The Influence of Rock Climbing as a Treatment Modality for Children with ADHD

By

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Abstract

Current treatment options for children with attention deficit hyperactivity disorder (ADHD) include pharmacotherapy, behavioural therapy and cognitive behavioural therapy (CBT). There is limited research surrounding how exercise, specifically rock climbing, can be utilized in addressing the maladaptive symptoms of ADHD. A connection exists between exercise and improved executive functions (EFs) in children with ADHD, but the specific role of rock climbing in treating ADHD remains unclear. This literature review aims to investigate the following research question: "To what extent does physical activity, in particular, rock climbing, as a treatment modality, impact maladaptive symptoms in children diagnosed with ADHD?" According to the literature, physical activity, particularly a motor-cognitive exercise approach, is the most impactful in improving EFs in children with ADHD. Rock climbing is a motor-cognitive approach to exercise that can improve EFs such as sustained attention, problem-solving, planning, and inhibitory control. Rock climbing has also been linked to improved mindfulness and self-esteem, which could positively impact children diagnosed with ADHD. Recommendations for future research include the following questions: To what extent can rock climbing as an exercise intervention improve the physiological and psychological aspects of children with ADHD? To what extent can physical activity, in the absence of medication, alleviate the symptoms of ADHD in children and adolescents? Do children and adolescents with ADHD benefit more or less from exercise, such as rock climbing, compared to other treatment modalities such as pharmaceutical, behavioural, and cognitive? Lastly, To what extent can rock climbing aid in improving mindfulness and self-esteem in children and adolescents with ADHD?

Keywords: *ADHD, executive functions, physical activity, rock climbing, children, adolescents*

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TABLE OF CONTENTS

Background Information.....6

Prevalence……8

The Implication of Using Medication……..9

Research Problem……..10

Objective and Research Question of the Study…….……11

Significance of the Study……...11

Theoretical Framework……..11

Researcher's Positioning Statement……...12

Overview of the Paper……...……13

Methods……..……14

Search Criteria…….....14

Inclusion and Exclusion Criteria……15

Challenges Encountered During the Literature Search Process……16

Evaluation of Significant Studies Reviewed……..16

Methodological Concerns and Issues Observed……17

Literature Review……19

How Exercise Impacts Symptoms of ADHD……19

How Motor Cognitive Approach with Exercise Improves ADHD Symptoms……..20

Executive Functions and the Link to Rock Climbing……24

How Rock Climbing Improves EF: Sustained Attention……...24

How Rock Climbing Improves EF: Problem Solving and Planning…….26

How Rock Climbing Enhances EF: Inhibitory Control……..…28

The Link Between Mindfulness and Rock Climbing……29

Rock Climbing and the link to Self-Esteem in Children with ADHD……...30

Summary of Findings…….32

Ethical Considerations Regarding Research Methods……...33

Consent Forms……...33

Recruitment……33

Application to Clinical Practice……..35

Therapist Direct Implications……35

Recommendations within a Rock Climbing Setting……..36

Recommendations within a School Environment……..37

How the Research Findings, Legislation, Cultural Differences Factor into the Ability to Use Current Research……38

Conclusion and Future Recommendations……39

Recommendations Future Research Questions……..40

Reflection……...41

References…….44

Chapter 1: The Influence of Rock Climbing as a Treatment Modality for Children with ADHD

This literature review highlights the symptoms associated with ADHD in children and adolescents, followed by an analysis of the challenges encountered and an exploration of its prevalence rate. Subsequently, the review considers the advantages and disadvantages of stimulant medication and the challenges with psychosocial treatment options. This leads to the research question, "To what extent does physical activity, in particular, rock climbing, as a treatment modality, impact the maladaptive symptoms in children diagnosed with ADHD?" The leading cognitive theory behind ADHD is impaired EFs, such as inhibitory control, working memory, and cognitive flexibility (Nejatit, 2021). This literature review examines how physical activity and rock climbing can enhance these critical EFs. Lastly, the review delves into the relationship between rock climbing, mindfulness and self-esteem in children and adolescents with ADHD will be explored.

ADHD is a lifelong disorder that interferes with functioning or development and is marked by inattention and/or hyperactivity-impulsivity lasting for a minimum of six months and occurring before the age of twelve (American Psychiatric Association, 2022). Potential factors that may contribute to the development of ADHD include genetic and environmental risk factors and structural and physiological changes in brain function (Jalilvand & Samadi, 2020).

As described by the APA (2022), inattention symptoms include children wandering off task, lacking persistence, having difficulty sustaining focus and being disorganized. Inattention symptoms of ADHD may lead to academic deficits, school-related problems, and peer neglect (Gradys et al., 2022). Angelini et al. (2020) note that common symptoms include being easily distracted, difficulty following directions, avoidance of sustained mental effort, inability to

organize tasks, inappropriate movement, decision-making without acknowledging the consequences, and interrupting others. Hyperactivity symptoms, identified by the APA (2022), entail excessive motor activity at inappropriate times, excessive fidgeting, tapping or talkativeness (APA, 2022). Impulsive symptoms, as stated by the APA (2022), involve rash actions occurring in the moment without much insight, potentially harming the individual. Moreover, impulsivity may reflect a desire for immediate rewards or the inability to postpone gratification (APA, 2022). Impulsiveness can also be characterized by social intrusiveness, including excessive interruptions of others and making decisions without considering the long-term consequences (APA, 2022). Hyperactivity or impulsivity in children with ADHD is associated with an increased risk of peer rejection and accidental injury, leading to social rejection and challenging relationships with family members and peers (APA, 2022; Gradys et al., 2022). The symptoms can range from mild to severe in children with ADHD (APA, 2022). In its severe form, ADHD can profoundly affect an individual's social, familial, educational, and occupational adjustment (Gradys et al., 2022).

Children with ADHD encounter numerous challenges that affect their academic, social, and emotional functioning (Angelini et al., 2020). They may have difficulty completing tasks, participating in community events, and succeeding in school (Angelini et al., 2020). Additionally, children with ADHD often display emotional dysregulation, which can cause issues with self-control and managing their emotions (Taylor et al., 2019). Negative stigma is also associated with ADHD and can significantly impact their lives, leading to social exclusion and labelling by peers and teachers (Angelini et al., 2020). The negative stigma associated with ADHD can affect the child's self-esteem, emotional and behavioural coping strategies, and

family relationships (Angelini et al., 2020; Gradys et al., 2022; APA, 2022). Within the family setting, conflict and negative interactions may arise (APA, 2022).

Children with ADHD are also more susceptible to obesity and reduced motor skills (APA, 2022). Children with ADHD may also have developmental problems, including reduced motor skills such as strength, equilibrium, coordination, and reaction time (APA, 2022). In addition, individuals may struggle with sensory processing and face challenges in producing appropriate responses in social settings (Dunn & Bennett, 2002; Kim, 2018). These difficulties also negatively impact the child's self-esteem, emotional and behavioural coping strategies (Gradys et al., 2022).

Children diagnosed with ADHD are at a higher risk of developing comorbid disorders such as conduct disorder, oppositional defiant disorder, and anxiety and depressive disorders (Dunn & Bennett, 2002). More than half of these children will continue to struggle with symptoms into adulthood, which can lead to poorer occupational performance, attainment and attendance, a higher likelihood of unemployment, and increased interpersonal conflict (APA, 2022; Tzang et al., 2019; Portrie-Bethke et al., 2009). The challenges associated with ADHD in adulthood include mental health problems, substance use disorders, unemployment, and difficulties maintaining interpersonal relationships (Gradys et al., 2022).

Prevalence

ADHD is a prevalent condition that affects approximately 5% of children and 2.5% of adults worldwide (APA, 2022). People typically notice ADHD between the ages of six and nine (APA, 2022; Gradys et al., 2022; Jeyanthi et al., 2021). African American and Latino populations in the United States tend to have lower identification rates for ADHD than Caucasian populations, mainly due to different diagnostic and methodological practices (APA,

2022). In addition, males within the general population are more frequently diagnosed with ADHD, with a ratio of approximately 2:1 (APA, 2022). Furthermore, females tend to present primarily with symptoms of inattentiveness (APA, 2022).

The Implication of Using Medication

Children with ADHD exhibit significantly lower baseline levels of norepinephrine and experience less of an increase in catecholamine dopamine (Angelini et al., 2020). Therefore, stimulant medication, such as sympathomimetic drugs including methylphenidate (MPH), amphetamines or atomoxetine, are often used to increase baseline levels of dopamine and norepinephrine within the prefrontal cortex, resulting in a higher success rate in school and improved cognitive control in people with ADHD (Angelini et al., 2020; Miklos et al., 2020; Taylor et al., 2019). In addition, stimulant medications benefit various aspects of cognitive functioning, including reaction time, variability, spatial short-term memory, spatial working memory, set-shifting and planning ability, attention, response inhibition, writing, and verbal working memory (Miklos et al., 2019). However, there are several disadvantages to adhering to medication in treating children with ADHD. According to Barranco-Ruiz et al. (2019), adverse effects, such as low tolerance, lack of treatment response, and potential dependence, have been associated with pharmacotherapy. First, MPH therapy is often not recommended for children under seven due to the potential side effects (Tzang et al., 2019). Short-term side effects include headaches, nausea, decreased appetite, and anorexia (Angelini et al., 2020; Ng et al., 2017). Secondly, stimulant medication stunts growth in children with ADHD, leading to a long-term reduction in growth velocity (Angelini et al., 2020; Ng et al., 2017). Thirdly, stimulant medications are less effective when children display comorbid internalizing disorders such as anxiety or depression than physical activity (Angelini et al., 2020). Moreover, within four

months of starting treatment, stimulant medication is associated with negative mood changes (Rajeh et al., 2017).

Research Problem

There is currently a lack of effective psychosocial treatment options that support the developmental process for children with ADHD (Ng et al., 2017). Therapy methods for children with ADHD include pharmacotherapy and behavioural therapy, including cognitive behavioural therapy (CBT). Effective, but none of these approaches are able to solve the cognitive difficulties, such as the executive dysfunctions, related to this disorder directly (Jalilvand & Samadi, 2020). Several issues arise with current pharmacologic and behavioural strategies for managing ADHD (Ng et al., 2017). Behavioural and psychological interventions can be onerous and difficult to maintain consistency for many families (Ng et al., 2017). CBT includes psychoeducation for parents and teachers regarding the nature and risks associated with ADHD (Döpfner & Van der Oord, 2018). CBT strategies may strain parents and teachers to implement strategies that manipulate the environmental antecedents and consequences of the child's behaviour to promote a more desirable outcome (Döpfner & Van der Oord, 2018). Moreover, symptoms of ADHD typically resurface upon discontinuation of pharmacologic and/or behavioural/psychological therapies, thus creating a pressing need for long-term treatment options (Ng et al., 2017). In addition, parents often prefer non-pharmacological interventions even though pharmacological treatment has increased over the years (Larsson et al., 2021).

Currently, there is a paucity of studies examining the relationship between rock climbing, and ADHD in children. Understanding how exercise therapy, in particular rock climbing can contribute to the treatment of ADHD remains limited. Although a connection between exercise and ADHD exists, the precise implications of rock climbing have not been clearly articulated in

the current body of research. The research question for this literature review is “to what extent does physical activity, in particular, rock climbing, as a treatment modality, impact maladaptive symptoms in children diagnosed with ADHD?”

Objective and Research Question of the Study

The main objective of this literature review is to investigate how physical activity, in particular, rock climbing, can be an effective treatment modality, impact maladaptive symptoms in children diagnosed with ADHD. In more specific term, the study will investigate the following study question: “To what extent does physical activity, in particular, rock climbing, as a treatment modality, impact maladaptive symptoms in children diagnosed with ADHD?”

Significance of the Study

Mental health counsellors are starting to incorporate physical activity into their treatment plans (Angelini et al., 2020). Integrating physical activity interventions, such as rock climbing, in children with ADHD could support schools, programs, and organizations in designing tailored exercise interventions to optimize the executive functioning of children with neurological disorders while enhancing performance in school and quality of life in children with ADHD (Sung et al., 2022). In addition, rock climbing, as a form of exercise therapy, can potentially enhance children’s interest in partaking in a simple lifestyle accommodation to optimize the long-term trajectory path of ADHD (Ng et al., 2017). As such, counsellors could recommend integrating climbing therapy for parents with children with ADHD.

Theoretical Framework

Executive function is one of the leading cognitive theories behind ADHD (Nejati, 2021). The theory of executive function explains that symptoms of ADHD are based on impaired executive functions, including inhibitory control, working memory, and cognitive flexibility

(Nejati, 2021). Therefore, a transdiagnostic approach to children with ADHD underlying the core symptoms of executive function problems within the prefrontal cortex, such as inattention, hyperactivity, and impulsivity, will be targeted. The transdiagnostic approach focuses on common underlying factors contributing to various psychological disorders' development (Dalgleish et al., 2020). A transdiagnostic process will analyze the components of rock climbing, thus supporting the review of how rock climbing can aid in treating children with ADHD. Rock climbing can address certain symptoms specific to ADHD, such as sustaining and enhancing attention and focus, increased dopamine from physical activity, and improved self-esteem and self-confidence.

Researcher's Positioning Statement

I am highly invested in this topic due to my background in rock climbing. My personal biases come from personal experience and observations. I have seen programs offering rock climbing treatment options for children with Autism. The impact of exercise and climbing are multimodal, including a social environment, an increase in self-worth, self-efficacy and confidence, personal mastery and achievement. In addition, there is research on how climbing therapy alleviates various symptoms, such as depression. I am highly interested in the many benefits it has on mental health conditions such as PTSD but, more specifically, the impact it can have on children with ADHD. I have preconceptions that rock climbing can be a great add-on in treating a wide variety of disorders. Rock climbing therapy is currently an under-researched area, therefore, I will set aside my bias to see the potential adverse effects rock climbing may have.

As a teacher, I have come across many children in the academic field who struggle with ADHD and its cost on their livelihoods. When looking for practicum placements that offered climbing therapy, I contacted the Institute of Climbing Therapy in Germany, which has

researched and designed activities for children with ADHD. Through this avenue, I came to understand the multiple benefits that rock climbing can have physically, cognitively, and emotionally. I also started seeing the connection between sensory integration therapy within rock climbing, such as proprioception and vestibular input, from the Autism Climbs program and the Institute of Climbing Therapy. This exposure led me to research the impact of executive functions on ADHD symptoms. To address this bias, I kept an open mind to include other potential contributors to ADHD.

Overview of the Paper

The overview of this paper will examine the literature search process, followed by the literature review. The literature review will examine how exercise impacts symptoms of ADHD, particularly the added benefits of adding a motor cognitive approach with exercise. The subsequent section will examine EF's and the link to rock climbing. By reviewing how rock climbing can enhance each area of EF, sustained attention, problem-solving and planning, and inhibitory control, there is a possibility that these benefits can transfer over to support children and adolescents with ADHD. The literature review then examines the link between mindfulness and rock climbing and how mindfulness can support children and adolescents with ADHD. Lastly, the literature review will examine how rock climbing can support self-esteem in children with ADHD. The last two chapters look at how physical activity, particularly rock climbing, can aid in clinical practice to support children and adolescents with ADHD, followed by recommendations.

Chapter 2: Methods of Literature Search

The methodology of the literature search process includes specific search criteria, key terms, and accessed databases. The inclusion and exclusion criteria is then examined followed by challenges that were encountered during the literature search process. An evaluation of the significance of each study is then explored. Lastly, the issue of potential misinterpretation of the data is reviewed with a focus on sample size and medication.

Search Criteria

The City University Library and Google Scholar were accessed to locate primary research papers for this literature review. Google Scholar was more helpful than the City University Library in having a more comprehensive selection of papers about rock climbing and EF. Once I added results beyond CityU collections, there was more variety of research papers to choose from on physical activity and ADHD and children.

I initially searched for key terms such as exercise, ADHD and children. This led to quite a few systematic reviews and meta-analyses. The primary research papers I did eventually found were based on the impact of acute, chronic and aerobic exercise on children diagnosed with ADHD. Other studies then compared different exercises, such as running and swimming. I felt these studies were becoming off-track from the original focus of this literature review, as I did not want to dive into the ongoing debate on frequency, duration and type of exercise best suited for children with ADHD. I then switched to key terms such as rock climbing and ADHD with limited results. These limited results led to Angelini et al., 2020 research on the impact of an adapted climbing program on children with ADHD, emphasizing the impact rock climbing has on EFs. I then started researching key terms such as rock climbing and EF. After completing the theme on EFs and the link to rock climbing, I returned to find primary articles to use for the

impact of exercise on children with ADHD. I then started narrowing down the search criteria to exercise, EFs and ADHD in children, where I came across recent studies highlighting the importance of a motor cognitive approach with exercise in enhancing EFs in children with ADHD. Other search terms used throughout this process included rock climbing therapy, rock climbing, rock climbing in children with ADHD, rock climbing and EF, and EFs and ADHD.

Inclusion and Exclusion Criteria

Both children and adults were included in the studies chosen due to the limited research pertaining to the influence rock climbing has on children with ADHD. The goal of including adults in the researchwas to explore the relationship between rock climbing and EFs. Most of the studies were within the past five years; however, the range extends from 2009 to 2023. My inclusion criteria were studies related to the benefits of rock climbing, the impact of exercise on children with ADHD and the impact of exercise on the executive functioning skills in children with ADHD.

The studies selected included quantitative, qualitative, and mixed methods approaches. Many of the studies selected were quantitative. For instance, Jalilvand & Samadi, 2020 and Wheatley, 2021 used quasi-experimental designs with a pre-test and post-test design, whereas Benzing et al., 2018 used a between-subject design. Lee & Song, 2015, conducted a quantitative case study on a seven-year-old boy with ADHD, gathering evidence at three stages of the intervention using electroencephalography (EEG) and a star cancellation test (SCT). Two studies chosen were qualitative. One focused on interviews with thirty experts in medicine education and psychology to gain viewpoints on therapeutic climbing (Fruhauf et al., 2021). The other qualitative study used an experimental repeat-measure design to examine the effect of an

exercise program designed for children with ADHD (Taylor et al., 2019). Lastly, one study used a mixed methods approach using quantitative and qualitative data (Angelini et al., 2020).

Challenges Encountered During the Literature Search Process

Challenges emerged when confronted with a wide variety of literature addressing different variations of exercise and its impact on children with ADHD. Each form of exercise, acute or long-term, had different outcomes for children and adolescents with ADHD. It is also difficult to compare the different types of activities due to the significant differences in the study designs, frequency, intensity and duration of the exercise (Neudecker et al., 2019). I limited the literature surrounding exercise to the latest research on a motor-cognitive approach. Other challenges occurred when there was limited research surrounding rock climbing and children with ADHD.

Evaluation of Significant Studies Reviewed

The relevance of four of the studies chosen showed a link between cognitively engaging physical exercise and enhanced EFs in children with ADHD (Benzing et al., 2018; Jalilvand & Samadi, 2020; Pan et al., 2019; Taylor et al., 2019). Rock climbing is a form of exercise that is cognitively engaging, requiring problem-solving, planning, decision-making and learning from mistakes (Angelini et al., 2020; Bailey, 2019; Frühauf et al., 2021; Lee & Song, 2015; Portrie-Bethke et al., 2009). Four other studies chosen showed how components of rock climbing could support the development of EFs, such as sustained attention, problem-solving, inhibitory control and working memory (Angelini et al., 2020; Bailey et al., 2019; Frühauf et al., 2021; Lee & Song, 2015). Whereas a quantitative study by Heilman, 2021, examined whether EFs and the domain-specific cognitive skills involved in rock climbing were transferable outside of climbing in adults. The results of this study showed that the EF skills used in rock climbing did not

transfer to EF tests conducted in the lab (Heilman, 2021). However, the qualitative data collected by Angelini et al., 2020 suggests that EF skills used in rock climbing are transferable. Two researchers examined the impact rock climbing has on children diagnosed with ADHD and discovered that rock climbing increased attention (Angelini et al., 2020; Lee & Song, 2015). Wheatley's study (2021) was chosen as it is the only study exploring the relationship between mindfulness and rock climbing. This study is relevant as some evidence suggests that physical exercise that incorporates mindfulness has the potential to alleviate symptoms of ADHD (Barranco-Ruiz et al., 2019).

Methodological Concerns and Issues Observed

The case study conducted by Lee & Song (2015) using climbing while wearing a weighted vest showed a potential relationship between movement and cognitive function associated with ADHD; however, it does not show the exact role rock climbing plays in alleviating the symptoms of ADHD in children. In one study conducted by Angelini et al., 2020, the use of both quantitative and qualitative data was selected. The qualitative data used a questionnaire incorporating parents' perceptions of the perceived benefits, enjoyment and future recommendations. All parents indicated that climbing was beneficial for their child, identifying key themes such as improved confidence, problem-solving, and perseverance and that rock climbing was an effective intervention to manage their children's symptoms. The quantitative data included a Trail Making Test B to track progress in attention, where significant changes were seen between pre and post-climbing attention (Angelini et al., 2020). Another identifiable concern is a study conducted by Taylor et al., 2019 who recruited children ages 10 to 11 attending a school in the UK. Since the study took place in only one primary school, there was a limited number of children of the correct age with ADHD available (Taylor et al., 2019).

It remains unclear whether exercise can benefit children on various medications compared to those who do not and whether physical activity, such as rock climbing, can be an alternative to medication (Pan et al., 2019; Piepmeier et al., 2015).Medication was often not well controlled within the studies (Miklos et al., 2020). Variations also existed among medication types and dose amounts, as did the time of day for testing (Pan et al., 2019). For instance, in the study conducted by Piepmeier et al. (2015), four children were not taking medication, while the rest of the children with ADHD differed in medication type and dose. Future research would need to explore whether the results remain consistent in the absence of medication (Benzing et al., 2018). Details of the studies chosen and the analysis will be discussed in Chapter three.

Chapter 3: Literature Review

Based on the neurophysiological effects of exercise, executive function, and problem-solving benefits, rock climbing could positively impact the daily function and participation of children with ADHD. This literature review examines the question, "to what extent does physical activity, in particular, rock climbing, as a treatment modality, impact maladaptive symptoms in children diagnosed with ADHD?" The themes within this review will address the link between rock climbing and its impact on executive functions, mindfulness and self-esteem, thereby potentially reducing symptoms of ADHD in children. In conjunction with these themes, the literature review will examine how these themes relate to the maladaptive symptoms of ADHD in children.

How Exercise Impacts Symptoms of ADHD

According to the literature, there is growing evidence to support the benefits of physical activity interventions for improving EFs in children with ADHD (Benzing et al., 2018; Jalilvand & Samadi, 2020; Piepmeier et al., 2015; Taylor et al., 2019). General exercise helps to improve attention deficits in children with ADHD due to the increased levels of dopamine, norepinephrine, and serotonin, which are typically reduced in children with ADHD, thus leading to improved focus and attention (Jeyanthi et al., 2021; Ji et al., 2023; Li et al., 2023). Some research indicates a positive relationship between physical activity and EFs by stimulating neural pathways in the brain and the neurogenesis process, which impacts the growth of brain cells (Jalilvand & Samadi, 2020). However, not all types of physical activity interventions effectively improve each area of EF, which may be due to the characteristics of the activities performed (Jalilvand & Samadi, 2020; Piepmeier et al., 2015). Utilizing physical activity with cognitively engaging activities is a new approach to treating children diagnosed with ADHD (Jalilvand &

Samadi, 2020). The cognitive stimulation hypothesis assumes that cognitively engaging physical exercise leads to increased benefits for cognitive performance by training the brain regions used for higher-order cognition (Benzing & Schmidt, 2019).

How Motor Cognitive Approach with Exercise Improves ADHD Symptoms

According to the literature, results of recent studies have shown that a combination of physical and cognitive training may increase the effectiveness of physical activity interventions for children with ADHD (Benzing et al., 2018; Jalilvand & Samadi, 2020; Li et al., 2023; Pan et al., 2019 & Taylor et al., 2019). Cognitively engaging exercise consists of physical activities with high levels of mental engagement that require cognitive control and varied environmental stimuli, for example, activities such as ball games, horseback riding and water sports (Li et al., 2023). Factors that may contribute to the enhanced improvement of cognitively engaging exercise might be related to higher levels of cognitive control, greater environmental variability, and additional attention needed to rapidly changing situations (Li et al., 2023). For instance, Taylor et al., 2019 conducted a study on exercise sessions designed for children with ADHD in physical education classes. The exercises involved short-duration activities of moderate to high intensity that were mentally and physically demanding, requiring focused attention**.** Twelve children, ages 10 to 11, partook in this study. Six of these children, five boys and one girl, were diagnosed with ADHD and were placed in the ADHD study group. The other six, three boys and three girls, had no diagnoses of ADHD and were placed in the control group. The children diagnosed with ADHD continued taking their regular medication throughout the intervention. Moreover, children diagnosed with a mental health disorder were excluded from this study. Both groups partook in 40-minute short-duration, mixed activity sessions twice weekly over twelve weeks. Each session involved a moderate to intense exercise that was both mentally and

physically challenging. Each session involved ten-minute activities with a twenty to thirty-second break in between. Focused attention was required as children listened to instructions and were required to wait their turn. An example of the mixed activities included two children taking turns at a balancing challenge while others completed a shuttle run. ADHD symptoms and exercise enjoyment were assessed in both groups at baseline, six and eleven weeks of the intervention. Both parents and teachers recorded observed baseline measures of ADHD symptoms for both groups. After eleven weeks, teacher observations showed a significant reduction in ADHD symptoms and increased engagement in classroom activities (Taylor et al., 2019). Problem-solving and using different movements throughout exercise can also enhance EFs (Jalilvand & Samadi, 2020). Two studies examined the effects of table tennis on motor skills and EFs in children with ADHD (Jalilvand & Samadi, 2020; Pan et al., 2019). Table tennis merges both physical and cognitive training by utilizing problem solving and different movements throughout the game (Pan et al., 2019). Players must process visual information of an approaching object, a tennis ball, and then predict the ball's trajectory and arrival accurately in order to be successful (Pan et al., 2019). Jalilvand & Samadi, 2020 conducted a quasi-experimental study with a pretest-posttest design to explore the effectiveness of a 12-week physical activity intervention with a motor-cognitive approach through table tennis on EF in children with ADHD. The study involved 30 children ages 9 to 11 diagnosed with ADHD for at least one to two years. Additionally, children who participated in this study were not using medication during the intervention. Thirty children were randomly divided equally into the experimental and control groups. The experimental group participated in motor-cognitive training through table tennis twice weekly, 60 minutes for 12 weeks. Exercises were focused on training components of attention and response inhibition. One exercise described by Jalilvand &

Samadi, 2020, involved catching orange balls with both hands while avoiding white balls or catching orange balls with the right hand and white balls with the left hand. Jalilvand & Samadi, 2020, found that after 12 weeks of motor-cognitive training, children diagnosed with ADHD demonstrated significant improvement in sustained attention and response inhibition through table tennis. Pan et al. (2019) investigated the effects of a 12-week physical exercise intervention, utilizing a table tennis program that integrated physical and cognitive training on motor skills and executive functions in children with ADHD. The exercise intervention occurred twice weekly, 70 minutes per session for 12 weeks. Children who partook in this study were all boys between the ages of 7 and 12, split into three groups. Group one consisted of 15 children diagnosed with ADHD who received the intervention. Group two also consisted of 15 children diagnosed with ADHD who did not receive the intervention, and group three consisted of 30 typically developing children who also did not receive the intervention training. Exclusion criteria included children diagnosed with major neurodevelopmental or psychiatric disorders such as autism, intellectual disability and cerebral palsy. Medication was also not controlled for; however, parents were asked to maintain the consistency of the type and dose throughout the study. The physical exercise intervention involved training motor skills and EFs through table tennis, which involved group games, basic table tennis skills, and condition. The findings indicated that children diagnosed with ADHD showed improvements in locomotor and object-control skills, as well as EFs (Pan et al., 2019).

According to the literature, exergame is a physical activity intervention combining learning and motor skill development to enhance EFs in children with ADHD **(**Benzing et al., 2018; Ji et al., 2023). Exergame is an XBOX Kinect game incorporating physical activity and cognitive stimulation **(**Benzing et al., 2018; Ji et al., 2023). Exergame employs motion-sensing

input devices for users to control and interact with the console through their body movements, requiring participants to jump, sidestep, or sprint on the spot. The exergame activates brain regions associated with higher-order cognitive processes (Benzing et al., 2018; Ji et al., 2023).The cognitively challenging exergame activities have been shown to have a more considerable impact on the EFs in adolescents than the version of the game with lower cognitive challenges (Benzing et al., 2018). It is unclear whether these effects are generated by the game or through exercise (Ji et al., 2023). Ji et al. 2023, investigated the comparison of the effect of exergaming on maladaptive symptoms in children with ADHD to that of aerobic exercise. Thirty children, ages 8 to 12, were randomly assigned to either the exergaming or bicycle exercise groups (Ji et al., 2023). Results showed that aerobic exercise and exergaming enhanced attention in children with ADHD. The benefits induced by exergaming were more significant than aerobic exercise. These results suggest that exercise with a cognitive component may stimulate the frontal lobes of the brain while positively impacting attention, processing speed, and cognitive control function in children with ADHD (Ji et al., 2023). Benzing et al. (2018) also explored the impact of integrating a mentally stimulating activity with acute physical activity, such as exergame, on the core EFs in children with ADHD. Forty-six children diagnosed with ADHD between the ages of 8 and 12 were randomly assigned to either the exergaming or control group. Within this between-subjects design, most children were regular users of stimulant medication, while children with neurological disorders, Tourette syndrome or epileptic disorders were excluded. The exergaming group played Shape Up, an exergame with a moderate to vigorous exercise intensity that incorporates cognitive challenges. The control group watched a 15-minute documentary report about mountain running. The acute intervention and assessments for the exergaming and control groups took place in the children's home and lasted 15 minutes with a

one-minute break. Upon completing the activity, perceived physical exertion, cognitive engagement and enjoyment were measured. Results showed that 14 to 15 minutes at moderate to vigorous intensity is enough to impact EFS positively. Reaction times in inhibition and task switching improved, whereas visual working memory or accuracy did not.

Executive Functions and the Link to Rock Climbing

According to the literature, a relationship exists between rock climbing and the development of EF such as problem-solving, planning, decision-making, improved attention and behaviour and learning from mistakes (Angelini et al., 2020; Bailey, 2019; Frühauf et al., 2021; Lee & Song, 2015; Portrie-Bethke et al., 2009). Components of rock climbing can aid in the improvement of each EF area: sustained attention, problem solving, inhibitory control and working memory (Angelini et al., 2020; Bailey, 2019; Lee & Song, 2015; Portrie-Bethke et al., 2009). Rock climbing requires the use of each executive function in order to plan the sequence of physical movements needed to navigate the route (Bailey, 2019).Rock climbing demands high attentional effort and concentration; during these periods, an EEG analysis has shown an increase in frontal beta amplitude, indicating higher activity in the cortical location linked to executive functioning and reasoning (Bailey, 2019).

How Rock Climbing Improves EF: Sustained Attention

Rock climbing, a unique form of physical activity, has been shown to enhance attention in children with ADHD (Angelini et al., 2020; Lee & Song, 2015; Villavicencio et al., 2021). One way to enhance attention is by using an emotionally salient stimulus, such as fear, which is more effective than neutral stimuli while interrupting impulsive responses (Tenenbaum et al., 2019). In children diagnosed with ADHD, rock climbing can offer a structured learning experience where fear is a motivating factor, contributing to enhancing attention and behaviour

(Angelini et al., 2020). While climbing, the participant is often cognizant of the potential of falling, thereby inducing fear and anxiety and elevating cognitive attention (Villavicencio et al., 2021). Rock climbing can also increase attention, as it is considered a form of physical activity associated with elevating dopamine and norepinephrine baseline levels (Angelini et al., 2020). Moreover, the psychological and physiological demands of climbing require participants to focus on the specific task, resulting in enhanced attention and concentration (Frühauf et al., 2021).

Angelini et al., 2020, conducted a mixed methods study on five children with ADHD between the ages of 8 to 13. Four of the five children were taking medication for their ADHD symptoms, while three were additionally diagnosed with mild autism, Tourette's syndrome, and anxiety (Angelini et al., 2020). The rock climbing program occurred for 60 minutes, one night per week for eight weeks, where the participants would freely climb routes of their choosing, and by week four, the participants were encouraged to follow specific routes (Angelini et al., 2020). Angelini et al. (2020) assessed the impact of exercise intensity by measuring the children's resting and working heart rates as they climbed. Three of the five children exercised at a light intensity, while the other two exercised at a moderate intensity (Angelini et al., 2020). Regardless of exercise intensity, significant changes were seen between pre and post-climbing attention in the five children (Angelini et al., 2020). The outcomes of this study indicate that rock climbing can be used throughout the day to improve attention (Angelini et al., 2020). Moreover, children with ADHD who struggle in the classroom, taking breaks for physical activity, such as rock climbing or recess, could have a beneficial impact on attention and focus (Angelini et al., 2020).

Wearing a weighted vest simulates deep pressure, a sensory integration technique, to help regulate arousal and improve the attention span of children with ADHD (Lee & Song, 2015). At

the same time, movement helps to improve the cognitive performance of children with ADHD (Lee & Song, 2015). By combining the two, Lee & Song (2015) conducted a case report to analyze the effect of rock climbing while wearing a weighted vest on the brain waves and attention of a male child aged seven diagnosed with ADHD. The child was also not taking any medications six months prior to the intervention (Lee & Song, 2015). The child was instructed to wear a weighted vest while climbing over four weeks (Lee & Song, 2015). Lee & Song (2015) demonstrated that wearing a weighted vest while climbing improved regulation of arousal and increased attention in children diagnosed with ADHD (Frühauf et al., 2021). In another study by Bailey et al. (2019), an EEG device was used to track the mental states of thirty-five competitive rock climbers during activity, 25% of whom were female. Ages were not specified within this study. The EEG analysis demonstrated increased activation in the prefrontal cortex during rock climbing, indicating higher focus and concentration levels (Bailey et al., 2019).

A qualitative study by Frühauf et al. (2021) interviewed thirty experts, including physicians, psychologists, and pedagogues with different experience levels, using rock climbing as a treatment modality. The interviews revealed a strong belief among these experts that rock climbing could enhance attention and concentration through unusual heights and by having to focus on specific tasks such as having trust and responsibility in the belaying partner (Frühauf et al., 2021). The interviewed experts acknowledged that rock climbing could benefit children diagnosed with ADHD due to the psychological and physiological demands that require attention and concentration (Frühauf et al., 2021).

How Rock Climbing Improves EF: Problem Solving and Planning

According to the literature, rock climbing requires planning and problem-solving skills, challenging the climber to use EFs throughout the climb (Angelini et al., 2020; Bailey et al.,

2019; Gassner et al., 2023; Portrie-Bethke et al., 2009). Rock climbing is a cognitively challenging sport that demands concentration and requires complex cognitive problem-solving abilities (Gassner et al., 2023; Heilmann, 2021; Portrie-Bethke et al., 2009). Before a climber begins a challenging route, the climber must incorporate various EF skills, such as planning the actions to perform on the wall, working memory and problem-solving (Bailey et al., 2019; Heilmann, 2021). While climbing, the individual has to perceive whether the next hold is reachable, how to grip the hold and decide which holds can be used as a foot support (Heilmann, 2021). As climbers approach a new route, they often imagine the sequence of the climb, mimicking the moves from the ground to figure out how to complete the climb successfully (Bailey et al., 2019; Heilmann, 2021). As individuals begin to climb, they are continuously problem-solving to pinpoint the progression of moves that achieve successful completion (Bailey et al., 2019; Heilmann, 2021). If individuals are unsuccessful, they often discuss strategies for overcoming challenges (Heilmann, 2021).

Can problem-solving skills in rock climbing possibly enhance EF skills in children diagnosed with ADHD? Portrie-Bethke et al. (2009) suggest that rock climbing can be beneficial for these children as it helps them enhance their problem-solving abilities. However, Heilman (2021) evaluated whether the EFs and domain-specific cognitive skills in rock climbing were transferable outside of climbing. This cross-sectional study involved nineteen climbers, nine females and ten males, ages eighteen to thirty-one. Ten were novices, and nine were expert climbers (Heilmann, 2021). Using general EF tests, Heilman (2021) discovered that skilled climbers did not outperform less experienced climbers in EFs of working memory and sequence planning. Therefore, the EF skills used in rock climbing did not transfer to the EF tests conducted in the lab (Heilmann, 2021). The population within this study were adults not

diagnosed with ADHD. Can the domain-specific EFs, such as problem-solving and planning, used in rock climbing be transferrable to support children with ADHD? Future studies would need to be conducted to assess if domain-specific cognitive skills can be transferable outside of rock climbing specifically for children diagnosed with ADHD. However, Angelini et al. (2020) found results suggesting that the domain-specific EF benefits gained from climbing are transferable in improving symptoms of ADHD in children. In their study, Angelini et al. (2020) used an open-ended questionnaire for parents to report their observations in assessing a change in their child's behaviour before and after the climbing intervention. One parent reported their child demonstrated improved problem-solving abilities and perseverance during high-stress situations by evaluating all possible solutions, remaining calm, and persistently trying again (Angelini et al., 2020). Another parent noted the transference of problem-solving skills learned in rock climbing to other real-life situations (Angelini et al., 2020). Moreover, each participant was challenged to problem-solve independently to improve self-confidence in overcoming their obstacles (Angelini et al., 2020).

How Rock Climbing Enhances EF: Inhibitory Control

Rock climbing enhances inhibitory control in children with ADHD (Angelini et al., 2020). In rock climbing, a false move can result in falling; therefore, climbers must inhibit competing stimuli to remain focused (Heilmann, 2021). Successfully navigating a climbing route requires participants to develop the ability to cope with stressful challenges (Bailey et al., 2019). These coping skills necessitate regulating emotions and managing their actions and responses while maintaining the mental capacity to interpret and respond to immediate feedback (Bailey et al., 2019; Diamond, 2012). Inhibitory control is thus essential in rock climbing as it involves resisting distracters and suppressing unwanted thoughts, actions, and emotions (Ludyga et al.,

2021). Throughout climbing, participants face stressful challenges requiring inhibitory control to manage and cope with emotions that arise (Bailey et al., 2019). Children diagnosed with ADHD present with challenges in inhibitory control, which involves resisting distracters and suppressing unwanted thoughts, actions, and emotions (Ludyga et al., 2021). To what extent can rock climbing aid in improving inhibitory control in children with ADHD? Angelini et al. 2020 showed that children with ADHD who partook in rock climbing had improved in managing conduct problems, learning problems, psychosomatic factors, impulsive/hyperactive behaviours, and anxiety (Angelini et al., 2020).

The Link Between Mindfulness and Rock Climbing

Rock climbing incorporates mindfulness, which helps to divert attention away from negative thoughts (Barranco-Ruiz et al., 2019; Liu et al., 2022; Wheatley, 2023). Mindfulness helps to enhance attention and focus by building the capacity to observe external and internal stimuli without reacting (Huguet et al., 2017; Lee et al., 2022). When the climber starts facing challenges due to the route's difficulty, it is easy to lose focus; therefore, climbers often use their breath, their eyes, and the sensation of the holds to bring their focus back to the present climb, thereby endorsing mindfulness (Wheatley, 2023). Fear often arises throughout climbing, forcing the climber to remain present and in control in an unpredictable environment if they are to be successful in the climb (Wheatley, 2023). Remaining focused and clearing the mind of worries can support the components of attention (Wheatley, 2023). One assumption articulates that mindfulness and rock climbing promote flow, the mental state where a person is fully engaged, focused and completely absorbed in the process, allowing the individual to live in the present moment (Wheatley, 2023). Wheatley, 2023 conducted a quasi-experimental design to assess whether participating in rock climbing would increase mindfulness in a non-clinical sample.

Sixty-eight adults, 18 and over, partook in this study, ranging from complete beginners who have never climbed to advanced beginner climbers who have climbed once or less than a year. In a control group, adults required to partake in regular strength and conditioning training were compared to a bouldering group. Indoor bouldering is a form of rock climbing where individuals climb up to 4.5m high without a rope. Individuals within the bouldering group would warm up for five minutes and then climb for one hour of unsupervised bouldering. Prior to the intervention and immediately after the intervention, mindfulness, well-being and anxiety were assessed in both groups. Results showed that the bouldering group had a significant increase in mindfulness. These results provide support for the assertion that rock climbing can be used to increase mindfulness and help focus the mind. There were no significant differences between the bouldering and control groups regarding anxiety and well-being (Wheatley, 2023).According to Barranco-Ruiz et al., 2019, physical exercise that incorporates mindfulness, such as tai chi or yoga can potentially alleviate symptoms of ADHD, particularly those related to stress reduction and emotional regulation.

Rock Climbing and the link to Self-Esteem in Children with ADHD

Rock climbing interventions have been found to affect self-esteem, self-efficacy, motivation, resiliency, and a growth mindset while increasing self-confidence and understanding of one's limitations and potential (Bailey, 2019; De Vita & Rosa, 2018; Frühauf et al., 2021). Enhancing self-esteem and social functions in children and adolescents with ADHD is considered relevant for treatment efficacy (Celebi & Unal, 2021; Molavi et al., 2020). Rock climbing, which integrates dynamic and action-oriented therapeutic approaches, also promotes feelings of belonging, significance and self-worth (Angelini et al., 2020). Rock climbing exercises can be tailored to the individual's skill level by selecting routes based on height and

difficulty, allowing for a sense of achievement and success (Liu et al., 2022). This accomplishment leads to positive emotions and enhanced self-efficacy and confidence as participants overcome challenges (Bailey, 2019; Liu et al., 2022). Overcoming challenges in rock climbing activates the brain's reward system, improving overall confidence and well-being (Liu et al., 2022). In addition, reaching the top of a route in rock climbing often elicits feelings of mastery, including improved self-efficacy, mood, and confidence (Gassner et al., 2023). Moreover, rock climbing has been successfully used as a treatment modality for anxiety and depression, as it enhances self-efficacy and self-image (Bailey, 2019). It might be possible that rock climbing may have the same impact on children with ADHD. According to experts interviewed by Frühauf et al. (2021), rock climbing can positively influence self-esteem and self-efficacy, which may carry over to everyday life. One study demonstrated the effectiveness of a 10-week therapeutic climbing program in improving self-esteem scores and reducing symptom severity in patients with depressive disorder (Frühauf et al., 2021). Results showed that the climbing program outperformed the waitlist control and the home-based supervised exercise interventions (Frühauf et al., 2021).The qualitative data from Angelini et al. (2020) climbing program gained parents' perspective through Conner’s Parent Rating Scale. Parents identified benefits in their children that included perseverance, problem-solving, and increased confidence (Angelini et al., 2020). Parents also identified benefits in their children with improvement in conduct problems, learning problems, psychosomatic factors, impulsive and hyperactive behaviours and anxiety (Angelini et al., 2020). The researchers within the study also observed improvements in motivation, acceptance of challenges, and improved independence (Angelini et al., 2020).

Summary of Findings

Exercise therapy has recently emerged as an additional treatment for children and adolescents with ADHD (Angelini et al., 2020; Barranco-Ruiz et al., 2019). General exercise has been shown to help improve attention deficits in children with ADHD while elevating the baseline levels of dopamine, norepinephrine, and serotonin (Angelini et al., 2020; Barranco-Ruiz et al., 2019; Jeyanthi et al., 2021; Ji et al., 2023; Li et al., 2023). However, not all types of physical activity interventions effectively improve each area of EF, which may be due to the characteristics of the activities performed (Jalilvand & Samadi, 2020; Piepmeier et al., 2015). Utilizing physical activity with a cognitive-based component is a new approach to treating children with ADHD, as it actively trains the brain regions required for higher-order cognition (Benzing & Schmidt, 2019; Jalilvand & Samadi, 2020; Li et al., 2023). Rock climbing, a form of exercise, involves many cognitive-based components, such as problem-solving, planning, and decision-making and has the potential to develop many of the EF skills that children and adolescents with ADHD lack (Angelini et al., 2020; Bailey, 2019; Frühauf et al., 2021; Gassner et al., 2023; Heilmann, 2021; Lee & Song, 2015; Portrie-Bethke et al., 2009). Wheatley, 2023, is the first study to show evidence that rock climbing can increase mindfulness in an adult population. Mindfulness helps to enhance attention and focus, minimize impulsivity and increase frustration tolerance (Huguet et al., 2017; Lee et al., 2022). Future studies would need to investigate whether rock climbing can increase mindfulness in children and adolescents with ADHD, leading to improved executive functioning (Huguet et al., 2017). Lastly, children and adolescents with ADHD often have low self-esteem and social functions (Celebi & Unal, 2021; Molavi et al., 2020); rock climbing may aid as an additional treatment option, as it has been

found to enhance self-esteem, self-efficacy, and resiliency (Bailey, 2019; De Vita & Rosa, 2018; Frühauf et al., 2021).

Ethical Considerations Regarding Research Methods

Some ethical concerns existed within the literature review. Under the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2), there were concerns regarding the lack of clarity surrounding consent forms and the recruitment process. Moreover, there was a lack of clarity on the cultural background of the samples chosen within the studies (Government of Canada, 2019).

Consent Forms

It is unclear whether the consent forms included the purpose of the research, what the research entails, foreseeable risks and potential benefits (Government of Canada, 2019). In three studies, the researchers did inform the participants about the study procedures (Angelini et al., 2020; Frühauf et al., 2021; Pan et al., 2019).

Recruitment

The recruitment process highlights the importance of fair and equitable conduct of research by distributing the benefits and burdens of research participation (Government of Canada, 2019). The recruitment process for the study conducted by Taylor et al., 2019, took place in one primary school, thereby missing the perspectives from the broader population (Government of Canada, 2019).

The research question should justify inclusion criteria and not exclude individuals from the opportunity to partake based on culture, language, ethnicity, race, disability, sexual orientation, linguistic proficiency, gender or age unless a valid reason is provided (Government of Canada, 2019). Some studies included more males than females; however, the male-to-female

ratio for children with ADHD was within the normal range (Benzing et al., 2018).In the study conducted by Pan et al., 2019, the fifteen children with ADHD receiving the intervention were all boys, limiting the generalizability of the study. Moreover, there was a lack of cultural studies regarding the impact of physical activity and rock climbing on children with ADHD. Only one study made mention of 2 children who were Asian British while the remaining children were Caucasian(Taylor et al., 2019).The information within this literature review will next examine how it can be applied to clinical practice.

Chapter 4: Application to Clinical Practice

Counsellors encounter many challenges when working with children and adolescents with ADHD, including impulsivity, distractibility, and hyperactivity, making traditional talk therapy challenging (Portrie-Bethke et al., 2009). As a result, mental health counsellors have started incorporating physical activity as an add-on treatment (Angelini et al., 2020). Integrating physical activity interventions, such as rock climbing, in children with ADHD could support schools, programs, and organizations in designing tailored exercise interventions to optimize the executive functioning of children with neurological disorders while enhancing performance in school and quality of life in children with ADHD (Sung et al., 2022). A multi-professional team is important when deciding upon the best therapy options that complement each other (Frühauf et al., 2021).

Therapist Direct Implications

Creating a therapeutic relationship with the client is supportive in understanding what motivates the client and how they learn, which is imperative before trying different learning techniques or coping strategies (Prevatt & Levrini, 2015). Individuals with ADHD often learn best and show improved behaviour when tasks are salient, novel, or interesting (Prevatt & Levrini, 2015). Moreover, integrating psychoeducation into the counselling session is supportive when addressing ADHD in dispelling myths and building clients up to believe they can be successful (Prevatt & Levrini, 2015).

The ability to recommend strategies that a client can use empowers the individual to find ways to manage their own life while providing long-term solutions for the client (Wilson, 2014). The counsellor's role is to provide information on how and why exercise is beneficial and whether exercise will be a part of their healing protocol (Wilson, 2014). A counsellor can also

support a client in overcoming obstacles by incorporating the client's social and familial support networks (Wilson, 2014). Counsellors could also recommend integrating rock climbing for parents with children with ADHD. Moreover, a practitioner could integrate short exercise routines into the therapy session and encourage children to exercise outside therapy. A short duration of exercise, between 10 to 15 minutes, can potentially provoke positive effects on cognitive performance in children (Benzing et al., 2018). Using psychoeducation, counsellors can teach their clients short exercise routines when they start losing focus outside of therapy sessions.

Recommendations within a Rock Climbing Setting

Group programs could be created to include therapeutic climbing activities for children with ADHD; these activities could incorporate wearing a weighted vest while climbing (Lee & Song, 2015). These group programs may additionally address the social difficulties that children with ADHD are challenged by (Lee & Song, 2015). Mental health counsellors can help facilitate problem-solving skills in children with ADHD through rock climbing (Portrie-Bethke et al., 2009). Conducting a therapy session at a climbing gym while working with the individual is possible. While working alongside the child, therapists can discuss climbing goals and how to achieve them (Portrie-Bethke et al., 2009). Once the child climbs, counsellors can facilitate discussion, exploring the most challenging aspects of the climb and what was supportive as they climbed (Portrie-Bethke et al., 2009). To encourage problem-solving, counsellors can also explore with the child what they would do differently to climb higher (Portrie-Bethke et al., 2009). The role of the counsellor can also be directed towards connecting each rock to a separate challenge in their day-to-day life. Discussion can also be oriented toward the child’s willingness to challenge themselves in overcoming obstacles and how they could apply the problem-solving

strategies in their daily life (Portrie-Bethke et al., 2009). The skills and knowledge gained during rock climbing can transfer into the child's everyday life (Angelini et al., 2020). Parents can prompt their children to use the problem-solving skills learned to improve behaviour at home (Angelini et al., 2020). Lastly, future implementation of rock climbing can help build resilience, within a therapeutic framework (Wheatley, 2021).

Recommendations within a School Environment

Integrating physical activity interventions, such as rock climbing, in children with ADHD could support schools, programs, and organizations in designing tailored exercise interventions to optimize the EFs of children with neurological disorders while enhancing performance in school and quality of life in children with ADHD (Sung et al., 2022).Findings extend beyond rock climbing as they can be applied to a school setting by encouraging daily physical exercise through scheduled activity periods to improve attention and manage the behaviour of children with ADHD (Angelini et al., 2020; Taylor et al., 2019). By taking breaks in the classroom for physical activity, students could improve their attention and behaviour during instructional education (Angelini et al., 2020). To support children with ADHD, teachers could schedule to teach more challenging subjects after a physical activity break to help facilitate attention and learning (Angelini et al., 2020). Classroom recommendations include incorporating physical movement during seated classroom activities (Taylor et al., 2019). Examples include having the child with ADHD collect books or squeeze a stress ball at their desk. Moreover, children with ADHD should not miss break times or physical education (Taylor et al., 2019).

The results from Taylor et al. (2019) suggest that regular physical activity through physical education classes is a practical way to reduce ADHD symptoms. Using exercises designed for children with ADHD in physical education classes was shown to significantly

reduce ADHD symptoms and increase engagement in learning activities, as observed by teachers (Taylor et al., 2019). The design and content of the exercise are important to consider (Taylor et al., 2019). Physical exercise introduced in the classroom or physical education classes should incorporate multiple activities with short periods spent on each (Taylor et al., 2019). An example of a program may be physical activity twice weekly over 12 weeks (Taylor et al., 2019). Activities must incorporate a variety of combinations in order to stimulate interest, starting with a 5 to 10-minute warm-up where children take turns to lead (Taylor et al., 2019). The chosen physical activities must be mentally engaging and physically demanding of a moderate to intense work rate (Taylor et al., 2019). Children with ADHD must pay attention to the tasks and instructions from the leaders while waiting for their turn (Taylor et al., 2019). One example is having children take turns at a balancing challenge while others partake in a shuttle run, requiring focused attention as various activities occur (Taylor et al., 2019).

How the Research Findings, Legislation, Cultural Differences Factor into the Ability to Use Current Research

Exercise is considered a low-threshold intervention designed to be easily accessible (Frühauf et al., 2021). Lower-income families can easily adopt an exercise plan recommended by a therapist into their weekly routine. However, barriers exist when integrating rock climbing, as a form of exercise, into therapy for children and adolescents with ADHD (Frühauf et al., 2021). It would be difficult for low-income families to afford the costs of rock climbing, including equipment and facilities (Frühauf et al., 2021). Physical exercise appears to be an intervention that does no harm; only positive changes have been observed (Pan et al., 2019). Possible adverse effects of rock climbing include a low risk of injury, including falling and injury to hands and feet (Frühauf et al., 2021).

Chapter 5: Recommendations and Conclusion

This literature review examined qualitative, quantitative and mixed methods approaches to answer the research question: "To what extent does physical activity, in particular, rock climbing, as a treatment modality, impact maladaptive symptoms in children diagnosed with ADHD?" The existing literature presents a gap in exploring various modalities, including physical activity and rock climbing, as treatment options for children diagnosed with ADHD. According to the literature, physical activity benefits children with ADHD. Research has established a link between physical activity and cognitive functioning in individuals with ADHD (Rassovsky & Alfassi, 2019). Moreover, engaging in physical exercise reduces distractibility and improves cognitive performance in measures of executive and attentional functions while reducing ADHD symptoms following moderate exercise (Rassovsky & Alfassi, 2019). General exercise also helps increase dopamine, norepinephrine, and serotonin, improving attention and focus (Jeyanthi et al., 2021; Ji et al., 2023; Li et al., 2023). The literature also suggests that physical activity mixed with a motor-cognitive approach can increase the effectiveness of physical activity interventions for children and adolescents with ADHD (Benzing et al., 2018; Jalilvand & Samadi, 2020; Li et al., 2023; Pan et al., 2019 & Taylor et al., 2019). Rock climbing is a motor-cognitive approach to exercise that can improve EFs such as sustained attention, problem-solving, planning, and inhibitory control (Angelini et al., 2020; Bailey, 2019; Frühauf et al., 2021; Lee & Song, 2015; Portrie-Bethke et al., 2009). This literature review helps to fill in the gap by showing that rock climbing, as a form of physical activity, can enhance mindfulness, self-esteem, self-efficacy and resiliency (Bailey, 2019; De Vita & Rosa, 2018; Frühauf et al., 2021; Wheatley, 2023). Enhancing self-esteem in children and adolescents with ADHD is an essential consideration for treatment efficacy (Celebi & Unal, 2021; Molavi et al., 2020).

Incorporating physical activity, such as rock climbing, into the treatment plan for children and adolescents with ADHD can offer a long-term alternative strategy for managing the symptoms of ADHD. Counsellors can provide information on how and why exercise is beneficial and choose whether or not to integrate it into their healing protocols (Wilson, 2014). Group programs could also include rock climbing activities, with counsellors facilitating EF skill development, including problem-solving. Through guided interactions, the therapist can engage children in discussions about climbing goals, challenges, and strategies for overcoming these challenges (Portrie-Bethke et al., 2009).

Recommendations for Future Research Questions

Based on the current research findings, future studies could investigate the following research question: To what extent can rock climbing as an exercise intervention improve the physiological and psychological aspects of children with ADHD? (Frühauf et al., 2021). Few research studies have examined rock climbing as an exercise-based treatment modality for children and adolescents with ADHD. Angelini et al. (2020) recommended focusing on a progression of the climbing programs to be standardized for all climbers while adjusting the difficulty to their climbing ability. This approach would promote further research into understanding the exact role rock climbing has in supporting ADHD symptoms in children. Several studies have suggested the need for larger sample sizes to establish the applicability of the findings to both sexes and various ages (Angelini et al., 2020; Benzing et al., 2018; Heilmann, 2021; Pan et al., 2019; Taylor et al., 2019). Further research on how rock climbing can enhance the EFs in children and adolescents with ADHD will aid counsellors in providing more effective treatment options.

Future studies could further investigate the question: To what extent can physical activity, including rock climbing, in the absence of medication, alleviate the symptoms of ADHD in children and adolescents? (Benzing et al., 2018). The literature review revealed a limited number of studies that controlled for medication in assessing the impact of physical activity and rock climbing in reducing ADHD symptoms in children and adolescents. Future studies could investigate EFs in healthy children compared to children with ADHD who continued medication use, in contrast to children who did not take medication while exercising (Benzing et al., 2018). Moreover, variations existed among the children with ADHD regarding ADHD subtype classification (Pan et al., 2019). Future research could explore whether the variations among children regarding the ADHD subtype affected the study's outcome (Pan et al., 2019).

Another gap within the literature review involves the comparison between various treatment modalities. For instance, investigating the question: Do children and adolescents with ADHD benefit more or less from exercise, such as rock climbing, compared to other treatment modalities such as pharmaceutical, behavioural, and cognitive? (Jalilvand & Samadi, 2020; Lee & Song, 2015). Lastly, To what extent can rock climbing aid in improving mindfulness and self-esteem in children and adolescents with ADHD?

Reflection

Through completing this capstone project, I have understood that there are various creative approaches to supporting children and adolescents with ADHD. By keeping the interventions fun and engaging, children and adolescents are more willing to learn strategies to manage their ADHD symptoms. Identifying the physical activities the child is interested in can contribute to the long-term success of these interventions. Given their desire for stimulating activities, introducing a novel physical activity such as rock climbing can open up many avenues

for intervention. When evaluating rock climbing as an exercise modality, many games can be incorporated into rock climbing to maintain mental and physical challenges, adding novelty with each session the child attends. A child or adolescent with ADHD could rock climb independently; having a trained professional to facilitate the therapeutic process could expedite the enhancement of EFs.

If there is no access to a rock-climbing facility, exercise can be condoned within the therapy room. This might include balancing activities such as standing on one foot while tossing a balloon or beanbag back and forth. The focus required in such activities helps to train the EFs, such as sustained attention. While rock climbing has many therapeutic values, such as sustaining attention and maintaining balance on the wall while problem-solving, it is not always easily accessible.

In reflecting upon the clinical and research perspectives, managing ADHD symptoms in children and adolescents is evolving. There is still limited information on how rock climbing can be used as an intervention to help support children and adolescents with ADHD. There is also limited research on the effectiveness of rock climbing in managing the symptoms of ADHD in children and adolescents. Understanding the role physical activity plays helps open up new opportunities for children with ADHD to manage their symptoms. These opportunities can support long-term, cost-effective options for managing symptoms of ADHD well into adulthood.

From a professional practice standpoint, a more comprehensive approach can be implemented in creating a treatment plan that is best suited for the individual. Monitoring progress and tailoring interventions helps ensure that children diagnosed with ADHD stay engaged and motivated while also finding ways to manage their symptoms in the long run. Integrating rock climbing into the treatment plan can complement and enhance other therapeutic

approaches, such as behavioural therapy. Finally, educating parents on the role that exercise with a motor-cognitive approach, such as rock climbing, can empower parents to find solutions to support their children.

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