in the C.G.. After intervention, the I.G. showed a level of stress that was almost 3 times lower than that in the C.G..

Before intervention (at the time of the IB math mock test), the results of the Perceived Stress Scale (PSS) found that students in the I.G. felt a higher level of self-

perceived stress than those in the C.G. (PSS Mean: IG=20; CG=17). **After intervention** (at the time of IB math final exam), the I.G. reported a lower level of self-perceived stress than at mock test (PSS Mean IG: Mock=20, Final= 17), while the C.G. reported a higher level of self-perceived stress (PSS Mean CG: Mock=19, Final= 21). The salivary cortisol test did not confirm the perceived increased level of stress for the control group.

Results of Spearman's coefficient measures showed that PSS and Salivary Cortisol tests were correlated in both groups combined (I.G. and C.G.) before both IB math mock test ($r=0.50$; $p=0.12$) and IB math final test ($r=0.89$; $p=0.0003$). These results suggest that the drop in stress as measured by the level of cortisol was perceived by the students themselves.

Math performances

Before intervention (at the time of the IB mock math test), both groups showed differences in math performance (out of 100). Students of the I.G. scored higher (mean: I.G.= 58.6) than students in the C.G. (mean: C.G.= 50). After intervention (at the time of the IB final math exam), the I.G. again scored higher than the C.G. (mean: I.G.=62.5; C.G.= 55). However, the magnitude of the change in group mean score between math mock test and math final exam was lower for the I.G. (I.G.=3.9) than for the C.G. (C.G.=5.0). One student in the C.G. was an outlier, gaining 15 points from the mock test to the final test.

Figure 3: Correlation between stress level and math score at IB final math exam for both groups combined

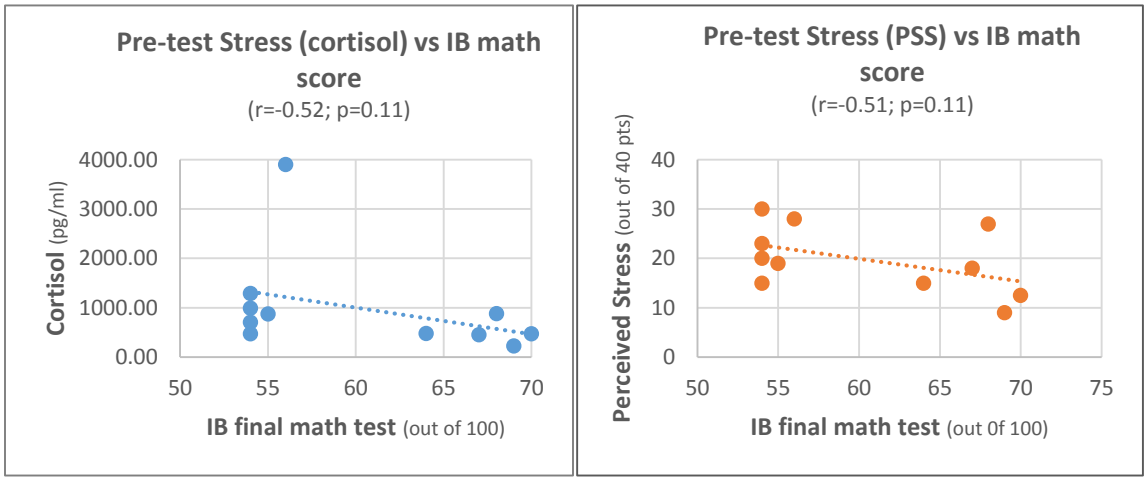


Figure 3 presents the results of Spearman's coefficient for the correlations of both measures of stress with the math score at the IB math final test. These data show a moderate negative correlation (r=-0.51) between perceived stress and math performance that does not achieve significance (p=0.11). There is similar moderate negative correlation (r=-0.52) between salivary cortisol and math performance that also does not achieve significance (p=0.10). Similar negative correlations, but less strong, were found at the time of the mock test (PSS: r= -0.23, p=0.49; cortisol: r = -0.15, p=0.66).

Post Hoc qualitative results

Although not formally assessed by our study, a few informal interviews conducted after the intervention with teacher, students, and administration suggest that training the teachers is a good model of delivering coping strategies for students, and that a short breathing intervention not only is feasible in the school routine, but also may enhance the class environment in a way that is conducive to learning. Both students and teacher shared that starting the class with a breathing exercise created an atmosphere of

peace, encouraged genuine listening, strengthened relationships, and supported emotional self-regulation. In addition, this approach seems to benefit both students and teachers, as teachers practice the stress management strategy they teach to students. This approach seems to have benefitted both students and the teacher.

Discussion

The results of this pilot study suggest that a short and inexpensive course to train IB teachers to implement a simple 5-minute coping strategy into their classroom may be effective in reducing students' stress. Furthermore, measures of both stress and performance in math indicate that IB students who are under a higher level of stress may perform less well in math, or the reverse.

Our findings may contribute to the existing literature on IB students by suggesting an effective positive coping intervention for IB students under stress, and as measured by both a subjective and objective measure of stress. As far as we are aware, this study is the first of its kind regarding IB students. Other studies carried out by Shaunessy and Suldo have investigated the relationships between stress, academic, and mental health (Suldo, Shaunessy, et al., 2008) stress and coping (Suldo & Shaunessy, 2008; Suldo et al., 2009), and more recently stress and resilience (Suldo & Shaunessy, 2013). Those studies have compared students' self-report of stress and coping strategies within IB students or with non-IB students, but none have used biomarkers of stress, nor a control group. Importantly, documenting the positive impact of a deep breathing strategy for students enrolled in IB program is relevant, as the program is receiving growing interest throughout the United States, in both private and public schools, and among increasingly diverse populations.

Our findings may contribute as well to the existing broader literature on MBIs in school settings, by supporting the current enthusiasm about their use. Here we report results suggesting that a mindful deep breathing strategy can reduce the level of stress as measured by both self-report and salivary cortisol measures. Stress as an outcome has been surprisingly less often investigated than resilience and emotional problems (Zenner et al., 2014).

Post Hoc qualitative results concur with prior literature which has found that teachers trained in mindfulness techniques create an atmosphere of calm that helps students to relax (Shonin & VanGordon, 2014), that a calm classroom becomes a conducive environment for learning (Srinivasan, 2014), and that relationships are fundamental to develop powerful connections with students (Srinivasan, 2014). Students' connectedness to school is an important indicator of school climate (Langford et al., 2014), and supports students' overall health. When students feel cared for by people and peers at their school, they are less likely to abuse substances, engage in violence, or initiate sexual activity at an early age (McNeely et al., 2002). Furthermore, recent research recommends training the teachers to implement coping strategies in the classroom rather than hiring out-of-school instructors, so that the teachers practice what they teach, and when they teach (Shonin & VanGordon, 2014). In addition, as school is both a learning place for students and a worksite for adults (Center for Disease Control and Prevention, 2015a), training the teachers themselves may promote teachers' well-being, support teachers' resilience and prevent them from burnout (Zenner et al., 2014). In turn, healthy and happy teachers are more productive, and may support student's

health and academic success by serving as role model for students (Center for Disease Control and Prevention, 2015a).

Moreover, practicing a simple coping strategy in school-routine such as a 5-minute deep breathing exercise, may facilitate the implementation of national health objectives standards (e.g. Common Core State Standards, United States National Health Education Standards and Benchmarks) that require students to develop social emotional skills (e.g. self-awareness, self-management), to practice health-enhancing behaviors to avoid or reduce risky behaviors, and to set personal goals to enhance their health (American Cancer Society et al., 2007). Importantly, the use of a deep breathing exercise in school does not violate the Constitution's separation of church and state, and thus should not prompt parent concerns about secularity of education. Deep breathing is a universal beneficial practice that has its roots in humanity, and is not what some proponents of mindfulness have named a Buddhist practice in secular clothing (Santorelli, 2016).

Both the trained teacher and the students who took part in the intervention reported sharing their experience with peers outside the classroom. As a result, teachers and students may be envisioned as agents and ambassadors of change (Zenner et al., 2014), to create a school climate that fosters healthy behaviors, and reduce disparities in children's health. Studies on school and health disparities have found that children enrolled in schools with a distressed school climate are less likely to experience physical and mental health (Huang et al., 2013). As a result, the Centers for Disease Control and Prevention (CDC) recommends that schools implement safe and healthy environment policies and practices to enhance the social and emotional climate, which in turn will

promote an environment conducive to learning, and in which students will reach their full potential (Center for Disease Control and Prevention, 2015a).

Our findings support as well the idea that school's interventions should not necessarily be placed on reducing stress, but rather on managing the stress of students. While stress has been widely recognized to have negative impacts on learners' cognition and performance, a growing body of research argues that a certain degree of stress can be positive, even increasing students' performance. The belief is that negative beliefs about stress interfere with the students' ability to use anxiety as a resource (McGonigal, 2015). In contrast, a positive mindset toward stress can influence positively how a person reacts to stressor, because when a person's perceptions change, his/her body's response changes (Crum & Langer, 2007). Furthermore, students who embrace stress feel more confident in their abilities, and improve their performance (Jamieson et al., 2012).

Although our findings are encouraging, the small sample size (n=11) for investigating our research question is an important limitation, and our findings might be less reliable. Moreover, the interpretation of our findings is complicated by the even smaller size of the control group (n=3). Other limitations include the observational nature of the study, which could be addressed in future research with a larger sample by randomizing the classes or the students to avoid selection bias. Another limitation is the potential for unmeasured confounders. While we limited the risk for confounders by comparing the changes pre- and post-intervention in variables (e.g. stress level, math scores) within students in each group, rather than comparing between both groups, we have not eliminated the risk for confounders in each paired *t*-tests tests. For instance, some factors in relation to the students' environment could have changed between the

mock & final test and influenced the variables observed. Additional limitation is the particular correlation between level of stress and math scores may raise a question about temporal relationship due to its cross-sectional nature. It is unclear without further measures to determine between stress and score in math, which one happened first. Finally, students' mindset, or "belief that biases how one's think, feel, and act" (McGonigal, 2015, p. 11), about the stress management intervention, may have influenced how students appraised their own level of stress, and/or how they performed in math.

Therefore, the results of our study while suggestive remain tentative. Nevertheless, given the level of interest to first address the level of stress of students, and second training the teachers in mindfulness, this pilot study can set the foundations for a larger and more definitive study to explore the feasibility and effectiveness of training teachers in different school settings (e.g., private, public), different educational tracks (e.g., IB, non-IB), and teachers who interact with populations more socially diverse.

This pilot study suggests that an affordable and easy to implement stress management intervention may support the mental health of students in school for a very little cost. While this intervention was tested among relatively well-off students, it may represent a promising avenue for schools with vulnerable populations, and disadvantaged students who face greater obstacles to health, and as a result experience multiple physical and mental health disparities (Huang et al., 2013). While addressing the mental health of youth in school requires new policies and practices, additional resources and expertise, and strong partnerships among schools' stakeholders and communities, teaching coping skills to students will nevertheless be a small step in the right direction. As proclaimed by

the 19th Surgeon General, United States should move from a culture of treatment to one of prevention (Murthy, 2015), and big issues may often be addressed by a succession of small solutions rather than commensurately big solutions (Heath & Heath, 2010).

Annex

A 5-minute deep breathing Exercise[2]

STOP what you are doing. You are to enter a safe place for the next 5 minutes

- Prepare your posture
- Come to a comfortable seated position
- Ground your feet on the floor
- Back straight. Roll your shoulders back & down, open your chest
- Place your palms on your belly
- Let your eyes close
- Sense your body breathing by itself

AWARENESS: become aware of what is going on for you in the present moment

- What are you thinking about?
- What feelings do you notice in your body?
- What sounds do you hear?
- Simply welcome all of them, and accept where you are, here and now

CONCENTRATE: breathe in through your nose, keeping your mouth closed

ENJOY:

- Inhale through the nose feeling your belly expanding, then your diaphragm and you lungs.
- Gently hold your breath at the top for 1, 2, 3,
- Exhale slowly through the nose, emptying your lungs, then your diaphragm, and feel your belly coming in.
- Inhale through the nose feeling your belly expanding. Gently hold your breath at the top for 1,2,3.
- Exhale slowly through the nose, feeling your belly coming in.
- Continue like that at your own rhythm, for the next 3 minutes.

Begin to move your awareness back to your surroundings

- Keeping your eyes closed, move slowly your feet, your fingers, then your mouth, and smile.
- Take a moment to give yourself praise. This breathing moment is a gift from you to you.
- At your own rhythm, allow your eyes to open.

[2] This exercise has been adapted from project UPLIFT (CDC & Emory University) to serve 12th graders

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