Chapter - 3

REVIEW OF SCIENTIFIC LITERATURE

3.0 REVIEW OF SCIENTIFIC LITERATURE

Educators, researchers, and health care providers working with children have long been interested in understanding what causes children with average intelligence to suffer from academic underachievement, particularly when these academic difficulties are not the result of physical, social and environmental factors. Behavioral problems in children including mood disorders, emotional distress, peer pressures and adjustment problems are all said to contribute towards academic underachievement. For example, emotional distress, disrupted cognitive functioning, and deterioration in academic performance have all been theorized to be possible results of depressive moods. Specific clinical features of depression such as reduced attention span, lethargy, poor concentration and memory, as well as abridged task perseverance are all factors that have emerged as obstacles to effective learning.

The development of executive function is observed in association with structural changes in the brain (Hughes, 2011). Morphological analyses in children and adolescents have shown that brain maturation occurs at different rates in different brain regions: the primary sensory and motor areas are the first to complete development, while the association areas, especially in the frontal and parietal regions, are the last to mature (Gaillard, Grandin, & Xu, 2001; Mizuno et al., 2011). Maturation of the frontal and parietal regions is of great importance for adequate processing of executive function. Executive function is also related to control of attention (Sowell, Thompson, Holmes, Jernigan, & Toga, 1999), an important element of information processing that is embodied in the central executive component in theoretical conceptions of working memory (Cowan et al., 2005). Attention competency develops steadily through early and late childhood, perhaps due in part to the development of core processing resources (Bisanz, Danner, & Resnick, 1979; Cowan, 1988). In the literature on normal cognitive development, there are two general hypotheses: that as children grow older, they have more resources (Kail, 1991), or that they are able to utilize their existing resources more efficiently (Pascual-Leone, 2000). With more

resources or increasing control over resources, children become able to pay attention to more stimuli, allocate their attention more efficiently in accordance with task demands, and generally use and benefit from more sophisticated strategies in complex activities such as dual tasks (Swanson, 1999). Studies have also shown yoga to improve attention, memory and physical performance in socially disadvantaged children when compared to dance (Joshi & Telles, 2008; Naveen, Nagendra, & Telles, 1997). Studies have also shown that yoga practices that involve asanas, breathing and meditation improve spatial memory scores and show improvement in letter cancellation task and aerobic capacity. However, these findings have limitations as they are from a small cohort of population and different approaches have been used in different studies (Jella & Shannahoff-Khalsa, 1993; Joshi & Telles, 2008; Naveen, Nagarathna, Nagendra, & Telles, 1997; Sharma, Das, Mondal, Goswami, & Gandhi, 2005). Even studies with exercise training have shown improvement in cognitive performance in children (Larun, Nordheim, Ekeland, Hagen, & Heian, 2006). However, these findings have limitations as they are from a small cohort of population and different approaches have been used in different studies. Even studies with exercise training have shown improvement in cognitive performance in children.

In this study we evaluated the effects of two months of yoga vs. exercise in adolescent school children studying in higher primary and high school in rural districts of Karnataka on executive functions and physical performance.

3.1 EDUCATION AND COGNITIVE DEVELOPMENT IN HIGH SCHOOL CHILDREN: PROBLEM STATEMENT:

In the early part of the last century the present view of children's cognitive activity was similar to that of adults and would become more efficient with its continuous use. Piaget challenged this view by his claim and proposed the idea that children's qualitative thinking and learning develops progressively due to metabolism and hormonal changes in a high degree which is seen in their transitional period of adolescence. This led him to implement and test various practical and

teaching methods for students to encourage operational thinking, understanding learning tasks and apply them in the physical world. Adolescent cause changes on self, social and behavioral changes and if they are not properly monitored can result adverse impact on cognition and learning. Several studies in adolescent children have shown aggressive behaviour, addiction habits etc. and certain behavioral interventions in stages are effective, instill confidence and show improvement in them. He proposed the idea that a child thinks and learns qualitatively in different ways corresponding to their development periods and this brings a change in hormones and metabolism during adolescence (Piaget, 1976). This led him to implement and test various teaching pedagogies and students were encouraged in operational thinking, conceptual understanding and apply the same in their life. However, period of adolescence sees hormonal increase, behavioral and social modifications and feeling of sense of self that can adversely impact learning and cognition if not channelized properly. Several studies have shown delinquency problems to surface during adolescence such as aggression, bullying, addictive behaviors etc. and behavioral interventions have been shown to be useful.

Improving physical fitness, cognitive abilities and positive health behaviors in adolescence is very vital to growth and development of a child during adolescence. It is here that yoga as a mind body medicine plays a pivotal role in cognitive restructuring and physical development of children. Earlier small pilot studies have shown yoga to improve strength, endurance, attention span, working memory, mental speed etc. in children. However, these studies were small in their sample size that could have resulted in type II errors.

3.2 FOLLOWING FACTORS ARE KNOWN TO AFFECT COGNITIVE DEVELOPMENT IN CHILDREN:

- **Adolescence**
- **Malnutrition**
- **Socioeconomic Causes**

- **Obesity**
- **Physical Activity/Exercise**
- **Peer Pressure**
- **Anaemia**
- **Yoga**

3.2.1 Adolescence:

Adolescence is the transitional period between late childhood and the beginning of adulthood. It marks the beginning of the reproductive lifespan in humans. Adolescence involves sexual maturity in terms of hormones and physical development of the body and is also characterized by an increase in the complexity of group interactions and thus social behavior (Steinberg & Lerner, 2004). Adolescence is a period of development and consolidation of the social self, of one's identity and understanding of the self in relation to the social world (Coleman & Hendry, 1990). Anecdotal evidence and self-report data suggest that children seem to become progressively self-conscious and concerned with other people's opinions as they go through puberty and the period of adolescence (Steinberg, 2005). The psychosocial context of adolescents is markedly different to that of children and adults. Relationships with peers, family and society go through distinct changes during this time. Adolescents begin to assert more autonomous control over their decisions, emotions and actions, and start to disengage from parental control. At the same time, the school context involves an intense socialization process during which adolescents become increasingly aware of the perspectives of classmates, teachers and other societal influences (Adams & Berzonsky, 2003). Educators, researchers, and health care providers working with children have long been interested in understanding what causes children with average intelligence to suffer from academic underachievement, particularly when these academic difficulties are not the result of physical, social and environmental factors. Behavioral problems in children including mood disorders, emotional distress, peer pressures and adjustment problems are all said to contribute

towards academic underachievement. For example, emotional distress, disrupted cognitive functioning, and deterioration in academic performance have all been theorized to be possible results of depressive moods. Specific clinical features of depression such as reduced attention span, lethargy, poor concentration and memory, as well as abridged task perseverance are all factors that have emerged as obstacles to effective learning. Remodeling of the brain that occurs in adolescents as described earlier has been elucidated to influence the cognitive development during adolescence (Kail, 1991; Sowell et al., 1999). It is potential that neural plasticity facilitates the development of social cognitive skills needed during the period of adolescence. In the following section, we describe considerable neural developmental changes that take place throughout the adolescence.

3.2.1a Development of the adolescent brain

Recent studies using structural MRI approaches show considerable development during adolescence. Studies have shown that the changes are more pronounced in the frontal and parietal regions are long lasting and prolonged (Giedd et al., 1999; Gogtay et al., 2004; Sowell et al., 2003; Toga, Thompson, & Sowell, 2006). Studies also show an increase in grey matter density in these areas prior to adolescence. This is followed by a decline in GM volume during adolescence (Giedd et al., 1999; Gogtay et al., 2004; Sowell et al., 2003; Toga, Thompson, & Sowell, 2006).

3.2.1b Development of executive function

Structural development of these cortical regions may influence cognitive functioning during adolescence. A combination of behavioral and fMRI studies has demonstrated development of executive functions, related primarily to PFC development. Development (Bjork et al., 2004; Brown et al., 2005; Casey et al., 1997; Gaillard et al., 2000; Luna et al., 2001; Tamm, Menon, & Reiss, 2002) in another longitudinal study MRI study of participants aged between 3 and 29 years revealed that the trajectory of change in cortical thickness is associated with the development of IQ (Shaw et al., 2006).

3.2.1c Problems in adolescent children:

Adolescence is marked by changes in one's emotions and behavior. Adolescence is defined as the period of life between the ages of 10-to 19 years. The following factors have shown to influence adolescence:

1. The adolescent tries to develop his individuality while still conforming to societal norms.
2. Rapid urbanization and modernization and media have exposed them to changes in society. Relocating to urban conglomerates in search of opportunities has led to disintegration of joint families and rise in nuclear families. The resultant breakdown in family structure, excessive or minimal control confuses the adolescent and makes him/her especially vulnerable to maladaptive patterns of thinking and behaviour.
3. Healthy adulthood depends upon successful resolution of these emotional and behavioural problems.
4. Most adolescents are successful in treading this tightrope and go through to adulthood normally. However not all adolescents are fortunate with some developing maladaptive patterns resulting in depression, delinquency and suicides among other problems.
5. Studies have shown an increasing prevalence of mental illness and maladaptive behaviours among adolescents. WHO estimate shows that up to 20% adolescent have one or more mental or behavioural problems, (World Health Organization, World Health Organization. Department of Mental Health, Substance Abuse, World Psychiatric Association, International Association for Child, Adolescent Psychiatry and Allied Professions. (2005). *Atlas: child and adolescent mental health resources: global concerns, implications for the future*. World Health Organization). Studies conducted in different parts of the world show that prevalence of behavioural and emotional problems in adolescent's range from 16.5% to 40.8% and in India it is in the range of 13.7%to 50%. As adolescents form one fifth of India's population, this means a sizable disease burden on the society (Roberts et al., 1998; Jensen et al., & Liu;1995,

Mishra & Sharma, 2001, Belfer, 2005). Results from a study shows prevalence rate of 12.5% for psychiatric disorders in children (Srinath et al., 2005).

3.2.2 Malnutrition and Cognition

Malnutrition in children is due to insufficient intake of protein, carbohydrates and other micronutrients available in their diet which is known to prevent infections and retard growth (Udani, 1992). Prevalence of malnutrition has not improved despite improvement in economy in our country. Prevalence of anemia in pregnant mothers, low birth weight, lack of food supplements and poor nutrition still exists in the first five years of life. Malnutrition is associated with both structural and functional changes in the body and brain (Upadhyay, Saran & Agarwal, 1992).

Malnutrition results in tissue damage, retardation of growth, irregular differentiation, reduction in neural plasticity, delay in formation of myelin sheath and reduced brain function. This can also lead to disturbances in the neural circuits, brain formation and its maturation (Udani, 1992). Malnutrition also leads to the long-term alterations in brain function and long-lasting cognitive impairments (Levitsky & Strupp, 1995).

Children with malnutrition of grade II and III had behavioral problems such as lack of memory, deficit in learning language, difficulty in identifying words and objects and other social competences (Upadhyay, Agarwal, & Agarwal, 1989b). Rural children studying were assessed on measures of social maturity (Vineland social maturity scale), visuo-motor co-ordination (Bender gestalt test), and memory (free recall of words, pictures and objects). Malnutrition was associated with deficits of social competence, visuo-motor coordination and memory. Malnourished boys had a delayed recall of words and pictures compared with the girls for only pictures, and children with severe malnourishment a significant decline in their IQ level performances based on their IQ scores were found. Intelligence of malnourished children was measured using Malin's Indian adaptation of the Wechsler's intelligence scale for children. Among different studies conducted on Children there was a decrease in IQ level performance as well as on the subtests of information and digit

span among the verbal sub tests (Upadhyay, Agarwal, & Agarwal, 1989a). In the above study though there was a decrease in full scale IQ, yet performance on all the subtests were not affected. Authors studying Malnutrition in Africa and South America suggests that malnutrition may affect different neuropsychological functions to different degrees and have focused on the effect of stunted growth on cognitive abilities using verbal intelligence tests based on assessment of reasoning (Mendez & Adair, 1999). This study does not provide all capabilities on cognitive processes like attention, memory, executive functions, visuo-spatial functions, and comprehension. This suggests that malnutrition may affect different neuropsychological functions. Hence, information on specific cognitive functions has implications for developing a cognitive rehabilitation program for malnourished children. A neuropsychological assessment highlights the functional status of brain- behavior co-ordination. Deficits of cognitive, emotional and behavioral functioning are linked to structural abnormalities of different regions of the brain. Brain structures and circuits compute different components of cognitive processes (Posner, Petersen, Fox, & Raichle, 1988). Although the cognitive processes like executive functions are not fully assessed malnutrition has a long-lasting effect in the domain of cognition and behavior (Levitsky & Strupp, 1995). Short and tall children do differ in some cognitive tests, but not in all as demonstrated in a study done in Orissa, India. Malnourished children with differential nature of cognitive deficits suggest that different areas of their brain are compromised to different degrees as assessed using neuropsychological tests. About 52% of the children in India are malnourished and Protein Energy Malnutrition is also associated with the poor socio- cultural class. Literacy level, height of children and stunting of growth is related to decrements in cognitive function (Das & Pivato, 1976). Neuropsychological tests in children can demonstrate delay in normally developing cognitive processes as well as permanent cognitive deficits.

3.2.3 Socio-economic causes and Cognition:

Cognitive Neuroscience highlights children's cognitive development on neural maturation and plasticity. Studies conducted on 5 to 10 % of all children who suffer from dyslexia with cognitive and neural deficiency showed brain gradually learns and processes language (Ahissar, 2007).

According to the studies and research on basic science shows how the brain gradually learns and processes language. Learning difficulties are due to low socioeconomic status (SES) and genetic inferiority factor and differences in the environment shape neural development (Hackman & Farah, 2009).

3.2.3a Influence of media on children:

Modern society has increasingly become dependent on media and communication technologies, Children and adults alike spend a significant amount of time on media technologies such as smart phones, television, video games, social media etc. that can lead to addictive behaviors. Children worldwide are spending more and more time in front of television sets or computer screens and on cell phones, making media a central part of their lives. Young people today are expected to be and are often constantly online and also experience cyber bullying and shaming (Cassano et al., 2010).

Although media is a knowledge resource for children and adolescents' mental health, its intense use leads to questions concerning young people's capacity and interest to bring balance between physical and mental activities. Increase reliance on mobile phones have also reduced playing time and outdoor activities and impacted physical health and led to obesity. More recently media has emerged as a factor of mental illness, dependency, obsessive compulsive behaviors, concentration problems, and other attention disorders (Bianchi, et. al., 2005; Kim & Lee, 2015; Leung, 2014; Roberts & Pirog, 2013; Song, Larose, Eastin, & Lin, 2004). Young children being exposed to violence, and sexually explicit material, as well as extreme or inappropriate behaviors, are being highlighted. The world at large, including the deviances of society, is much closer and easily accessible with media tools and technologies.

3.2.4 Obesity and Physical Health

Obesity is a condition where excess of fat gets accumulated in the body which may cause harmful effects on health. It is measured by body mass index (BMI) with obesity in Indians being defined as a BMI >30kg/m2 and overweight being 25 – 30 kg/m2.

According to National Health and Nutrition Examination Survey (NHANES) an increasing trend for obesity was seen in the US children in the period 2002 to 2012. The prevalence of obesity was 17.3% in children and 5.1% met criteria for class II and 2.3% for class 3 obesity (Skinner & Skelton, 2014).

In South Karnataka a survey among adolescent school children showed overweight among adolescents was 11.4% (25 – 29.9), and obesity (30 and above) was 4.8% (Kotian, Kumar, community, & 2010) in those with higher SES being twice more obese than others.

Obese children are less fit and physically not active. They tend to lead a sedentary life and have eating disorders. They show preference for sugars, sweets and high calorie diets. Obesity leads to diabetes, hypertension, sleep apnea, PCOS in girls and other health issues in adolescent children (Ogden, Carroll, Kit, & Flegal, 2012).

Children suffering with obesity are one of the main focuses in public health issues all over the world. Across every demographic area in the United States and currently over 35% of children are overweight or obese children have increased in the past 30 years (Ogden et al., 2012). Childhood obesity is still continuing, and BMI has been on the rise in children and adolescents (Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008) which may lead to metabolic and cardiovascular consequences it impacts adversely on psychosocial factors besides quality of healthy life and lower educational standards (Dietz, 1998). Behavioral and dietary changes and physical activity may have implications for cognitive health and scholastic performance.

3.2.4a Obesity and cognitive health:

The total impact of obesity on cognitive outcomes and educational standards is important (Telfair & Shelton, 2012). Lower academic performance could further predispose obese children to a lower quality of life. Association between obesity and academic performance also includes psychosocial factors (such as altered peer relationships), (Wong et al., 2011a) poor self- esteem (Wang &

Veugelers, 2008), and weight-based teasing (Krukowski et al., 2009), physiological factors (such as sleep apnoea) (Spruyt & Gozal, 2012), and school absenteeism. (Schwimmer, Burwinkle, & Varni, 2003) Low academic performance could further lower quality of life (Ashlesha Datar, Sturm, & Magnabosco, 2004; Zavodny, 2013) sometimes teacher's perception may also be negatively associated with obese children showing poor performance in test scores (Veldwijk et al., 2012). There is conflicting evidence showing direct link between childhood obesity, cognitive outcomes, and in measures of poor academic performances. Cross-sectional studies have found an inverse relationship between BMI and visuospatial organization and general cognitive ability, after controlling covariates (Li, Dai, Jackson, & Zhang, 2008; Veldwijk et al., 2012). Few other studies that focus mainly on adolescents have found statistically significant associations in language and math grades, (Mo-suwan, Lebel, Puetpaiboon, & Junjana, 1999) with grade progression, (Falkner et al., 2001) and grade point average in girls, (Ding, Lehrer, Rosenquist, & Audrain-McGovern, 2009). Others have found no evidence of an independent association. (Kaestner & Grossman, 2009; Veldwijk et al., 2012; Scholder, Smith, Lawlor et al., 2012) minimum two longitudinal studies have found an inverse association between academic performance and BMI in elementary school children (Averett & Stifel, 2010; Datar & Sturm, 2006). Data and colleagues (2006) examined the association between changes in overweight status and changes in school outcomes over time; where they showed that changes in weight did affect the outcomes. Other studies have found no association between obesity and academic performance (Carter, Dubois, & Ramsay, 2010; Pereira et al., 2007). It is worth noting that even studies using similar or overlapping populations within the same data set have found inconsistent results, likely reflecting differences in model specification (Carter et al., 2010; Datar & Sturm, 2006; von Hinke Kessler Scholder et al., 2012).

3.2.5 Exercise and Cognition:

Several studies support the role of exercise in improving cognitive function, prevent psychiatric disorders and boost mental health. Neuroimaging findings examined on individuals who practice

exercises reveal that there is a relationship between cognitive gain and activity of specific neural network in the cerebral cortex and hippocampus (Bugg & Head, 2011; Pereira et al., 2007). Exercises affect the underlying mechanisms of cognitive abilities, learning and memory. Exercise has its influence on synaptic plasticity and cognition also harmonizes metabolism of energy at cellular level associated with synaptic plasticity and neuronal excitability. It also supports neuronal signaling through plasma membrane of mitochondria. Brain derived neurotrophic factor (BDNF) molecular systems can play an important role on exercise induced cognitive enhancement

3.2.5a Exercise during childhood:

Sibley and Etnier (Kramer & Erickson, 2007) conducted a meta-analysis and found a positive relationship between physical activity and cognitive function in school age children (age 4–18 years), suggesting that physical activity may be related to cognition during development. Examination of the findings revealed that physical activity participation was related to cognitive performance along eight measurement categories (i.e., perceptual skills, intelligent quotient, achievement, verbal tests, mathematics tests, memory, developmental level/academic readiness, and other), with results indicating a beneficial relationship of physical activity on all cognitive categories, with the exception of memory (Kramer & Erickson, 2007). Although this effect was found for all age groups, it was stronger for children in the 4 to 7 and 11 to 13-year groupings, compared to the 8 to 10 and 14 to 18-year groupings.

Studies have shown association between fitness and cognition during preadolescent development. In a study changes in aerobic capacity was related to changes in performance in Stroop task (Erickson et al., 2010). School-age children provide an excellent means by which to examine this relationship in the real world, as performance on fitness tests and academic achievement tests are routinely assessed as part of school curriculum. A growing literature base is beginning to develop on this topic, with the available data indicating that fitness has either a positive relationship or no relationship to scholastic measures of cognition (Flöel et al., 2010; Ostrosky-Solís, 2003; Raz,

Gunning-Dixon, Head, Dupuis, & Acker, 1998; Wu & Bancalari, 2017). Regardless, the data suggest that time spent engaged in physical activities is beneficial as it does not detract from scholastic performance and can in fact improve overall health and function.

3.2.5b Biological rationale for the effects of exercise on cognition:

Physical activity influences hippo campus one of the main brain region for memory processing, it also influences the hypothalamus which controls cognitive abilities and produce energy for various activities of motor function of the body like upright walking and with the coordination of cognitive strategies of the brain is also known as metabolic brain (Chaddock et al. 2010)

Studies on effects of physical activity on neuronal and cognitive functions can be gained from experiments in the ageing population**.** Studies done on images on older humans compared the volume of hippocampus with cognitive performance as a function of aerobic fitness (Erickson et al., 2009, 2010, 2011). Specifically, Erickson et al. (2011) investigated 165 cognitively healthy older adults between 59 to 81 years had their cardiorespiratory fitness assessed via a maximal graded exercise test, and their hippocampal volume measured using(fMRI) on a spatial memory task performance. Findings also indicates that higher fitness was linked with larger bilateral hippocampal volume, and this was further associated with better spatial memory performance (Erickson et al., 2010). Another study shows that exercise increases hippocampal volume and higher levels of BDNF with improvement in spatial memory and memory performance (Laske et al., 2010).

Within the hippocampus, the dentate gyrus is uniquely susceptible to exercise intervention, with an increase in exercise-relate behaviour relating to neurogenesis (Chaddock et al., 2010). BDNF has been related to hippocampal volume, has implications for learning and memory. Specific to humans, circulating BDNF has been related to hippocampal volume, with aerobic fitness related to the upregulation of BDNF serum levels and greater hippocampal volume among older adults (Chaddock et al., 2010). Study in younger populations, suggests that aerobic fitness relates to

larger hippocampal volume and better relational memory performance (Spirduso, 1980), during preadolescent childhood.

3.2.6 Peer Pressure:

Peer Influences on Adolescent Risk Behavior

Peer pressure and competitiveness no doubt pose a significant stress in adolescents leading to aggression, poor academic grades and often a delinquent behavior. Adolescents are more vulnerable and get into risk decisions very soon (Gardner & Steinberg, 2005; Steinberg & Monahan, 2007). Family feuds, divorces and single parenting, low socioeconomic status not only cause distress but also lead them towards bad health behaviors such as smoking, drug addiction etc. at this young age. Also, the fear of exclusion from the peer group may also lead them to socialize and engage in risky behavior (Bauman & Ennett, 1996).

3.2.7 Anemia and Cognitive performance in children:

Anemia affects almost 300 million children worldwide Ruel-Bergeron et al., (2015) with iron deficiency (ID) the most important cause. Impairments in cognitive development caused by ID are the cornerstone for iron supplementation and nutritional intervention in children and pregnant mothers. An association between impaired cognitive development and ID has long been recognized and has underpinned the rationale for policy. Various studies have shown anemia to impair cognitive function in children (Allen et al., 2017). However, recent evidence synthesis has drawn attention to the limitations in our understanding of this topic. Nutrition is very important in the first two years of life where brain development is the fastest (Prado & Dewey, 2014). There has been enormous interest in optimizing iron stores during this sensitive period of rapid brain development (Cusick & Georgieff, 2016), and interventions which prevent or treat iron deficiency anemia (IDA) in pregnancy or in the first 2 years of life have been considered crucial to improving long-term outcomes in children. However, the results with iron supplementation are not

conclusive. There are several studies that have shown hematological disorders that causes anemia to impair cognitive performance in children (Allen et al., 2017).

3.2.8 Role of yoga in improving performance in children:

It is common knowledge that stress can have serious health consequences. If unaddressed consistently, a high stress level could become a chronic condition, which could result in a range of health problems, including anxiety, insomnia, muscle pain, high blood pressure, and a weakened immune system. Research indicates that stress can even contribute to the development of major illnesses such as heart disease, depression, and obesity or exacerbate existing health issues. When such young adults are responsible for child care, they may tend to transmit their tensions to their children; thus, the situation becomes doubly alarming and worrisome for their families. Children learn to internalize the stresses. Their self-imposed expectations to meet the standards set by their caregivers, schools, and society may cause them anxiety. Moreover, internalization of self-expectation may become non-malleable for young people.

Yoga involves an eight-fold step or techniques some of which are postures (*asanas*), Breath control (*pranayama*), relaxation and meditation (focussed attention) (Muktibodhananda, 2012). All these techniques seem to exert psychophysiological effects that influence one's psychological state (Telles, Gaur, & Balkrishna, 2009; Telles, Singh, Joshi, & Balkrishna, 2010) bringing about reductions in depression, stress, anxiety levels (Büssing, Michalsen, Khalsa, Telles, & Sherman, 2012; Erickson et al., 2009; Ferreira-Vorkapic, et al, 2015; Granath, Ingvarsson, von Thiele, & Lundberg, 2006; Kirkwood, 2005; Kozasa et al., 2008; Naveen et al., 1997; Subramanya & Telles, 2009a; Telles, Singh, Bhardwaj, Kumar, & Balkrishna, 2013) and posttraumatic disorder (Cabral, Meyer, & Ames, 2011).There are also improvements in mood (Khalsa, 2013), quality of life, and well-being (Balasubramanian & Pansare, 1991; Lin, Hu, Chang, Lin, & Tsauo, 2011). Apart from these therapeutic effects, yoga has been utilized in school settings, where students are trained on wellness and health (Serwacki & Cook-Cottone, 2012).

Children and Adolescents spend an average of 10 to 15 years in schools. Schools can mold children's healthy behaviours at an early age. The discipline and resilience developed by practicing contemplative techniques help children to deal with stressors, anxiety, traumas, abuse, learning disabilities, and even bullying, (Ramadoss & Bose, 2010). Adolescence is a vulnerable age for onset of most mental health disorders with prevalence rate for them being around 7.5% (DSM IV-TR criteria) (Noggle, Steiner, Minami, & Khalsa, 2012b).

Mind-body practices have been shown to redirect attention, improve concentration, increase self-control, and bring about healthy coping mechanisms to manage anxiety, stress and learning disabilities (Ramadoss & Bose, 2010). However, the evidence for efficacy of such practices among children is insufficient. While a review conducted by Galantino et al. (2008) found beneficial effects of yoga in the children. A recent meta-analysis concluded that the data effects of yoga among the children are uncertain (Birdee et al., 2009a). Though there was a benefit finding, the results were based on trials of poor quality.

Studies on yoga in school settings have been shown to benefit children and adolescents in reducing anxiety, negative behaviour, improve attention and cognitive skills (Serwacki & Cook-Cottone, 2012). According to Khalsa et al. (2012), a yoga program might help children recover their self-esteem and confidence, reduce stress, anxiety, mood disorders and promote positive health. Unfortunately, today's education focuses primarily on intellectual development, and not on one's personality development programs. Studies have also shown yoga to improve attention, memory and physical performance in socially disadvantaged children when compared to dance (Joshi & Telles, 2008; Naveen et al., 1997). Studies have also shown that yoga practices that involve *āsanas*, breathing and meditation improve spatial memory scores and show improvement in letter cancellation task and aerobic capacity. However, these findings have limitations as they are from a small cohort of population and different approaches have been used in different studies (Jella & Shannahoff-Khalsa, 1993; Joshi & Telles, 2008; Naveen et al., 1997; Sharma et al., 2005). Even

studies with exercise training have shown improvement in cognitive performance in children (Larun et al., 2006).

Academic accomplishment is shown to be related to health status and ability to maintain health is related to learning and academic performance. There is an urgent need to evaluate cost-effective and evidence-based wellness programs that can be delivered in school settings.

In a recent review on yoga interventions in school children Forty-eight peer reviewed, published studies were analyzed where cognitive functions and psychologic wellbeing were analyzed. After analysis, nine studies were selected (Ferreira-Vorkapic et al., 2015).

Among the studies that looked at effects of yoga on psychological well-being, three of them support the benefits of yoga-based programs for children in school settings. Khalsa et al., 2013 showed that yoga participants had better anger control and decrease in fatigue/inertia than controls following intervention Noggle et al. (2014) also observed preventive benefits in psychosocial well-being (anxiety and negative affect). While Ramadoss and Bose (2010), demonstrated a decrease in stress while maintaining self-control following yoga.

In contrast, three other studies did not show significant differences between yoga and control groups. Haden et al., (2014) and White (2010a) observed a significant increase in perceived stress in the yoga group compared to the physical education and control groups, respectively. However, in White (2010b), there was no significant difference between yoga and control groups on self-esteem and self-regulation over time. Lastly, Hagins et al. (2014) did not find difference in stress reactivity between yoga and control groups.

3.2.8a Role of yoga in improving cognitive functions in children:

Yoga was an important part of gurukul tradition in ancient India. The philosophy and practice of yoga has been passed over generations and centuries through the Guru Shishya parampara. There have been several studies on effects of yoga in children and more so in education and development.

Yoga defined as 'way of life', is characterized by balance, health, harmony and bliss. The holistic practice of yoga includes ethical, physical, emotional, and mental discipline as well as the attainment of enlightenment Burkett, (2006). Apart from achieving physical health through breathing techniques and asanas, the psychological benefits of yoga include the ability to maintain cognitive control, especially in the areas of attention, concentration and memory. Meditation is the process of training one's attention to either focus on one thing (e.g., breath, a mantra) or to notice and observe external and internal sensations without judgment-or both. Yoga and meditation practice has been found to have positive effects on physical fitness, mood, anxiety level and cognitive functioning (Abadi & Venkatesan, 2008; Berger & Owen 1992; Subrahmanya & Telles, 2009). Regular practice of yoga is implicated in the healthy development of the body, mind and spirit, leading to a more fulfilling life (Bhole, 1983). Specifically, inverted yoga positions have been associated with claims of increased memory and attention due to increase blood flow to the brain. Schaeffer (2002) claimed that yoga can prevent memory lapses and enhance concentration. It can also improve powers of recall by increasing circulation to brain. Anantharaman and Kabir (1984) reported the beneficial effect of yoga practices on attention, concentration and memory.

Sahasi (1984) found that practicing yoga/meditation improves memory and attention in children. Another study Peck, Kehle, Bray, &Theodore, (2005) found that children had improved functions on measures of attention after practicing yoga. Modern cognitive psychology describes attention as the ongoing process of filtering out information from the perceived environment and of focusing on specific elements (Ashcraft, 2005; Goldstein, 2007). Valentine and Sweet (1999) have repeated that there was statistically significant increase in attention test scores after mindfulness meditation,

and concentrated mediation sessions. Concentration is the cognitive process of selectively paying attention to one thing to the exclusion of other over a period of time. Dolde (2011) reported that yoga produces positive changes in concentration, energy and wellbeing. Memory is the ability to recall or remember past events or previously learnt information or skills. Amit and Neelam (2012) conducted a study on adolescents which showed that the adolescents who practice yoga have had higher concentration levels and exhibited better short-term memory. Despite the facilitatory role of yoga and meditation on our day-to-day activities, cognitive functions and well-being, the practice of yoga has not yet become a regular part of our curriculum. Recently several schools have come forward to introduce yoga and its daily practice a compulsory element of schooling.

3.3 LIMITATIONS IN EXISTING STUDIES:

There are several limitations in the existing studies. Majority of the studies do not have an active control group, most are of small sample size and lack generalizability of findings, and many more have design and methodology issues as evidenced by metanalysis.

The modest or negative effects of yoga observed in some of the studies may be due to (1) the adaptation process, (2) attentional control, and (3) inadequacy of yoga practice for children. Initially the practice of yoga may seem difficult as it requires effort and discipline. This may lead to an initial increase in stress as a part of the adaptation process (Wong et al., 2011b), Additionally, accomplishment in yoga depends on acquired self-confidence where studies have demonstrated that participants in yoga show increased self-worth based on one's confidence (Benavides & Caballero, 2009).

Secondly, Yoga techniques such as breathing, and meditation require attentional control, an executive function that is still not mature in children and adolescents. As the frontal lobes mature (Gogtay et al., 2004), children's capacity to exercise attentional control increases (Astle & Scerif, 2009), but this ability remains much poorer in children (Davidson, Winchester, Taylor, Alderman, & Ingels, 1979). Yoga has been found to improve attention in adults and children (Harrison, Manocha, & Rubia, 2004a; Jensen & Kenny, 2004a; Subramanya & Telles, 2009b). Therefore,

yoga practice should be specifically adapted to children to enable them to reap the benefits seen in adults.

Third, duration of yoga practice observed in some of the studies might not be suitable for children due to their inability to control attention and reduced discipline. In studies where the yoga practice has not been found beneficial for the students (Birdee et al., 2009b; Noggle, Steiner, Minami, & Khalsa, 2012a; Ramadoss & Bose, 2010), sessions were short and condensed, lasting from 15 to 30 minutes. Additionally, many of these studies compared the effects of yoga to exercise (physical education) and have observed very similar results.

One of the highlights of yoga practice is self-awareness and mindfulness, a primary difference between yoga and standard physical education, and these variables were not assessed in any of the studies. Physical education and yoga can be considered as complementary to one another each having its own synergistic effects.

A recent review identified three RCT studies that compared the effects of yoga-based interventions on different cognitive functions, such as attention, memory, and developmental abilities. Overall, there were improvements in mini mental status scale (Rao & Sarokte, 2013a), mental ability, and memory (Verma, Singh, Gupta, & Gupta, 2001) while performing the Stroop task (Telles et al., 2013). Lowered mood is associated with declines in cognitive function. In adults, yoga has been reported to produce improvements in mood (Berger & Owen, 1988, 1992). Yoga improves general attention abilities in adults (Harrison, Manocha, & Rubia, 2004b; Jensen & Kenny, 2004a; Maddigan, et al., 2003; Subramanya & Telles, 2009c). Internal awareness is a key aspect of yoga and promotes effects similar to relaxation such as self-control, concentration, self-efficacy, and body awareness. Improvements in attention tasks have been observed in studies with children suffering from ADHD (Jensen & Kenny, 2004b; Maddigan et al., 2003). Neuroimaging studies in adults showed increased grey matter density in putamen (Pagnoni, 2007) and anterior cingulate cortex (Grant et al., 2013), structures involved in attention processing.

Yoga practice has been shown to reduce psychological arousal and anxiety (Telles, Nagarathna, & Nagendra, 1998) (though this variable was not measured), and studies with adults have verified that anxiety affects performance on attentional tasks (Keeley & Fox, 2009; Sarang & Telles, 2007). All these studies suggest anxiety reduction as the principal mechanism for beneficial effects.

Two of the studies showed significant improvements in memory tasks after a few weeks of yoga-based interventions (Rao & Sarokte, 2013b; Verma, Shete, & Thakur, 2014). Memory improvement following the practice of breathing exercises (pranayama) (Naveen et al., 1997) or contemplative techniques such as meditation (Bishop et al., 2006; Ortner, Kilner, & Zelazo, 2007), a pivotal part of the yoga practice, has been widely demonstrated. Activation in the hippocampus, a subcortical structure known to be critically involved in memory processes (Squire, 1992), has been reported during meditative states

3.4 NEED FOR THE STUDY:

Due to low quality of studies and inconclusive findings as described above, it is imperative to conduct a large phase III Randomized controlled study to increase the generalizability of the findings to the population. Second, the study conducted in field settings will help throw feasibility of such interventions in community settings. Third, using physical education classes as an active comparator helps understand the utility of yoga intervention viz. current approaches.