Crim Fitness Foundation Mindfulness Initiative

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For the Crim Fitness Foundation

Executive Summary

The Crim Fitness Foundation is dedicated to creating a viable and vibrant community by offering programs that enhance health and wellbeing. The organization is uniquely positioned to benefit the Flint community because of a high degree of community trust, and a reputation for providing 40 years of exceptional service to Genesee County, including 10 years of physical activity, nutrition and, more recently, mindfulness programming to Greater Flint Schools. In the advent of the Flint Water Crisis, leading health experts, including Dr. Mona Hanna-Attisha, have indicated that these programs and services will be crucial in the effort to mitigate the effects of lead exposure, particularly for young children.

Mindfulness programming is central to Crim's programmatic outreach. Mindfulness skills hold promise for increasing key cognitive and behavioral capacities and social competencies that are likely most affected by lead exposure. In 2016, Crim launched an initiative to expand its mindfulness training to include children in Flint Community Schools, and to extend that training to the Genesee Independent School District. This involves increasing training and support for teachers, students, and families, and raising community awareness of the benefits of mindfulness practices, particularly in the context of stress resiliency.

This report addresses 4 key areas related to this effort:
(1) The impact of lead exposure;
(2) The benefits of mindfulness-based practices on markers of health and wellbeing;
(3) The effects of mindfulness programs in school settings; and
(4) Crim's unique position and vision to deliver these programs.

(1) Impact of Lead Exposure: There is strong evidence that many Flint children had elevated blood lead levels following the water source change. This was particularly true for children from economically disadvantaged neighborhoods. These children now face numerous threats to their immediate and long-term flourishing. For example:

- Many Flint children are at high risk for poor developmental outcomes due to high rates of poverty, crime, and poor nutrition, compromised rearing environments, domestic violence and racial discrimination. Lead exposure will only serve to magnify these effects.
- Decades of research link lead exposure in childhood to a breadth of developmental problems including cognitive deficits such as poor attention and decision-making, limited self-regulation, impaired information processing, low motivation, and an increased risk for antisocial behavior, substance use, aggression, and criminal activity. Emerging studies suggest that these effects may be multi-generational.
- A longitudinal study of the effects of prenatal and early childhood lead exposure on long-term neural development reveals a direct association between childhood blood lead concentrations and early adult brain volume loss in the prefrontal cortex - a region responsible for executive functioning, fine motor control, and behavioral regulation. This is particularly true for men, which may explain the higher incidence of antisocial behaviors among men compared to women.
- There is significant evidence that children and adults with a history of lead exposure have long-term, potentially irreversible learning, behavioral, and social difficulties, and require intensive and ongoing support.

(2) Benefits of Mindfulness-Based Practices: Mindfulness-based programs and practices are associated with a number of important benefits that may be particularly relevant to those facing the impact of lead exposure including:

- Reducing physiological and psychological stress and related symptoms including anxiety.
- Increasing cognitive functioning including enhanced attention, self-regulation, and executive functioning.
- Ameliorating mental and physical health, and the impact of stress-related conditions.
- Lessening depression and anxiety, and reducing the risk for depressive relapse.
- Alleviating pain.
- Improving quality of life and subjective wellbeing.

Mindfulness studies show a direct association between regular practice and changes in brain structure and functional connectivity including:

- Increasing volume and activation of the prefrontal cortex (PFC) - *a region negatively impacted by lead exposure* and related to attention, decision-making, planning, and prosocial behavior.
- Enhancing functional efficiency of the anterior cingulate cortex (ACC). The ACC is associated with directing attention, self-regulation, impulse control, and focused problem solving, and is *adversely affected by lead exposure*.
- Reducing amygdala activity and density, suggesting increases in emotion regulation, and decreases in emotional reactivity.
- Changing the default mode network (DMN) - a PFC structure important for executive control functions, social information processing, self-referencing, and thinking about others. This region is also *uniquely susceptible to stress and lead exposure*.
- Affecting neurobiological changes related to improved mood, decreased anxiety, and decreased aggression, antisocial behavior and substance use.

(3) Benefits of Mindfulness Programs in School Settings: Although mindfulness-based programmatic research in schools is emerging, initial studies show that programs for students and teachers yield numerous benefits including:

- Increasing stress resilience and stress reduction.
- Improving self-regulation, emotion modulation, and subjective wellbeing.
- Enhancing attention, academic success, and cognitive performance.
- Decreasing anxiety, mood problems, and antisocial behavior.
- Enhancing prosocial behavior.
- Lessening teacher stress and burnout, and amplifying teacher health and wellbeing.

(4) The Crim's Unique Position to Deliver Programs: Crim is in a unique position to deliver high quality, evidence-based interventions due to its long history of providing exceptional educational programs to Flint schools, including mindfulness education. This capacity includes:

- Integration of mindfulness education with nutrition and fitness instruction to provide holistic life-skills training.
- A well-established relationship and proven track record working with school district leaders, administrators, and educators.
- A high level of community trust and good will.
- The ability to collaborate with medical, research and education partners to comprehensively evaluate program effectiveness.

Impact of Lead Exposure

Background

Greater Flint is a post-industrial area of approximately 500,000 inhabitants faced with a declining quality of life after General Motors closed its auto manufacturing plants in the 1980s and 1990s. In the intervening years, population has steadily declined, unemployment rates have consistently exceeded the national average, and the region has faced high levels of poverty, violent crime, housing instability, domestic violence, substance use/abuse, racial discrimination, and poor health outcomes including infant mortality (United States Census Bureau, 2015). In 2011, Flint was declared to be in a financial state of emergency, at which time the state of Michigan assumed budgetary control, and began a series of cost-cutting measures. These included the April 25, 2014 switch of the Flint water supply from Lake Huron to the Flint River - a move by state-appointed officials intended to decrease water costs while a new pipeline to Lake Huron, scheduled to be completed in 2016, was under construction (Kennedy, 2016). The combination of Flint's aging infrastructure and corrosive, untreated water from the polluted river created a recipe for disaster.

The Flint water delivery system contains a high percentage of lead in both its pipes and plumbing (Fonger, 2015). Moreover, Flint River water contains high chloride, a high chloride-to-sulfate mass ratio, and no corrosion inhibitor. The interaction of the Flint water and aging infrastructure resulted in significant amounts of lead, a water-soluble metal, being leached into the Flint water supply for more than 18 months (Edwards et al., 2005). This persisted despite repeated complaints of the water's taste, color, and smell by residents, and reports of rashes and hair loss (Associated Press, 2015).

Thanks to a team of researchers from Virginia Tech University, the truth of Flint's water supply was finally revealed. Their independent assessment of the water in 252 area homes detected lead levels of 13,200ppb, far greater than the level of 5,000ppb at which water is declared *hazardous waste* (Roy, 2015). Shortly thereafter, a study released by Dr. Mona Hanna-Attisha and colleagues at the local Hurley Medical Center showed large numbers of area children ages 5 and under with significantly elevated blood lead levels following the water source change (Hanna-Attisha et al. 2016). This news launched a firestorm of political controversy, and a rising tide of fear that Flint area children may have suffered irreversible brain damage due to nearly 18 months of exposure to contaminated water (Adams, 2016).

Lead is a neurotoxin, known to significantly impact childhood development, and initiate long-term deficits in intelligence, behavioral problems, and poor achievement across the lifespan (Centers for Disease Control and Prevention, 2005). It is particularly pernicious because it remains in the brain for at least 2 years and in bone for decades, and disrupts many neural and physiological functions due to its ability to substitute for calcium ions in the body (Lidsky & Schneider, 2003).

Sadly, Flint is not alone. Communities from Washington, DC, Baltimore, Cincinnati, and Chicago to Oregon and First Nations peoples of Canada are experiencing the devastating effects of lead poisoning from buildings, pipes, and contaminated soil. These effects include the high probability long-term, irreparable neurological damage. The families in these communities, and the schools and community resources that serve them, need *immediate, sustained financial, psychological, educational, and health support* to assist them in dealing with the acute trauma and potentially lasting impact of lead exposure. The *Crim Fitness Foundation*, which has served the people of Flint and its schools for 40 years, is in a unique and unprecedented position to lead that effort.

Deleterious Effects of Lead Exposure

The scientific, medical, public health, and business communities have long known of the poisonous and neurotoxic effects of lead (Denworth, 2009). Decades of investigation provide indisputable evidence that lead exposure has deleterious and potentially irreversible consequences for a child's developmental trajectory and long-term success (Centers for Disease Control and Prevention, 2005; Lidsky & Schneider, 2003). Studies show that lead in drinking water is particularly damaging to developmentally vulnerable children and pregnant mothers. This is because children absorb higher proportions of water-soluble lead when ingested orally (40-50%) compared to adults (3-10%) (US Department Of Health and Human Services, 2007). For children, every 1 part per billion increase in water lead results in a 35% increase in blood lead (Ngueta et al., 2015). The risk is even greater for infants consuming reconstituted formula.

For the children of Flint, Dr. Hanna-Attisha's study found statistically significant increases in blood lead concentrations following the water source change. This was particularly true for children living in poverty, exacerbating an already pronounced risk for disadvantaged and minority populations. "*Flint children already suffer from risk factors that innately increase their lead exposure: poor nutrition, concentrated poverty, and older housing stock. With limited protective measures, such as low rates of breast-feeding, and scarce resources for water alternatives, lead in water further exacerbates preexisting risk factors*. *Increased lead-poisoning rates have profound implications for the life course potential of the entire cohort of Flint children already rattled with toxic stress contributors…"* (Hanna-Attisha et al., 2016, p. 286). What's more, recent studies suggest that these effects may be cross-generational (Sen et al., 2015).

Lead Exposure and Changes in Brain Structure and Function

There are few studies examining the specific brain structures, mechanisms, and processes that are directly affected by lead exposure. Research shows significant reductions in intelligence, cognitive functioning, and behavioral skills related to self-regulation (Bellinger et al., 1987; Aizer et al., 2016; Reyes, 2014), and suggests that toxic levels of lead exposure in childhood may directly impact the pre-frontal cortex (PFC), which is central to the executive control system. This system is implicated in key capacities including planning, decision-making, emotional regulation, problem solving, and the moderation of social behavior (Frith & Dolan, 1996).

One longitudinal study of the effects of lead exposure on brain change suggests that lead may exert a long-term impact on the executive control system (Cecil et al., 2008). The study included a subsample of adults from the *Cincinnati Lead Study (CLS)*, an urban, inner-city cohort of individuals with detailed prenatal and post-natal histories of mild to moderate lead exposure, and documented cognitive and behavioral outcomes over a 25-year period. The CLS included a sample of pregnant women recruited between 1979 and 1984 who lived in neighborhoods with high rates of childhood lead poisoning. Their children were assessed beginning at birth, then quarterly up until 5 years of age, semi-annually from ages 5 to 6 ½, then again at age 10, and between the ages of 15 and 17. A total of 157 of the children in that sample (83 male) consented to participate in a brain imaging study in early adulthood (ages 19-24, mean 20.9 yrs, SD .90). Whole brain imaging was conducted using a high-resolution, Tesla magnetic resonance imaging (MRI) scanner to assess global and regional changes in brain tissue. Brain scans showed a significant, direct relationship between childhood blood lead concentrations and "considerable" decreases in gray matter volume in several key regions of the prefrontal cortex (PFC) including the anterior cingulate cortex (ACC) and ventrolateral prefrontal cortex (VLPFC). This effect was particularly pronounced for male

participants. Further analyses comparing imaging results to neuropsychological testing scores revealed a strong link between PFC changes and deficits in fine motor skills (Cecil et al., 2008).

The ACC, a cortical component of the brain's limbic system, is associated with a number of important functions including processing emotional and cognitive information, attention modulation, motivation, emotion regulation, decision-making, processing complex information, and fine motor control. The VLPFC is known to be associated with regulation of mood, which is an essential component of successful social functioning. "Volume loss in [these] frontal brain regions, including both the cognitive and emotional territories of the ACC is consistent with, and potentially explanatory for cognitive and behavioral problems previously associated with lead exposure, " the CLS authors concluded. "These problems include general intellectual and executive functioning, antisocial behaviors, and attention deficit hyperactivity disorder (ADHD)" (Cecil et al., 2008, p. 744).

Findings of this study build on the existing literature that shows that childhood lead exposure is associated with numerous, significant outcomes including infant mortality (Troesken, 2003), child mortality (Clay et al., 2006), poor child development (Bellinger et al., 1987), elevated levels of child and adolescent antisocial and risky behavior (Reyes, 2014), and violent crime (Reyes, 2007), and that lead poisoning may be one of the causes of ongoing gaps in academic test scores between poor, minority children and non-disadvantaged children (Aizer et al., 2016).

Summary

There is strong evidence that Flint children had significantly elevated blood lead levels following the water source change. This was particularly true for children from economically disadvantaged neighborhoods. These children now face numerous threats to their immediate and long-term flourishing. For example:

- Many Flint children are at high risk for poor developmental outcomes due to high rates of poverty, crime, poor nutrition, compromised rearing environments, housing instability, domestic violence, and racial discrimination. Lead exposure will only serve to magnify these effects.
- Decades of research link lead exposure in childhood to a breadth of negative developmental problems including cognitive deficits such as poor attention and decision-making, limited self-regulation, impaired information processing, low motivation, as well as an increased risk for antisocial behavior, substance use, aggression, and criminal activity. Emerging studies suggest that these effects may be multi-generational.
- A longitudinal study of the effects of childhood lead exposure on long-term outcomes finds that lead exposure in early childhood is associated with brain volume loss in adulthood in regions responsible for executive functioning, fine motor control, and behavioral regulation. This is particularly true for men, which may explain the higher incidence of antisocial behaviors among men than women.
- Overall, these findings support the argument that children and adults with a history of lead exposure have long-term, potentially irreversible learning, behavioral, and social difficulties, and require intensive and ongoing support.

Benefits of Mindfulness-Based Practices

Mindfulness generally refers to a "quality of consciousness" (Brown & Ryan, 2003). Research shows that mindfulness-oriented practices may enhance our wellbeing by grounding our minds and bodies in the present moment, allowing us to examine carefully the thoughts, feelings, sensations, and beliefs that influence our experience (Davis & Hayes, 2011; Kabat-Zinn, 1990). A state of mindfulness creates discriminant awareness, an ability to consider alternative explanations, strategies, and responses to life's circumstances rather than reacting mindlessly. This capacity can be particularly beneficial when we are negotiating difficult or stressful terrain in our lives, our relationships and our communities.

Mindfulness Research

Although the word "mind" is emphasized in the word mindfulness, mindfulness represents a holistic state or disposition that includes the mind and body. This may be one reason why contemplative scientists find that mindfulness-oriented practices yield both physical and psychological benefits. Emerging research shows that mindfulness practices like meditation and yoga may help to reduce the impact of stress-related conditions, lessen depression and anxiety, ameliorate depressive relapse, alleviate pain, improve quality of life, attenuate HIV progression, and increase emotion regulation and subjective well-being (e.g. Baer, 2003; Brown, Ryan, & Crewsell, 2007; Cherkin et al., 2016; Chisea & Serretti, 2009; Creswell et al., 2016; Davis & Hayes, 2011; Goyal et al., 2014; Grossman et al., 2004; Khoury et al., 2013; Khoury et al., 2015; Pascoe & Bauer, 2015).

A large body of evidence also documents the efficacy of mindfulness-based psychotherapeutic interventions in the treatment of depression (Hofmann et al., 2010; Segal et al., 2010; Teasdale et al., 2000), anxiety (Goldin & Gross, 2010; Hofmann et al., 2010), eating disorders (Tapper et al., 2009), and chronic pain (Grossman et al., 2007). This may be due, in part, to positive changes in autonomic nervous system (ANS) functioning, including the regulation of heart rate and respiration (Goyal et al., 2014; Streeter et al., 2010, 2012; Telles et al., 2013), as well as changes in brain regions associated with attention, self-regulation, self-control, focused problem-solving, adaptive behavioral coping, interoception, in addition to enhanced memory, reduced emotional interference, and increased cognitive efficiency (Lazar et al., 2005; Gard et al., 2014; Vago & Silbersweig, 2012; see Boccia, Piccardi, & Guariglia, 2015, for a review).

Meditation and Brain-Related Change

During the past several decades, contemplative neuroscientists have explored how mindfulness practices like meditation may alter brain structure and connectivity, and enhance mental function (e.g. Brewer et al., 2011; Creswell et al., 2016; Hölzel et al., 2010, 2011a; Jha, Krompinger, & Baine, 2007; Lazar et al., 2005; Tang, Hölzel, & Posner, 2015). Using brain-imaging techniques like EEG (Davidson et al., 2003), and fMRI (Farb et al., 2010; Lazar et al., 2005; Lutz et al., 2008) researchers have discovered that experienced meditators show increased volume and activation in the prefrontal cortex (PFC), a region largely responsible for judgment, decision-making, and planning (Lazar et al., 2005). Increased activity in the PFC is linked to prosocial behavior such as empathy, compassion, and kindness.

The PFC is particularly susceptible to stress (Arnstein 1999, 2009). Even mildly acute, uncontrollable stress can lead to a dramatic decline in prefrontal cognitive abilities, and prolonged stress can result in alterations to the PFC's neural pathways. This may be one possible explanation why individuals with lead exposure early in life show structural changes to the PFC in adulthood (Cecil et al.,

2008). As such, enhancing PFC volume and activation may serve to buffer the effects of stress and the neurotoxic effects of lead, and increase cognitive capacities essential for lifelong flourishing.

Research also shows a relationship between sustained meditation practice and change in the anterior cingulate cortex (ACC) and mid-cingulate cortex (MCC). Collectively, the ACC and MCC are implicated in self-regulation: the capacity to purposefully direct attention, control impulses, behave thoughtfully and intentionally, engage in focused problem-solving, and enact adaptive behavioral responses under challenging conditions. People with damage to the ACC tend to be aggressive, impulsive, rigid in their thinking, and persist in using ineffective problem-solving strategies even when they don't work.

A 2014 systematic review and meta-analysis of published neuroimaging studies of meditators found that those practicing meditation showed differential activation in the ACC and MCC (Fox et al., 2014). Specifically, meditators developed increased ACC and MCC functionality, which may augment self-regulation, attention, learning, memory, and self-awareness. Indeed, a study of 16 adults following an eight-week mindfulness-based stress reduction (MBSR) course demonstrated increases in gray matter in the brain regions associated with perspective-taking, emotion regulation, learning, memory, and self-referential processing. Participants also reported feeling less stress (Hölzel et al., 2011a).

Meditation is also thought to be associated with changes in the limbic system – the region of the brain that processes emotion (Hölzel et al., 2010; Desbordes et al., 2012). The limbic system, which includes the amygdala, is particularly susceptible to stress. Stress-induced changes to the amygdala are thought to be associated with long-term deficits in cognitive performance, increased emotional – reactivity, as well as pathological levels of anxiety. Early studies point to changes in amygdala function and volume following meditation training. For instance, one study found that as little as eight weeks of mindful attention training or cognitively-based compassion training resulted in decreases in right amygdala activation (Desbordes et al., 2012). In a longitudinal MRI study investigating the association between changes in perceived stress and changes in amygdala gray matter density, participants reported significantly less perceived stress following eight weeks of mindfulness-based stress reduction training. In addition, changes in perceived stress correlated significantly with decreased right basolateral amygdala gray matter density. The more perceived stress was reduced, the less gray matter density in the right amygdala (Hölzel et al., 2010). This implies that regular meditation may directly safeguard against the impact of stress, and increase emotional resilience.

The default mode network (DMN), the part of the brain associated with mind wandering, is another structure that appears to be impacted by meditation practice (Brewer et al., 2011; Garrison et al., 2015; Jang et al., 2011; Tomasino et al., 2013). The DMN is represented by a number of highly interconnected structures including the posterior cingulate cortex (PCC), dorsolateral (dlPFC) and medial prefrontal cortex (mPFC), angular gyrus, precuneus, and hippocampus. The DMN is associated with three primary functions: self-referencing, thinking about others, and recalling the past and anticipating future events. Research shows that this network is vulnerable to fear and stress, and may play an important role in depression, chronic pain, schizophrenia, autism spectrum disorders, and Alzheimer's disease (Buckner, Andrews-Hanna, & Schacter, 2008).

The DMN is increasingly gaining attention because of its role in social information processing. A highly active DMN may be a marker of perseverative rumination, a hallmark of anxiety disorders and depression. In one study, Judson Brewer, Director of Research at the Center for Mindfulness at the University of Massachusetts, found that the DMN was "relatively deactivated" in experienced

meditators, suggesting that meditation may help to reduce mind wandering and possibly rumination (Brewer et al., 2011).

J. David Creswell and colleagues at Carnegie Mellon University examined the relationship between the DMN and physiological stress markers in a highly stressed population of job-seeking adults (Creswell et al., 2009). Thirty-five participants were randomly assigned to an intensive, 3-day, residential mindfulness meditation retreat or a relaxation retreat. Resting brain scans and blood tests were taken immediately before and after the intervention, and blood was again drawn at a four-month follow-up. Post-intervention scans showed increased resting state functional connectivity of regions of the DMN associated with attention and executive control (dlPFC) in the meditation group only. The meditation group also had reduced interleukin-6 levels, which suggests an attenuated inflammatory response. These findings show that meditation may enhance executive control and stress regulation, in addition to affecting stress-related health indicators like inflammation. Furthermore, a meta-analysis of neuroimaging studies that included data from 24 experiments found consistent evidence that meditation is associated with changes in executive attention function, including functional alterations in the default mode network (Tomasino et al., 2013).

Neurobiological changes have also been detected following regular yoga practice (Streeter et al., 2010, 2012). In a 2010 study, Dr. Chris Streeter and colleagues randomly assigned adult participants to either a yoga intervention or an active walking group. Both yoga and walking group members participated in three 60-minute sessions per week for 12 weeks. Greater improvements in self-reported mood and anxiety ratings were found in the yoga group compared to the walking group following the intervention. Yoga participants also showed a positive correlation among improved mood, decreased anxiety, and increased thalamic GABA levels (Streeter et al., 2010).

One of the most promising and impactful benefits of mindfulness practice may be in its ability to reduce stress. According to the World Health Organization, stress costs American businesses approximately $300 billion per year, predominantly in the form of higher healthcare costs, employee absence, and reduced productivity. A review of 25 randomized controlled trials examined the published evidence of the effects of breathing exercises, yoga, meditation, and other mindfulness practices (or their combination) on the sympathetic nervous system and hypothalamic pituitary adrenal (HPA)-axis, both of which are well-known indicators of stress (Pascoe & Bauer, 2015). It included studies that measured structural and/or functional brain regions associated with stress and mood regulation, as well as other physiological indicators like heart rate, blood pressure, and cortisol levels. Mindfulness practices were associated with improved SNS and HPA-axis regulation, as well as decreased symptoms of anxiety and depression across a diverse range of participants. Similarly, a review and meta-analysis of 7 controlled and randomized controlled trials where MBSR was compared to other forms of treatment in the relief of stress and stress-related symptoms in healthy individuals, found that MBSR participants reported reduced stress and fewer symptoms of ruminative thinking and anxiety, as well as increased self-compassion and empathy (Chisea & Seretti, 2009).

Summary

Mindfulness-based programs and practices are known to be associated with a number of important benefits that may be particularly relevant to those facing the impact of lead exposure including:

- Reducing physiological and psychological stress and related symptoms including anxiety.
- Increasing cognitive functioning including enhanced attention, self-regulation, and executive functioning.

- Ameliorating mental and physical health and the impact of stress-related conditions.
- Lessening depression and anxiety, and reducing the risk for depressive relapse.
- Alleviating pain.
- Improving quality of life and subjective wellbeing.

Mindfulness studies show a direct association between regular practice and changes in brain structure and functional connectivity including:

- Increasing volume and activation of the prefrontal cortex (PFC) - a region negatively impacted by lead exposure and related to attention, decision-making, planning, and prosocial behavior.
- Enhancing functional efficiency of the anterior cingulate cortex (ACC).
- Reducing amygdala activity and density, suggesting increases in emotion regulation, and decreases in emotional reactivity.
- Changing the default mode network (DMN), a PFC structure important for executive control functions, social information processing, self-referencing, and thinking about others.
- Affecting neurobiological changes related to improved mood, decreased anxiety, and decreased aggression, antisocial behavior, and substance use.

Evidence also suggests that regular yoga practice is linked to neurobiological changes related to improved mood and stress resilience, decreased anxiety, aggression, antisocial behavior, and substance use.

Benefits of Mindfulness Education in School Settings

The communities of Greater Flint have long struggled to overcome a legacy of challenging socio-political, economic, and environmental conditions. Poverty, unstable housing, deficits in nutrition, exercise, and sleep, racial discrimination, neighborhood crime and violence, and a host of other factors have made it difficult for children, families, and educators to provide rearing and academic environments that permit children to thrive. Compound these issues with the very real probability of toxic lead exposure, and the scenario is made exponentially worse.

Problems related to childhood stress and psychological problems have escalated in recent years. This may be due to the fact that stress impacts brain structures involved in both cognition and mental health (Lupien et al., 2009). Schools provide stable, safe, structured environments that are designed to scaffold child development. Although the focus has largely been on academic achievement, youth in Flint schools are now in even greater need of programs to support key competencies related to socioemotional learning. These competencies, including sustained attention, present-focused awareness, acceptance, self-awareness and self-regulation, kindness and compassion, and, most importantly, stress resilience, are cornerstones of mindfulness education (Davidson et al., 2012).

A 2012 article by The Mind and Life Education Research Network (MLERN) outlines the prospects and potential functions of mindfulness-based practices and mental training in American education (Davidson et al., 2012). The article synthesized research from neuroscience, cognitive science, developmental psychology, education, and contemplative studies to advocate for practices such as meditation, yoga, relaxation, and compassion training as essential to inculcate the development skills and socioemotional competencies necessary for child flourishing. Its authors concluded that mindfulness practices strengthen academic and psychosocial qualities (e.g. focused attention, self-regulatory skills, and prosocial behaviors) that are essential for both academic success and long-term positive adjustment including health, financial stability, and educational attainment (Moffitt et al., 2011).

Studies examining mindfulness-based training for school children have continued to proliferate in recent years, with findings suggesting benefits across many domains of youth functioning. A 2016 systemic review and meta-analysis of the existing published and unpublished research examining the impact of mindfulness-based trainings for elementary, middle school and high school youths identified significant improvements in cognitive performance, resilience, stress reduction, and emotional problems. These programs were found to be well accepted, and were generally implemented with few difficulties or adverse effects (Zenner et al., 2016).

Student-Centered Programs

Pre-School and Elementary School

Research examining the effects of mindfulness practices on preschool and elementary school children has focused on their effects on executive function, social-perspective taking, and self-care. In one randomized controlled trial, 68 preschool children were assigned to either a 12-week, mindfulness-based Kindness Curriculum delivered in public schools or a control group. Children in the mindfulness group showed greater improvements in social competence, and received higher report card grades on measures of learning, social-emotional development, and health. Conversely, control group children demonstrated increased selfish behavior (Flook et al., 2015).

In another study, preschool-aged children who were randomly assigned to 5 weeks of mindfulness-based training demonstrated improvements in sustained attention and perspective-taking compared to controls (Johnson et al., 2011). A study of second and third grade students with poor

executive function found that 8 weeks of mindfulness-based training was linked to significant increases in parent and teacher ratings of students' abilities to direct, sustain, and monitor their attention, compared to controls (Flook et al., 2010). Similar studies in which younger children received mindfulness-based training found improvements in behavioral measures of selective attention, decreased self-reported anxiety, and decreased teacher-rated attention problems, relative to controls (Napoli, Krech & Holley, 2005).

Although evidence regarding the effectiveness and safety of these practices for children is still limited, preliminary research finds that developmentally-appropriate mindfulness practices are feasible (Zelazo & Lyons, 2012). There also may be an advantage to offering mindfulness skills to young children, because of the relative plasticity of their cognitive and affective neural networks (Carlson, et al., 2013).

Middle and High School

There are a number of studies assessing the impact of mindfulness-based education on adolescent functioning (Schonert-Reichl & Lawlor, 2010). One such study examined the effects of 10 weeks of mindfulness training on students' social-emotional wellbeing and socially responsible behavior. At the end of training, teachers rated students who received mindfulness education as less aggressive and less oppositional, better able to focus attention, and more likely to act prosocially towards others compared to teacher ratings of control group students.

School-based Yoga Programs

Yoga is a mindfulness-based practice that emphasizes integration of the mind, body, and breath through movement, breathing exercises, guided relaxation and meditation. It is particularly impactful for children and adolescents because it incorporates physical activity with the principles of mindful awareness. Over the past decade, an increasing number of schools have incorporated yoga education into their regular or after-school curricula (Khalsa & Butzer, 2016). Likewise, there has been a sharp increase in the number of studies devoted to examining the effects of yoga programs on student and educator wellness in the schools.

Research also shows that school-based yoga programs may support children's development of competencies that may have been altered by lead exposure. A recent systematic review of 47 peer reviewed scientific articles found that participation in a school-based yoga program was associated with improvements across a wide variety of student domains including stress reduction, mood, self-regulation, self-esteem, working memory, and positive health, and decreases in depression, anxiety, aggression, psychological problems, and alcohol use. Several studies also indicated positive changes in student physiological outcomes including increased heart rate variability, decreased cortisol concentration and declines in physiological stress reactivity, improved respiratory muscle and abdominal strength, and greater flexibility (Khalsa & Butzer, 2016).

Teacher-Centered Programs

Teachers are key points of contact for children and youths, and have proved to be important beneficiaries of mindfulness education. Studies suggest that teacher-centered mindfulness-based interventions may be particularly impactful, as many educators experience high levels of stress, and are offered few resources to enhance their resilience (Montgomery & Rupp, 2005). Research assessing the effects of mindfulness education for teachers suggests that regular mindfulness practice may enhance their emotional- and self-regulation, promote cognitive flexibility, increase self-efficacy, health, and subjective well-being, and support teacher's ability to create nurturing relationships with students and

effectively manage classroom behavior (Meiklejohn et al., 2012). Mindfulness-based practices may also reduce teacher's occupational stress, burnout, and emotional distress (Benn, Akiva, Arel & Roeser, 2012; Kemeny et al., 2011; Roeser et al., 2013).

Although most yoga programs in schools are offered to students, several have included teachers and school staff. In one study of a stress management program for school employees, results showed significant decreases in teacher mental and physical stress and increases in cheerfulness, calmness, and comfort (Nosaka & Okamura, 2015). A study of middle school teachers noted self-reported increases in mindfulness, positive mood, classroom management, distress tolerance, and several physical indicators of stress following a brief, daily intervention (Harris et al., 2016). Another study found a trend toward lowered perceived stress and emotional exhaustion among educators (Ancona & Mendelson, 2014). In general, studies show that mindfulness-based practices like meditation, yoga, breath exercises, and guided relaxation are feasible and beneficial for both students and teachers.

Summary

Although mindfulness-based programmatic research in schools is emerging, initial studies show that programs for students and teachers yield numerous benefits including:

- Increasing stress resilience and stress reduction.
- Improving self-regulation, emotion modulation, and subjective wellbeing.
- Enhancing attention, academic success, and cognitive performance.
- Decreasing anxiety, mood problems, and antisocial behavior.
- Enhancing prosocial behavior.
- Lessening teacher stress and burnout, and amplifying teacher health and wellbeing.

Crim's Strength of Positioning

The Crim Fitness Foundation is dedicated to creating a viable and vibrant community by offering programs that focus on health and wellbeing. The organization is uniquely positioned to benefit the Flint community because of a high degree of community trust, a reputation built on providing 40 years of exceptional service to schools throughout Genesee County, and over a decade of offering successful physical activity, nutrition and, more recently, mindfulness programming to Flint Community Schools. In the advent of the Flint Water Crisis, leading health experts, including Dr. Mona Hanna-Attisha, have indicated that these programs and services may be crucial in mitigating the effects of the Water Crisis and community lead exposure.

Mindfulness programming is central to Crim's programmatic outreach. As noted previously, mindfulness skills hold promise for increasing key cognitive, behavioral, and social competencies that are likely most affected by lead exposure. Crim intends to continue its work with the community to expand its mindfulness training for children in Flint Community Schools and the Genesee Independent School District, increase education and support for teachers, and raise community awareness of the benefits of mindfulness practices, particularly in the context of stress resiliency.

Crim's school-based Mindfulness Initiative is already yielding beneficial results. Preliminary data examining the outcomes of a randomized pilot study of 8 weeks of mindfulness education for 4^{th} and 5^{th} grade students suggests that children in the mindfulness education group reported higher levels of mindfulness at program completion after controlling for baseline mindfulness scores (Diltz, Clevenger, Florida, Barkman, Sellers & Pfeiffer, 2016). Further, one of the schools' teachers reported, "*We noticed a marked difference in students who practiced mindfulness. They did more work, ate better, and were happier. We have had fewer referrals to the office, resulting in more instructional time and increased student achievement*." Another commented, "*Our students have a lot of stress and tension at home. Mindfulness gives them a tool to use to deal with their home life."*

Conclusion

The citizens of Flint and the outlying communities, as well as schools, health providers, businesses, and civic organizations are coping with an abundance of negative consequences precipitated by the lead crisis. Businesses have lost considerable revenue, and individuals and the entities that serve them have been traumatized by the persistent reality lead exposure, and the ongoing fear and uncertainty about its long-term consequences and resolution. Mindfulness practices, which emphasize empowerment, may help to mitigate some of these effects. Indeed, by providing educators and students with psychoemotional and behavioral support, we may be able to allay some of the negative consequences of lead exposure and impoverishment that have plagued Flint citizens for generations.

As the impacts of the lead crisis emerge, enhancing the scope and depth of mindfulness training for students, educators and the community will become even more crucial. Sustained and frequent mindfulness practice will help children increase their awareness of others in social situations, and provide tools for impulse control, and emotion and behavioral regulation. This will support the cultivation of less stressful classroom environments that are more conducive to academic success, social emotional learning and child flourishing.

There is great demand from the teachers and administrators of the Flint Community Schools and Genesee Independent School District to expand Crim's mindfulness programming to meet the needs of students, teachers, families, and the community at large. As Flint teachers are continually

faced with pay cuts, layoffs, and working with children who have many preexisting emotional, physical, and environmental issues that are barriers to learning, they have even greater need for support. For Greater Flint, the impact of the Water Crisis is vast and complex. Those of us working in the community recognize that mindfulness education addresses but one, small piece of a multifaceted puzzle. But we are optimistic that these steps will enhance resilience, strengthen cognitive and behavioral capacities, and promote kindness, and compassion, which will considerably benefit the community and the region during the decades of healing to come.

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4. Crim's Strength of Positioning

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Footnote

[1] The Centers for Disease Control and Prevention guidelines classify blood level (BLL) toxicity at 10 micrograms per deciliter of lead or greater. These guidelines have been under attack. Studies by Druce Lanphear, MD, MPH, director of the Cincinnati Children's Environmental Health Center at the Cincinnati Children's Hospital Medical Center, one of the country's top pediatric lead researchers, find that considerably smaller levels of lead, less than 10mg/dl, put children at risk for cognitive damage. Studies conducted at the University of Rochester School of Medicine, and Cornell University also found that children with BLLs below

10 mg/dl showed intellectual impairment, with the amount of impairment being more pronounced at lower levels.