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Relationship between exercise and the expression of ADHD symptoms in college students

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RELATIONSHIP BETWEEN EXERCISE AND THE EXPRESSION OF ADHD SYMPTOMS IN COLLEGE STUDENTS

by
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Dedication

I would like to dedicate this manuscript to Little Nick for inspiring me to start my research and to Big Nick for providing me with enough love and support to finish it . . . especially when I wanted to throw my computer out a window.

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Abstract

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The goal of this study was to examine the relationship between cardio-respiratory exercise levels and the expression of symptoms commonly associated with Attention-Deficit/Hyperactivity Disorder (ADHD) in a college population. Previous research suggests physical exercise may reduce common behavioral symptoms of ADHD. Symptoms commonly associated with ADHD include an inability to focus and feelings of restlessness, which may be harmful to a college student's academic success. The present study surveyed the exercise level, symptom expression, and diagnostic history of undergraduate students (N=315) at Rowan University. Exercise frequency and duration were calculated based on the U.S. Department of Health and Human Services (2008) recommendations for adults. ADHD symptom expression was measured using the Adult ADHD Self-Report Scale-V1.1 Screener (World Health Organization, 2005) and Yes/No questions determined if a subject had ever been diagnosed, medicated, or classified as a result of ADHD. A two-way analysis of variance (ANOVA) evaluated the interaction of exercise level, symptom expression and diagnostic history, with mixed results. The investigator concluded that exercise remains an important clinical target for research into ADHD management.

Table of Contents

Abstract	v
List of Figures	vii
List of Tables	viii
Chapter 1: Introduction	1
1.1 Statement of the Problem	1
1.2 Hypothesis	2
1.3 Definitions	3
Chapter 2: Literature Review	6
2.1 ADHD	6
2.2 Adult ADHD	9
2.3 Treatment	13
2.4 Exercise	16
Chapter 3: Methodology	22
3.1 Participants	22
3.2 Design	24
Chapter 4: Findings	26
Chapter 5: Discussion	30
5.1 Conclusions	30
5.2 Limitations	31
5.3 Future Directions	32
List of References	33
Appendix A Survey Instrument	37

List of Figures

Figure	Page
Figure 1 Predicted Distribution of ASRS Scores	27
Figure 2 Actual Distribution of ASRS Scores	27

List of Tables

Table	Page
Table 1 Descriptive Statistics for Socio-demographic Variables	26
Table 2 ANOVA Results: Exercise, Diagnosis and ASRS Score	28
Table 3 Descriptive Statistics for Study Variables	28
Table 4 Cross-tabulation Results: ADHD Diagnosis and ASRS Score	29

Chapter 1

Introduction

Statement of the Problem

This study will examine the persistence of ADHD into young adulthood, functional impairments unique to the college setting, the pharmacological treatment approach, alternative therapies, and the impact of exercise on ADHD symptom expression.

Significance of the Study

Currently, much attention in popular media and professional literature is given to Attention-Deficit/Hyperactivity Disorder, referred to as simply ADHD for short. Many people, specifically parents and teachers, may encounter these terms every day; though only trained professionals are able to diagnose and treat ADHD. A recent New York Times article (2012, January 29) by Dr. L. Alan Sroufe of the University of Minnesota's *Institute of Child Development* gained media attention (Snyderman, 2012) for publicly confronting the rising dependence on pharmaceuticals to treat Attention-Deficit Hyperactivity Disorder across the lifespan. Dr. Stroufe claimed that he has observed a twentyfold increase in the consumption of prescription drugs for ADHD symptoms management over the past thirty years.

Research is emerging in support of the suggestion that physical exercise has a measurable effect on an individual's expression of the symptoms commonly associated with ADHD (Lufi & Parish-Plass, 2011; Mulrine, Prater & Jenkins, 2008). However, the majority of these studies were on children (Azrin, Ehle & Beaumont, 2006; Kiluk, Weden & Culotta, 2009; McKune, Pautz & Lombard, 2003; Norling, Sibthorp, Suchy, Hannon &

Ruddell, 2010; Tantillo, Kesick, Hynd & Dishman, 2002), or in some cases laboratory rats (Hopkins, Sharma, Evans & Bucci, 2009; Robinson, Hopkins & Bucci, 2011).

DuPaul, Weyandt, O'Dell and Varejao (2009) cited an inability to locate any empirical studies at that time which investigated the effects of psychosocial interventions on the symptoms or associated functional impairments of college students with ADHD. A very limited number of studies have been conducted with college students with ADHD, and most were complicated by restrictive inclusion criteria and unreliable assessment measures. One of the only studies that thoroughly examined the impact physical exercise has on college students' expression of the symptoms commonly associated with ADHD was an unpublished doctoral dissertation from SUNY Buffalo (Wendt, 2000). The commonly associated symptoms of ADHD include the inability to focus and feelings of restlessness, which may be harmful to a college student's academic success (Jones, Kalidova & Higbee, 1997). The present study examines the relationship between the frequency of exercise and the presence of symptoms commonly associated with ADHD in an undergraduate college population.

Purpose of the Study

The purpose of this study was to determine how exercise frequency impacts the expression of symptoms commonly associated with Attention Deficit Hyperactivity Disorder in a college population.

Hypothesis

This study hypothesized that college students who exercise at least 150 minutes average per week would be less likely to screen positive on the *Adult Self-Report Scale-V1.1 (ASRS-V1.1) Screener* than those who exercise less than 150 minutes per week.

Definitions

Active: Refers to participants who met or exceeded the minimum threshold of an averaged 150 minutes of cardiorespiratory exercise per week, based on the American College of Sports Medicine's recommendation.

ASRS: The *Adult Self-Report Scale-Version 1.1 Screener*, which is a 6-item subset of the World Health Organization's 18-item *Adult ADHD Self-Report Scale-Version 1.1 Symptom Checklist* and was used to measure ADHD symptom expression in this study.

Attention-Deficit/Hyperactivity Disorder (ADHD): A neurobehavioral disorder characterized by a persistent pattern of inattention and/or hyperactivity/impulsivity that is more frequently displayed and more severe than is typically observed in individuals at a comparable level of development (American Psychiatric Association, 2000). The four subtypes are: Predominantly Inattentive (I), Predominantly Hyperactive/Impulsive (H/I), Combined (C), and Not Otherwise Specified (NOS).

Classified Student: Refers to participants currently receiving special academic accommodations through the Academic Success Center at Rowan University.

Diagnosed Student: Refers to participants currently under the care of a physician and receiving psychopharmacological treatment for Attention Deficit Hyperactivity Disorder.

Disability: Defined by the Americans with Disabilities Act (1990) as a physical or mental impairment that substantially limits one or more major life activities, such as learning.

Disability Resources: Accommodations and assistance in the class room granted to students with documented disabilities under Section 504 of Services to Students with Disabilities. These support services are provided to students by the Academic Success Center at Rowan University and require documentation from a physician.

DSM: Diagnostic and Statistical Manual of Mental Disorders; Five versions have been published by the American Psychological Association from 1968 to 2000.

Hyperactivity: A state of heightened motor and emotional activity (Barkley, 2006)

Impulsivity: A lack of self control over one's actions and words (Barkley, 2006)

Inactive: Refers to participants who did not meet the minimum threshold of an averaged 150 minutes of cardiorespiratory exercise per week, based on the American College of Sports Medicine's recommendation.

Inattention: The state of being distracted, or the inability to concentrate (Barkley, 2006)

Assumptions

Several assumptions were made in regards to the students participating in this study. It was assumed that students responded to the survey instrument honestly and to the best of their knowledge. It was further assumed that respondents were aware of accurate information pertaining to their diagnostic and academic statuses. Without a comprehensive understanding of the differences between common behaviors and clinical diagnoses, and likewise the differences between professor-granted exceptions and official disability resources, a respondent could have unintentionally misreported information. Any and all academic supports received by classified students were also assumed to be medically necessary and appropriate.

Limitations

There were several limitations present within the constructs of this study. The homogeneity of participants is a possible cause for concern. The entire sample was obtained on the campus of a small public university in the northeast with a predominantly in-state student population. A further limitation of the sample demography was the

limited racial diversity. Regarding diagnoses, this study did not exclude participation of individuals with comorbid disorders. Therefore, not only was the uniqueness of individuals a limitation, but also the uniqueness of varying interactions of different disorders in combination with varying subtypes of ADHD.

The integrity of self-report data is also questionable. Students may not respond to the survey instrument honestly, possibly as a result of social desirability or for lack of understanding the serious nature of research. The direction of the relationship between exercise and symptomology may be misrepresented due to the cross-sectional nature of the survey instrument. Assessing exercise level through a series of original questions with unknown validity was an added limitation. There may have also been extraneous variables, such as concurrent treatment programs confounding the results.

Chapter 2

Literature Review

The topic of Attention-Deficit/Hyperactivity Disorder (ADHD) has become increasingly popular in recent years. Many researchers (Barkley, 2004; Biederman, 2003; Brue & Oakland, 2002; DuPaul, Weyandt, O'Dell & Varejao, 2009; Faraone & Biederman, 2009; Pelham et al., 2000) have sought to discover the most effective ways to manage ADHD at all ages with the fewest side effects. The standard treatment modality is pharmacology (American Academy of Pediatrics, 2011; Barkley, 2004; Jardin, Looby & Earleywine, 2011), but complementary and alternative methods are emerging with mixed reviews regarding efficacy (Chelonis, Johnson, Ferguson, Berry, Kubacak, Edwards & Paule, 2011; Peck, Kehle, Bray & Theodore, 2005). One idea gaining empirical validity is the notion that exercise can have a significant impact on the interfering symptoms that are commonly associated with the disorder (Azrin et al. 2006; Hopkins et al., 2009; Kiluk et al., 2009; Lufi & Parish-Plass, 2011; McKune et al., 2003; Mulrine et al., 2008; Norling et al., 2010; Robinson et al., 2011; Tantillo et al., 2002).

Attention-Deficit/Hyperactivity Disorder

This literature review examines relevant research regarding ADHD and the pursuit of appropriate treatment modalities. The current classification, prevalence and major impairments of the disorder, along with its perseverance into young adulthood and the specific implications of adult ADHD will be discussed. The emphasis on pharmacological treatment methods, as well as empirically based alternative treatments that highlight the use of exercise, will be offered to provide greater understanding of the

various types of treatment available and the circumstances under which their efficacy may be outweighed by their risk.

Classification

Although the general public may believe that ADHD is fairly new diagnosis, the condition has actually existed in some form for nearly a century, undergoing many name changes over time. In that time, nomenclature has included hyperactive child syndrome, hyperkinetic reaction of childhood, minimal brain dysfunction, and attention deficit disorder (Barkley, 2011a). The American Psychiatric Association publishes the Diagnostic and Statistical Manual of Mental Disorders (DSM) as the standard system of classifying, describing and diagnosing mental disorders. The evolution of traditional ADHD classification can be traced throughout the DSM publications. Starting with the DSM-II (1968), "hyperkinetic reaction of childhood" was characterized by a short attention span, hyperactivity, and restlessness. The DSM-III (1980) renamed the disorder Attention Deficit Disorder (ADD) and redefined it as primarily a difficulty with inattention, rather than hyperactivity. The DSM-III also divided ADD into two subtypes: ADD/H meaning with hyperactivity, and ADD/WO meaning without hyperactivity. The DSM-III-R (1987) then proceeded to consolidate the symptoms back into one dimension and change the name to Attention Deficit Hyperactivity Disorder (ADHD).

The debate over whether or not ADHD should be a multi-dimensional disorder was settled when the DSM-IV (1994) revealed that symptoms were to be divided into two categories, Inattentive and Hyperactive-Impulsive. The DSM-IV also re-instated subtypes, presenting three: Primarily Inattentive (ADHD-I), Primarily Hyperactive Impulsive (ADHD-H/I), and Combined (ADHD-C) types. In its current version, the

DSM-IV-TR (2000) defines the presence of ADHD by diagnostic criteria that include two related symptom dimensions consisting of difficulties with inattention and with hyperactive-impulsive behavior, and adds a Not Otherwise Specified (NOS) subtype.

Prevalence

One national study (Wolriach et al., 1998, as cited in Faraone & Biederman, 2009) examining the diagnostic validity of DSM-IV criteria found a range of 6.8% up to 16.1% prevalence rates wherein variance directly coincided with criteria used. Recent national reports indicate that ADHD is on an upward climb. Longitudinal data (NCBDDD, DHDD, 2011) found that the percentage of children with a parent-reported ADHD diagnosis increased by 22% between 2003 and 2007.

Developmental Persistence

ADHD is presently considered by the American Academy of Pediatrics (2011) to be the most common neurobehavioral disorder of childhood. It is the position of the AAP that ADHD can profoundly affect the academic and social achievement of children. At all ages, the functional impairments associated with ADHD include school dysfunction, social relations, family conflict (Faraone & Biederman, 2009), self-sufficiency, antisocial behavior and adherence to social rules, norms, and laws (Barkley, 2004).

Russell Barkley (2004), a renowned expert in the study of ADHD, considers the research of ADHD in teenagers and adults significantly less advanced than comparable research in children. This disparity is particularly troubling in light of a claim made by the National Center on Birth Defects and Developmental Disabilities, Division of Human Development and Disabilities (2011) that diagnosis rates are raising faster among older teens than younger children.

Adult ADHD

Recent data estimate a 4.4% prevalence rate (Kessler et al., 2006) for adult ADHD. The legitimacy of this estimate is questionable because the diagnosis can be much harder to come by for adults. Although the symptom presentation may be different, adult ADHD reflects the same basic dimensions of childhood ADHD (Barkley, 2011b).

Controversial Assessment

Significant debate exists about the appropriate criteria for a diagnosis of adult ADHD and whether or not current models yield accurate conclusions. It is a statistical reality that more adults are seeking ADHD evaluations than ever before (Barkley, Fischer, Smallish & Fletcher, 2002) and it follows that more research is exploring ADHD in adulthood as well. The Barkley et al. investigation cited results of more interpretive studies suggesting young adults who seek clinical services are not simply overreacting to normal inattentional difficulties, contrary to arguments made by skeptics in the media. In fact, such young adults are generally found to exhibit a statistically significant elevation in impairment rates across multiple domains of functioning. Some of the disagreement has centered on the actual perseverance of childhood ADHD into young adulthood, but the findings of Murphy, Barkley and Bush (2002) contribute to the validity of adult ADHD as a psychiatric disorder Clinical research counters that out of all the children diagnosed with ADHD it is likely only 20- 35% will be free of symptoms and associated impairments in their adult lives, despite widespread belief otherwise (Barkley, 2011a).

Current DSM criteria for clinical qualification of adults require that impairing symptoms not only meet the threshold, but also date back to childhood. The majority of this determination is based on adult self-reported recollections. One concern about this

practice is the accuracy of those recollections which define diagnosis. Researchers advise practitioners to use discretion when considering an adult patient's memory of symptoms from childhood as evidence supporting a diagnosis (Barkley et al., 2002).

Barkley (2011b) criticized the DSM threshold as being inapplicable to adults given that it was based entirely on children. Longitudinal research (Barkley et al., 2002) has shown that at least one-third of patients with childhood ADHD symptoms that have persisted into adulthood and who place at the 98th percentile for adults no longer meet DSM diagnostic criteria for ADHD. Kessler et al. (2010) examined the stability of ADHD symptoms from childhood to adulthood, as well as the structure of adult ADHD and the adult symptoms most predictive of current clinical diagnoses. Out of 345 subjects, nearly half who had been diagnosed with childhood ADHD continued to meet the full DSM-IV criteria for current adult ADHD. Adult persistence was much greater for inattention than for hyperactivity/impulsivity. Additionally, there was a group of respondents who met the full criteria for current adult ADHD despite not having met the full childhood criteria.

Another study (Kessler et al., 2006) found that symptoms were more subtle and varied in adults than in children. This supports the use of a wider symptom range to allow for better clinical assessment in adults. Some research (Barkley et al., 2002) considers the criteria outlined in the DSM inconsistent because the symptom threshold is not proportionate to age. The current minimum requirement deviates progressively in direct relation to age at evaluation. Due to these confounding factors, previous investigations relying heavily on self-report data or DSM-criteria may have drastically underreported the actual rates of ADHD diagnoses persisting into young adulthood.

Impairment in the College Setting

Each stage of life makes new demands and meeting them can be significantly more challenging for students with ADHD. Although diagnosed adolescents may be perfectly capable of mastering high school academics, many are known to drop out of high school because they lack the attention or executive function skills necessary for success (Weiss & Weiss, 2004). A recent report (Barkley, 2011a) estimated that as many as 30-50% of students with ADHD had been retained in a school grade at least once and another 25-36% never finished high school. Yet despite the odds, many young adults with ADHD do go on to college where the demands are even more rigorous and require even more concentration. Being that children and adolescents with ADHD are often adversely impacted academically, socially, and psychologically, experts like Russell Barkley (2006) suggest it is logical to expect that diagnosed college students would experience similar decreased functioning in these areas. DuPaul et al. (2009) estimated that anywhere from 2-8% of U.S. college students report clinically significant levels of ADHD symptoms; but official prevalence rates for the disorder in the college population are not available, largely because students with ADHD are not required to disclose their disability to their educational institution.

Adjusting to college is difficult in its own right and can independently trigger psychological distress (Shaw-Zirt, Popali-Lehane, Chaplin & Bergman, 2005). The college environment is considerably less structured than high school and full of new distractions, placing inattentive students at risk for academic failure (Norwalk, Norvilitis & MacLean, 2009). Students experiencing symptoms of ADHD rate significantly below their peers on several domains of adjustment (Shaw-Zirt et al., 2005). College students

with ADHD may have particular difficulty obtaining social support (Blase et al., 2009) which could further complicate their adjustment.

Adults with ADHD are eligible for accommodations in their educational settings under the Americans with Disabilities Act (1990) provided that they disclose their disorder to their educational institution (Barkley, 2011a). Preliminary estimates (DuPaul et al., 2009) suggest that nearly one quarter of all students who receive disability support services are receiving them for ADHD. Even so, DeAngelo (2011) found that students who report ADHD are less likely to expect a B average or better, more likely to need tutoring, and take longer to earn their college degree.

There is a plethora of research exploring the common academic difficulties of diagnosed college students (Blase et al., 2009; DeAngelo, 2011; DuPaul, Weyandt, O'Dell & Varejao, 2009; Jardin, Looby & Earleywine, 2011). In terms of academic functioning, students with a current diagnosis of ADHD have been found to maintain significantly lower GPAs than students with a past diagnosis and students who had never been diagnosed (Blase et al., 2009). Some studies have found that increased ADHD symptom expression is indirectly proportional to unsuccessful study habits and an unsuccessful adjustment to the academic rigors of collegiate curricula (Norwalk et al., 2009). Other investigations found that inabilities to focus, sustain attention, or maintain organization, as well as deficits in executive functions (Weyandt & DuPaul, 2008) all occurred in similar trends.

So what is an inattentive and overwhelmed college student to do? Pharmacology is widely relied upon (American Academy of Pediatrics, 2011; Barkley, 2004; Jardin et al., 2011) to clinically manage the common symptoms that hinder academic success.

Treatment

It is estimated that 2 to 3 million children in the United States are affected by Attention Deficit Hyperactivity Disorder (Akinbami, Liu, Pastor & Reuben, 2011). Coupled with the knowledge that stimulant medication is one of the most routinely prescribed ADHD treatments (Barkley, 2011a; Biederman, 2003; DuPaul et al., 2009; Jardin et al., 2011), the logical conclusion is that a substantial population of children is dependent upon such medication to function every day. As these children grow, their dosages will likely increase and in many cases multiply. During the titration process, the patient takes on the added responsibility of noticing side effects and responses to each dosage as the amount is gradually adjusted (Barkley, 2006). One study (Kinsbourne, De Quiros & Tocci Rufo, 2001) pointed out that an objective medication assessment would streamline the process of determining a patient's ultimate optimal dose, potentially saving the patient weeks on an ineffective and/or excessive dosage regime.

Some patients suffering from ADHD try to avoid prescription dependence by seeking out nontraditional treatments. The appeal of complementary and alternative medicine (CAM) lies not only in the general health aspect, but in the fact that many patients are dissatisfied with results of their conventional care, or concerned about adverse effects of stimulants. Faraone and Biederman (2009) estimate that 30-40% of patients with ADHD are unresponsive or intolerant to currently available therapies. Among the unconventional methods are elimination diets, megavitamin therapy, sensory integration training, chiropractic manipulation, play therapy, psychotherapy, and perhaps the most common, social skills training (Parr, 2011). The success of CAM varies and is typically implemented on a trial-and-error basis (Brue & Oakland, 2002).

Regardless of the chosen treatment method, ADHD is a chronic developmental disorder that needs to be addressed slowly and systematically (Weiss & Weiss, 2004). According to Barkley (2011a), proper treatment requires a comprehensive behavioral, psychological, educational, and medical evaluation followed by exploration of all available methods proven to assist with its management.

Pharmacology

To date, there are no pharmacological treatments that aim to cure this disorder, but there are many which effectively assist with its management. In Barkley's 2004 treatment overview, the four classes of psychotropic drugs proven useful for the management of ADHD symptoms were listed as stimulants, noradrenergic reuptake inhibitors, tricyclic antidepressants, and antihypertensive agents. Each was empirically proven effective in reducing ADHD symptoms in clinical trials, as pharmaceuticals are strictly regulated by the Food and Drug Administration. In 2007, parent reports indicated that 2.7 million children aged 4-17 years, 66.3% of those with a current diagnosis, were receiving medication as their primary ADHD treatment (NCBDDD, DHDD, 2011). According to a US Drug Enforcement Agency report, methylphenidate (i.e. Ritalin) was the third most prescribed drug in the country in 2005 (DuPaul et al., 2009).

As with any disorder, treatments will vary. Some individuals with ADHD may require combinations of these medications, or others, for the management of their disorder (Barkley, 2011a). Other treatments may then be added as adjuncts for domains of impairment that are unaffected by the stimulant medication or when medication-free periods are required (Barkley, 2004). ADHD diagnoses may also be co-morbid with other mental disorders which require additional medications (Barkley, 2006).

The children who are most often diagnosed come from the socioeconomic strata least able to afford long-term medication treatment (Akinbami et al., 2011). In the decade spanning 1999-2009 alone, ADHD diagnoses reached 10% of households with family income less than 100% of the poverty level and 11% of households with family income between 100% and 199% of the poverty level. Based on these rates, children with Medicaid are more likely than uninsured children or privately insured children to be diagnosed with ADHD (NCBDDD, DHDD, 2011). Assuming these children can overcome their disability and persevere into a college setting, the financial responsibility of maintaining their treatment may be an insurmountable burden.

Treatment Integrity

A sweeping estimate is that 10-25% of medically managed ADHD patients develop difficulties with over-use, dependence upon, or even abuse of legal substances like alcohol and tobacco or illegal substances like marijuana, cocaine, or un-prescribed drugs (Barkley, 2011a). The findings of Kessler et al. (2006) from the National Comorbidity Survey Replication (NCS-R) support the case that adults diagnosed with ADHD experience greater instances of alcohol and drug abuse. Additional related difficulties included divorce and unemployment or an inability to work.

On the other hand, refuting evidence suggests that stimulant treatment of childhood ADHD might actually reduce subsequent risk of substance use disorders. The findings of Biederman (2003) included confirmation that stimulant therapy protected medicated ADHD patients against substance use disorder, which presented 3 to 4 times more often with untreated ADHD patients.

Multimodal Treatment

Recent advances in the treatment of ADHD combine several treatment approaches, known as multimodal treatment. Barkley (2004, 2006, 2011a, 2011b) is a strong proponent for the combination and regular maintenance of treatments over long periods of time to sustain the initial treatment effects. In this light, ADHD is encouraged to be viewed as a chronic medical condition that requires ongoing treatment to manage symptoms rather than cure the underlying cause. Combining treatment modalities could potentially create less of an ongoing dependence on medication alone. Using combined treatments for ADHD, the dosage of both medication and behavioral treatments may be varied simultaneously (Pelham et al., 2000). Treatment is likely to be multidisciplinary, requiring the assistance of the mental health, educational, and medical professions at various points in its course. Barkley (2011a) believes that adults suffering from ADHD are able to enjoy "satisfactory, reasonably adjusted, and productive lives" (p.5) if multimodal treatment is practiced effectively.

Exercise

The chief recommendation of any medical doctor or clinical practitioner is to advance and sustain health. An investigation by Haskell et al. (2007) addressed the updated recommendation for adults from the American College of Sports Medicine (ACSM) and the American Heart Association (AHA) regarding physical activity and public health. These agencies specifically advocate that adults aged 18-65 have moderate-intensity aerobic physical activity for a minimum of 30 minutes, at least five times every week. This official recommendation was published in *Physical Activity Guidelines for Americans* (2008) by the United States Department of Health and Human Services.

Exercise and the Brain

The utility of exercise goes beyond the overall health and fitness benefits. Being that the pathophysiology of ADHD involves dysregulation of dopaminergic (i.e. dopamine) and noradrenergic (i.e. norepinephrine) systems, it follows that stimulant medications are prescribed for their utility in enhancing dopamine and norepinephrine neurotransmission (Faraone & Biederman, 2009). However, research has consistently demonstrated that physical activity also influences those same dopamine, norepinephrine, and serotonin regulating systems which affect arousal and attention (Kiluk et al., 2009).

Dr. John Ratey, an associate clinical professor of psychiatry at Harvard Medical School and author of *Spark: The Revolutionary New Science of Exercise and the Brain*, explains that exercise turns on the attention system, including executive functions such as sequencing, working memory, prioritization, inhibition, and the sustaining of attention (Ratey & Hagerman, 2008). Exercise increases blood flow, allowing for more oxygen and nourishment to reach the different parts of the brain, with resulting effects on brain chemistry, cerebral metabolism, and growth and development (Mulrine et al., 2008). Aerobic exercise has also been found to increase stem-cell development in areas of the brain that are responsible for learning and memory (Putnam, 2003).

According to MRI testing, the brains of individuals diagnosed with ADHD are volumetrically different than non-diagnosed controls (Parr, 2011). Individuals with ADHD naturally lack the brain chemicals (i.e. neurotransmitters) that affect focus and attention, but exercise has been shown to alter these levels in the blood (McKune et al., 2003). Increasing neurotransmitter levels improves the regulation of attention circuits, which subsequently reduces cravings for new stimuli and increases alertness (Ratey &

Hagerman, 2008). Thus, researchers (Hopkins et al., 2009) acknowledge that physical exercise is presently being studied to a greater extent for its potential therapeutic effects on mental health.

According to Hopkins et al. (2009), it is well established that exercise improves cognitive functioning in both humans and rodents. Their investigation examined the effects of voluntary physical exercise on attentional function and social behavior in male and female spontaneously hypertensive rats, a commonly used animal model of ADHD. Data from this and a similar study (Robinson et al., 2011) suggest that exercising during a critical phase of brain development and plasticity can impact behavior of juvenile rats, implying a foundation for further research in humans.

Exercise and ADHD

Although the physical health benefits of exercise are well-known to parents and educators, the mental benefits are less obvious (Putnam, 2003). Researchers have evaluated antecedent physical activities, such as routine running (Norling et al., 2010), other aerobic activities (McKune et al., 2003), weight training, and simple movement as potential interventions for managing disruptive behavior (Barkley, 2004). Dr. Ratey suggests thinking of exercise as medication (Ratey & Hagerman, 2008). It is important to note that endorsing exercise does not necessitate opposing the use of medication (Wendt, 2000). One study (Tantillo et al., 2002) hypothesized exercise would lead to a decrease in dopaminergic-like responses such as motor impersistence (the inability to sustain simple motor acts, e.g. maintaining a steady gaze) among children with ADHD. Results found a reduction of motor impersistence after exercise that was dependent on exercise intensity, therefore suggesting exercise has potential efficacy for treating ADHD behavior.

Given that fidgeting and out-of-seat behavior are common symptoms of ADHD, increased use of recess and physical exercise might reduce hyperactivity (Loe & Feldman, 2007). McKune et al. (2003) found that at the end of one experimental five week exercise program, the total behavior, attention, emotional, and motor skills dimensions of 5-13 year old subjects with ADHD were significantly improved compared to baseline data. Another study (Kiluk, Weden & Culotta, 2009) found that children with ADHD who participated in 3 or more sports displayed significantly fewer anxiety or depression symptoms than those who participated less.

Yoga has even been examined for its effects on improving time on task in a school setting (Peck et al., 2005). Using a multiple baseline design across three grade level groups with a comparison group, researchers had the students perform simple warm up exercises like jumping up and down before replicating a series of video-guided deep breathing and relaxing physical postures during the school day. The study yielded significant improvement of children's concentration, as measured by scores on coding, static motor performance tasks, heart rate, and general tension/stress symptoms. A direct implication of these and other results is the possible utility of exercise as a reinforcer for ADHD children. This application could be therapeutically beneficial to the contingency management of ADHD in the classroom (Azrin et al., 2006).

In the article *The Active Classroom* (2008), authors Mulrine, Prater and Jenkins suggest that keeping students with ADHD away from exercise may actually have a causal relationship with some classroom-related problems. References are often made (Mulrine et al., 2008) to literature from physical education, special education, and neuroscience that reiterate the relationship between physical activity and improved educational

performance. In one particular experiment, classroom behavior was found to improve dramatically (Putnam, 2003) when hyperactive children ran before class. Primary care physicians gradually reduced stimulant dosages for children who were running every day. The children seemed to require less medication the more they ran.

Some research (Putnam, 2003) considers hyperactivity not only a symptom but also a coping mechanism, in other words a use of movement to increase focus. Mulrine et al. (2008) underscore the belief that exercise increases attention to various cognitive tasks and can help boost academic performance. It would appear that some schools agree, as more of them are starting to include exercise in their curricula to help kids perform better in the classroom (Ratey & Hagerman, 2008). Progressive physical education staff members in schools that have not eliminated recess might allow proactive intervention labs (Putnam, 2003) as a preventative measure against problem behaviors. Simple activities like classroom transition exercises, lesson energizers, and structured movement games for recess (Mulrine et al., 2008) are suggested for their possible utility in improving attention in the school setting.

Anecdotal reports from parents and teachers (Tantillo et al., 2002) supported the notion that vigorous exercise is beneficial for children with ADHD. Surgeon-general reports (Putnam, 2003) have connected inactivity to poor mental health and obesity. Considering the rising childhood obesity rate, participation in physical activity should always be encouraged because of the direct physical health benefits (Loe & Feldman, 2007). Wendt (2000), a New York educator, explains that exercise helps students who take medication as well as those who do not. His research found that forty minutes per day of exercise five days a week for six weeks significantly improved the behavior of

ADHD students. The inclusion of physical activity into treatment approaches for children with ADHD may be especially beneficial given their propensity toward mood or anxiety symptoms and deficits in executive control (Kiluk et al., 2009).

While there is exhaustive research on the impact of physical activity as it pertains to ADHD in children, it is nearly impossible to locate any studies geared toward a college population. At this time, there are no empirical investigations focused specifically on the impact that physical exercise may have on college age students' expression of the symptoms commonly associated with ADHD. However, many studies (Azrin et al., 2006; Norling et al., 2010) do have implications for clinical work with ADHD and results supporting the efficacy of physical exercise in the reduction of maladaptive behaviors.

As Barkley (2004) has stated, any treatment must be maintained over extended months and years in order to be effective in altering eventual prognosis. This fits very well with the concept (Loe & Feldman, 2007) that increased physical exercise would be beneficial for the long-term health and behavioral regulation of individuals diagnosed with Attention-Deficit/Hyperactivity Disorder.

Chapter 3

Methodology

This research was conducted in order to determine whether frequency and intensity of exercise plays a significant role in the expression of behaviors commonly associated with ADHD among a college population. In order to understand the relationship, the researcher gathered data from undergraduate college students. Specifically, a total of 315 respondents from a mid-size public university in New Jersey were randomly selected to make up the sample. Participants completed a survey instrument comprised of two questionnaires. Data gathered from this research instrument were then computed for interpretation. Along with primary data, the investigator also made use of secondary resources in the form of published articles and literature to provide context and support for the survey results.

Participants

In order to determine whether exercise frequency and/or intensity play a significant role in the expression of symptoms commonly associated with ADHD, a total of 315 respondents were solicited for participation in various classrooms. As the study aimed to address a diverse range of students, the researcher chose not to use the Psychology Subject Pool for sample selection. To obtain appropriate participants, certain inclusion criteria were imposed. The participants qualified for sample selection must have been at least 18 years old at the time of participation, currently enrolled as undergraduate students at Rowan University and fluent in the English language. These qualifications ensured that all members of the sample were college students of consenting age who would be able to read the survey.

The respondents were selected from 15 classrooms across 35 academic disciplines, with a total of 315 students surveyed. Simple random sampling using the fish bowl technique was utilized for sample selection. This method involves the selection of classrooms at random from the sampling frame through the use of random number tables. Numbers were assigned to each class on a master list. These numbers were written on pieces of paper and drawn from an envelope; the process was repeated until the desired sample size was reached.

Materials

A survey was used as the main data-gathering instrument for this study (See Appendix A). The 30-item questionnaire addressed three topics in four subsections: the first topic was ADHD symptom expression, the second was exercise habits, and the third was the past and current status of ADHD diagnosis, classification and treatment to the best of an individual's knowledge. The survey in its entirety is included in Appendix A.

The first section of the survey (questions 1-6) was the short version of the World Health Organization's (WHO) Adult ADHD Self Report Scale (ASRS) Version 1.1 designed to screen for adult ADHD in community samples. The ASRS and scoring system were developed in 2003 in conjunction with the WHO and the Workgroup on Adult ADHD, including a team of psychiatrists and researchers from New York University Medical School and Harvard Medical School. The 6-item inventory has outperformed the full-scale ASRS in clinical calibration studies (Kessler et al., 2005). The ASRS screener and background materials are published by the WHO for unrestricted use.

The second section of the survey (questions 7-16) addressed participation in various activities that would qualify as cardio-respiratory exercise. Questions identified

activities such as playing a sport, taking a group exercise class, using cardio equipment, and jogging or running for the purpose of exercising. Response options ranged from 1-7 indicating exactly how many days per week an individual participated in each activity throughout the past month. The researcher chose to request an exact number because it was thought that students would be more likely to round up if asked to give an average.

The third section of the survey (questions 17-24) addressed the motivating factors toward and perceptions of an individual's exercise habits. Questions included *"When I am feeling overwhelmed, I exercise to help clear my mind."* and *"After I exercise, my hands or feet feel less fidgety than usual."* Responses for this subset were True or False.

The fourth section of the survey (questions 25-30) assessed past and current status of ADHD diagnosis and pharmacological treatment. This section also inquired about the student's attitude toward such supports and whether or not they were perceived effective. Examples of these items are *"I received medication from a doctor for ADD/ADHD before college."* and *"I am currently receiving accommodations from the Academic Success Center at Rowan University because of my ADD/ADHD status."* Response options for this subset were Yes, No, or Does Not Apply To Me. The final questions of the survey requested basic demographic information, including age, gender, race, ethnicity, as well as current year in college and academic major.

Design

After gathering the completed questionnaires from the respondents, responses for each item were tabulated. The experiment used a 2x2 between-subjects factorial design. The independent variables were ADHD Diagnosis, with Yes and No levels, and Exercise Intensity, with Active and Inactive levels. The dependent variable was the Adult ADHD

Self-Report Scale (ASRS) screener score. Responses marked in the “Very Often”, “Often”, or “Sometimes” columns for questions 1-3 or in the “Very Often” or “Often” columns for questions 4-6 each counted as one (1) point towards the score for the symptom expression subset. A total score of four (4) or more qualified as a Positive screen for expression of symptoms commonly associated with ADHD while scores of three (3) or less were categorized as Negative screens.

Procedure

For this study, the investigator solicited students currently enrolled in variety of courses across multiple subjects at Rowan University. Upon entering each classroom, the investigator summarized the purpose of the research and distributed surveys to all students who were willing to participate and confirmed that they were at least 18 years old. Participants were given a set of questions to assess the presence of symptoms commonly associated with ADHD (ASRS-V1.1: World Health Organization, 2005), frequency and duration of physical exercise using the standards outlined by the United States Department of Health and Human Services (2008), as well as simple Yes/No questions to determine if the student is/was diagnosed and/or medicated and/or classified as a result of ADHD. After completing the survey, which took approximately 10 minutes, students were thanked for their participation and reminded that they could contact the investigator or faculty advisor with any questions or concerns.

Chapter 4

Findings

The sample consisted of 315 undergraduate students enrolled at Rowan University. Subjects ranged in age from 18-27 (M=21, SD=1.74). As listed in Table 1, subjects were mostly Caucasian with slightly more females (54.9%) than males (45.1%).

Table 1
Descriptive Statistics for Socio-demographic Variables

Variable	Descriptive Statistic
Gender	
Males	142 (45.1%)
Females	173 (54.9%)
Age	21 (1.74)
Race	
Caucasian	264 (83.8%)
African-American	27 (9.4%)
Asian	9 (2.9%)
Other	11 (3.5%)

Note: Frequencies (%) are reported for categorical variables and means (SD) are reported for continuous variables.

Based on prior research, it was hypothesized that subjects who exercise for at least the nationally recommended average of 150 minutes or more per week (USDHHS, ODPHP, 2008) would be less likely to score a positive result on Adult ADHD Screener than those who exercise for less than 150 minutes per week. Figure 1 demonstrates an estimate of the anticipated scoring outcomes for both Active and Inactive groups according to this hypothesis. Figure 2 shows the actual score outcomes of both subsets, indicating that the Inactive group did not follow the hypothesized model.

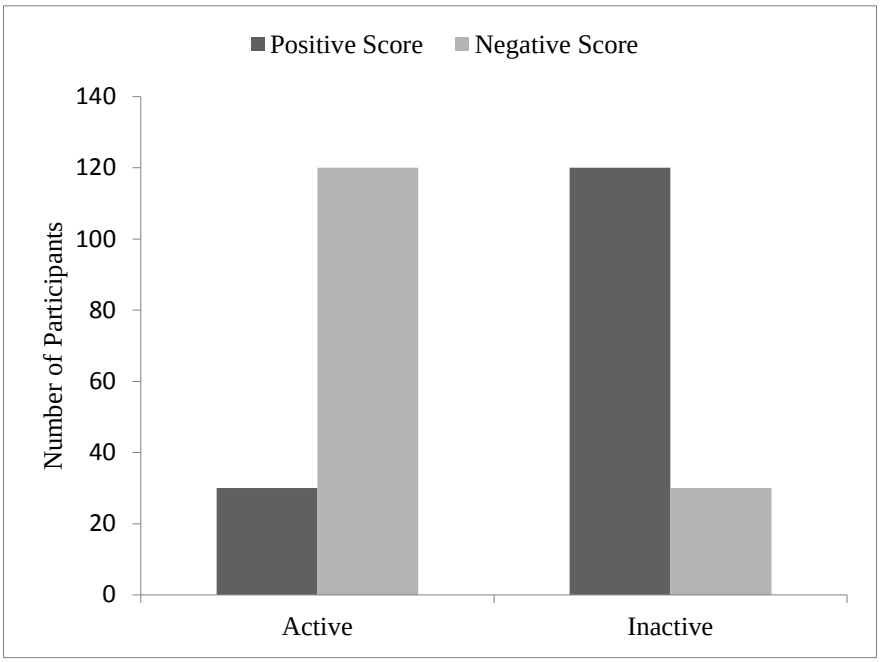

Figure 1
Predicted Distribution of ASRS Scores

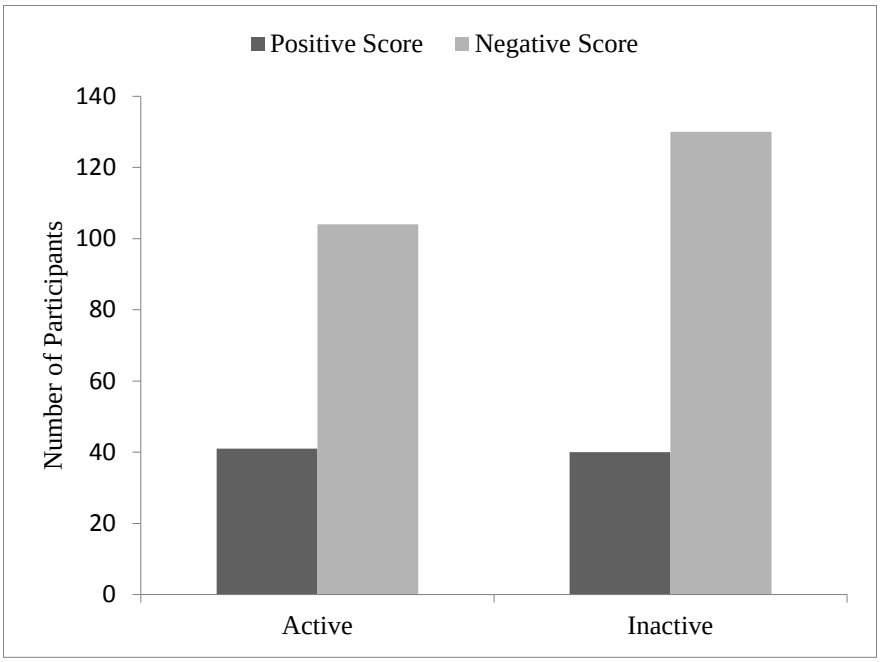

Figure 2
Actual Distribution of ASRS Scores

Hypothesis Testing

A two-way analysis of variance (ANOVA) was used to test the hypothesis. The analysis found a statistically significant relationship between ADHD Diagnosis and ASRS Score, $F(1,311) = 4.033$, $p = .043$. Both the main effect for the Exercise factor and the interaction were non-significant. Table 2 lists the full results of the analysis.

Table 2
ANOVA Results: Exercise, Diagnosis, and ASRS Score

Between Subjects	**Sum of Squares**	***df***	**MS**	***F***	***p***
Exercise	.008	1	.008	.043	.837
Diagnosis	.767	1	.767	4.033	.045*
Exercise x Diagnosis	.018	1	.018	.094	.760
Error	59.179	311	.190		
Total	81	315	.190		

*p<.05

A significant relationship between the ADHD Diagnosis factor and ASRS Score means that a subject's diagnosis status is related to his or her score on the symptom screener. The sample was divided almost equally in half between the Active and Inactive exercise levels. The specific results of each study variable are listed in their entirety in Table 3.

Table 3
Descriptive Statistics for Study Variables

Variable	**Descriptive Statistic**
ADHD Diagnosis	
Yes	20 (6.3%)
No	295 (93.7%)
ADHD Symptoms	
Positive	81 (25.7%)
Negative	234 (74.3%)
Exercise Level	
Active	145 (46%)
Inactive	170 (54%)

Note: Frequencies (%) are reported for categorical variables.

A cross-tabulation of the multivariate frequency distribution for ADHD Diagnosis and ASRS Score yielded the contingency table output seen in Table 4.

Table 4
Cross-tabulation Results: ADHD Diagnosis x ASRS Score

		ASRS Score		
		Negative	*Positive*	**Total**
ADHD Diagnosis	*No*	223	72	295
	Yes	11	9	20
	Total	234	81	315

These results indicate that the small clinical subset of ASRS scores was more evenly distributed between exercise levels than the large nonclinical group. The implications of these and other unbalanced groupings will be discussed in the following chapter.

Chapter 5

Discussion

This study examined the effect of physical exercise on the expression of symptoms commonly associated with ADHD among a mixed population of diagnosed and undiagnosed undergraduate college students. The present study improved upon other research (Azrin et al., 2006; Kiluk et al., 2009; Lufi & Parish-Plass, 2011; McKune et al., 2003; Tantillo et al., 2002) by focusing specifically on a population of adult college students in its investigation of the relationship between exercise and ADHD symptoms. However, the results did not support the hypothesis that exercise level measurably impacts a subject's likelihood of expressing ADHD symptoms.

Conclusions

The findings of the present study indicate that undergraduate college students are about three times more likely to screen negative on the Adult ADHD Self-Report Scale V1.1 Screener (World Health Organization, 2005) regardless of whether they are getting the nationally recommended amount of exercise.

Convergent Findings

The statistically significant relationship between ADHD Diagnosis and ASRS Score was not surprising in context of the previously demonstrated concordance (Kessler et al., 2005) between item responses and clinical symptom ratings. The present findings further support the validity of the ASRS as a strong indicator of ADHD. Also, if the estimated 4.4% prevalence rate (Kessler, et al., 2006) from 2006 is viewed with respect to the national reports of rising diagnosis rates (Akinbami et al., 2011) from 2011, the 6.3% clinical prevalence found in this sample may be appropriate for 2012.

Divergent Findings

Previous research (Kessler et al., 2005) using 154 respondents from the US National Comorbidity Survey Replication found that over two-thirds of clinical ADHD cases and only a negligible proportion of non-cases screened positive on the ASRS. However, the present study of 315 respondents found that only one-third of the positive screen group was composed of clinical cases, while two-thirds were non-cases. This reversal of distribution is contrary to prior results.

Limitations

The findings of the present study must be considered in context of several internal and external limitations. A major limitation of this study was the use of original questions with unknown reliability and validity to assess exercise level. Lack of significance for the exercise factor could very well be due to lack of accurate assessment. The direction of the relationship between exercise and ADHD symptoms may also be misrepresented by the cross-sectional nature of the survey instrument.

Although the present sample included participants of both genders, ranging in age, with different ethnicities, and from a variety of academic majors, the results may not generalize to all college or university students. In addition, the outcome measures of the present study consisted solely of self-report questionnaires, potentially reducing the construct validity of the variables, as indicated by Shaw-Zirt and colleagues (2005). Even so, the considerably large sample size (N= 315) was a distinct advantage to the statistical power of the results. The statistical analysis of these results relied upon a significance criterion of .05, thereby reducing the likelihood of reporting a false negative but also allowing greater opportunity for a false positive.

The survey instrument was unable to be distributed as planned during workshops held at the Academic Success Center, which may have provided a higher percentage of clinically relevant subjects. Within the 20 included subjects who were diagnosed with ADHD, only 9 produced a positive score on the symptom screener. Any of several confounding variables may explain this situation. One possible explanation is that the 11 negative subjects are currently medicated and therefore do not experience symptoms. Such unanswered questions underscore the need for further exploration.

Future Directions

Further in-depth studies of exercise as a form of treatment are encouraged (Barkley, 2004) since it is not only effective (Azrin et al., 2006; Norling et al., 2010), but also nationally advised (USDHHS, ODPHP, 2008), socially acceptable, and provides abundant positive side effects. Forthcoming research efforts would benefit from a longitudinal design with multiple evaluation points. The ability to periodically re-screen subjects over time would vastly improve the reliability of the findings. Based on the efficacy of the ASRS in the present study and its status as a validated testing instrument, the use of a statistically valid exercise inventory is advised. A more thorough evaluation of ADHD symptoms in college students may also include: clinical interviews with multiple parties, childhood behavioral questionnaires completed by parents, a review of school records, and intellectual or achievement testing if appropriate (Barkley, 2006).

In closing, the investigator recommends that although this study cannot serve as empirical evidence for the benefits of physical activity on ADHD symptom reduction, exercise should remain an important clinical target for research into ADHD management.

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Appendix A
Survey Instrument

Statement of Consent

This survey is being conducted by Jessica McDaniel in partial fulfillment of the requirements of the Master of the Arts Degree at Rowan University. The purpose of this research is to evaluate the link between physical activity and attentiveness. You will be asked to complete a set of questions related to attentiveness, physical activity, and mental health. Your participation in the study is voluntary and should not exceed ten minutes. There are no physical or psychological risks involved in this study and all responses will remain anonymous. You are free to withdraw your participation at any time without penalty. Survey data will be published in a Master's Thesis and may be presented publicly.

By taking this survey you certify that you are at least 18 years old and agree that any information obtained from this study may be used in any way thought best for publication or education provided that you are in no way identified and your name is not used. Participation does not imply employment with the state of New Jersey, Rowan University, the principal investigator, or any other project facilitator. Consent will be assumed if the questions have been answered. You may directly contact Jessica at McDani19@students.rowan.edu or her thesis advisor, Dr. Roberta Dihoff of the Psychology Department at Dihoff@rowan.edu or (856) 256-4500 x3783 with any further questions. Results can be made available upon request.

Please read each question and place an X in the box that best describes how you have felt and conducted yourself in the past six months.	**Never**	**Rarely**	**Sometimes**	**Often**	**Very Often**
1) How often do you have trouble wrapping up the final details of a project, once the challenging parts have been done?					
2) How often do you have difficulty getting things in order when you have to do a task that requires organization?					
3) How often do you have problems remembering appointments or obligations?					
4) When you have a task that requires a lot of thought, how often do you avoid or delay getting started?					
5) How often do you fidget or squirm with your hands or feet when you have to sit down for a long time?					
6) How often do you feel overly active and compelled to do things, like you were driven by a motor?					

Please circle exactly how many days per week you did each of the following activities in the past month.	How many days per week
7) I walked or rode my bike/skateboard to class.	**0 1 2 3 4 5 6 7**
8) I took the stairs instead of the elevator.	**0 1 2 3 4 5 6 7**
9) I participated in a group exercise class at a gym.	**0 1 2 3 4 5 6 7**
10) I used a treadmill/elliptical/exercise bike for at least 30 minutes.	**0 1 2 3 4 5 6 7**
11) I followed a weight training program on my own or with trainer.	**0 1 2 3 4 5 6 7**
12) I followed a yoga/Pilates program on my own or with instructor.	**0 1 2 3 4 5 6 7**
13) I played a sport for at least 30 minutes.	**0 1 2 3 4 5 6 7**
14) I practiced dance or martial arts for at least 30 minutes.	**0 1 2 3 4 5 6 7**
15) I walked briskly, jogged or ran for the purpose of exercising.	**0 1 2 3 4 5 6 7**
16) I exercised in another way:	**0 1 2 3 4 5 6 7**

Please consider the past <u>month</u> while reading the following statements. Choose the responses that best fit your personal experiences. There are no "right" answers and your honesty is appreciated.		
17. I exercise for the following reasons (check all that apply): ___ It makes me happy ___ It relieves stress/anxiety ___ It helps me lose weight ___ I work in a health field ___ I need physical therapy ___ I am an athlete		
18. When I am feeling overwhelmed, I exercise to help clear my mind.	True	False
19. After I exercise, my hands or feet feel less fidgety than usual.	True	False
20. If I am feeling restless, I know that exercising will make me feel worse.	True	False
21. After I exercise, I find it easier to focus on tasks that require organization.	True	False
22. I do not feel any additional anxiety if I skip my normal exercise routine.	True	False
23. When I exercise regularly, I am more motivated to accomplish tasks.	True	False
24. I would be willing to try an exercise program designed to help me focus.	True	False

Please read the following statements <u>carefully</u> and mark the response that is true to the best of your knowledge.	**YES**	**NO**	**Does Not Apply To Me**
25. I received medication from a doctor for ADD/ADHD before college.			
26. I received support services at school for ADD/ADHD before college.			
27. I am currently receiving medication from a doctor for ADD/ADHD.			
28. I believe the medication that my doctor prescribes to me is effective.			
29. I am currently receiving accommodations from the Academic Success Center at Rowan University because of my ADD/ADHD status.			
30. I believe the accommodations (extended testing time, assistive technology, preferred seating) that Rowan provides to me are effective.			

Age _____

Gender Male Female

Race Caucasian African-American Asian Other

Ethnicity Hispanic Non-Hispanic

Year Freshman Sophomore Junior Senior

Major _____