J Abnorm Child Psychol (2010) 38:985–994
DOI 10.1007/s10802-010-9418-x

Feasibility and Preliminary Outcomes of a School-Based Mindfulness Intervention for Urban Youth

Tamar Mendelson · Mark T. Greenberg · Jacinda K. Dariotis · Laura Feagans Gould · Brittany L. Rhoades · Philip J. Leaf

Published online: 4 May 2010

Abstract Youth in underserved, urban communities are at risk for a range of negative outcomes related to stress, including social-emotional difficulties, behavior problems, and poor academic performance. Mindfulness-based approaches may improve adjustment among chronically stressed and disadvantaged youth by enhancing self-regulatory capacities. This paper reports findings from a pilot randomized controlled trial assessing the feasibility, acceptability, and preliminary outcomes of a school-based mindfulness and yoga intervention. Four urban public schools were randomized to an intervention or wait-list control condition (n=97 fourth and fifth graders, 60.8% female). It was hypothesized that the 12-week intervention would reduce involuntary stress responses and improve mental health outcomes and social adjustment. Stress responses, depressive symptoms, and peer relations were assessed at baseline and post-intervention. Findings suggest the intervention was attractive to students, teachers, and school administrators and that it had a positive impact on problematic responses to stress including rumination, intrusive thoughts, and emotional arousal.

Keywords Mindfulness · Yoga · Prevention · School-based intervention · Chronic stress

T. Mendelson (✉)
Department of Mental Health,
Johns Hopkins Bloomberg School of Public Health,
624 N. Broadway, Room 853,
Baltimore, MD 21205, USA
e-mail: tmendels@jhsph.edu

M. T. Greenberg · B. L. Rhoades
Prevention Research Center, Pennsylvania State University,
University Park, PA, USA

J. K. Dariotis
Department of Population, Family, and Reproductive Health,
Johns Hopkins Bloomberg School of Public Health,
615 N. Wolfe Street, Room E4535,
Baltimore, MD 21205, USA

L. F. Gould
Academy for Educational Development,
Washington, D.C., USA

P. J. Leaf
Department of Mental Health,
Johns Hopkins Bloomberg School of Public Health,
624 N. Broadway, Room 819,
Baltimore, MD 21205, USA

Youth who experience persistent poverty or other chronic environmental stressors face serious challenges to healthy development. Exposure to environmental stress is a key contributor to the etiology and maintenance of internalizing and externalizing disorders in youth (Compas et al. 2001; Grant et al. 2006). Indeed, as many as one quarter of impoverished youth have social and emotional difficulties relative to their more economically advantaged peers (Keenan et al. 1997). Those disparities persist and are part of a pathway leading to high rates of poor academic performance, school dropout, and negative social outcomes among socio-economically disadvantaged youth (Reynolds et al. 2001).

Childhood Adversity and Impaired Regulatory Systems

Emerging evidence supports at least one mechanism along this pathway in that childhood adversity has been found to trigger neurobiological events that alter brain development (Andersen 2003; Shonkoff et al. 2009; Teicher et al. 2002), potentially impairing the stress response systems that underlie cognitive and emotion regulatory capacities (Andersen and Teicher 2009). As a result, chronically-stressed children are at risk for difficulties with cognitive

and emotion regulation. Consistent with this biological research, exposure to multiple poverty-related risks was found to increase children's risk for poorer emotional self-regulation in a nationally representative sample of over 20,000 youth (West et al. 2001).

Cognitive and emotion regulation–which include the ability to modulate responses to stress–are increasingly found to contribute to overall adjustment, including social-emotional development (e.g., peer relations) (Greenberg 2006). How youth regulate their emotional responses and cope with stressors influences their level of risk for maladaptive developmental trajectories (Compas et al. 2001). Indeed, emotional regulatory capabilities mediated the relationship between exposure to stress and youth outcomes in multiple studies (Sandler et al. 2000; Wolchik et al. 2006). Consequently, training youth to better modulate their responses to stress and emotional states has been the focus of many interventions for the treatment and prevention of psychopathology (e.g., Clarke et al. 1995; Kendall et al. 1997; National Research Council and Institute of Medicine 2009) and may be particularly well-suited to youth who face chronic adversity and stress. Intervening in regulation may help modify the underlying stress-response system and deflect problematic trajectories more often faced by at-risk youth.

Involuntary reactions to stressors, which include automatic and physiologically-mediated responses such as rumination and intrusive thoughts, are a component of self-regulation and may be particularly relevant for understanding the symptoms and behaviors observed with chronically-stressed youth. Those reactions are likely the individual's first response to stressful situations and may be overlearned (Compas et al. 1999) and contribute to the cumulative effects of chronic stress on the body, i.e., allostatic load (Evans et al. 2007; McEwen and Seeman 1999; Shonkoff et al. 2009). Rumination and intrusive thoughts are common correlates of both externalizing and internalizing problems, but particularly depression (Wadsworth et al. 2005). Rumination has been linked prospectively to depressive and anxious symptoms in children and adolescents (Roelofs et al. 2009), and it was found to mediate the relation between female gender and risk for depressive symptoms in low-income, urban, African American youth (Grant et al. 2004). Consequently, identification and modification of these involuntary responses may be particularly important components of interventions for at-risk youth (Wadsworth et al. 2005).

Mindfulness-Based Interventions

Based on research conducted primarily with adults, mindfulness-based approaches such as yoga and meditation may have the potential to enhance regulatory capacities among chronically-stressed youth. Derived from Eastern contemplative traditions, *mindfulness* involves attending to the present in a sustained and receptive fashion (Brown and Ryan 2003). Yoga, meditation, and other mindfulness practices cultivate capacities for attention and awareness (Brown and Ryan 2003) that have beneficial effects on the ability to respond to stress without adverse psychological or physical outcomes (i.e., resilience). Indeed, research with adults suggests mindfulness-based practices train capacities for attention (Brefczynski-Lewis et al. 2007; Carter et al. 2005; Jha et al. 2007; Lazar et al. 2005; Srinivasan and Baijal 2007) and enhance the ability to inhibit cognitive and emotional processes, like rumination, that increase or maintain stress (Brefczynski-Lewis et al. 2007). Mindfulness practices are also reported to have positive effects on adult physical and mental health, such as reducing mood and anxiety disorders, distress, and blood pressure (Arias et al. 2006; Kirkwood et al. 2005; Ospina et al. 2007; Pilkington et al. 2005; Shapiro et al. 2007).

Although much less studied, interventions involving meditation with youth have been reported to reduce distress, anxiety, and emotional and behavioral reactivity and improve self-awareness and sleep among youth (Bootzin and Stevens 2005; Napoli et al. 2005; Semple et al. 2005; Wall 2005). The first controlled trial in this area found that an 8-week mindfulness-based stress reduction course reduced symptoms of anxiety, depression, and somatic distress and improved self-esteem, sleep, and clinician-rated functioning among adolescents in outpatient mental health (Biegel et al. 2009). In addition, a recent review reports there is preliminary evidence that yoga also has physical and mental health benefits for youth, including improved stress management (Galantino et al. 2008).

Yoga, which involves focused attention on the breath and on a series of poses that strengthen and stretch the body, may offer additional benefits for youth given that it combines mindfulness with physical activity. Physical activity is associated in its own right with improved health and mental health outcomes among youth, including lower rates of substance use (Pate et al. 2000; Ströhle et al. 2007) and depressive and anxiety symptoms (Floriani and Kennedy 2008). Hypothesized mechanisms for prevention effects via physical activity include enhanced emotion regulation and executive function (Pentz 2008).

Despite emerging evidence regarding the impact of mindfulness-based practices with youth, most studies in this area have significant limitations, including non-randomized designs (Biegel et al. 2009; Galantino et al. 2008). In addition, the impact of yoga and other mindfulness-based strategies on *underserved, urban youth populations* has received almost no attention, despite encouraging preliminary evidence that those practices

enhance regulatory and coping processes and thus may be particularly well-suited for chronically-stressed youth. Existing data suggest mindfulness-based interventions may have the potential to improve aspects of functioning associated with self-regulation, including responses to stress, mood, and social-emotional development, thereby promoting more positive developmental trajectories among chronically-stressed youth.

The Present Study

Given the need for innovative interventions to reduce social-emotional and behavioral problems in disadvantaged youth, prevention researchers from two universities partnered with the Baltimore-based Holistic Life Foundation (HLF) to develop and evaluate a mindfulness-based intervention for youth. HLF is a non-profit organization that offers yoga classes and other activities aimed at improving emotional and academic outcomes among inner-city youth. Most of the youth served by HLF are African American and live in low-income neighborhoods with high levels of violence. The founders of HLF were born and raised in Baltimore City, are of African American and Latino descent, and have strong ties to the community. Our collaboration goals were to further develop and manualize HLF's mindfulness and yoga program, evaluate its impact on youth in school settings, and use this information for program refinement. Designed for an urban youth population, the program aims to counter the psychological and neurocognitive effects of chronic stress exposure by cultivating a state of calm attention and awareness. Figure 1 displays our model of hypothesized intervention effects, based on the literature reviewed above. We conceptualized *overall adjustment* as including affective, cognitive, social-emotional, and behavioral components.

We conducted a pilot randomized controlled trial of the mindfulness and yoga program with two specific aims: (1) to evaluate the feasibility and acceptability of the intervention and (2) to assess its promise for improving key domains of youth functioning that may impact maladaptive trajectories. This trial included fourth and fifth graders across four Baltimore City public elementary schools (n= 98 students). Fourth and fifth graders were selected as our target population because middle childhood and early adolescence are developmental periods when the ability to exhibit self-regulation and inhibitory control increases. The dynamic growth and development of those regulatory capacities from ages 10 to 15 suggests this is a favorable time to intervene (Windle et al. 2008). We believed that intervening at the start of this period would be particularly beneficial, in part because of the potential to enhance students' capacities for responding to stress before the often-stressful transition from elementary to middle school.

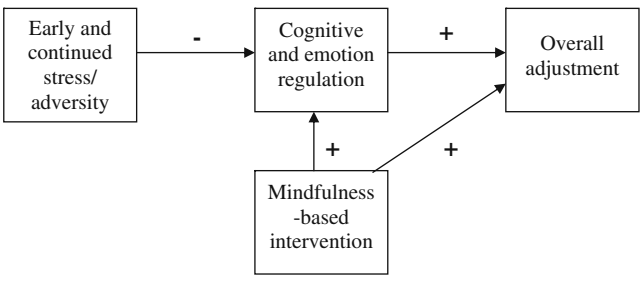

Fig. 1 Model of the intervention's hypothesized effects. *Note*: We anticipate that the intervention may influence some adjustment outcomes in part directly or through other mediational pathways, suggested by the arrow linking the intervention directly to overall adjustment

Two schools were randomized to receive the 12-week intervention; the other two schools served as wait-list controls and did not receive the intervention until after completion of the pilot trial. Youth social, emotional, and behavioral outcomes were assessed at baseline and immediately following the intervention. For Aim 1, we evaluated intervention feasibility and acceptability based on our recruitment and retention rates and qualitative feedback from students and teachers. We anticipated that interest in the intervention would be sufficiently strong to support enrollment of approximately 25 students per school and that 75% of participants would complete at least three quarters of the interventions sessions. For Aim 2, we hypothesized the intervention would produce improvements in the following components of youth adjustment: involuntary stress responses, mood, and relationships with peers and teachers.

Methods

Participants

Participants were 97 fourth and fifth grade students recruited from four Baltimore City public elementary schools. After approval by the relevant Institutional Review Boards, the intervention and research study were described to parents in a letter mailed to the home. The same information was described to students by the intervention instructors in presentations during visits to classrooms and student assemblies. All students in the 4th and 5th grades were invited to provide assent and parental consent if they wished to participate. Students were informed that, due to resource constraints, only 25 students could be enrolled in the study per school and that 25 students would be randomly selected from among those who provided assent and parental consent. The final sample consisted of 55 fourth graders (56.7%) with a mean age of 9.7 years (SD=0.7) and 42 fifth graders (43.3%) with a mean age of 10.6 (SD=0.7). Fifty-nine participants

were female (60.8%). Eighty-one students (83.5%) self-identified as African American, four (4.1%) self-identified as Latino, four (4.1%) as White, and seven (7.2%) as "mixed race" or "other;" one student (1.0%) did not report race/ethnicity. Our sample included 51 students in the intervention condition and 46 students in the control condition.

Measures

Involuntary Stress Responses The Responses to Stress Questionnaire (RSQ; Connor-Smith et al. 2000) was used to assess children's involuntary responses to stress. This 57-item self-report checklist assesses voluntary and involuntary responses to sources of social stress in adolescence. Voluntary Stress Responses reflect coping activities that are within an individuals' conscious control, and Involuntary Stress Responses reflect more unconscious physiologic or temperamental reactions to stressors. Confirmatory factor analyses across three independent samples indicate a consistent factor structure across sample, gender, and type of stressor. The RSQ has been found to have strong internal consistency and test-retest reliability and good criterion validity. All the RSQ scales displayed moderate to strong associations with behavioral and emotional problems as indexed by the CBCL, YSR, and YASR, and involuntary coping scales correlated with heart-rate reactivity on a laboratory task (Connor-Smith et al. 2000).

In this study, we administered the Involuntary Engagement Coping Scale, which is composed of theoretically-relevant subscales assessing Rumination, Intrusive Thoughts, Emotional Arousal, Physiological Arousal, and Impulsive Action. Items assessed the degree to which participants "do" or "feel" each coping strategy when they have problems with their peers on a scale from (1) "not at all" to (3) "a lot" (e.g., "*When I have problems with other kids, I feel it in my body, like my heart races or my muscles tighten up*"). We adjusted the response format from a four- to a three-point scale to make it more age-appropriate based on a recommendation from the developer of the measure (Connor-Smith, personal communication, 07/25/2007). Pretest internal reliability was α=0.79 for the Involuntary Engagement Scale in our sample, with reliabilities for the five component subscales ranging from 0.52 to 0.61.

Depressive Symptoms The Short Mood and Feelings Questionnaire—Child Version (SMFQ-C; Angold et al. 1995) was used to assess depressive symptoms. The SMFQ-C is a 13–item self-report scale assessing depressive symptoms experienced over the past two weeks. Respondents rate each item as "true," "sometimes true," or "not true." The scale has been shown to have adequate internal reliability and high criterion validity (Angold et al. 1995). The scale's Cronbach alpha at pretest in the current study was 0.82.

Positive and Negative Emotions The Emotion Profile Inventory (EP; Benn 2003), a 24-item self-report scale, was used to assess children's positive and negative emotions. Respondents are asked how often in the past couple of days, including the present day, they experienced different feelings on a 4-point scale ranging from "not much" to "most of the time." We added two items, "mad" and "annoyed," to the EP to better capture feelings of anger. In this study, pretest internal reliability was α=0.76 for positive emotions and α=0.86 for negative emotions.

Relations with Peers and School People in My Life (PIML; Cook et al. 1995; Murray and Greenberg 2000) was used to evaluate participants' relations with peers and school. PIML is a self-report measure that assesses the relationships children have with their parents, friends, school, and neighborhood. It was developed for easy comprehension by 10- to 12-year olds, and its component scales have good internal reliability. Responses range from "almost never or never true" (1) to "almost always or always true" (4). To minimize participant burden, only the friends and school factors scales (brief versions) were administered in this study; we anticipated that the intervention may have the most impact on peer relations and school factors because it was administered in the school setting to groups of peers. Pretest Cronbach alphas for the PIML Trust in Friends, Communication with Friends, Teacher Affiliation, and Dissatisfaction with Teachers scales were 0.79, 0.62, 0.67, and 0.66 respectively in our sample. In contrast, alphas for the Alienation/Dissatisfaction with Friends and School Bonding were low ($\alpha \leq 0.45$); we chose not to report findings from those two scales due to concerns about their reliability in our sample.

Procedures

Participants at the intervention schools attended the mindfulness program during school hours four days per week for 12 weeks. Each intervention session lasted 45 min. In consultation with school administrators, intervention sessions were scheduled during "resource time," a period in which students engage in non-academic activities. Intervention class sizes were approximately 25 students each with two HLF instructors per class; fourth and fifth graders were taught together. The HLF instructors were males of similar racial and ethnic background as the students (three instructors were African-American, one was Latino). The intervention was delivered at each school in a space conducive to physical activity (e.g., gym). Pre and post-intervention assessments were administered by trained research assistants to groups of participants in the school setting. All questionnaires were read aloud to participants to facilitate comprehension. Following

completion of the intervention, focus groups were conducted at each intervention school with consenting youth who participated in the intervention and with teachers whose students participated.

Intervention Components

Key intervention components included yoga-based physical activity, breathing techniques, and guided mindfulness practices. The intervention is secular, and the instructors did not utilize terminology that would be considered religious or unusual for this cultural context. In each class, youth were taught yoga-inspired postures and movement series, including bending, stretching, and fluid movement. Poses were selected to enhance muscle tone and flexibility, and students were taught the health benefits of the poses. Students also practiced breathing, starting with beginner exercises and gradually moving to more advanced ones. These exercises trained the youths to use their breath to center and calm themselves. At the end of each class, youth lay on their backs with their eyes closed while the instructors guided them through a mindfulness practice, which involved attending to a specific focus for several minutes, such as paying attention to each breath or sending out positive energy to others. The movement, breathing, and mindfulness components of the class were each designed to enhance the youths' capacities for sustained attention, promoting greater awareness of cognitive, physiologic, and bodily states and how to regulate those states. In addition, each class session included a brief period of discussion prior to the guided mindfulness practice in which instructors offered didactic information about topics such as identifying stressors, using mindfulness techniques to respond to stress, cultivating positive relationships with others, and keeping one's mind and body healthy. This information was often woven into the subsequent guided mindfulness practice (e.g., using the breath to create calm if something stressful has happened). Students were encouraged to practice these skills outside class.

Results

Aim 1: Intervention Feasibility and Acceptability

Recruitment and Attendance Students reported considerable enthusiasm about the program, and we did not have difficulty recruiting participants from the target population. Early in the program, three students who started the intervention had to withdraw, one due to an injury unrelated to the intervention group and two others due to school transfers. Two students in the control condition also left the study due to school transfers. With respect to intervention attendance for the remaining students, 73.5% of students at one intervention school completed at least 75% of the intervention classes, with most absences the result of students missing school on that day. By contrast, slightly under 40% of students attended three quarters of the class sessions at the other intervention school. While school absence contributed to those missed classes, teacher focus group data indicated that some teachers at that school had prevented students from attending the intervention classes as a punishment for poor behavior in class.

Acceptability to Students and Teachers We conducted three focus groups with three to seven intervention participants in each group in order to evaluate their experience of the program and the extent to which they found the skills useful. Responses indicated that students generally had a positive experience in the program and felt they learned skills that helped them in their day-to-day lives:

- "*The program has helped me because now I know different routines and exercises that I can do at home that helps me lower and reduce my stress. So whenever I get stressed out I can just do a pose and sometimes I can show my mother and my family.*" –4th grade girl
- "*Most important thing I learned in the program is that it's all different ways to deal with your stress like instead of like fighting and stuff.*" –5th grade boy
- "*It helps you relieve stress when you really feel stressed out or you're really mad and focus on what's inside of you and just make sure that you stay calm.*" –5th grade girl

We conducted one teacher focus group at each intervention school with four to five classroom teachers in each group to explore whether they felt students had benefitted from the program and whether program implementation had been organized effectively. Teachers were uniformly supportive of the idea of training urban youth using yoga and mindfulness-based techniques. Several teachers noted that training in awareness and attention could offer significant advantages for the youth in their classes who struggled with behavioral problems, high activity level, and poor attentional focus. Some teachers noted that they had observed improvements in their students; other teachers were not sure whether their students had shown changes, and one teacher did not believe she had seen changes. Teachers expressed interest in knowing more about the intervention curriculum so that they could reinforce the skills students learned.

Aim 2: Preliminary Youth Outcomes

We compared intervention and control group participants with respect to age, grade, gender, and baseline scores on all

measures using analysis of variance (ANOVA) for continuous variables and Chi-square tests for categorical variables. Children in the intervention group were more likely than control group children to be in Grade 4 (35 fourth graders versus 21 fourth graders; $p<0.05$) and to be of younger age ($M=9.8$ years old ($SD=0.77$) versus $M=10.3$ years old ($SD=0.89$); $p<0.01$). There were no significant differences at pretest between students in the two study conditions on any psychosocial outcome variables.

To assess intervention effects, we estimated general linear models separately for each outcome, controlling for gender, age, grade, and baseline score on that outcome. We controlled age and grade because those variables differed by study condition, as noted above. Gender was also entered as a covariate given its association with several of the psychosocial outcome measures at baseline. School was not significantly related to any outcome variables at pretest according to ANOVA and Tukey adjusted pairwise comparisons. Thus, we used the most parsimonious model and did not include school as a covariate in analyses. The students who did not complete the study ($n=5$) were not included in analyses. As complete data are needed for the models and the percent of missing data was small (most outcome scales were completed by over 93% of participants), listwise deletion was judged a suitable means of handling missing data.

Table 1 displays adjusted post-intervention means and effect sizes for the outcome variables by study condition. The intervention group reported significant improvements on the overall scale of Involuntary Engagement compared to the controls ($p<0.001$). In addition, significant differences were found on three of the five subscales of this factor, including Rumination ($p<0.01$), Intrusive Thoughts ($p<0.05$), and Emotional Arousal ($p<0.01$), and a trend in the predicted direction for Impulsive Action ($p=0.07$) and Physiologic Arousal ($p=0.07$). Figure 2 displays pre- and post intervention group means on the Involuntary Engagement Scale assessed as a total score.

Although other differences were not statistically significant, adjusted post-intervention means displayed a pattern consistent with predictions for depressive symptoms (7.02 in the intervention group versus 7.62 in the control group) and negative affect (28.80 in the intervention group versus 29.93 in the control group). The groups did not differ significantly with respect to changes in positive affect or in relationships with peers and teachers, but there was a trend for control group members to report more trust in friends than intervention group members ($p=0.06$).

Discussion

This was the first randomized controlled trial to our knowledge of a school-based mindfulness and yoga intervention for urban youth. Taken together, our findings suggest that a mindfulness-based intervention (1) is feasible to implement in urban public

Table 1 Post-Intervention Means by Study Condition Adjusted for Gender, Age, Grade, and Baseline Score

	Adjusted Mean (Standard Error)		
Time 2 Measure	Intervention	Control	ES
EP Positive Affect	31.85 (0.91)	31.62 (0.98)	0.04
EP Negative Affect	28.80 (1.22)	29.93 (1.31)	0.13
SMFQ Depression Score	7.02 (0.66)	7.62 (0.70)	0.13
PIML Trust in Friends	16.84 (0.60)	18.53 (0.62)	0.40
PIML Communication with Friends	10.89 (0.39)	11.37 (0.41)	0.17
PIML Teacher Affiliation	10.35 (0.51)	10.03 (0.52)	0.09
PIML Dissatisfaction with Teacher	6.96 (0.35)	6.76 (0.37)	0.08
RSQ Involuntary Engagement (IE)	0.75 (0.05)	1.05 (0.05)	0.83***
Rumination (IE subscale)	0.76 (0.08)	1.15 (0.08)	0.70**
Intrusive Thoughts (IE subscale)	0.68 (0.07)	0.95 (0.08)	0.51*
Emotional Arousal (IE subscale)	0.65 (0.07)	1.00 (0.08)	0.64**
Impulsive Action (IE subscale)	0.99 (0.09)	1.23 (0.09)	0.38
Physiologic Arousal (IE subscale)	0.70 (0.07)	0.91 (0.07)	0.39

Five students did not complete the study; of the remaining sample, some students did not complete all post-intervention measures. As a result, sample sizes across the measures range from 42 to 47 in the intervention group and from 40 to 43 in the control group

ES effect size, *EP* Emotion Profile Inventory, *SMFQ* Short Mood and Feelings Questionnaire, *PIML* People in my Life, *RSQ* Responses to Stress Questionnaire

*$p<0.05$ **$p<0.01$ ***$p<0.001$

schools and is likely to be attractive to students, teachers, and administrators, and (2) shows promise in reducing problematic physiological and cognitive patterns of response to stress among youth. This initial pilot study provided some support for a model in which yoga with mindfulness was related to changes in self-regulatory capacities, as indexed by involuntary stress response.

Intervention Feasibility and Acceptability

Response to our recruitment efforts was encouraging and suggests that a school-based mindfulness program is attractive to students, teachers, and school administrators. Student attendance data highlight the need for strategies to address student absences. In the future, intervention instructors should identify frequently-absent students and work closely with classroom teachers and administrators to monitor and improve their attendance in school. In addition, consistent communication between program instructors and teachers is critical to ensure that student attendance at the intervention is facilitated by teachers (e.g., attending the intervention must not be contingent upon good behavior in class). As advocated by teachers in focus group discussions, greater involvement by teachers also offers potential for them to help students generalize intervention skills to classroom settings. In future work we have planned a series of meetings with teachers to discuss effective involvement strategies and the creation of a brief manual for teachers that summarizes the intervention content and rationale and presents simple suggestions they can use for promoting use of skills in the classroom.

Preliminary Youth Outcomes

Analysis of the effects of this mindfulness and yoga program on youth functioning suggests that it was effective in reducing problematic involuntary engagement responses to social stress among intervention youth. The RSQ Involuntary Engagement Scale and its component subscales for rumination, intrusive thoughts, emotional arousal, impulsive action, and physiologic arousal are particularly relevant to our model and intervention. The scales assess aspects related to automatic and physiologically-mediated stress of self-regulation reactivity and have been shown to correlate with heart-rate reactivity on a laboratory task (Angold et al. 1995). Those sorts of stress reactivity factors have been linked to over-sensitization of the stress response system via early and continued exposure to stress and adversity (Andersen and Teicher 2009). The intervention group's reduction in involuntary stress reactions suggests that mindfulness-based practices were effective in enhancing self-regulatory capacities and in reducing activation and persistent or worrying thoughts for the youth. Theory and empirical findings indicate that these improvements should enhance youths' subsequent development in social, emotional, and behavioral domains (e.g., Greenberg 2006). Of note, rumination has been linked not only to increased risk for onset and persistence of depression (Nolen-Hoeksema 1991; Nolen-Hoeksema et al. 2008) but also to risk for somatic diseases, including hypertension (Brosschot et al. 2006; Brosschot et al. 2005; Gerin et al. 2006; Key et al. 2008). Thus, reduced rumination has positive implications for long-term mental and physical health.

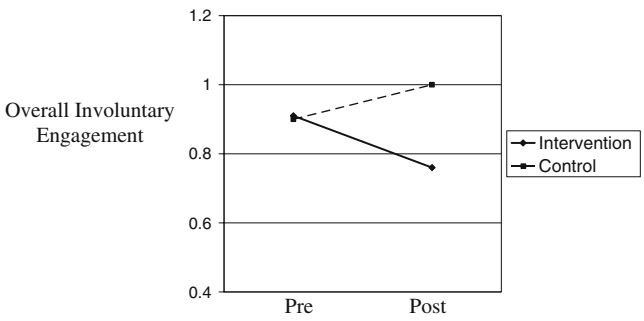

Fig. 2 Pre and post-intervention scores on Overall Involuntary Engagement by study condition

We did not observe significant group differences on measures of mood or relationships with peers and teachers, although the pattern of scores was generally in the predicted direction for the mood variables. The pattern of scores was not in the predicted direction for the two peer relationship scales, which merits further exploration in future work. Given our logic model predicts that self-regulatory capacities mediate the impact of intervention effects on certain domains of adjustment, it is possible that those adjustment domains (e.g., mood, peer relations) may take longer to show improvement than involuntary stress responses. Future research should explore this possibility by including one or more follow-up assessments to observe group differences in adjustment over time as reported by both students and teachers.

This study has several limitations. The small size of our sample did not permit rigorous tests of moderation or mediation, and it limited power to detect group differences that are small to medium in size. Further, we are well aware that we do not know the Type I error rate. Findings are consistent with an intervention effect, but we cannot infer causal effects given we did not account for the clustered nature of the data (Murray et al. 2004). We did not utilize hierarchical linear models (HLM) given the small number of schools in this pilot study. The recommended number of units at higher levels (e.g., level 2) in HLM ranges from 20 as a minimum, 50 as a preference, and 100 as very adequate (Cheung and Au 2005; Hox 1995). As involving such a large number of schools presents formidable challenges, next steps in this research will involve exploring other options for

addressing the issue of clustering, including randomizing by child or randomizing classrooms within schools.

Our recruitment methods likely biased our sample toward more highly motivated students and/or those with more engaged parents, who provided signed consent forms in a timely manner. Although this bias presumably affected intervention and control groups similarly, we cannot conclude that study findings generalize to those students who did not volunteer for the research. Many theoretically-related outcome measures were not assessed, including youth executive functions (e.g., attention), as well as teacher ratings of behavior, attention in the classroom, and academic performance. The youth self-report measures of functioning administered in this study may be influenced by social desirability and other sources of bias. Future research should incorporate non-self-report assessment methods, including teacher reports of youth functioning, student grades and test scores, and physiological measures likely to capture changes associated with mindfulness and yoga (e.g., cortisol). Given the initial pilot nature of this study, intervention implementation was also not evaluated for fidelity and quality.

This study supports previous research suggesting that mindfulness-based approaches may be beneficial for enhancing responses to stress among youth. In addition, our findings suggest that a school-based intervention involving mindfulness and yoga may be feasible and acceptable to youth, teachers, and school administrators in urban public schools serving chronically stressed and disadvantaged youth. Our focus on enhancing youth capacities for cognitive and emotion regulation is consistent with recent reviews calling for interventions to focus less on specific symptoms or disorders and more on positive youth development (e.g., Greenberg 2006; Guerra and Bradshaw 2008). Enhancing regulatory capacities and responses to stress among at-risk youth has the potential to facilitate development of core competencies that will promote a range of positive emotional, behavioral, and academic outcomes.

Acknowledgments This work was supported by grants from the Mind and Life Institute, the Attias Family Foundation, the Center for Prevention of Youth Violence at Johns Hopkins University (5U49CE000728), and the Penn State Prevention Research Center. We are grateful for the close collaboration and partnership with the Holistic Life Foundation who provided the intervention and fully complied with all research requirements. We thank our project manager, Sarah Godby, for her assistance with data collection and management, as well as the other members of our research team. We also thank the Baltimore City Public Schools and the teachers, parents, and students who participated in this project.

References

Andersen, S. L. (2003). Trajectories of brain development: point of vulnerability or window of opportunity? *Neuroscience and Biobehavioral Reviews, 27*, 3–18.

Andersen, S. L., & Teicher, M. H. (2009). Desperately driven and no brakes: developmental stress exposure and subsequent risk for substance use. *Neuroscience and Behavioral Reviews, 33*, 516–524.

Angold, A., Costello, E. J., Messer, S. C., Pickles, A., Winder, F., & Silver, D. (1995). Development of a short questionnaire for use in epidemiological studies of depression in children and adolescents. *International Journal of Methods in Psychiatric Research, 5*, 237–249.

Arias, A. J., Steinberg, K., Banga, A., & Trestment, R. L. (2006). Systematic review of the efficacy of meditation techniques as treatments for medical illness. *Journal of Alternative and Complementary Medicine, 12*, 817–832.

Benn, R. (2003). Transcendental meditation and emotional functioning in fifth-grade students. *Focus on Alternative and Complementary Therapies, 8*, 480–481.

Biegel, G. M., Brown, K. W., Shapiro, S. L., & Schubert, C. M. (2009). Mindfulness-based stress reduction for the treatment of adolescent psychiatric outpatients: A randomized clinical trial. *Journal of Consulting and Clinical Psychology, 77*, 855–866.

Bootzin, R. R., & Stevens, S. J. (2005). Adolescents, substance abuse, and the treatment of insomnia and daytime sleepiness. *Clinical Psychology Review, 25*, 629–644.

Brefczynski-Lewis, J. A., Lutz, A., Schaefer, H. S., Levinson, D. B., & Davidson, R. J. (2007). Neural correlates of attentional expertise in long-term meditation practitioners. *Proceedings of the National Academy of Sciences of the United States of America, 104*, 11483–11488.

Brosschot, J. F., Pieper, S., & Thayer, J. F. (2005). Expanding stress theory: prolonged activation and perseverative cognition. *Psychoneuroendocrinology, 30*, 1043–1049.

Brosschot, J. F., Gerin, W., & Thayer, J. F. (2006). The perseverative cognition hypothesis: a review of worry, prolonged stress-related physiological activation, and health. *Journal of Psychosomatic Research, 60*, 113–124.

Brown, K. W., & Ryan, R. M. (2003). The benefits of being present: mindfulness and its role in psychological well-being. *Journal of Personality and Social Psychology, 84*, 822–848.

Carter, O. L., Presti, D. E., Callistemon, C., Ungerer, Y., Liu, G. B., & Pettigrew, J. D. (2005). Meditation alters perceptual rivalry in Tibetan Buddhist monks. *Current Biology, 15*, R412–413.

Cheung, M. W.-L., & Au, K. (2005). Applications of multilevel structural equation modeling to cross-cultural research. *Structural Equation Modeling, 12*, 598–619.

Clarke, G. N., Hawkins, W., Murphy, M., Sheeber, L. B., Lewinsohn, P. M., & Seeley, J. R. (1995). Targeted prevention of unipolar depressive disorder in an at-risk sample of high school adolescents: a randomized trial of a group cognitive intervention. *Journal of the American Academy of Child and Adolescent Psychiatry, 34*, 312–321.

Compas, B. E., Connor, J. K., Saltzman, H., Thomsen, A. H., & Wadsworth, M. (1999). Getting specific about coping: Effortful and involuntary responses to stress in development. In M. Lewis & D. Ramey (Eds.), *Stress and soothing* (pp. 229–256). New Jersey: Lawrence Erlbaum Associates, Inc.

Compas, B. E., Connor-Smith, J. K., Saltzman, H., Thomsen, A. H., & Wadsworth, M. E. (2001). Coping with stress during childhood and adolescence: problems, progress, and potential in theory and research. *Psychological Bulletin, 127*, 87–127.

Connor-Smith, J. K., Compas, B. E., Wadsworth, M. E., Tomsen, A. H., & Saltzman, H. (2000). Responses to stress in adolescence: measurement of coping and involuntary stress responses. *Journal of Consulting and Clinical Psychology, 68*, 976–992.

Cook, E. T., Greenberg, M. T., & Kusche, C. A. (March, 1995). *People in my life: Attachment relationships in middle childhood.* Paper presented at the Society for Research in Child Development; Indianapolis, IN.

Evans, G. W., Pilyoung, K., Albert, H., Tesher, H. B., & Shannis, D. (2007). Cumulative risk, maternal responsiveness, and allostatic load among young adolescents. *Developmental Psychology, 43*, 341–351.

Floriani, V., & Kennedy, C. (2008). Promotion of physical activity in children. *Current Opinion in Pediatrics, 20*, 90–95.

Galantino, M. L., Galbavy, R., & Quinn, L. (2008). Therapeutic effects of yoga for children: a systematic review of the literature. *Pediatric Physical Therapy, 20*, 66–80.

Gerin, W., Davidson, K. W., Christenfeld, N. J., Goyal, T., & Schwartz, J. E. (2006). The role of angry rumination and distraction in blood pressure recovery from emotional arousal. *Psychosomatic Medicine, 68*, 64–72.

Grant, K. E., Lyons, A. L., Finkelstein, J. S., Conway, K. M., Reynolds, L. K., O'Koon, J. H., et al. (2004). Gender differences in rates of depressive symptoms among low-income, urban, African American youth: a test of two mediational hypotheses. *Journal of Youth and Adolescence, 33*, 523–533.

Grant, L. E., Compas, B. E., Thurm, A. E., McMahon, S. D., Gipson, P. Y., Campbell, A. J., et al. (2006). Stressors and child and adolescent psychopathology: evidence of moderating and mediating effects. *Clinical Psychology Review, 26*, 257–283.

Greenberg, M. T. (2006). Promoting resilience in children and youth: preventive interventions and their interface with neuroscience. *Annals of the New York Academy of Science, 1094*, 139–150.

Guerra, N. G., & Bradshaw, C. P. (2008). Linking the prevention of problem behaviors and positive youth development: Core competencies for positive youth development and risk prevention. In N. G. Guerra & C. P. Bradshaw (Eds.), *Core competencies to prevent problem behaviors and promote positive youth development. New Directions for Child and Adolescent Development, 122*, 1–17.

Hox, J. J. (1995). *Applied multi-level analysis* (2nd ed.). Amsterdam: TT-Publikaties.

Jha, A. P., Krompinger, J., & Baime, M. J. (2007). Mindfulness training modifies subsystems of attention. *Cognitive, Affective, and Behavioral Neuroscience, 7*, 109–119.

Keenan, K., Shaw, D. S., Walsh, S., Delliquadri, E., & Giovanelli, J. (1997). DSM-III-R disorders in pre-school children from low-income families. *Journal of the American Academy of Child and Adolescent Psychiatry, 36*, 620–627.

Kendall, P. C., Flannery-Schroeder, E., Panichelli-Mindel, S. M., Southam-Gerow, M., Henin, A., & Warman, M. (1997). Therapy for youths with anxiety disorders: a second randomized clinical trial. *Journal of Consulting and Clinical Psychology, 65*, 366–380.

Key, B. L., Campbell, T. S., Bacon, S. L., & Gerin, W. (2008). The influence of trait and state rumination on cardiovascular recovery from a negative emotional stressor. *Journal of Behavioral Medicine, 31*, 237–248.

Kirkwood, G., Rampes, H., Tuffrey, V., Richardson, J., & Pilkington, K. (2005). Yoga for anxiety: a systematic review of the research evidence. *British Journal of Sports Medicine, 39*, 884–891.

Lazar, S. W., Kerr, C. E., Wasserman, R. H., Gray, J. R., Greve, D. N., Treadway, M. T., et al. (2005). Meditation experience is associated with cortical thickness. *Neuroreport, 16*, 1893–1897.

McEwen, B. S., & Seeman, T. E. (1999). Protective and damaging effects of mediators of stress: Elaborating and testing the concept of allostasis and allostatic load. In N. E. Adler, M. Marmot, B. S. McEwen, & J. Stewart (Eds.), *Socioeconomic status and health in industrial nations* (pp. 30–47). New York: New York Academy of Sciences.

Murray, C., & Greenberg, M. T. (2000). Children's relationship with teachers and bonds with school: an investigation of patterns and correlates in middle childhood. *Journal of School Psychology, 38*, 423–445.

Murray, D. M., Varnell, S. P., & Blitstein, J. S. (2004). Design and analysis of group-randomized trials: a review of recent methodological developments. *American Journal of Public Health, 94*, 423–432.

Napoli, M., Krech, P. R., & Holley, L. C. (2005). Mindfulness training for elementary school students: the attention academy. *Journal of Applied School Psychology, 21*, 99–125.

National Research Council and Institute of Medicine. (2009). *Preventing mental emotional, and behavioral disorders among young people. Progress and possibilities*. Washington, D.C.: The National Academies.

Nolen-Hoeksema, S. (1991). Responses to depression and their effects on the duration of depressive episodes. *Journal of Abnormal Psychology, 100*, 569–582.

Nolen-Hoeksema, S., Wisco, B. E., & Lyubomirsky, S. (2008). Rethinking rumination. *Perspectives on Psychological Science, 3*, 400–424.

Ospina, M. B., Bond, K., Karkhaneh, M., Tjosvold, L., Vandermeer, B., Liang, Y., et al. (2007). Meditation practices for health: state of the research. *Evidence Report/Technology Assessment (Full Report), 155*, 1–263.

Pate, R. R., Trost, S. G., Levin, S., & Dowda, M. (2000). Sports participation and health-related behaviors among U.S. youth. *Archives of Pediatric and Adolescent Medicine, 154*, 904–911.

Pentz, M. A. (2008, June). *Translating drug use prevention to obesity prevention*. Paper presented at the National Institute on Drug Abuse Science Meeting, "Can Physical Activity and Exercise Prevent Drug Abuse?" Bethesda, MD.

Pilkington, K., Kirkwood, G., Rampes, H., & Richardson, J. (2005). Yoga for depression: the research evidence. *Journal of Affective Disorders, 89*, 13–24.

Reynolds, A. J., Temple, J. A., Robertson, D. L., & Mann, E. A. (2001). Long-term effects of an early childhood intervention on educational achievement and juvenile arrest: a 15-year follow-up of low-income children in public schools. *Journal of the American Medical Association, 285*, 2339–2346.

Roelofs, J., Rood, L., Meesters, C., Te Dorsthorst, V., Bogels, S., Alloy, L. B., et al. (2009). The influence of rumination and distraction on depressed and anxious mood: a prospective examination or the response styles theory in children and adolescents. *European Child and Adolescent Psychiatry, 18*, 635–642.

Sandler, I. N., Tein, J. Y., Mehta, P., Wolchik, S., & Ayers, T. (2000). Coping efficacy and psychological problems of children of divorce. *Child Development, 71*, 1099–1118.

Semple, R. J., Reid, E. F. G., & Miller, L. (2005). Treating anxiety with mindfulness: an open trial of mindfulness training for anxious children. *Journal of Cognitive Psychotherapy: An International Quarterly, 19*, 379–392.

Shapiro, S. L., Brown, K. W., & Biegel, G. M. (2007). Teaching self-care to caregivers: effects of mindfulness-based stress reduction on the mental health of therapists in training. *Training and Education in Professional Psychology, 1*, 105–115.

Shonkoff, J. P., Boyce, W. T., & McEwen, B. S. (2009). Neuroscience, molecular biology, and the childhood roots of health disparities. Building a new framework for health promotion and disease prevention. *Journal of the American Medical Association, 301*, 2252–2259.

Srinivasan, N., & Baijal, S. (2007). Concentrative meditation enhances preattentive processing: a mismatch negativity study. *Neuroreport, 18*, 1709–1712.

Ströhle, A., Höfler, M., Pfister, H., Müller, A. G., Hoyer, J., Wittchen, H. U., et al. (2007). Physical activity and prevalence and incidence of mental disorders in adolescents and young adults. *Psychological Medicine, 37*, 1657–1666.

Teicher, M. H., Andersen, S. L., Polcari, A., Anderson, C. M., & Navalta, C. P. (2002). Developmental neurobiology of childhood stress and trauma. *Psychiatric Clinics of North America, 25*, 397–426.

Wadsworth, M. E., Raviv, T., Compas, B. E., & Connor-Smith, J. K. (2005). Parent and adolescent responses to poverty-related stress: tests of mediated and moderated coping models. *Journal of Child and Family Studies, 14*, 283–298.

Wall, R. B. (2005). Tai chi and mindfulness-based stress reduction in a Boston public middle school. *Journal of Pediatric Health Care, 19*, 230–237.

West, J., Denton, K., & Reaney, L. M. (2001). *The kindergarten year: Findings from the Early Childhood Longitudinal Study, kindergarten class of 1998–1999 (Publication No. NCES2001-023)*. Washington, DC: Department of Education, National Center for Education Statistics.

Windle, M., Spear, L. P., Fuligni, A. J., Angold, A., Brown, J. D., Pine, D., et al. (2008). Transitions into underage and problem drinking: developmental processes and mechanisms between 10 and 15 years of age. *Pediatrics, 121*(Suppl. 4), S273–S289.

Wolchik, S. A., Tein, J. Y., Sandler, I. N., & Ayers, T. S. (2006). Stressors, quality of the child-caregiver relationship, and children's mental health problems after parental death: the mediating role of self-system beliefs. *Journal of Abnormal Child Psychology, 34*, 221–238.