2019

The Effects of a 10-week Judo Program on Cortisol and Stress in Children with Autism Spectrum Disorder

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THE EFFECTS OF A 10-WEEK JUDO PROGRAM ON CORTISOL AND STRESS IN CHILDREN WITH AUTISM SPECTRUM DISORDER

by

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B.S. West Virginia University, 2015

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Science
in the School of Kinesiology and Physical Therapy
in the College of Health Professions and Sciences
at the University of Central Florida
Orlando, Florida

Spring Term
2019

ABSTRACT

Children diagnosed with Autism Spectrum Disorder (ASD) often have increased levels of stress, leading to dysregulated production of cortisol. Elevated levels of cortisol have numerous known adverse health consequences, and therefore, interventions should be established to help attenuate cortisol production. As judo combines physical activity and mindfulness practice, it may aid in stress reduction and decreased levels of cortisol. **Purpose**: To examine the effects of a 10-week judo program on stress reactions and salivary cortisol levels in youth with ASD. **Methods:** 20 children with ASD participated in the 10-week judo program. Changes in acute (before and after one judo session) and chronic salivary cortisol levels were assessed at baseline and post intervention. Parents of participants were asked to complete the Stress Survey Schedule (SSS) to determine severity of stress reactions. The SSS consists of 10 subscales: changes, anticipation, unpleasant, positives, food related, rituals, social/environmental, sensory/personal, fears, and life stressors. Sleep quality was assessed via Actigraph GT9X accelerometers over a 7-day period at baseline and post-intervention. Paired samples t-tests were used to determine differences SSS pre/post-intervention. Repeated measures ANOVA was conducted to determine differences and in cortisol levels before and after one judo session and pre and post-intervention. Spearman correlations were used to determine correlations between sleep quality and subscales of the SSS. **Results**: Although not statistically significant, a trend was noted indicating a decrease in cortisol levels following one judo session ($p=.057$). Nonsignificant reductions in the subscales “changes ($p=.14$)” and “unpleasant ($p=.12$)” of the SSS were also observed. **Conclusion:** Acute changes in cortisol levels may be seen following one session of judo. Subscales of parent-reported questionnaire may also show improvements following 10 weeks of participation in a judo program.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I: INTRODUCTION

Autism Spectrum Disorder (ASD) is a developmental disability that affects approximately 1 in 59 children in the United States (CDC, 2018). This number had increased nearly threefold since 2000 when diagnosis rates were 1 in 150 children (CDC, 2018). Individuals diagnosed with ASD face a variety of behavioral, social/emotional, and intellectual challenges such as repeated body movements (such as flapping or rocking), over-reaction to sensory input (e.g. bright lights, or loud noises) and aggressive, self-harming behaviors (Bremer, Crozier, & Lloyd, 2016; Miles, 2011). A primary symptom of ASD is impairments in communication and social interaction with other peers (Bremer et al., 2016). In addition, individuals with ASD tend to be inflexible, preferring to adhere to a routine rather than engage in a variety of new activities. Finally, evidence indicates that the majority of youth with ASD do not meet the recommended levels of physical activity (PA), and are less active than their typically developing (TD) counterparts (Ash, Bowling, Davison, & Garcia, 2017). Due to the multitude of challenges faced by individuals with ASD, high levels of stress are common, which may lead to adverse health conditions (Bremer et al., 2016; Zinke, Fries, Kliegel, Kirschbaum, & Dettenborn, 2010).

Individuals with ASD reportedly experience more stress than their TD counterparts, partly due to their inability to adapt to unfamiliar situations (Bremer et al., 2016). According to Zinke et al (2009), difficulties responding to changes in routine or environment may be related to altered functioning of the hypothalamus-pituitary-adrenal (HPA) axis. The HPA axis is responsible for the production of cortisol, which is secreted both in a diurnal rhythm and in

response to stressors (Corbett, Schupp, Levine, & Mendoza, 2009; Zinke et al., 2010). It has been previously shown that children with ASD exhibit a prolonged elevation of cortisol when exposed to a stressor, in comparison to TD children. Previous research suggests that this response is indicative of an impaired negative feedback mechanism (Corbett, Mendoza, Abdullah, Wegelin, & Levine, 2006). In other words, while cortisol levels in TD children usually increase during a period of stress and then return to baseline levels following the cessation of the stress, this may not be true in individuals with ASD. Prolonged elevated levels of cortisol can be detrimental due to the associated adverse health effects that include the following: weight gain, high blood pressure, fatigue, impaired sleep, anxiety, irritability, and cognitive difficulties (Fraser et al., 1999). These symptoms are concerning in a population that is already susceptible to these risk factors. Impaired sleep is particularly bothersome, given the high prevalence of sleep disturbances in this population and the consequences that often correspond (Cortesi, Giannotti, Ivanenko, & Johnson, 2010). Therefore, it is critical to develop interventions that may help to attenuate prolonged elevated levels of cortisol in this population.

Treatments for behavioral symptoms of ASD typically consist of various pharmacological or cognitive behavioral therapeutic approaches; however, the use of PA as an alternative treatment has been gaining support among health professionals. It has been well established that participation in PA is linked with improvements in physiological and psychosocial health factors (Ash et al., 2017). Specifically, evidence indicates that various modes of physical activity alleviate symptoms of depression, anxiety, aggression, and stress in children (Ash et al., 2017). It has been shown that physically active children demonstrate reductions in stress reactivity (i.e., cortisol response) (Horsch A et al., 2014). Unfortunately, these findings are

limited to TD children, and therefore, it is imperative to investigate perceived stress and cortisol response following PA interventions in youth with ASD.

Interestingly, participating in PA that incorporates mindfulness practices, such as yoga, may be superior to other forms of PA in reducing symptoms of stress in youth with ASD (Butzer et al., 2015). Although no studies have investigated cortisol levels and stress response to mindfulness-based PA in youth with ASD, results from similar programs in TD populations demonstrate significant reductions in stress and cortisol production (Butzer et al., 2015).

Another effective mindfulness-based activity is the practice of martial arts, which has been linked with improvements in several physical and psychosocial measures, such as self-regulation, and social interaction (Lakes & Hoyt, 2004). While numerous types of martial arts have been shown to increase both physical and mental health of children, judo is especially intriguing as it incorporates mindfulness components to a greater degree than other forms of martial arts such as karate or taekwondo (Hanrahan, McCarthy, Kleiber, Lutgendorf, & Tsalikian, 2006; Lamarre & Nosanchuk, 1999). Judo promotes self-discipline and body awareness, which are two areas often limited in youth with ASD. It is established that separately, mindful activities (e.g., yoga) and moderate-to-vigorous physical activity (MVPA) both attenuate adverse physical, behavioral, and psychosocial health risks typically experienced by individuals with ASD. Because judo incorporates both mindfulness and intense bouts of PA, it may be especially beneficial to this population. As there are no studies that have evaluated the effect of participation in a mindfulness-based PA program in youth with ASD, the purpose of this study was to examine the effects of a judo intervention on cortisol levels and psychosocial stress in youth with ASD.

CHAPTER II: REVIEW OF LITERATURE

The prevalence of Autism Spectrum Disorder has nearly tripled between the years of 2000 and 2014 (Center for Disease Control and Prevention (CDC), 2018). This is concerning due to the plethora of challenges faced by these individuals. ASD is typically characterized by a variety of behaviors and impaired social interaction/communication (American Psychiatric Association, 2016). Behavioral symptoms include flapping, rocking, echolalia, and other various compulsions, while social impairments consist of communication deficits, lack of empathy, difficulty making friends, and lack of eye contact (Bremer et al., 2016; American Psychiatric Association, 2016). Because of the need for consistency and routine, unfamiliar social situations that require spontaneous reactions or responses contribute to increased anxiety and stress (Lopata, Volker, Putnam, Thomeer, & Nida, 2008). Increased levels of stress and anxiety result in an increase in the production of cortisol, which can lead to additional adverse health consequences (Corbett, Schupp, Simon, Ryan, & Mendoza, 2010).

The production of cortisol follows a circadian rhythm, with the peak production being early in the morning, shortly thereafter awakening (Wilson, 2014). In addition, cortisol is produced in response to both physical and psychosocial stressors. The HPA axis is ultimately responsible for the production and regulation of cortisol via a negative feedback mechanism (Smith & Vale, 2006). When a stressor is present, the hypothalamus produces Corticotropin-releasing hormone (CRH), which causes the pituitary gland to secrete adrendocorticotropic hormone (ACTH), and in turn, the adrenal glands secrete cortisol (Sean Smith & Vale, 2006). Cortisol then inhibits additional production of ACTH. After the stressor has subsided, cortisol levels will begin to gradually fall back down to baseline levels for approximately one hour (Spratt et al., 2012). For individuals with ASD, cortisol levels tend to remain elevated for

prolonged periods of time after stress has subsided (Spratt et al., 2012). It is believed that this population has an impaired negative feedback mechanism (Corbett et al., 2006). Prolonged elevated levels of cortisol are associated with numerous adverse health effects such as high blood sugar, high blood pressure, weight gain, decreased muscle mass, cognitive difficulties, anxiety, fatigue (Walker, 2006). Experiencing high levels of cortisol for an extended period of time increases the risk of metabolic syndrome and cardiovascular disease (Walker, 2006). Furthermore, chronically elevated levels of cortisol can lead to a change in circadian rhythm cortisol production (Wilson, 2014). Typically, cortisol production peaks approximately 30 minutes after awakening and steadily decreases throughout the day; in individuals with ASD, it has been shown that while cortisol production in the morning may be normal, levels do not steadily decrease and moreover, begin to rise again at night (Corbett et al., 2009). For those who experience chronic stress, morning cortisol levels may even be low (Corbett et al., 2009). Low levels of cortisol are associated with adrenal fatigue and symptoms are similar to those of high cortisol (Wilson, 2014). As individuals with ASD are already susceptible to many of these negative effects, it becomes vital to understand how to prevent such irregular levels of cortisol. Further, it is critical to develop interventions that attenuate abnormal cortisol levels or responses.

Varying data exists to describe stress response in children with ASD. Extant literature has attempted to examine cortisol response, typically involving psychosocial stressors; however, methodologies and sample sizes are limited. The majority of research examines the effect of social stress on cortisol production and perceived stress. In a study by Richdale and Prior (1992), it was found that children with ASD (n=18), when compared to TD children (n=19), experienced increased urinary cortisol levels when they were integrated into mainstream school system (thus creating an unfamiliar social situation). The children were then removed from the mainstream

school system, and cortisol levels returned to match control subjects (Richdale & Prior, 1992). A study by Lopata et al. (2008) found similar results; 33 children diagnosed with ASD were placed in a summer program. Participants were then exposed to either a person that they were familiar with or a person that they were not familiar with. When exposed to a familiar individual followed by an unfamiliar individual, cortisol levels increased. Another study by Corbett et al. (2010) observed 21 children with ASD and 24 TD children after placing them in a social situation on a playground. Playground settings consisted of one child with ASD, one TD child, and a child who served as a confederate. Following a 20-minute play session, children with ASD had elevated cortisol levels in comparison to TD children. Interestingly, this study found that children with ASD aged 11 and older showed significantly higher levels of cortisol compared to children with ASD aged 9 or younger. This could potentially be because younger children with ASD were more likely to avoid the unfamiliar social situation altogether, as opposed to the older group that engaged with others (Corbett et al., 2010). Other studies used non-social stressors in order to gauge cortisol responses in children with ASD. Corbett et al. (2005) compared 12 children with ASD to 10 TD children following a mock MRI. Salivary cortisol was measured before and after exposure, and as expected, children with ASD showed not only higher levels of cortisol than TD children, but a prolonged recovery period as well. In other words, 120 minutes after exposure, children with ASD still had higher cortisol levels than TD children (Corbett et al., 2005). Likewise, a study by Spratt et al. (2011) found that children with ASD had higher levels of cortisol than TD children after subjected to a non-social stressor: a blood draw. These children also experienced prolonged recovery period (Spratt et al., 2012).

It has been well documented that PA improves both physical, behavioral, and psychosocial factors for TD children. Further, numerous studies have examined the effects of

various types of PA on stress in this population. A systematic review by Poitras et al. (2016) evaluated 162 studies that showed physical activity in youth populations results in a wide variety of positive results such as improvements in adiposity, cardiometabolic markers, physical fitness, bone health, quality of life, motor development, and psychological distress (Poitras et al., 2016). According to Min et al. (2017), increasing vigorous physical activity (VPA) by at least once a week significantly improves both happiness and stress levels. In general, overweight children and adolescents are more stressed and less happy than children of normal weight; however, significant improvements are still seen when VPA is increased (Min et al., 2017). A review by Calfas and Taylor (1994) examined the effects of physical activity on psychological variables in youth (aged 11-21). Studies found that physical activity was related to improvements in anxiety, stress, and depression (Calfas & Taylor, 1994). Further, cortisol and behavior were measured in second and third graders who participated in a 10-week yoga intervention in a study by Butzer et al. (2015). Results showed that only second graders showed significant reductions in cortisol levels from baseline to post intervention along with teacher reported positive changes in behaviors; these included abilities to deal with stress, confidence, mood, and academic performance. Third grade students, however, showed no change in either cortisol or behaviors (Butzer et al., 2015).

Typically, treatment for symptoms of ASD include pharmacological and cognitive, occupational, and behavioral therapies; however, recent research has examined the effects of PA in reducing these symptoms. A systematic review by Bremer et al. (2016) demonstrates the positive impact that physical activity has on children with ASD. A variety of physical activity interventions were reported including jogging, horseback riding, swimming, and martial arts. While all studies found improvements in various behavioral measures, horseback riding and

martial arts appeared to have the greatest benefits, specifically in stereotypic behavior and social-emotional behavior. It should be noted that all studies reviewed used only subjective measures (i.e., questionnaires/observations) (Bremer et al., 2016).

In typically developing children, martial arts has been shown to improve factors such as self-regulation, social behavior, and classroom conduct (Lakes & Hoyt, 2004). Additionally, another study compared tae-kwon-do to modern martial arts and found that in TD children the tae-kwon-do group had less aggression and anxiety, and higher self-esteem and social skills (Diamond & Lee, 2011). A few studies have examined various behaviors in children with ASD. Bahrami et al. (2012) found that Kata (techniques from various martial arts) techniques improved stereotypy in this population. It was also determined that more strenuous exercise resulted in more positive changes than less strenuous exercise (Bahrami, Movahedi, Marandi, & Abedi, 2012). Movahedi et al. (2013) found that Kata techniques improved social dysfunction in children with ASD (Movahedi, Bahrami, Marandi, & Abedi, 2013). It should be noted that these two studies utilized different subscales of the same questionnaire (Bahrami et al., 2012; Movahedi et al., 2013). All studies mentioned have used subjective measures to collect data (i.e., questionnaires).

Judo is a specific martial art that is especially interesting as it considers both MVPA and mindfulness. A fundamental aspect of judo is translated to “the most effective use of one’s spiritual and physical strength” (Fukuda, Stout, Burris, & Fukuda, 2011). While the principles of judo go beyond physical activity, physical demands should not be underestimated. Judo is considered a high-intensity sport, and competitors have shown a wide variety of physiological enhancements such as greater bone mineral density, aerobic capacity, and appendicular muscle mass, compared to athletes of a different sport or a control group (i.e., nonathletes) (Fukuda et

al., 2011). Research regarding judo in youth populations is growing, as the sport gains popularity. In addition to physiological benefits, judo also has been shown to increase life satisfaction and quality of life in adolescents (Matsumoto & Konno, 2005). Because children with ASD face both physiological and psychological struggles, judo may be particularly beneficial to this population.

While there is sufficient data to suggest that PA improves stress levels in TD children, most data only looks at stress subjectively. Moreover, data is significantly limited regarding children with ASD and objective measures of stress. Even further, there is inadequate research that examines interventions for impaired stress responses in children with ASD.

Due to the tendency of children with ASD to exhibit a wide variety of physical, behavioral, social/ emotional disabilities, increasing physical activity appears to be vital. Evidence suggests that various forms of martial arts are effective ways to improve these symptoms in children with ASD (Bahrami et al., 2012). Furthermore, more strenuous forms of exercise are more effective at reducing these behaviors than mild exercise (Bahrami et al., 2012). Due to the increased frequency and intensity at which children with ASD experience stress, it is crucial to find proficient interventions that improve their stress response (Ash et al., 2017). Because judo consists of both strenuous physical activity and mindfulness (e.g., self-awareness, self-regulation), it may prove to be an effective way to improve levels of cortisol (HPA activity) and in turn, stress levels, in addition to improvements in overall physical health (e.g., weight) and behavior (e.g., stereotypy).

CHAPTER III: METHODOLOGY

Study Design

The current study is part of an already existing study to examine the effects of a 10-week judo program on children with ASD. This study examined salivary cortisol levels in children and adolescents with ASD who are currently participating in the judo program. The following sections will describe sample, setting, and procedures.

Participants

The study included 20 children (ages 8-17) who have been diagnosed with Autism Spectrum Disorder (ASD). All participants were recruited from the Center for Autism and Related Disabilities (CARD), an organization that provides assistance and guidance to children with autism and their families. To be included in this study, all participants were required to have a formal diagnosis of ASD and have no physical limitations that prevented participation. After receiving an explanation of all procedures involved in participating in this study, parental consent/child assent was obtained. All procedures were approved by the University of Central Florida's Institutional Review Board.

Measures and Procedures

Overview of the larger study

The primary study examined the effects of a 10-week judo program on youth with ASD, through a series of physical and psychosocial assessment measures. It is a mixed-methods convenience sample of 11 adolescents and 9 children, recruited from CARD. Participants were offered the option to attend sessions once (N=14) or twice (N=6) a week for 45 minutes each. A certified black belt judo coach taught each session. Participants learned a variety of judo skills and techniques, focusing on self-awareness. Each session followed a similar structure and began with an appropriate warm-up, followed by both individual and partner-centered judo exercises, and then proper cool down.

Current Study Measures

Demographics

Parents of participants were asked to complete a demographics questionnaire on behalf of their child. The questionnaire consists of 10 items pertaining to participants' age, gender, activity levels, diagnoses, and current medications. Responses consist of multiple choice and open-ended questions.

Physiological Assessments

Body Mass Index (BMI)

Height and weight measurements were taken using a stadiometer (Patient Weighing Scale, Model 500 KL, Pelstar, Alsip, IL) at baseline and post-intervention. BMI and BMI percentile were calculated from this data.

Accelerometers

Actigraph GT9x accelerometers (ActiGraph, Inc., Pensacola, FL) were worn around the non-dominant wrist for 7 days and nights (week 1 and week 10). These devices measured total sleep time, average wake after sleep onset (WASO), average sleep efficiency (% of time asleep over total time in bed), and average activity counts. Validated algorithms (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992) were utilized to analyze the collected data (in Actilife version 6).

Salivary Cortisol

Salivary cortisol measures were taken at four time points: two at baseline and two post intervention. Samples were obtained prior to and following a judo session. Saliva was collected using Salimetrics SalivaBio Orab Swabs (SOS) (Salimetrics, LLC, Carlsbad, CA). Participants placed a cotton swab under the tongue for two minutes, at which time, they spit the swab out into a tube labeled with their participant ID number. Participants were asked to be fasted for 30 minutes prior to sample collection, as certain foods may interfere with results. Participants were also asked to refrain from brushing their teeth prior to obtaining cortisol samples (Hanrahan et

al., 2006). All cortisol samples were stored in a freezer at -20◦C until they were analyzed (described further below).

Psychosocial Measures

The Stress Survey Schedule (SSS)

The Stress Survey Schedule (Groden et al., 2001) is a 49-item questionnaire that measures intensity of stress reactions in response to certain events (e.g., having a change in schedule or plans). There are eight total categories (changes, anticipation, unpleasant, positives, food related, rituals, social/environmental, and sensory/personal). Responses range from 1 (none to mild) to 5 (severe). A higher score indicates greater levels of perceived stress in participants. Parents of participants in both the intervention and control conditions were asked to complete this questionnaire pre- and post-intervention.

Data Processing and Analysis

Salivary Analysis

Salivary cortisol was assayed using SalivaBio Oral Swab (SOS) kit (Salimetrics, LLC, Carlsbad, CA). Analysis of salivary cortisol was performed in-house using the expanded range/high sensitivity salivary cortisol enzyme immunoassay kit. Prior to assay, samples were thawed, vortexed, and centrifuged at 1500 rpm for 15 minutes. The intra-assay coefficient of variation is 6.67.

Statistical Analysis

Shapiro-Wilk's test was used to assess normality of distribution. Spearman correlations were used to examine the associations between sleep quality and stress. Paired samples t-tests were used to determine any changes in the SSS questionnaire from baseline to post intervention. A 3-way repeated measures ANOVA (acute × chronic × age group) was conducted to compare cortisol levels in both acute (pre/post one judo session) and chronic (baseline and post intervention) measurements between older (13-17 years) and younger (8-12 years) children. All analyses will be conducted in SPSS 9.4 with a significance level set at $\alpha<.05$.

CHAPTER IV: RESULTS

Twenty participants (75% male, age 12.8 ± 2.80) diagnosed with ASD participated in the 10-week judo intervention. All descriptive statistics and attendance are displayed in Table 1. Justification of sample sizes for each analysis is displayed in Table 2.

Baseline Stress and Sleep Correlations

A total of 15 participants were included in the baseline analysis (Tables 3&4). Negative correlations existed between sleep efficiency and the SSS subscales *unpleasant* stress (r=-.53 p=.04), and *food-related* stress (r=-.68 p=.01). Similarly, total sleep time was negatively associated with *changes* (r=-.50 p=.06), *unpleasant* stress (r= -.65 p=.01), and *food-related* stress (r=-.71 p=.00). No additional associations were seen between sleep components and subscales.

Pre-Post Stress (SSS)

A total of 14 participants were included in this analysis. Three participants did not return in the final weeks of judo, and 1 participant did not return questionnaires post intervention. Table 5 displays stress subscale scores for baseline and post intervention assessments. There were no significant differences, however, trends existed for the subscales *changes* (p=.14) and *unpleasant* (p=.12), with decreases observed post-intervention for both.

Cortisol

Salivary cortisol was measured at four different time points, as shown in Table 6. A total of 12 participants were included in this analysis. Participants were split into age groups: younger (8-12 years) and older (13-17 years). No significant chronic × age ($F(1,10) = .046$, p=.835, .005) interactions were noted. No significant acute × age ($F(1, 10) = 4.38$, p=.057, .316) interactions

were noted, although a trend existed indicating that cortisol levels were decreased after one session of judo for older children. A large effect size is noted for acute effects in older children (Cohen's *d*= 1.2) vs younger (Cohen's *d*=.01).

Cortisol Collection Protocol

As there is limited research regarding collecting salivary cortisol samples in youth with ASD in a group setting, a protocol to ensure successful collection was developed. Participants were asked to line up together against a wall and swabs were passed out. Participants were instructed to open the package of the swab without touching (help was provided when needed). A team of researchers held stopwatches so that all participants could see how much time they had left to hold the swab in their mouth. Once the timer ran out, participants could spit the swab into the Salivette that they were given and handed them back to researchers to store.

CHAPTER V: DISCUSSION

The purpose of this study was to determine if judo practice could decrease stress and cortisol levels in children with ASD. It was hypothesized that 1) Cortisol levels will decrease before and after one judo session and 2) Cortisol levels will decrease from baseline to post-intervention. The results of this study indicate that there are no significant changes in cortisol from baseline to post-intervention. There is, however, a trend that indicates lower cortisol levels acutely, post judo session. Two subscales of the SSS, *changes* (e.g., having a change in task to a new task with new directions) and *unpleasant* (e.g., receiving a reprimand) showed a trend to decrease from baseline to post intervention. In addition to these subscales having the most questions, is it likely that the judo intervention provided the most exposure to these particular stressors. Although no significance was shown, this could be due to several limitations, as mentioned below.

A previous study by Hiller et al. (2011) measured cortisol production and anxiety in individuals with ASD before and after a low-intensity physical activity program. Although participants in this study were older (13-27 yrs.), similar results were found. There was a significant decrease in cortisol levels following one session of physical activity. However, there were no significant differences shown from week 2 to week 6. This was attributed to small sample size, and length and frequency of exercise intervention (Hillier, Murphy, & Ferrara, 2011). Although the present study increased the length to 10 weeks and gave the option to attend twice per week, results were similar. Not all participants opted to attend twice per week. A meta-analysis by Bell et al. (2016) indicates that a minimum of 12 weeks (twice per week) of martial arts training should be utilized to evoke significant changes (Bell, Palace, Allen, & Nelson, 2016).

Negative correlations existed at baseline between components of sleep and subscales of the SSS. This indicates that worse sleep habits are associated with more severe stress reactions. This is expected, as sleep, or lack thereof affects the diurnal production of cortisol and psychological stress (Franzen et al., 2011; Redwine, Hauger, Gillin, & Irwin, 2000).

Additionally, differences in cortisol production between age groups was shown; Children aged 13-17 had higher levels of cortisol than children aged 8-12. This is in line with previous research by Corbett et al. (2010), which suggested that based on age, children with ASD react to unfamiliar social situations differently, eliciting differing stress responses (Corbett et al., 2010). Older children were also more likely than younger to engage in social interactions, whereas younger participants avoided novel situations. Such findings were interpreted to suggest that older children are more aware of their behaviors and also of their expectations, provoking a greater stress reaction to the situation. The current study may replicate a similar social situation. It should be noted that while older participants had higher levels of cortisol, they also had a greater change in cortisol levels before and after one session of judo than younger participants. This could potentially be due to older individuals being more engaged in practice. Future research should further explore these age-related differences.

Several strengths of the current investigation should be noted. The study is one of the first to examine the effects of judo on youth with ASD. Both objective measures and parent reported questionnaires were utilized to measure stress. The research team partnered with CARD, who were instrumental in recruitment for this study. Both the presence of CARD staff and the judo instructor, who had previous experience teaching judo to this populations helped to create a successful, engaging environment for participants.

There were also limitations to this study. First, the sample size was limited, which may account for lack of significance among acute cortisol measurements. Secondly, the duration of the study may have been too short to elicit significant changes. According to a recent review, significant changes in behaviors are observed in studies lasting a minimum of 12 weeks (Bell et al., 2016). Researchers additionally suggested a frequency of twice per week, which could also potentially explain the lack of significance (Bell et al., 2016). It should be noted that a subsample of participants chose to attend judo twice per week; however, no differences in cortisol or stress reactions were observed. Future studies should consider comparing duration and frequency of sessions to determine optimal dose. Cortisol samples taken in this study were similar to those in previous studies (Hiller et al., 2011; Corbett et al., 2006; Corbett et al., 2009). However, individual differences in circadian rhythm production of cortisol were not controlled for in this study. Also, the present study was limited to cortisol measurements before and immediately after judo sessions (at 18:00h and 18:50h). The present study did not account for the effects of any medications that may have interfered with cortisol values; five participants were receiving such medication at the time of data collection. Finally, although the research team emphasized the importance of fasting prior to cortisol collection, it was difficult to confirm compliance.

Implications for Practice

Several implications can be drawn from the current study. There is limited research regarding using exercise as an intervention to improve stress and cortisol production. First, there has been limited research describing the cortisol collection procedures that are specific to this population. Youth with ASD often have sensory issues that limit their willingness to participate in tasks that involve new sensations, such as chewing on a cotton swab. In the current study,

investigators were able to develop a standardized protocol to collect cortisol that minimized refusal rates and reduced variability among collection procedures.

Results indicated that there was a decrease in acute levels of cortisol (i.e., before and after one judo session). Although changes were not significant, the findings support the use of judo to attenuate stress and cortisol levels in this population. Additionally, observations reported by CARD staff and parents of participants supported implementation of a judo program as it contributed to several positive changes in participants' behaviors. As this intervention required partner-based as well as solo activities, it may also be beneficial to developing social skills and adapting to unfamiliar situations. Therefore, even in the absence of significant changes in cortisol levels, judo may offer additional psychosocial benefits to this population. Based on this information, the use of a mixed-methods design may be imperative when assessing outcome measures with similar protocols.

Conclusion

Although not significant, salivary cortisol tended to decrease following one session of judo; however, there were no significant differences seen in salivary cortisol measurements from baseline to post intervention. Age-related differences in cortisol levels warrant further investigation to determine whether interventions to reduce stress should differ according to age groups. More research is needed to understand age-related differences in cortisol in youth with ASD.

APPENDIX A: SSS

The Stress Survey Schedule Questionnaire

Please rate the intensity of the stress reaction to the following events by checking or marking the appropriate box.

Item				None to Mild	Mild to Moderate	Moderate	Moderate to Severe	Severe
				1	2	3	4	5
		1	Receiving a present					
		2	Having personal objects or materials out of order.					
		3	Waiting to talk about a desired topic.					
		4	Having a change in schedule or plans					
		5	Being in the vicinity of noise or disruption by others					
		6	Waiting for preferred events					
		7	Having a cold					
		8	Being touched					
		9	Having personal objects or materials missing					
		10	Having a change in task to a new task with new directions					
		11	Going to the store					
		12	Being prevented from completing a ritual					
		13	Having a change in environment from comfortable to uncomfortable					
		14	Being prevented from carrying out a ritual					
		15	Moving from one location to the next					
		16	Playing with others					
		17	Having a change in environment from familiar to unfamiliar					
		18	Receiving activity reinforcement					
		19	Having something marked as correct					
		20	Being in the vicinity of bright lights					
		21	Following a diet					
		22	Having unstructured time					
		23	Being allowed to attend a party or favoured event					
		24	Receiving a reprimand					
		25	Transitioning between preferred and non preferred activity					

Comments:

Please rate the intensity of the stress reaction to the following events by checking or marking the appropriate box.

Item				None to Mild	Mild to Moderate	Moderate	Moderate to Severe	Severe
				1	2	3	4	5
		26	Being told "NO"					
		27	Receiving criticism					
		28	Having something marked incorrect					
		29	Being interrupted while engaging in a ritual					
		30	Receiving hugs and affection					
		31	Having to engage in a not-liked activity					
		32	Waiting in line					
		33	Being unable to communicate needs					
		34	Waiting at a restaurant					
		35	Going home (from school, to visit parents)					
		36	Waiting for transportation					
		37	Being unable to assert oneself with others					
		38	Needing to ask for help					
		39	Participating in group activity					
		40	Having a change in staff, teacher, or supervisor					
		41	Losing at a game					
		42	Waiting for reinforcement					
		43	Feeling crowded					
		44	Someone else making a mistake					
		45	Receiving tangible reinforcement					
		46	Waiting for food					
		47	Waiting for routine to begin					
		48	Having a conversation					
		49	Receiving verbal reinforcement					

Comments:

Please rate the intensity of the stress reaction to the following events by checking or marking the appropriate box.				None to Mild	Mild to Moderate	Moderate	Moderate to Severe	Severe
Item				**1**	**2**	**3**	**4**	**5**
			FEARS					
		50	Fear of animals					
		51	Fear of water (pool, lake, ocean, etc)					
		52	Fear of crowds					
		53	Fear of closed spaces					
		54	Fear of the dark					
		55	Fear of being left alone					
Comments:								
			Life Stressors					
		56	Going to the doctor or dentist					
		57	Having seizures					
		58	Having a new sibling					
		59	Moving to a new house					
		60	Moving to a new school					
		61	Having parents getting divorced					
		62	Having a parent re-marry					
Comments:								

APPENDIX B: LIST OF TABLES

Table 1: Participant Characteristics

Variable	N (%)	Mean (SD)
Age (years)		12.8 (2.8)
Male	15 (75%)	
Caucasian	15 (75%)	
Overweight (above 85% BMI percentile)	11 (55%)	
Classes attended		10.6 (5.7)

Table 2: Justification of Sample Sizes

Analysis	**N**	**Reason for participants not completing**
Baseline correlations	16	1→accelerometer strap broke so device was not worn 3→ Refused to wear device
SSS pre/post	14	1→ did not return after 1 judo practice 2→ Did not return for last 2 judo practices 1→ Parents did not return questionnaires post
Acute cortisol 1 (baseline)	16	1→ Child assent not obtained 1→ Child refused 1→ Child was late to practice and missed measurement 1→Not enough sample (volume) for data to be obtained
Acute cortisol 2 (post intervention)	14	1→ Child assent not obtained 2→ Child refused 2→ Did not return for last 2 judo practices 1→ did not return after 1 judo practice
Chronic cortisol (pre/post)	14	1→ Child assent not obtained 2→ Child refused 2→ Did not return for last 2 judo practices 1→ did not return after 1 judo practice

Table 3: Correlations for SSS and Sleep

	Changes	Anticipation	Unpleasant	Positives	Food_ Related	Rituals	Social_ Environmental	Sensory_ personal
Avg. Efficiency								
TST								
Avg. Activity								
Avg. WASO								
Changes	—							
Anticipation	.764**	—						
	.000							
Unpleasant	.791**	.810**	—					
	.000	.000						
Positives	.285	.350	.254	—				
	.223	.130	.279					
Food_Related	.580**	.731**	.758**	.111	—			
	.007	.000	.000	.643				
Rituals	.381	.624**	.465*	.366	.615**	—		
	.097	.003	.039	.112	.004			
Social_	.676**	.486*	.556*	.438	.287	.184	—	
Environmental	.001	.030	.011	.053	.219	.437		
Sensory_	.686**	.472*	.456*	.050	.316	.257	.433	—
Personal	.001	.036	.043	.834	.175	.274	.057	

*p<.05; **p<.01; ***p<.001 TST= Total Sleep time WASO= Wake after sleep onset

Table 4: Correlations for SSS and Sleep

	Avg. Efficiency	TST	Avg. Activity	Avg. WASO
Avg. Efficiency	—			
TST	.803**	—		
	.000			
Avg. Activity	-.561**	-.209	—	
	.030	.454		
Avg. WASO	-.714**	-.325	.950**	—
	.003	.237	.000	
Changes	-.298	-.504	.129	.165
	.281	.055	.646	.556
Anticipation	-.289	-.326	.000	.139
	.297	.236	1.000	.622
Unpleasant	-.530**	-.651**	.095	.201
	.042	.009	.737	.474
Positives	-.153	-.005	-.220	-.239
	.586	.985	.432	.390
Food_Related	-.684**	-.706**	.226	.375
	.005	.003	.418	.168
Rituals	-.200	-.230	.065	.160
	.475	.410	.817	.569
Social_ Environmental	-.304	-.442	.120	.232
	.270	.099	.671	.406
Sensory_ Personal	-.005	-.329	.077	.065
	.985	.231	.784	.818

*p<.05; **p<.01; ***p<.001 TST= Total Sleep time WASO= Wake after sleep onset

Table 5: SSS Subscales

Variable	Baseline (mean)	Post-judo (mean)	P-value
Changes	2.42	2.12	.140
Anticipation	1.79	1.86	.695
Unpleasant	2.51	2.28	.125
Positives	1.65	1.70	.739
Food Related	1.67	1.73	.755
Rituals	1.81	1.94	.514
Social Environmental	1.81	1.81	.999
Sensory Personal	1.90	1.77	.455

Table 6: Cortisol Descriptions

Time Point	Description
1	Baseline pre-judo
2	Baseline post-judo
3	Post-intervention pre-judo
4	Post-intervention post-judo

Table 7: Cortisol ANOVA

	P-value	Partial eta squared
Acute	.063	.304
Acute × Age	.057	.316
Chronic	.835	.005
Chronic × Age	.456	.057

APPENDIX C: IRB APPROVAL

University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: **UCF Institutional Review Board #1**
FWA00000351, IRB00001138

To: **Jeanette Garcia** and Co-PIs: **David Fukuda, Jaime Lee Best, Justine M Renziehausen, Kayla Baker, Morgan Diaz, Paola Rivera**

Date: **September 20, 2018**

Dear Researcher:

On 09/20/2018 the IRB approved the following human participant research until 09/19/2019 inclusive:

Type of Review:	UCF Initial Review Submission Form Expedited Review
Project Title:	Examination of a Martial Arts Program on Physical and Psychosocial Factors in Children with Autism Spectrum Disorder
Investigator:	Jeanette Garcia
IRB Number:	SBE-18-14361
Funding Agency:	Toni Jennings Exceptional Education Institute(TJEEI)
Grant Title:	
Research ID:	N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at https://iris.research.ucf.edu .

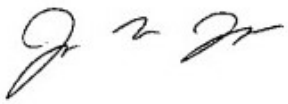
If continuing review approval is not granted before the expiration date of 09/19/2019, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

This letter is signed by:



Signature applied by Jessica Jacques on 09/20/2018 02:15:06 PM EDT

Designated Reviewer

APPENDIX D: IRB FORM

PROTOCOL TITLE:

Examination of a Martial Arts Program on Physical and Psychosocial Factors in Children with Autism Spectrum Disorder

PRINCIPAL INVESTIGATOR:

Jeanette M. Garcia, Ph.D.

CO-INVESTIGATORS:

David H. Fukuda, Ph.D.
Kayla Baker, M.S.
Nicholas Leahy, M.S.
Paola Rivera, B.S.
Justine Renziehausen, B.S.
Jaime Best, M.S.
Morgan Diaz, M.S.

VERSION NUMBER:

Version 1

DATE:

September 13, 2018

Table of Contents

Objectives*

- The purpose of this study is to examine physical and psychosocial benefits the 12-week CARD Judo program in youth with Autism Spectrum Disorder (ASD).
- It is hypothesized that children with ASD will show improvements in physical and psychosocial factors following the program.

Background*

Inactivity and poor nutrition in youth is a public health concern in the U.S. These behaviors contribute to childhood obesity which typically continues into adulthood. For children diagnosed with Autism Spectrum Disorder (ASD), the prevalence of obesity, inactivity, and poor nutrition is even worse. Therefore, it is critical to improve these behaviors in children with ASD. Standard treatment of ASD primarily addresses cognition, language, and social development while attempting to suppress behaviors such as repetitive movements and rigidity (Joosten et al., 2009; Koening et al., 2010). While these treatments are shown to be effective for improvement in these areas, they do not address other health risks that children with VEs are susceptible to developing such as obesity and Type 2 diabetes (Srinivasan et al., 2014). Over the past several years, the concept of physical activity as an alternative form of treatment in children with varying exceptionalities has been gaining more support, especially with evidence showing that physical activity may also improve social, emotional, and behavioral characteristics in youth with ASD (Movahedi et al., 2013; Bass et al., 2009). Furthermore, studies have shown that physical activity may help with improving balance, flexibility, and coordination in children with ASD, which is crucial given the deficiencies in motor control characteristic of this disorder (Pitetti et al., 2007).

One such area of physical activity and sport that may particularly benefit children with ASD is martial arts training (Baharmi et al., 2016; Rajan et al., 2015). Although few studies have examined martial arts training in children with ASD and other behavioral disorders, the results have been positive, with participants showing improvement in communication skills, reduced stereotypical behaviors, improvement in academic achievement, and improved self-efficacy (Rajan et al, 2015). Although little to no research has been conducted in children with ASD, the martial art of judo, in particular, has been associated with significant improvements in both physical and psychosocial health in children and adolescents. Standardized judo curricula generally focus on proficiency in the areas of movement patterns, age-appropriate technique, and personal development (United States Judo Federation). Specifically, youth engaged in judo training have demonstrated improvements in aerobic capacity, muscular strength and endurance, balance, flexibility, and body composition (Fukuda et al., 2011). Furthermore, youth judo athletes report greater well-being and life satisfaction scores as compared to normative data (Matsumoto & Konno, 2005). The impact of judo training on at-risk (Fleisher et al., 1995) and clinical populations has also been explored with positive results reported in personal and social adjustment (David & Byrd, 1975); anxiety, coping, and self-esteem (Gleser & Brown, 1986); and companionship, respect to others, confidence, and self-assertiveness (Gleser & Lison, 1986). Thus, the interactive nature of judo, which often requires the ability to work with a partner, and

its unique emphasis on physical education, intellectual training, and social interaction (Kano, 2005) provide a unique platform for children with ASD.

Inclusion and Exclusion Criteria:

- Participant Inclusion criteria:
    - Currently enrolled in a judo program offered by the Center for Autism and Related Disorders (CARD)
    - Between the ages of 6 – 17 years old.
    - Free of any severe behavioral issues that would hinder participation in the study.
    - Primary parent or caregiver willing to participate in the study.
- Parent Inclusion criteria:
    - Parent of a child participating in the study.
- Participant Exclusion criteria:
    - Not participating in the CARD judo program.
    - Any severe or violent behaviors that may be disruptive for other participants or could increase risk of injury to the child or other participants.
    - Parents or caregivers unwilling to participate in the study.
    - Not between the ages of 6 and 17
- Indicate specifically whether you will include or exclude each of the following special populations
    - Adults unable to consent- exclude
    - Individuals who are not yet adults (infants, children, teenagers)- include
    - Pregnant women- exclude
    - Prisoners- exclude

Study-Wide Number of Subjects*

It is expected that 40 children and their parents will be participating in this study. Therefore, a total of 80 participants will be enrolled in this study.

Study-Wide Recruitment Methods*

Participants will be recruited primarily by two methods. First, the participating schools and organizations will send out email announcements to parents to explain the study. Second, each participating school and organization will hold a parent meeting where parents are invited to hear the primary investigator discuss the study in details.

Multi-Site Research*

Although the study will be recruiting participants at different locations, all data will be stored and analyzed at a central location which will be the PI's lab at the University of Central Florida.

Study Timelines*

The proposed study will consist of four visits at each judo location (Sasaki judo and UCF gymnasium). The first visit will involve the presentation of the study to parents (approximately 10 – 15 minutes) which will occur prior to the beginning of the first judo session (Parents and children will be asked to arrive 10 – 15 minutes prior to the start of the judo class). If parents provide consent, the study investigators will hand out a demographic and child behavior questionnaires for the parents to complete. Parents will be given instructions on how to obtain cortisol samples at home, and investigators will collect baseline cortisol samples. In addition, accelerometers will be handed out to children, who will be asked if they give assent to wear the devices. Participants will be fitted with the accelerometers and instructed to wear them for the next 7 days and nights. The investigators will return the following week at the same time (prior to the judo class), to collect the accelerometers. The third visit will occur on the final day of the judo program (the 12th week), where parents will be asked to complete the same questionnaires from the first week, and provided instructions on collecting cortisol samples at home once more. Investigators will collect the post-program cortisol samples, and ask children to wear the accelerometers once more over a 7-day period. Investigators will ask parents and children to return the accelerometers the following week during the judo showcase which occurs a week after the last judo class. Parents will also be asked to take part in a short interview at that time. All children who are not participating in this study will continue to participate in the regularly-scheduled CARD judo program.

Study Endpoints*

The study will end for participants when our study investigators collect the accelerometer devices a week after the last judo session

Procedures Involved*

- Objective measures and questionnaires will be used to conduct the research (described below) and will involve both parents and children.
    - Child participant measures:
        - Physical activity and sleep quality assessment with accelerometers
        - Salivary cortisol assessment
    - Parent/caregiver measures:
        - Demographic and child behavior questionnaires
        - Interviews
- Description of measures. All of the following questionnaires and surveys are included with this application.
    - **Child participant measures**
        - **Body Composition.** Prior to the testing sessions, participants will be asked to be sufficiently hydrated and to have abstained from food consumption for a minimum of two hours. After recording their height, participants will be asked to remove their footwear, including socks, and

stand on a platform while holding two handles out to the side. They will hold this position for one minute as the multi-frequency bioelectrical impedance analysis device and/or bioelectrical impedance spectroscopy device, transmits a minute electrical current will be conducted through the body to determine body composition variables, including body fat percentage

- **Physical Activity and Sleep Quality.** Physical activity and sleep quality will be assessed at baseline and post-intervention using an ActiGraph GT9X Link accelerometer (similar to a FitBit). Participants will be asked to wear the device on their non-dominant wrist, similar to a watch, and wear it for the following seven days. Participants will be instructed to wear the devices continuously, only removing them when they do any water-based activities (e.g. showering, swimming). The device will assess the minutes per day that participants engage in low, moderate, and high intensity physical activity. Additionally, the device will measure the number of minutes that participants are asleep, and the number of times their sleep is disrupted. Both parents/caregivers and participants will be provided with instructions on wearing devices.
- **Salivary cortisol.** Salivary cortisol will be assessed using Salivettes (Salimetrics), which are tubes that contain cotton swabs. Samples will be taken on 1 judo day and 1 non-judo day during weeks 2 (first week of judo) and 13 (final week of judo). On the non-judo day, parents will be asked to assist in collecting a cortisol sample within 30 minutes of awakening and at 3pm in the afternoon (the same time as the judo class). Parents will be provided a list of instructions that research assistants will explain to them during the consent process. For the judo day, samples will be collected right before the start of judo class (3:00) and immediately following the end of the judo class (4:30). Research assistants, listed on the protocol, will assist with the collection of samples on the judo days. The procedure consists of research assistants/parents removing the cap on the tube and placing the swab under the child's tongue by topping the tube so that the swab falls into the mouth. The child will be asked to roll the swab around in his/her mouth for about 2 minutes and then will spit the swab back into the tube, which will then be sealed with the cap by either the research assistant or the parent. Cortisol samples taken at UCF will be immediately stored in the freezer (-20◦C); cortisol samples taken at Sasaki Judo will be refrigerated (including during transport) until they arrive at UCF, where they will be placed in the freezer (-20◦C) If this is a non-judo day, the parent will be instructed to write the date on the label (which will already have the participant ID), and place in the freezer. Parents will be asked to bring the sample with them the next time they arrive at judo. If the sample is collected on a judo day, once the research assistant secures the samples, he/she will place it in the freezer in our laboratory that day. The sample should be kept in the freezer until it is time to leave for the next session. This procedure will be repeated the final week of judo. For familiarization purposes, the child will be permitted to practice with a

cotton swab to ensure he/she is comfortable with the procedure. The samples will be analyzed using an ELISA kit in the human performance laboratory.

Cortisol Sampling Timeline

Sample #	Week	Day	Time	Collected by
1	2	Non-Judo day	Upon awakening	Parent
2	2		~3pm – 6pm	Parent
3	2	Judo day	Upon arrival at UCF	Research assistant
4	2		After practice	Research assistant
5	13	Non-Judo day	Upon awakening	Parent
6	13		~3pm – 6pm	Parent
7	13	Judo day	Upon arrival at UCF	Research assistant
8	13		After practice	Research assistant

- **Parent measures.**
  - **Demographics.** Parents will be asked to complete a short questionnaire in regards to their child's demographics and health behaviors. The questionnaire will be less than a page long and take less than 5 minutes to complete.
  - **Stress Survey Schedule.** Parents will be asked to complete this questionnaire, which consists of 62 items related to the severity of their child's stress response in various situations.

- **Anxiety Scale for Children with ASD (parent version).** Parents will be asked to complete this 24-item questionnaire, which consists of statements assessing the severity of children's anxiety levels.
- **Abberant Behavior Checklist (ABC).** Parents will be asked to complete this 58-item checklist that consists of questions assessing their child's behaviors at home and at school.
- **PA and sleep.** Parents will be asked to complete a 6 item questionnaire in regards to their child's current physical activity levels, screen time, and sleep patterns.
- **Interviews.** Parents will be asked to participate in a semi-structured informal interview following the cessation of the judo program. These interviews will consist of several questions regarding their perception of the program and any changes (either positive or negative) that they may have witnessed as a result of their child's participation in the judo program. Interviews will last approximately 10 – 15 minutes and will be audio-recorded for transcription purposes.
- All questionnaires will be completed electronically through Qualtrics, which parents can complete on their cell phone, however, paper copies will be provided upon request.

Data and Specimen Banking*

The results of this study will be submitted for publication in peer-reviewed scientific journals. No individual results will be published or shared with any person or party. All information attained from the questionnaires, accelerometers, cortisol samples, and interviews will be held in strict confidence. Individual results will remain confidential and only be related to the participant upon request. All psychosocial and activity questionnaires, as well as data collection sheets will be kept in a locked cabinet during and following the study. All information will be destroyed five years from the end of the study and not used for other research purposes. Participant folders will be marked with an I.D. number to protect against a breach of confidentiality. Participant names and I.D. numbers will be stored apart from the subject folders. Cortisol samples will be disposed of following the cortisol analysis, and will not contain any identifiable information. The samples will ONLY be used to assess salivary cortisol.

Data Management* and Confidentiality

The results of this prospective examination will be de-identified and published as aggregated data as part of a scientific publication (no names or identifiable data will be used). All data obtained from participants is completely confidential and will only be reported in an aggregate format (by reporting only combined results and never reporting individual ones). All information pertaining to the prospective study (including questionnaire responses and testing results) will be linked to a participant number. No personal data will be released. All questionnaires and audio tapes will be concealed, and no one other than the primary investigator

and Co-Investigators listed on the protocol will have access to them. All information obtained from performance tests will be held in strict confidence. Individual results will remain confidential between the research team involved in testing and participants. All participants are aware that demographic data will be aggregated and published to describe the study sample. All information will be destroyed 5 years from the end of the study, however, audio-recordings will be destroyed immediately after transcription. Participant folders and cortisol samples will be marked with an I.D. number to protect against a breach of confidentiality, and the ID number will be removed upon disposal. All questionnaires and data collection sheets will be kept in a locked cabinet during and following the study. Cortisol samples will be stored in a secure laboratory freezer until the samples are analyzed, where they then will be destroyed following the analysis.

Quantitative analysis: Repeated measures ANOVA will be conducted to examine the pre and post changes in behavioral and psychosocial factors in children. All data will be analyzed using SAS version 9.4.

Qualitative analysis: Using content analysis, transcripts fromparent interviews will be read line by line and marked with independent codes that described the content response (Patton 2002). Two researchers will code the transcriptions independently, meet to refine code definitions, and address any inconsistencies that may exist. Cohen's Kappa statistic will be calculated to assess inter-rater reliability. The data and coding structure will be entered into NVivo qualitative analysis software, version 11.0. After the coding will be applied in NVivo, the software will be used to identify patterns of code, which will then be summarized into tables.

Withdrawal of Subjects*

A participant may withdraw from the study at any time for any reason, regardless of the status of the study.

Risks to Subjects*

There is minimal risk involved with participation in this study. There is a very slight chance that children may feel uncomfortable wearing the accelerometers, however, all accommodations will be made to adjust the devices to minimize any level of discomfort.

Potential Benefits to Subjects*

There are no direct benefits to participants. The testing procedures do not provide any direct medical benefit to the participant, and will not be used to provide a medical diagnosis or prognosis

Vulnerable Populations*

The participants will be minors and considered a child under the Florida Statute 63.032(7) in which "'Child' means any unmarried person under the age of 18 years who has not been emancipated by court order." As such, the consent process will require a signed consent form by one parent or legal guardian as well as verbal assent from the child prior to assessment.

Community-Based Participatory Research*

1.1 This section is not applicable to this study.

Sharing of Results with Subjects*

Upon request, results will be shared with the participant at the conclusion of all data collection and analyses.

Setting

This study will occur at two sites that will be the locations for a 12-week judo program offered by CARD. The first site is Saski Judo, which is a judo center in Casselberry, FL. The second site is the gymnasium in the Education Complex at the University of Central Florida. Classes are held once a week for 45 minutes at both locations.

Resources Available

The research staff will recruit the required number of participants from the judo classes held by Center for Autism and Related Disabilities (CARD). Approximately 40 children will be recruited (20 from each site). A research staff of 8 members will be utilized, including 2 assistant professors, and 6 graduate students. All research staff has acceptable amounts of research experience and knowledge of the study sites, culture, and society. All staff members will be assigned research-related duties. Group meetings will allow for each research staff member to be up-to-date with the latest protocol and products for the proposed study. All equipment and instruments used during data collection are available in the UCF Institute of Exercise Physiology and Wellness (IEPW), and have the capacity to be transported easily for data collection at approved off-site locations (Sasaki Judo).

Prior Approvals

Both CARD and the Judo Instructor of Sasaki Judo, who is also teaching the judo program at the UCF gym, have provided their approval for the investigative team to conduct this research.

Recruitment Methods

The listed investigators will present their study during a parent meeting hosted by CARD prior to the start of the first judo class. Investigators will then distribute the consent forms to parents and

answer any questions parents may have. Both child assent and signed parental consents will be required for all participants prior to data collection.

Local Number of Subjects

It is expected that ~40 children and their parents (80 total) will be participating in this study.

Provisions to Protect the Privacy Interests of Subjects

Participants' privacy will be protected at all times. No participant names will be used in the interviews. No information on topics of a sensitive nature will be collected. If a participant feels uncomfortable with any aspect of the Human Research situation at any time, consideration of the participant's privacy will be taken, and the participant will be removed from the situation, if he or she desires.

Consent Process

Parents of the potential participants will be advised of the nature of the study and the goals of the researcher in the informed consent document. Additionally, the investigators will describe the study to the parents during the parent meeting prior to the judo session. Parents will be able to ask questions pertaining to any of the study measures during this time.The consent form will contain information on all child and parent research activities, and a description of all of the questionnaires and testing assessments involved in the study.

Parents must provide signed consent before the study is discussed with the child. The study will be explained to the child by the listed investigators when he/she arrives for the first judo session. Then verbal assent from the child will be obtained prior to commencement of any of the procedures in the study protocol. The participant will be provided with the time necessary to review the physical testing procedures and expectations. There will be an investigator available to explain the study's protocol and answer any questions that each potential participant may have.

All consent documentation will be reviewed and obtained prior to any assessments and testing sessions.

Process to Document Consent in Writing

All consent documentation will be available in a paper format, and sent home with potential child participants. The parent guardian may request a face to face informed consent meeting, or may request to discuss any portion of the consent form in person, before signed consent to participate is given.

Drugs or Devices

The Actigraph accelerometer will be used in this study. All devices are labeled with the contact information of the PI in the event a device is lost. Each participant will be assigned an accelerometer device which will be linked to the participant's ID number. These devices require special software to initialize and view physical activity data, therefore, a graduate student researcher will initialize each device for the specific participant it was assigned. Participants will wear the device for a week, and upon return, graduate student researchers will collect each device, ensuring that all participants have returned their device and downloading the data. Since the device requires special software, only the PIs and selected Co-PIs (PhD students) will have the ability to initialize, download, and view participants' data.

REFERENCES

American Psychiatric Association. What Is Autism Spectrum Disorder? (2016). Retrieved June 13, 2018, from https://www.psychiatry.org/patients-families/autism/what-is-autism-spectrum-disorder

Ash, T., Bowling, A., Davison, K., & Garcia, J. (2017). Physical Activity Interventions for Children with Social, Emotional, and Behavioral Disabilities-A Systematic Review. *Journal of Developmental and Behavioral Pediatrics: JDBP*, *38*(6), 431–445. https://doi.org/10.1097/DBP.0000000000000452

Bahrami, F., Movahedi, A., Marandi, S. M., & Abedi, A. (2012). Kata techniques training consistently decreases stereotypy in children with autism spectrum disorder. *Research in Developmental Disabilities*, *33*(4), 1183–1193. https://doi.org/10.1016/j.ridd.2012.01.018

Bell, A., Palace, K., Allen, M., & Nelson, R. (2016). Using Martial Arts to Address Social and Behavioral Functioning in Children and Adolescents With Autism Spectrum Disorder. *Therapeutic Recreation Journal*, *50*(2). https://doi.org/10.18666/TRJ-2016-V50-I2-7287

Bremer, E., Crozier, M., & Lloyd, M. (2016). A systematic review of the behavioural outcomes following exercise interventions for children and youth with autism spectrum disorder. *Autism*, *20*(8), 899–915. https://doi.org/10.1177/1362361315616002

Butzer, B., Day, D., Potts, A., Ryan, C., Coulombe, S., Davies, B., … Khalsa, S. B. S. (2015). Effects of a Classroom-Based Yoga Intervention on Cortisol and Behavior in Second- and Third-Grade Students: A Pilot Study. *Journal of Evidence-Based Complementary & Alternative Medicine*, *20*(1), 41–49. https://doi.org/10.1177/2156587214557695

Calfas, K. J., & Taylor, W. C. (1994). Effects of Physical Activity on Psychological Variables in Adolescents. *Pediatric Exercise Science*, *6*(4), 406–423. https://doi.org/10.1123/pes.6.4.406

CDC. (2018, April 26). Data and Statistics | Autism Spectrum Disorder (ASD) | NCBDDD | CDC. Retrieved June 26, 2018, from https://www.cdc.gov/ncbddd/autism/data.html

Cole, R. J., Kripke, D. F., Gruen, W., Mullaney, D. J., & Gillin, J. C. (1992). Automatic sleep/wake identification from wrist activity. *Sleep*, *15*(5), 461–469.

Corbett, B. A., Mendoza, S., Abdullah, M., Wegelin, J. A., & Levine, S. (2006). Cortisol circadian rhythms and response to stress in children with autism. *Psychoneuroendocrinology*, *31*(1), 59–68. https://doi.org/10.1016/j.psyneuen.2005.05.011

Corbett, B. A., Schupp, C. W., Levine, S., & Mendoza, S. (2009). Comparing cortisol, stress, and sensory sensitivity in children with autism. *Autism Research*, *2*(1), 39–49. https://doi.org/10.1002/aur.64

Corbett, B. A., Schupp, C. W., Simon, D., Ryan, N., & Mendoza, S. (2010). Elevated cortisol during play is associated with age and social engagement in children with autism. *Molecular Autism*, *1*, 13. https://doi.org/10.1186/2040-2392-1-13

Cortesi, F., Giannotti, F., Ivanenko, A., & Johnson, K. (2010). Sleep in children with autistic spectrum disorder. *Sleep Medicine*, *11*(7), 659–664. https://doi.org/10.1016/j.sleep.2010.01.010

Diamond, A., & Lee, K. (2011). Interventions Shown to Aid Executive Function Development in Children 4 to 12 Years Old. *Science*, *333*(6045), 959–964. https://doi.org/10.1126/science.1204529

Franzen, P. L., Gianaros, P. J., Marsland, A. L., Hall, M. H., Siegle, G. J., Dahl, R. E., & Buysse, D. J. (2011). Cardiovascular reactivity to acute psychological stress following sleep deprivation. *Psychosomatic Medicine*, *73*(8), 679–682. https://doi.org/10.1097/PSY.0b013e31822ff440

Fraser, R., Ingram, M. C., Anderson, N. H., Morrison, C., Davies, E., & Connell, J. M. (1999). Cortisol effects on body mass, blood pressure, and cholesterol in the general population. *Hypertension (Dallas, Tex.: 1979)*, *33*(6), 1364–1368.

Fukuda, D. H., Stout, J. R., Burris, P. M., & Fukuda, R. S. (2011). Judo for Children and Adolescents: Benefits of Combat Sports: *Strength and Conditioning Journal*, *33*(6), 60–63. https://doi.org/10.1519/SSC.0b013e3182389e74

Groden, J., Diller, A., Bausman, M., Velicer, W., Norman, G., & Cautela, J. (n.d.). The Development of a Stress Survey Schedule for Persons with Autism and Other Developmental Disabilities, 11.

Hanrahan, K., McCarthy, A. M., Kleiber, C., Lutgendorf, S., & Tsalikian, E. (2006). Strategies for salivary cortisol collection and analysis in research with children. *Applied Nursing Research*, *19*(2), 95–101. https://doi.org/10.1016/j.apnr.2006.02.001

Hillier, A., Murphy, D., & Ferrara, C. (2011). A Pilot Study: Short-term Reduction in Salivary Cortisol Following Low Level Physical Exercise and Relaxation among Adolescents and Young Adults on the Autism Spectrum. *Stress and Health*, *27*(5), 395–402. https://doi.org/10.1002/smi.1391

Horsch A, Boichat A, Kriemler S, Munsch S, Crottet B, Marques-Vidal P, … Puder JJ. (2014). Impact of physical activity on stress reactivity in obese and normal weight children. *Endocrine Reviews. Conference: 96th Annual Meeting and Expo of the Endocrine*

Society, ENDO 2014. Chicago, IL United States. Conference Start: 20140621. Conference End: 20140624. Conference Publication: (Var.Pagings), 201435(no pagination).

Lakes, K. D., & Hoyt, W. T. (2004). Promoting self-regulation through school-based martial arts training. *Journal of Applied Developmental Psychology*, *25*(3), 283–302. https://doi.org/10.1016/j.appdev.2004.04.002

Lamarre, B. W., & Nosanchuk, T. A. (1999). Judo--the gentle way: a replication of studies on martial arts and aggression. *Perceptual and Motor Skills*, *88*(3 Pt 1), 992–996. https://doi.org/10.2466/pms.1999.88.3.992

Lopata, C., Volker, M. A., Putnam, S. K., Thomeer, M. L., & Nida, R. E. (2008). Effect of Social Familiarity on Salivary Cortisol and Self-Reports of Social Anxiety and Stress in Children with High Functioning Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders*, *38*(10), 1866–1877. https://doi.org/10.1007/s10803-008-0575-5

Matsumoto, D., & Konno, J. (n.d.). The Relationship Between Adolescents' Participation in Judo, Quality of Life, and Life Satisfaction. Retrieved February 4, 2019, from https://www.jstage.jst.go.jp/article/budo1968/38/1/38_13/_article

Miles, J. H. (2011). Autism spectrum disorders—A genetics review. *Genetics in Medicine*, *13*(4), 278–294. https://doi.org/10.1097/GIM.0b013e3181ff67ba

Min, J. H., Lee, E.-Y., Spence, J. C., & Jeon, J. Y. (2017). Physical activity, weight status and psychological well-being among a large national sample of South Korean adolescents. *Mental Health and Physical Activity*, *12*, 44–49. https://doi.org/10.1016/j.mhpa.2017.02.004

Movahedi, A., Bahrami, F., Marandi, S. M., & Abedi, A. (2013). Improvement in social dysfunction of children with autism spectrum disorder following long term Kata techniques training. *Research in Autism Spectrum Disorders*, *7*(9), 1054–1061. https://doi.org/10.1016/j.rasd.2013.04.012

Poitras, V. J., Gray, C. E., Borghese, M. M., Carson, V., Chaput, J.-P., Janssen, I., … Tremblay, M. S. (2016). Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. *Applied Physiology, Nutrition, and Metabolism*, *41*(6 (Suppl. 3)), S197–S239. https://doi.org/10.1139/apnm-2015-0663

Redwine, L., Hauger, R. L., Gillin, J. C., & Irwin, M. (2000). Effects of Sleep and Sleep Deprivation on Interleukin-6, Growth Hormone, Cortisol, and Melatonin Levels in Humans. *The Journal of Clinical Endocrinology & Metabolism*, *85*(10), 3597–3603. https://doi.org/10.1210/jcem.85.10.6871

Richdale, A. L., & Prior, M. R. (1992). Urinary cortisol circadian rhythm in a group of high-functioning children with autism. *Journal of Autism and Developmental Disorders*, *22*(3), 433–447. https://doi.org/10.1007/BF01048245

Sean Smith, & Vale, W. (2006). The role of the hypothalamic-pituitary-adrenal axis in neuroendocrine responses to stress. *Dialogues in Clinical Neuroscience*, *8*(4), 383–395.

Spratt, E. G., Nicholas, J. S., Brady, K. T., Carpenter, L. A., Hatcher, C. R., Meekins, K. A., … Charles, J. M. (2012). Enhanced Cortisol Response to Stress in Children in Autism. *Journal of Autism and Developmental Disorders*, *42*(1), 75–81. https://doi.org/10.1007/s10803-011-1214-0

Walker, B. R. (2006). Cortisol--cause and cure for metabolic syndrome? *Diabetic Medicine: A Journal of the British Diabetic Association*, *23*(12), 1281–1288. https://doi.org/10.1111/j.1464-5491.2006.01998.x

Wilson, J. L. (2014). Clinical perspective on stress, cortisol and adrenal fatigue. *Advances in Integrative Medicine*, *1*(2), 93–96. https://doi.org/10.1016/j.aimed.2014.05.002

Zinke, K., Fries, E., Kliegel, M., Kirschbaum, C., & Dettenborn, L. (2010). Children with high-functioning autism show a normal cortisol awakening response (CAR). *Psychoneuroendocrinology*, *35*(10), 1578–1582. https://doi.org/10.1016/j.psyneuen.2010.03.009