A Systematic Review of Yoga Studies to Design Children’s Yoga-Intervention Programs
Julie A. Wancik and Valerie E. Cadet, PhD
Dept of Biomedical Sciences, GA Campus, Philadelphia College of Osteopathic Medicine

Abstract
The movement of incorporating yoga and meditation programs into schools has become a current sensation in the United States. Historically, qualitative research measuring yoga and meditation’s effectiveness has laid the groundwork for recent quantitative studies. One study claims that yoga may induce immunoglobulin genetic variant shifts toward better health. Most of the variables isolated in yoga studies offer mental and behavioral health benefits for school-aged children. Research on cerebral cortical changes in the hypothalamic-pituitary-adrenal axis (HPA-axis) induced by high cortisol levels illustrated externalization of behaviors in children. To this end, a review of the reduction of cortisol levels in younger populations with yoga-meditation intervention programs has shown to be beneficial. Positive outcomes in self-esteem and a reduction in aggressioniveness have been widely reported with yoga trials in children. Further, an intervention of yoga and mindfulness with obese children showed a positive impact on reducing BMI levels and decreasing overall negative feelings. The empirical relevance of the social and emotional impact of yoga and meditation is clear yet needs further replication and increased methodology rigor of study designs. The direction for future research is toward more quantitatively, replicable studies that will assist in developing and validating the need for additional school-based yoga programs.

Selected Variables of Yoga Studies
Yoga decreases cortisol levels
- Cortisol level increase has been attributed to stress-induced situations and behaviors. Salivary cortisol levels have become the latest experimental variable used to quantitatively analyze the effects of yoga.

- Measurements of salivary cortisol levels in second and third grade students enrolled in classroom-based yoga were taken for 10 weeks. Enrolled students maintained significantly decreased salivary cortisol levels even after a stress stimulus was delivered (Butzer, et al 2015).

- The effect of social stress on weight gain and attention were assessed by measuring salivary cortisol levels in 84 middle school students. High salivary cortisol levels were positively correlated to the retention of excess weight and a decrease in task-oriented response-time. These students also had difficulty in discriminating directions in initiating task-oriented activities (Verdejo-Garcia, et al 2015).

- A longitudinal analysis of HPA-axis changes observed that hyper- and hypo-cortisolism could be associated with internalizing and externalizing behaviors caused by the disruption of diurnal cortisol patterns in the brain (Ruttle, et al 2011).

- Hankin et al (2015) uncovered that determining cortisol levels predate symptom elevations, thus correlating that an HPA-axis shift in adolescent girls could suggest a predisposition to psychopathologies.

Yoga causes mononuclear genetic changes
- In a small sample population of 10 subjects age 18-50 years old, yoga induced rapid changes in circulating immune cells significantly over a control group. Microarray analysis showed upregulation of peripheral blood mononuclear cell genes. Congruencies between experimental (Fig. A) and control groups (Fig. B) were assessed. Figure C shows that he congruently affected genes between the yoga and control groups (Qu, et al 2013).

- Nuclear Factor Erythroid 2 (NFE2) plays a role in megakaryocyte maturation. NFE2 deficiency is noted to cause a lack of platelets and hemorrhagic morbidity in lab animals.

- Upregulation of NFE2 was significantly different between the yoga intervention group and the control group (Fig. D).

Yoga affects behavior and promotes psychological changes in adolescents
- With a basic yoga technique called Iyengar, a 14-year old girl who suffered from persistent abdominal pain, sudden weight loss, and symptoms of anxiety made a dramatic full recovery from both pain and unwanted weight loss with diminished symptoms of anxiety (Evans, et al 2013).

- A review of short- and long-term psychological benefits of yoga studies in school-aged children shows that yoga improves the health outcomes in both healthy subjects and in subjects with physical illnesses (Menezes, et al 2015).

Future Study Recommendations
- Adequate control groups are essential to show evidence-based outcomes even in psychological test parameters.
- Salivary cortisol level fluctuation standardization and age-range should be taken into study design and methodology planning. Both time of day and age can determine variable readings and outcomes in yoga studies (Butzer, et al 2015).
- Understanding of the tendency for cortisol levels to down-regulation in high-risk, stressed adolescents is crucial to consider in a cortisol measured-stress reduction yoga study design (Ruttle, et al 2011).
- Genetic variant upregulation should be further measured and functional consequences assessed (Qu, et al 2013).
- Population demographics should be weighted with yoga intervention programs in order to account for socioeconomic stratification (Haden, et al 2014).

Acknowledgments
Appreciation and thanks to Dr. Brian Matayoshi for his influence and guidance in the development of this research topic.
Appreciation and thanks to my advisor, Dr. Valerie Cadet for her continued commitment and patience.
Special thanks to my fellow classmate, Nicole McManus, for her graphic design critiques.

References
- A 12-week study of middle-school aged children showed that yoga increased mindfulness and body awareness (Haden, et al 2014).
- An 8-week study of 66 college freshmen participating in a yoga-nirda intervention program (yoga with a guided meditation practice) showed that participants perceived a reduction in stress and an increase in mindfulness with skill-based tasks (Eastman-Mueller, et al 2013).
- Cognitive, social, and emotional skill improvements in second and third graders enrolled in classroom-based yoga for 10 weeks were assessed. Classroom teachers perceived mixed results with some teachers seeing improvements while others did not (Butzer, et al 2015).