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The Effects of a Remote Based Exercise Intervention on Psychosocial Factors in Young Adults with Autism Spectrum Disorder

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THE EFFECTS OF A REMOTE-BASED EXERCISE INTERVENTION ON PSYCHOSOCIAL FACTORS IN YOUNG ADULTS WITH AUTISM SPECTRUM DISORDER

By:

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ABSTRACT

AIM: The aim for this study was to identify the effects of physical activity (PA) on the psychosocial factors (PA self-efficacy, enjoyment of PA, perceived stress, and depression) amongst young adults with Autism Spectrum Disorder (ASD) through the use of a 12-week remotely prescribed exercise program. **METHODSs:** This quasi-experimental study consisted of a 12-week remote-based exercise intervention (and a no-exercise control group) for young adults (18 – 35 years) with ASD. Participants were recruited through the Center for Autism and Related Disabilities (CARD), an organization that provides resources to individuals with ASD and their families. The exercise program occurred twice a week for 45 minutes each session. Both the intervention and control groups were asked to complete surveys on PA self-efficacy, PA enjoyment, perceived stress, and depression. **RESULTS:** A total of 16 young adults (intervention = 10; control = 6) with ASD were included in the final analysis. Findings revealed that there was a significant decrease in depression scores in the intervention group following the exercise intervention ($p = 0.03$). Additionally, the change in depression scores from baseline to post-exercise program was significantly greater than in the control condition ($p=0.017$). Findings were not significant for either exercise group and control group for scores in enjoyment, self-efficacy, and perceived stress. **CONCLUSION:** Preliminary evidence suggest that a remote-based exercise intervention may reduce symptoms of depression in young adults with ASD. Future studies that consider the type of exercise program prescribed and increasing the sample diversity and size are needed.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF ACRONYMS

ASD	Autism Spectrum Disorder
CARD	Center of Autism and Related Disabilities
PA	Physical Activity
PSS	Perceived Stress
CESD	Depression

CHAPTER ONE: INTRODUCTION

Autism Spectrum Disorder (ASD) is a neurodevelopmental disability characterized by impairments in communication and language, and difficulties with social interaction (Diagnostic and Statistical Manual of Mental Disorders-5). According to the Center for Disease Control (CDC), 1 in 54 children are diagnosed with ASD every year, which is a substantial increase from 20 years ago when the prevalence was 1 in 150 children (CDC. 2018). Individuals with ASD may display a variety of symptoms, including balance and coordination issues, aggressive tendencies, and repetitive movement or stereotypic behaviors, such as, body rocking and arm flapping. Additionally, individuals with ASD tend to have increased levels of stress, depression, and anxiety compared to their neurotypical (NT) counterparts (Narzisi. 2020; Maenner et al. 2016; Srinivasan, et al. 2014; Lang et al 2010). The presence of these symptoms can negatively affect overall quality of life in individuals with ASD and their families.

Participation in physical activity (PA) has been shown to have numerous physical and psychosocial health for all populations, however, PA may be especially beneficial for individuals with ASD (Hillier et al. 2020; McCoy et al. 2016, Lang et al. 2010). For example, prior research has found that greater levels of PA may help to reduce ASD-related symptoms, such as repetitive behaviors, and improve challenges with social interaction. Unfortunately, individuals with ASD typically have lower levels of PA compared to their NT peers (Hillier et al. 2020; McCoy et al. 2016). While there have been many PA interventions to increase PA in children and adolescents with ASD, few have focused on young adults (18 – 35 years) with ASD. This is concerning as young adulthood tends to be in a time when declining PA levels are often observed in both NT and ASD populations (Eaves & Ho. 2008). Participation in PA is important for young adults with

ASD as it has been linked with a sense of autonomy, improved social skills, and improved quality of life (Hillier et al., 2020). Young adults with ASD are also at an increased risk of obesity and obesity-related diseases compared to NT young adults, so the need for PA interventions at this stage is even more critical for young adults with ASD (Howlin, 2021).

There has been much focus on psychosocial factors associated with PA participation in NT populations (Garcia et al., 2016; Jago et al., 2011). For example, PA self-efficacy and PA enjoyment have been consistently linked with greater levels of PA in NT adults (Diorio et al., 2018; Garcia et al., 2016). Similar psychosocial factors such as anxiety, stress, and depression appear to be linked with PA participation in ASD populations as well (Hillier 2020; Srinivasan et al. 2014; Curtin et al. 2010; Pan & Frey 2006). Research in NT adults suggests that exercise interventions aimed at increasing levels of PA enjoyment and self-efficacy may encourage long-term participation in PA.

In March 2020, the coronavirus (COVID-19) was declared a global pandemic by the World Health Organization (WHO), which resulted in the majority of U.S. schools, businesses, and community organizations to suspend all in-person activities indefinitely, (Rothan & Byrareddy 2020; WHO 2020). Recent studies have found that young adults with ASD reported an increase in perceived stress and depressive symptoms during the pandemic, which is problematic given that this population tends to have greater levels of depression compared to NT adults (Bal, 2021; Howlin, 2021; Yarimkaya & Esenturk 2020). A recent review also revealed that emotional outcomes such as stress, depression, anxiety, irritability, and anger have been associated with the quarantine and even continued on after the quarantine was lifted (Pfefferbaum 2020). While participation in PA has been reported to decrease levels of depression

and stress, there is evidence that indicates participation in PA has declined during the pandemic for both NT and ASD populations (Garcia et al., 2021; Moore et al., 2020).

Due to the restrictions on social gatherings during the pandemic, there has been a transition to remote-based interactions. The use of remote-based instruction to deliver an exercise intervention for young adults with ASD would be a possible solution to encourage participation in PA during the COVID-19 outbreak. The use of video-directed instruction has been found to be an evidenced-based treatment for effective learning in individuals with ASD, however there is limited research on the benefits of a remote-based exercise intervention in young adults with ASD (Sam et al., 2020). Therefore, the purpose of this study was to examine the benefits of a remote-based exercise intervention on young adults with ASD during the COVID-19 pandemic.

CHAPTER TWO: LITERATURE REVIEW

This literature review will consist of the following sections: a description of ASD, information on the benefits of PA for young adults with ASD, barriers and risks of physical inactivity, and the effects of the COVID-19 pandemic on young adults with ASD.

Description of ASD

The prevalence of ASD has continued to increase, with 1 in 54 children being diagnosed with ASD (CDC) which classifies this as one of the most diagnosed disorders in the US (Garcia et al. 2020). ASD, a neurodevelopmental disability, can be characterized through two aspects: 1) deficits in social communication and interaction which can further be defined as deficits in social interactions, problems with nonverbal communication and difficulty understanding relationships and 2) restricted repetitive behaviors (RRBs), interests, and activities which include repetitive motor movement, ritualized behavior, unusually strong interests in objects and perseveration, and heightened sensitivity to sensory stimulation (Diagnostic and Statistical Manual of Mental Disorders-5 (DSM-V)).

Treatment of ASD Symptoms

As the symptoms of ASD can have negative effects on an individual's quality of life, a variety of treatments, therapies, and medications have been used to improve symptoms. Such treatment strategies have included various medications (antidepressants, antipsychotics, anti-anxiety) and a variety of therapies (occupational, family, behavior management), however, many can be costly or have troublesome side effects (Samata et al. 2018; Choueiri & Zimmerman 2018; Dwayne et al. 2012). Recently, research has found that several lifestyle habits can affect

ASD-related behaviors, as well as physical and psychosocial health benefits. One of the primary health behaviors is physical activity (PA) and exercise. Many studies have shown that participating in PA can have many numerous benefits for individuals with ASD (Hillier et al. 2020; McCoy et al. 2016).

Physical Health Benefits of Physical Activity

According to the Physical Activity Guidelines for Americans (2nd edition) the benefits of PA on the health of individuals and across one's lifespan include brain maturation, development and academic achievement, improved cognition, quality of life, and sleep while also reducing feelings of anxiety and depression (CDC. 2018). Piercy et al. (2018) further summarized these guidelines and found that different variations of PA including aerobic activity, muscle-strengthening activity, bone strengthening activity and multicomponent physical activity as well as the type of intensity incorporated in the PA, such as absolute intensity and relative intensity, are beneficial for health of all individuals. Specifically, for young adults with ASD, the guidelines stated that individuals with intellectual disabilities should follow the instructions of professionals and engage in PA according to their abilities and to try and avoid inactivity (Piercy et al. 2018).

Psychosocial Benefits of PA

According to the Physical Activity Guidelines Advisory Committee, many health disparities can be prevented by participating in PA. For individuals with ASD, PA may beneficially affect measures of brain health, and more specifically, the individual's psychosocial factors (PAGAC 2018). Psychosocial factors can be defined as the social, cultural, and

environmental influences that affect mental health and behavior (VadenBos GR. 2015). More specifically, the factors of self-efficacy, enjoyment, stress, and depression, as a result from PA, will be highlighted in this paper. Previous research has shown that self-efficacy is a significant indicator of sport and exercise participation in typically developing populations and populations with physical disabilities (Te Velde et al. 2018). As such, identifying a greater perceived enjoyment and promoting a positive self-efficacy for young adults with autism may lead to increases in PA participation.

An important form of promoting PA for individuals with ASD is to create a program that is enjoyable for the individual. This is because self-efficacy is a significant indicator of PA in TD populations (Te Velde et al. 2018; Resnick & Jenkins 2000), while self-perceived enjoyment may be the key to opening the door of barriers that attenuate the opportunities for PA (Kendzierski & DeCarlo 1991). As such, the Physical Activity Enjoyment Scale (PACES) (Kendzierski & DeCarlo 1991) and Physical Activity Self-Efficacy for Exercise Scale (SEE) (Resnick & Jenkins 2000) were created to help quantify any individual's interest when it comes to exercise and PA. In fact, both scales have been studied and have determined that self-efficacy and enjoyment of physical activity are considered to be important variables in regard to participation in sport and exercise, however only the PACES has been studied specifically on individuals with ASD (Resnick & Jenkins 2000; Kendzierski & DeCarlo 1991).

Furthermore, a study by Jozkowski & Cermak compared physical activity and enjoyment responses in 36 individuals (18 with ASD and 18 without ASD) and found that both groups experienced high enjoyment through the use of physically active videogame play (exergaming) (2020). This study concluded that young adults with ASD, who participated in exergaming, found social interaction to be enjoyable, helped to motivate PA participation, and also improved

the experience of exercise (Jozkowski & Cermak 2020). Additionally, the self-efficacy of the individual is equally as important as their enjoyment. The belief that an individual has the ability to successfully involve themselves in a specific behavior, in this case PA and exercise, is termed self-efficacy (Olander et al. 2013). Self-efficacy has been identified as a key determinant in increasing PA for TD adults because of its ability to mediate between the intervention and the individual (Olander et al. 2013; Bauman et al. 2012).

Benefits of PA for individuals with ASD

Further research has shown that PA has benefits for those with ASD. For example, research has found that PA can reduce negative stereotypic behaviors and promote positive behaviors in individuals with ASD (Hillier et al. 2020; McCoy et al. 2016, Lang et al. 2010). A meta-analysis comprising sixteen studies, of which five studies focused on young adults including an age range from 17 to 40 years old, describing exercise-based interventions (including swimming, jogging, horseback riding, cycling, weight training, walking, other) reported positive effects on motor and social deficits amongst individuals with ASD (Sowa & Meulenbroek 2012). Another study conducted by Lalonde et al. (2014) aimed to introduce aerobic activity (walking) to four men with ASD (age range 21-26) in an attempt to help meet or exceed the minimum protocols for aerobic activity . The results of the study found that participants were walking over 10,000 or more steps a day, which is sufficient to meet the needs to prevent heart disease and other related health benefits (Lalonde et al. 2014; Iwane et al. 2000). As such, PA through different modalities can be beneficial for the overall health of individuals with ASD.

Perceived Barriers & Challenges to PA in ASD Populations

Despite the aforementioned benefits of PA, research has shown that young adults with ASD are less likely to engage in PA when compared to TD counterparts (Hillier et al. 2020; McCoy & Morgan 2020; McCoy et al. 2016). This low turnout for PA may be due to the impairments in motor, social communication, sensory and behavioral domains (McCoy & Morgan 2020; Srinivasan et al. 2014; Curtin et al. 2010; Pan & Frey 2006). McCoy et al. (2016) reviewed BMI, PA, and sedentary behaviors of adolescents (n = 42,747; aged 10-17), of which n = 915 had ASD. Results of this study found that adolescents with ASD are less likely to engage in the recommended amount of PA compared to TD adolescents, including regular physical activity, sport participation, and club participation (all three factors proved significant $p < 0.001$) (McCoy et al 2016). McCoy et al. (2016) stated that possible reasons for this lack of participation may have been due to deficits in motor skill development, cardiovascular endurance, upper body muscular strength and endurance, and lower body flexibility when compared to TD peers. Most recently, Hillier et al. (2020) had 30 participants with ASD (aged 18-27 years) complete a questionnaire consisting of three measures: The Godin-Shepard Lesiure-Time Physical Activity Questionnaire, Kerner & Grossman's (2001) Scales, and lastly the Barriers to Physical Exercise & Disability survey (2020). Results from this study showed that young adults with ASD participated in PA less frequently, had fewer favorable attitudes towards PA ($p = 0.001$), indicated lower perceived behavioral control of performing PA ($p = 0.006$), and reported greater barriers to PA when compared to their TD peers ($p = 0.017$) (2020). Unfortunately, from the reviewed studies, it can be seen that many barriers to PA include a lack of motor control, a reduced ability to perform the required tasks, and less ability to engage in certain activities which can inhibit desires to participate in more PA. Because individuals with ASD are found to lack the

recommended amount of PA needed, they are more susceptible to health disparities associated with physical inactivity.

As mentioned previously, psychosocial factors may affect participation in PA (Jozkowski & Cermak 2020; Te Velde et al. 2018). Physical activity self-efficacy has shown to be a strong predictor of participation in sport, exercise, and PA in TD individuals (Te Velde et al. 2018). Although fewer studies have been conducted with young adults with ASD, several studies in older adolescents with ASD have found that low PA enjoyment and lack of confidence may be linked with low PA participation (Stanish 2015). Additionally, individuals with ASD have often reported a lack of opportunities to participate in PA (Garcia et al. 2020). This lack of exposure to different types of PA may partially explain low self-efficacy and enjoyment, especially as individuals with ASD tend to be reluctant from trying new activities in unfamiliar environments (Garcia et al. 2020). Therefore, it is critical to provide further opportunities to introduce young adults with ASD to a variety of PA options in a familiar setting, with the hope of improving self-efficacy and enjoyment of these activities.

Consequences of Physical Inactivity

In addition to ASD-related symptoms, individuals with ASD have a greater risk of obesity when compared to the general population (TD) (McCoy & Morgan 2020; Criado et al. 2018; Vinck-Baroody et al. 2015; Srinivasan et al. 2014; Curtin et al. 2010). The concern of the presence of obesity with young adults with ASD, as well as TD individuals, is that obesity has been shown to negatively impact the life expectancy, health, function, mental health and quality of life of these individuals; as well as increasing the incidence of other health disparities such as type II diabetes, cancer, cardiovascular disease, asthma, gallbladder disease, osteoarthritis and

chronic back pain (Srinivasan et al. 2014; Tyler et al. 2011; Guh et al. 2009). One example indicating the prevalence of obesity amongst adolescents with ASD is through a study conducted by Eaves & Ho (2008) who conducted a follow up assessment of 48 young adults with ASD (age range 19-31 years) and concluded that obesity rates were 42% more common in young adults with ASD compared to TD peers. Additionally, a case-controlled analysis of the electronic health records of 108 adults with ASD (mean age of 28.8 years) was conducted at the Cleveland Clinic between the years of 2005 to 2008 (Tyler et al. 2011). It was found that, without any intervention, adults with ASD have a chronic rate of obesity (34.9%), hyperlipidemia (31.5%) and hypertension (19.4%) greater than adults without ASD (Tyler et al. 2011).

Additionally, McCoy & Morgan (2020) analyzed the likelihood of becoming overweight and obese while participating in regular physical activity or sedentary behaviors in association with autism severity between adolescents (two groups aged 10-12 and 13-17) with ASD and to their TD peers (2020). Although the age range of McCoy & Morgan's study is younger than that of the current investigation, much of what was learned can be translatable to our target population. As such, results found that individuals with ASD are more likely be overweight [odds ratio (OR) = 1.37; 95% CI (1.10,1.70)] and more likely to be obese [OR = 1.94; 95% CI (1.60,2.36)] than TD adolescents (McCoy & Morgan 2020). Additionally, it was found that adolescents with ASD are less likely to participate in sport [OR = 0.19; 95% CI (0.16, 0.230] and more likely to be viewing the television for 2 hours or more [OR = 1.25; 95% CI (1.07,1.270)] (McCoy & Morgan 2020). Concluding findings from the study state that adolescents with ASD were 84% more likely to be obese compared to TD individuals (McCoy & Morgan 2020). According to the CDC, one of the most beneficial recommendation for treating and preventing obesity among all people is PA (CDCC. 2018). Additionally, a mixture of diet, sleep, excess

media time, and living a sedentary lifestyle, may also contribute to obesity in all individuals (Brazendale et al. 2017). However, due to the lack of PA that ASD individuals typically engage in, the more susceptible they are in encountering these health disparities, with obesity as one of the main concerns.

The CORONAVIRUS (COVID-19) Pandemic

In Spring 2020, the outbreak of the Coronavirus (COVID-19) became a global pandemic. To prevent the transmission and spread of a communicable disease, many government health officials ordered a quarantine for their respective countries, which resulted in the closure of many businesses, schools, and community organizations. Although the quarantine is essential to help prevent the spread of the disease, it has been linked to several adverse physical and psychosocial health factors in both TD individuals and individuals with ASD (Brooks et al. 2020; Garcia et al., 2020). Garcia et al. (2020) studied the effects of the COVID-19 pandemic on health behaviors on individuals with ASD aged 14-19. Individuals with ASD were found to have decreased time spent performing PA ($p = 0.007$) and an increased screen time during the weekdays ($p = 0.007$) and during the weekend ($p = 0.004$) (Garcia et al. 2020). In another study, Brooks et al. (2020) reviewed 24 papers associated with the psychological impact of quarantine and found that stressors of the quarantine include duration, fears, frustrations, and inadequate information which ultimately led to consequences of health if not appropriately managed. Lippi et al. (2020) further commented on physical inactivity at the time of COVID-19, stating that limited PA during a quarantine may be associated with increased symptoms of stress, depression, and confusion. Unfortunately, these feelings of anxiety and fear may be exacerbated in the ASD

population, as these individuals tend to prefer structure and routine, often showing feelings of distress when there are disruptions to their typical schedule (Garcia et al. 2020).

Moreover, due to the COVID-19 pandemic, many individuals, especially young adults with ASD, are now withheld from the benefits of educational resources, such as opportunities at school, intervention programs, and special education, which are used as main interventions for symptoms of ASD (i.e. social interactions and communication opportunities) (Esenturk. 2020). Esenturk (2020) performed a thematic analysis, by conducting semi-structured interviews to determine their experiences, knowledge, attitudes, and feelings in regard to the parents' perception of their children participating in PA during the COVID-19 pandemic. The participants in the interviews consisted of 10 parents (six mothers and four fathers) of individuals with ASD (ages 9-16) from Erzincan, Turkey (Esenturk 2020). One of the themes found in the thematic analysis was titled "physical activity barriers during the COVID-19 outbreak" which further stated that increases in anxiety are due to the changes in an individual's routine (Esenturk 2020). Due to COVID-19, the home routine, school routine, and other previously used resources are now disrupted, and this interruption may increase anxiety in individuals with ASD which may prevent them from participating in PA (Esenturk 2020). These psychosocial factors are of much concern to individuals with ASD especially since it has been stated that environments filled with stress and anxiety (e.g., COVID-19) can ultimately increase symptoms of ASD (Garcia et al. 2020; Brooks et al. 2020; Lippi et al. 2020; Esenturk 2020).

Due to the increased anxiety, and further potential decline of PA levels during this pandemic, it is essential to promote opportunities for PA participation in young adults with ASD. Since in-person programs are prohibited, the use of remote-based programs to improve PA may be a potential option for this population. Previous research has demonstrated the effectiveness of

remote based programs for all individuals with disabilities, including ASD (Paneraie et al. 2018; Aresti et al. 2014). For example, Paneraie et al. (2018) studied the feasibility and effectiveness of a remote-home based rehabilitation for adults with intellectual disabilities. Through the satisfaction questionnaire, participants found the remote-home based program to be useful and fun (Paneraie et al. 2018). Additionally, a systematic review done by Aresti-Bartolome and Garcia-Zapirain (2014) analyzed technologies such as virtual reality applications, telehealth systems, social robots, and dedicated applications to which the authors concluded that ASD individuals are able to use of these technologies through training their strengths and weaknesses, while also sustaining their enjoyment. As such, the option for remote-based programs should be considered when working with young adults with ASD.

Literature Review Summary

From the previous research, it is evident that PA is beneficial for young adults with ASD, demonstrating improvements in physical and psychosocial health. Unfortunately, a majority of young adults with ASD do not meet the recommended levels of PA, which is further exacerbated by COVID-19. Although opportunities to participate in PA programs are limited due to social distancing, remote-based PA programs may be beneficial, especially for young adults with ASD, as remote-based platforms have been classified as an evidence-based treatment for the ASD population.

CHAPTER THREE: METHODOLOGY

Study Design:

The current study was a pretest – posttest quasi-experimental design with an exercise intervention group and a control group. Assessments of PA, PA enjoyment, PA self-efficacy, perceived stress and depression scores will be measured at pretest and posttest. It is hypothesized that PA scores, PA enjoyment and PA self-efficacy will increase, while perceived stress and depression will decrease in the exercise group compared to the control group after the 12-week program. All study procedures and assessments occurred remotely with surveys administered through Qualtrics survey software, and the exercise intervention delivered via the Zoom platform.

Participants:

The sample included 24 individuals (ages 18-35) with a primary diagnosis of Autism Spectrum Disorder (ASD). Participants self-selected into the exercise group or the control group. Fourteen of these individuals participated in the exercise intervention, while the remaining 10 participants served as the no-exercise control group. Participants were recruited through the Center for Autism and Related Disabilities (CARD), an organization that aids in assisting both individuals with ASD and their families through the use of consultations, programs, and education. CARD staff sent out email announcements to potentially eligible individuals and posted a message describing the study through social media. Individuals who were interested in participating were screened to ensure they were eligible for the program. To be included in the study, participants needed to have access to a computer and the Zoom platform. Additionally, participants could not have a severe disability or impairment that would prevent them from being

physically active. Informed consent was given prior to any participation of the study. All study procedures were approved by the University of Central Florida's Institutional Review Board.

Measures & Procedures

Overview of Exercise Intervention

The exercise intervention occurred on Tuesdays and Thursdays over the duration of the 12-week study. The 45-minute exercise sessions were taught by a certified exercise instructor who had received prior training to teach exercise classes remotely. All sessions began with a warm-up and ended with a gentle cool-down and light stretching. At the end of each Thursday session, the exercise instructor would give the participants "homework" (i.e., exercises to do at home) to complete for the session on the following Tuesday. This homework encouraged the individuals to exercise outside of the two scheduled sessions. Classes consisted of a mixture of aerobic exercise and strength-training. Table 1 displays the schedule of exercise sessions, and Table 2 describes a sample exercise session. The control group was told to continue their current routine.

Assessment Measures

Demographic Survey:

Participants were asked to complete a demographics survey preceding the 12-week exercise program. The survey consists of nine questions regarding the participant's age, gender, race, employment, school participation, and living conditions (Appendix A).

Physical Activity Surveys:

Physical Activity Enjoyment Scale (PACES) is an 18-item measure created to assess the extent to which an individual enjoys doing any given physical activity, regardless of whether the activity is done for exercise or for sport (Kendzierski & DeCarlo 1991). Two validation studies were performed in by Kendzierski & DeCarlo (1991) and were found to have a high reliability and validity of the PACES, as well as an alpha coefficient of 0.96. For the purposes of this study, only an eight-item measure was implemented rather than the original 18-item measure.

Physical Activity Self-Efficacy for Exercise Scale (SEE) is a measure used to describe self-efficacy expectations in relation to one's ability to confidently perform exercise when confronted with various barriers to exercise (Resnick & Jenkins 2000). Resnick & Jenkins (2000) researched the validity of the SEE scale and provided evidence for the reliability and validity by illustrating an alpha coefficient of 0.92. Participants were asked to complete both scales PACES & SEE pre- and post-intervention (Appendix C & D respectively).

Godin and Shepard Leisure Time and Exercise Questionnaire was used to measure a participant's PA levels. It was designed to be used to monitor the impact of health and physical fitness promotion programs in an easy and efficient manner (Godin & Shepard 1985). Recent studies have applied the questionnaire in populations with ASD (Hillier et al. 2020).

Psychosocial Scales

Levels of depression were measured by the *Center for Epidemiological Studies Short Depression Scale* (CESD-10) (Radloff 1977). The CESD-10 is a 10-item questionnaire that assesses how individuals feel during the past week (e.g. I was bothered by things that don't

usually bother me). Response options range from “rarely or none of the time” (<1 day) to “all of the time” (5 to 7 days). A higher score indicates a higher level of depression.

Levels of perceived stress were measured by the *Perceived Stress Scale* (PSS) developed by Cohen (1994). This 10-item scale asks the individual about their thoughts and feelings in the past month (e.g., In the last month, how often have you been upset because of something that happened unexpectedly). Response options range from 0 (never) to 4 (very often) with a higher score indicating greater levels of perceived stress (Appendix E & F respectively).

Statistical Analysis

All statistical analysis were conducted on the SAS program. Assessments included the Godin & Shepard questionnaire, PACES, SEE, PSS and CESD. A paired samples t-test was performed to compare all assessment scores from baseline to post-test. Additionally, independent samples t-tests were performed to compare the change in mean scores between the exercise group and the control group for each assessment. After the original analysis of the data was completed, a second round of analysis was conducted in SPSS Statistic 23 to confirm the finalized data. Statistical significance was determined at $p < 0.05$.

CHAPTER FOUR: RESULTS

Participant characteristics

Out of the 14 participants in the exercise intervention group, 3 dropped out of the program, leaving a sample of 11 participants that finished the 12-week program. One of the participants withdrew from the program due to an injury sustained (unrelated to the program), another participant dropped out because she preferred to exercise on her own, and the third participant dropped out of the program due to a loss of interest in the program. Out of the 11 remaining participants, one of the participants failed to complete both the pre- and post-program surveys, leaving a total of 10 participants from the exercise group that were included in the final analysis. Out of the 10 participants recruited for the control group, 4 of the participants failed to complete the pre- and post-program surveys, leaving a total of 6 participants from the control group in the final analysis. Table 1 displays the participant characteristics for each group.

Physical Activity Scores

A significant increase was seen in the PA levels from pre-intervention to post in the exercise group (16.5 $\pm$ 24.53 to 38.7 $\pm$ 25.83) compared to the control (45.33 $\pm$ 33.58 to 40.4 $\pm$ 37.67) (Table 4). However, because the PA scores in the survey do not tell us objective measures, it is difficult to determine an absolute value for each individual. In a relative sense there is an observed increase in PA for the exercise group compared to the control group as PA post exercise was significantly greater in the intervention ($p = 0.006$) than PA in controls ($p=0.293$). PA scores can be found in Table 4.

Psychosocial Factors: PA Self-efficacy & Enjoyment

Within-Subjects (Pre-Post scores)

In the intervention group, there was an increase in enjoyment of exercise from baseline (33.1 ± 8.88) to post-test (40.3 ± 10.87; p=0.09) but this increase was not statistically significant (Table 4). No significant change was observed in PA self-efficacy from baseline (30.1 ± 11.96) to post-test (26.8 ± 14.12; p=0.51), which was found not statistically significant (p = 0.511) (Table 4). The no-exercise control group displayed no significant differences from baseline to post-test in either exercise enjoyment (43.2 to 41.5, p=0.42) or PA self-efficacy (25.2 to 26.7, p=0.58). All results can be seen in Table 4.

Between-Subjects (Comparison of Δ scores in Exercise & Control groups)

There were no significant differences in change scores for either PA enjoyment (p=0.1) or PA self-efficacy (p=0.48) between the exercise and control groups. The change scores can be viewed in Table 5.

Psychosocial Factors Perceived Stress & Depression

Within-Subjects (Pre-Post scores)

In the exercise group, there was no significant difference in perceived stress scores from baseline (40.8 ± 9.92) to post-test (37.4 ± 8.1; p=0.36), however, there was a significant decrease in depressive levels from baseline (23.7 ± 7.18) to post-test (16.9 ± 7.52; p=0.03). In the no-exercise control group, there were no significant differences in either perceived stress scores

from baseline (36.0 ± 5.51) to post-test (39.8 ± 2.86; p = 0.08) or depressive levels from baseline (19.0 ± 5.67) to post-test (21.8 ± 8.69; p=0.12).

Between-Subjects (Comparison of Δ scores in Exercise & Control groups)

There were no significant differences in change scores for perceived stress scores between the intervention group and the no-exercise group (p=0.15). There was a significant difference in change scores for depressive levels between the exercise group and the no-exercise control group (p=0.02). All change scores are displayed in Table 5.

CHAPTER FIVE: DISCUSSION

The purpose of the current study was to examine the effects of a remote-based exercise intervention on PA-related psychosocial factors, perceived stress, and levels of depression in young adults with ASD during the COVID-19 pandemic. It was hypothesized that there would be a significant increase in both PA enjoyment and exercise self-efficacy in the exercise intervention group while there would be no change in levels in the control group. Additionally, it was also hypothesized that there would a significant decrease in both perceived stress and depression in the exercise intervention group, and no change in stress or depression in the control group. Our hypothesis was partially upheld in that there was a significant decrease in depression in the exercise intervention group at the end of the 12-week program, while there was no change in the control group. In contrast to our hypothesis, however, there were no significant differences in enjoyment, exercise self-efficacy, and perceived stress in the exercise group following the 12-week program. As expected, there were no differences in psychosocial factors in the control group.

Depression scores significantly decreased in the exercise intervention group after the completion of the remote exercise program, while there was no change in the control group. Previous research on the general population has found that individuals considered overweight and obese are more likely to be depressed (Faith et al. 2011). For individuals with ASD, Verstat and Hedges (2015) reported that being overweight or obese can increase the prevalence of ASD symptoms such as depression. Because individuals with ASD are more likely to be overweight and obese compared to NT peers (McCoy & Morgan 2020; Criado et al. 2018), the likelihood for depressive symptoms may be greater for individuals with ASD. Furthermore, the presence of the

COVID-19 pandemic is yet another consideration that may hinder an individual's depressive symptoms. Recently, Lippi et al. (2020) commented on physical inactivity at the time of COVID-19, stating that limited PA during a quarantine may be associated with increased symptoms of stress, depression, and confusion. Despite the increased possibility of symptoms, the results of this study exhibited that the incorporation of PA can help improve symptoms of depression for individuals with ASD. Participation in a remote exercise program may improve feelings of depression even when facing the challenges of obesity, the presence of the COVID-19 pandemic, and the diagnosis of ASD. Though decreases in depressive symptoms were seen, PA may not be the limiting factor as many other covariates may have lead to this outcome.

Although not significant, there was an observed increase in PA enjoyment in the intervention condition following the 12-week intervention. In regard to PA, enjoyment is typically seen as a motivator and a way to overcome barriers to PA for both NT individuals and individuals with ASD (Jozkowski & Cermak 2020, Stanish 2015, Kendzierski & DeCarlo 1991). Many factors may explain the non-statistically significant result. One reason is that the introduction of a new program may limit the amount of enjoyment for individuals with ASD as it is known that a change of routine is not of typical interest for individuals with ASD (Garcia 2020; Stanish 2015). It is also possible that the general interest in the prescribed exercise program may have limited the amount of enjoyment the individuals with ASD experienced, as an individual's interest in an activity is considered a strong motivator when participating in PA and exercise (Jozkowski & Cermak 2020). Overall, the small sample size may have been the limiting factor in detecting statistically significant changes as a result of the program

Surprisingly, in contrast to our hypothesis, there was no significant increase in self-efficacy following the exercise intervention. Olander et al. (2013) and Bauman et al. (2012) identified exercise self-efficacy as a key determinant in increasing PA for NT adults, however, there is limited research on the link between PA self-efficacy and PA levels in young adults with ASD. One theory, reported by Hortz et al. (2015), suggests that PA self-efficacy scores may decrease in previously sedentary individuals following a new exercise program due to changes in exercise-related expectations and goals. This theory may help explain the lack of change in PA self-efficacy scores for the exercise group, however, further research is needed to better understand the role of PA self-efficacy in young adults with ASD (Hortz et al. 2015). Another reason may have been the variety of exercise introduced in the exercise program. As previously stated, individuals with ASD tend to prefer structure and routine, often showing feelings of distress when there are disruptions to their typical schedule (Garcia et al. 2020). Thus, the continual introduction of new exercises every week may have instilled a lack of confidence in the participants and ultimately inhibiting the PA self-efficacy scores.

A slight decrease in perceived stress was found for the exercise group at the end of the remote exercise program and a slight increase was seen in the control group, however no statistical significance was determined. The implementation of the exercise program did demonstrate the impact PA can have on an individual's perceived stress as the exercise group had a decrease in stress scores compared to the control group. This is supported by previous research which has stated that PA can help attenuate symptoms of stress and anxiety for both TD individuals and individuals with ASD (Garcia et al. 2020; Hillier et al. 2020; McCoy et al. 2016, Lang et al. 2010). However, it was also previously mentioned that symptoms of ASD can be exacerbated by environments filled with stress and anxiety, which in this case refers to the

presence of the COVID-19 pandemic (Garcia et al. 2020; Brooks et al. 2020; Lippi et al. 2020; Esenturk 2020). This pandemic brought many rules, regulations, and uncertainty in the lives of all people, especially to individuals with ASD. For example, the main interventions for symptoms of ASD, which include educational resources and opportunities at school, intervention programs, and special education (i.e. social interactions and communication opportunities) were all withheld or were inaccessible for individuals with ASD (Garcia et al. 2020; Esenturk. 2020). This unfamiliar and uncomfortable environment, in addition to the lack of resources available may have introduced new stressors, explaining the slight increase in stress for the control group and the lack of statistical significance for both the control and exercise group.

Strengths

The current study had several strengths. First, the study focused on young adults with ASD, which is a population that has typically been overlooked in individuals with ASD. Additionally, the study included a control group of young adults with ASD who did not take part in the exercise intervention. The most important strength provided in this study was its accessibility. When considering the presence of the COVID-19 pandemic, the resources, opportunities, and intervention programs for individuals with ASD were inaccessible (Garcia et al. 2020; Esenturk 2020). The remote aspect of the study however, found a way to make exercise accessible. By bringing exercise and PA to the homes of the individuals with ASD, many individuals from different locations are provided the opportunity to participate without leaving their homes. Additionally, the remote aspect of the program provided a safe and accessible way to perform exercise during the COVID-19 pandemic, while adhering to CDC guidelines.

Limitations

Several limitations should also be noted. First, the small sample size was a limitation. Second, due to the pandemic, the study team was unable to obtain certain measurements, such as accelerometers, which could objectively measure activity levels. Even though self-reported physical activity were collected, it is prone to bias, and as an additional result of the pandemic, activity levels currently reported may not accurately reflect daily activity patterns. Although the remote-based nature of the program may have been appealing to participants, it also limited the types of exercise that could be taught due to space restrictions. Additionally, although there was a decrease in depressive symptoms following the 12-week period in the exercise group, there may have been other factors that contributed to this decrease, such as the increased social interaction the participants had as a result of this intervention.

Conclusion

A key component for a healthy lifestyle is PA. The idea that movement is medicine is at times overlooked by many clinical practitioners, despite the many beneficial outcomes that follow movement and exercise. According to the Physical Activity Guidelines Advisory Committee (2018) scientific report, many health disparities can be prevented by participating in PA. For individuals with ASD, PA may beneficially affect measures of brain health, and more specifically, the individual's psychosocial factors. The importance of movement and exercise for individuals with ASD is greatly supported by this study as it has proven that PA does have a role on the psychosocial aspects for individuals with ASD. Practitioners, therapists, and other personnel who work alongside individuals with ASD must consider psychosocial factors when implementing different programs and treatments as individuals with ASD may experience more

favorable outcomes if enjoyment of the program and appropriate self-efficacy in the program is applied. Additionally, this study has found initial evidence that incorporating PA may provide improvements in perceived stress and the depressive symptoms for individuals with ASD. There is still much to learn regarding the impact on these conditions, or the long-term impact of PA during childhood and adulthood. Many ideas come to mind for future research. The idea of incorporating longitudinal studies is important as there is limited research on young adults with ASD compared to children with ASD. Other ideas such as continued research on exercise and PA in young adults with ASD is a consideration, specifically with different types of exercise protocols (i.e., aerobic vs anaerobic training). Another idea may be comparing remote interventions to in-person interventions and considering the benefits of both modalities. Furthermore, the focus on psychosocial factors with the incorporation of a qualitative aspect on ASD populations is yet another topic of research. There are many directions to consider when researching this population. As such, it is important to continue research on young adults in the ASD population

APPENDIX A: TABLES

Table 1: Schedule of Exercise Sessions

Week	Tuesday Sessions	Thursday Sessions
1	Cardio Variations	Bodyweight Strength
2	Calisthenics	Yoga, Stretching, Meditation
3	Cardio Variations	Bodyweight Strength
4	Yoga, Stretching, Meditation	Mini-Bootcamp: High Intensity Interval Training
5	Bodyweight Strength	Cardio Variations
6	Calisthenics	Strength & Core
7	Mini-Bootcamp: High Intensity Interval Training	Bodyweight Strength
8	Calisthenics	Cardio Variations
9	Bodyweight Strength	Yoga, Stretching, Meditation
10	Strength & Core	Bodyweight Strength
11	Cardio Variations	Yoga, Stretching, Meditation
12	Strength & Core	Mini-Bootcamp: High Intensity Interval Training

Table 2: Example of an exercise session – Cardio Variations

Component	Exercises	Duration
Warm-up	March in place Lateral step touch Out-Out-In-In Knee Raises Butt Kicks Torso Rotations Arm Circles	~ 5-10 minutes
Cardio Set (each set repeated 3 times)	Inchworms (NEW) Squat punches (alternate high low) Fingertip to toe jacks Squat kicks (alternating legs) Windmill toe touches Mummy Kicks (adding arms to this movement) Standing bicycle crunches (NEW)	~ 25 minutes
Cool Down/Stretch	Moving lateral lunge stretches Standing quad stretch both legs (use wall for balance) Hip Stretches	~10 minutes
Exercise "Homework" for the week	Pick a strength based exercise and do at least 40 reps of it before next session	

Table 3 Descriptive Characteristics of the Exercise Intervention

Descriptive Characteristics		
Variables	Intervention Group (n = 10)	Control Group (n=6)
Age (yrs), m ± SD	26.1 ± 1.52	25.2 ± 1.46
Males, n (%)	7 (70%)	4 (67%)
White, n (%)	8 (80%)	4 (80%)[a]
Of Hispanic Decent, n (%)	4 (40%)	1(17%)
Currently Employed, n (%)	2 (20%)	2(33%)
Attends School, n (%)	1 (10%)	2 (33%)
Lives with Family, n (%)	8 (80%)	5(83%)

Comparison of Participant Characteristics at Baseline

[a]One participant did not response to this question (n=5)

Paired Sample Statistics Table

Table 4 Paired Sample Statistics Table

Paired T-Test						
Condition	Exercise (n = 10)			No-Exercise Control (n = 6)		
Variable	Pre $\bar{x}$ (σ)	Post $\bar{x}$ (σ)	p-value	Pre $\bar{x}$ (σ)	Post $\bar{x}$ (σ)	p-value
PA Score	16.5 (24.53)	38.7 (25.83)	**0.006**	45.33 (33.58)	40.4 (37.67)	0.29
PA Enjoyment	33.1 (8.88)	40.3 (10.87)	0.09	43.17 (3.6)	41.5 (6.44)	0.42
Exercise SE	30.1 (11.96)	26.8 (14.11)	0.51	25.17 (13.18)	26.67 (10.29)	0.58
Perceived Stress	40.8 (9.92)	37.4 (8.1)	0.35	36 (5.51)	39.83 (2.86)	0.08
Depression	23.7 (7.18)	16.9 (7.52)	**0.03**	19 (5.66)	21.83 (8.68)	0.12

$\bar{x}$ = mean; (σ) = standard deviation; significance at $p < 0.05$

Table 5 Comparison of change scores between Exercise & Control Group

Variables	Exercise Δ Score	Control Δ Score	p-value
Δ Total PA Score	**+22 (19.8)**	**-11.4 (21.1)**	**0.01**
Δ PA Self-efficacy	-3.3 (15.25)	+1.5 (6.16)	0.48
Δ PA Enjoyment	+7.2 (11.8)	-1.67 (4.68)	0.1
Δ Depression	**-6.8 (8.1)**	**+2.8 (3.7)**	**0.02**
Δ Perceived Stress	-3.4 (11.02)	+3.83 (4.4)	0.15

Post-test mean – baseline mean; significance at $p < 0.05$

APPENDIX B: DEMOGRAPHICS SURVEY

Demographic Survey

1. Date of birth:_____
2. Gender:_____
3. Are you of Spanish or Latino origin? _____Yes _____No
4. Race (Please list all that apply):_____
    a. African American
    b. Asian
    c. Native American
    d. White
    e. Other
5. Are you currently employed? _____Yes – full-time _____Yes – Part-time _____No
6. If you are employed, please list your job(s)?_____
7. Are you currently in school? _____Yes – full-time student Yes – Part-time student _____No
8. Do you currently live: _____in a house _____in an apartment _____dorm room _____other
9. Do you live?: _____on your own _____roommate _____family _____friends _____other

APPENDIX C: PHYSICAL ACTIVITY ENJOYMENT SCALE

Physical Activity Surveys (8 items)

Physical Activity Enjoyment Scale

Please rate how you feel *at the moment* about the physical activity you have been doing.

***I find it pleasurable**	1	2	3	4	5	6	7	**I find it unpleasurable**
It's no fun at all	1	2	3	4	5	6	7	**It's a lot of fun**
***It's very pleasant**	1	2	3	4	5	6	7	**It's very unpleasant**
***It's very invigorating**	1	2	3	4	5	6	7	**It's not at all invigorating**
***It's very gratifying**	1	2	3	4	5	6	7	**It's not at all gratifying**
***It's very exhilarating**	1	2	3	4	5	6	7	**It's not at all exhilarating**
It's not at all stimulating	1	2	3	4	5	6	7	**It's very stimulating**
***It's very refreshing**	1	2	3	4	5	6	7	**It's not at all refreshing**

***Item is reversed scored (i.e., 1=7, 2=6, …6=2, 7=1).**

APPENDIX D: PHYSICAL ACTIVITY SELF EFFICACY SCALE

Self-efficacy For Exercise (SEE) Scale

How confident are you right now that you could exercise three times per week for 20 minutes if:

	Not Confident									**Very Confident**
1. The weather was bothering you	1	2	3	4	5	6	7	8	9	10
2. You were bored by the program or activity	1	2	3	4	5	6	7	8	9	10
3. You felt pain when exercising	1	2	3	4	5	6	7	8	9	10
4. You had to exercise alone	1	2	3	4	5	6	7	8	9	10
5. You did not enjoy it	1	2	3	4	5	6	7	8	9	10
6. You were too busy with other activities	1	2	3	4	5	6	7	8	9	10
7. You felt tired	1	2	3	4	5	6	7	8	9	10
8. You felt stressed	1	2	3	4	5	6	7	8	9	10
9. You felt depressed	1	2	3	4	5	6	7	8	9	10

APPENDIX E: GODIN & SHEPPARD QUESTIONNAIRE

The Leisure Time Exercise Questionnaire of Godin and Shephard

Overview:
Godin and Shephard developed a simple questionniare to measure a person's leisure time exercise. It was designed to be reliable valid and easy to complete quickly without a need for detailed review. This can be used to monitor the impact of health and physical fitness promotion programs in the community. The authors are from the Universities of Laval and Toronto in Canada.

Questionnaire

(1) Considering a 7-day period (a week) how many times on the average do you do the following kinds of exercise for more than 15 minutes during your free time? •

strenous exercise (heart beats rapidly): number of times in week •
moderate exercise (not exhausting): number of times in week •
mild exercise (minimal effort): number of times in week

(2) Considering a 7-day period (a week) during your leisure time how often do you engage in any regular activity long enough to work up a sweat (heart beats rapidly)? •

often •
sometimes •
never or rarely

Strenous exercise (9 METS): running jogging hockey football soccer squash basketball cross country skiing judo roller skating vigorous swimming vigorous long distance bicycling.
Moderate exercise (5 METS): fast walking baseball tennis easy bicycling volleyball badminton easy swimming alpine skiing popular and folk dancing
Mild exercise (3 METS): yoga archery fishing from river bank bowling horseshoes golf snow mobiling easy walking.

Activity score in arbitrary units =
= (9 * (number of strenuous exercise episodes)) + (5 * (number of moderate exercise episodes)) + (3 * (number of mild exercise episodes))

Interpretation: • A person reporting strenuous exercise and frequent sweating episodes was likely to be thin. • An effective exercise promotion program will result in an increase in the activity score

APPENDIX F: PERCEIVED STRESS SCALE

PSS-14

INSTRUCTIONS:

The questions in this scale ask you about your feelings and thoughts during THE LAST MONTH. In each case, you will be asked to indicate your response by placing an "X" over the circle representing HOW OFTEN you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate.

	Never 0	Almost never 1	Sometimes 2	Fairly often 3	Very often 4
1. In the last month, how often have you been upset because of something that happened unexpectedly?	○	○	○	○	○
2. In the last month, how often have you felt that you were unable to control the important things in your life?	○	○	○	○	○
3. In the last month, how often have you felt nervous and "stressed"?	○	○	○	○	○
4. In the last month, how often have you dealt successfully with day to day problems and annoyances?	○	○	○	○	○
5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?	○	○	○	○	○
6. In the last month, how often have you felt confident about your ability to handle your personal problems?	○	○	○	○	○
7. In the last month, how often have you felt that things were going your way?	○	○	○	○	○
8. In the last month, how often have you found that you could not cope with all the things that you had to do?	○	○	○	○	○

9. In the last month, how often have you been able to control irritations in your life?	○	○	○	○	○

	Never 0	Almost never 1	Sometimes 2	Fairly often 3	Very often 4
10. In the last month, how often have you felt that you were on top of things?	○	○	○	○	○
11. In the last month, how often have you felt that things were going your way?	○	○	○	○	○
12. In the last month, how often have you found that you could not cope with all the things that you had to do?	○	○	○	○	○
13. In the last month, how often have you been able to control irritations in your life?	○	○	○	○	○
14. In the last month, how often have you felt that you were on top of things?	○	○	○	○	○

PSS-14

APPENDIX G: CESD-10 (DEPRESSION SCALE)

Center for Epidemiologic Studies Depression Scale (CES-D), NIMH

Below is a list of the ways you might have felt or behaved. Please tell me how often you have felt this way during the past week.

During the Past Week

	Rarely or none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	Most or all of the time (5-7 days)
1. I was bothered by things that usually don't bother me.	○	○	○	○
2. I had trouble keeping my mind on what I was doing.	○	○	○	○
3. I felt depressed.	○	○	○	○
4. I felt that everything I did was an effort.	○	○	○	○
5. I felt hopeful about the future.	○	○	○	○
6. I felt fearful.	○	○	○	○
7. My sleep was restless.	○	○	○	○
8. I was happy.	○	○	○	○
9. I felt lonely.	○	○	○	○
10. I could not get "going."	○	○	○	○

APPENDIX H: IRB APPROVAL

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

Memorandum

To: Juan Mayo

From: UCF Institutional Review Board (IRB)

Date: April 19, 2021

Re: IRB Coverage

The IRB reviewed the information related to your thesis *The Effects of a Remote Based Exercise Intervention on Psychosocial Factors in Young Adults with Autism Spectrum Disorder*

Your project data is covered under the following protocol previously approved by the IRB where you are listed as a Sub-Investigator.

IRB study name	IRB Approval Number
Evaluation of a Remote-based Nutrition and Exercise Program for Young Adults with Autism Spectrum Disorder	STUDY00002111

If you have any questions, please contact the UCF IRB irb@ucf.edu.

Sincerely,

Renea Carver
IRB Manager

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