Understanding How an App-based Group Chat Impacts Physical Activity Behaviour and Mental Health Indices in an Individualized 6-week Aerobic Physical Activity Program for University Students

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Abstract

Background: With the escalating mental health crisis among post-secondary students, accessible support becomes crucial. In this context, individualized physical activity (PA) programming can present a viable aid by alleviating stress, anxiety, and depression symptoms. While an unsupervised PA program can lead to engagement challenges, a program that incorporates an asynchronous app-based group chat may offer a suitable solution by fostering social support, potentially improving PA behaviour and mental health. Currently, there is limited research on the effectiveness of such individualized PA programs for post-secondary students.

Research questions: How does the addition of an app-based group chat to an individualized 6-week PA program impact PA behaviour, aerobic fitness, and mental health indices for university students, and to what degree are these changes, if any, maintained 4 weeks post-program completion? How do participants view engaging in these types of interventions?

Experimental design: Pilot experimental pre-post parallel group randomized trial design integrating quantitative and qualitative methods.

Hypothesis: It was hypothesized that while an exercise program alone would yield positive improvements to all mental health indices, the benefits would be greater for those participating in an app-based support group. Participants in the online group were also expected to have higher PA engagement (measured by total minutes of PA) throughout the exercise program, given the known benefits of social support. It was anticipated that the qualitative findings would provide insight into participant study-related experiences and add further context to the quantitative data.

Methods: University students at a mid-sized university who did not meet national PA guidelines (< 150 mins/week) were recruited to participate. Before their programs began, participants filled out questionnaires assessing demographics, PA behaviour, symptoms of depression, anxiety, and

stress levels, as well as mental health indices (i.e., emotional, social, and psychological well-being), and completed a test to assess aerobic fitness. All participants were then provided with an individualized 6-week aerobic-based PA program; half were randomly assigned to a condition involving the usage of an app-based group chat. Upon program completion, participants filled out the questionnaires again with the addition of open-ended questions to explore their study-related experiences and completed the aerobic fitness test. To determine the degree to which changes were maintained, participants were also asked to complete a 4-week assessment remotely following intervention completion. Quantitative data were analyzed using a combination of descriptive statistics, t-tests, and repeated measures ANOVAs. Qualitative findings were analyzed using a general thematic analysis.

Results: This study enrolled 21 less active (under 150 minutes of MVPA/week) full-time Lakehead University students. Nineteen (Mage = 24.8 years; female = 12; undergraduate = 11; with support =10) completed the study and were included in the analysis. Quantitative results revealed that the exercise only group experienced a significant decrease in sedentary minutes over time compared to those in the group chat condition *(*$p < .001$) with changes occurring specifically between baseline and post-intervention ($p = .02$), and baseline and follow up ($p = .01$). While no other between group differences were revealed, several favourable within group changes occurred including: a significant increase in VO_2 max from baseline to post-intervention ($p < .001$); a significant decrease in depression scores between baseline and post-intervention ($p = .02$); and a significant decrease in stress scores from post-intervention to follow up ($p = .03$). Alternatively, significant within-group changes took place for all subscales of mental health throughout the intervention and follow-up periods with decreases observed for emotional, social, and psychological well-being. Qualitatively, all participants expressed their appreciation of the

individualized and structured PA program and described several involvement benefits related to motivation, health, and awareness. While barriers to PA engagement such as school, health issues, lack of motivation, and work-related commitments were identified as a whole, those in the group chat condition highlighted its merit as a PA facilitator and provided several suggestions for future research.

Conclusion: This novel study confirmed that an individualized PA program can promote PA engagement and improvements to aerobic fitness, in addition to positive changes in mental health indices, regardless of implementation of a social support such as a group chat. While no quantitative results supported the hypotheses regarding a supplementary app, participants highlighted several benefits related to group support in this context. More research is needed to determine the optimal structure for this type of intervention (e.g., frequency, monitoring, prompts), in addition to a larger sample size.

Key Words: app-based support, individualized physical activity program, university students, mental health, pilot study

Operational Definitions

Physical Activity: bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization, 2022)

Physically Active: Equal to or greater than 150 minutes of moderate- to vigorous-intensity aerobic PA per week, in bouts of 10 minutes or more (Canadian Society for Exercise Physiology, 2021)

Physically Inactive: Less than 150 minutes of moderate- to vigorous-intensity aerobic PA per week (CSEP, 2021)

Well-being: State of being happy, healthy, and prosperous, composed of nine dimensions: physical, intellectual, emotional, interpersonal, cultural, spiritual, vocational, financial, and environmental (Stoewen, 2017)

Physical Activity Program: Structured plan of activity geared toward achieving or maintaining physical well-being (DeJonge, 2021)

Individualization: Training principle that states a program must take the individual needs, wants, and abilities into consideration as no two individuals will respond the same way to a given training program (Kent, 2006)

Individualized Physical Activity Program: Considering participant goals, likes, dislikes, barriers, and facilitators to a PA program to engage in meaningful self-directed PA (DeJonge, 2021)

App-based Group Chat: Group of individuals on an online platform that engage in sharing their experiences, progress, and words of encouragement to motivate others (McKeon, 2021). This will also be referred to as the "support group" herein.

Physical Activity Behaviour: Degree to which an individual follows a program, as measured by percentage of the prescribed PA completed in minutes of activity as recorded by participant's logbook (McKeon, 2021).

Sedentary Behaviour: Refers to low-energy activities done while awake, such as sitting or lying down (Owen et al., 2010).

Group-based Physical Activity Program: Structured plan of activity geared toward achieving or maintaining physical well-being in a group setting (Golaszewski et al., 2022)

WhatsApp: WhatsApp Messenger, or simply WhatsApp, is an internationally available freeware, cross-platform centralized instant messaging and voice-over-IP service owned by American company Meta Platforms (WhatsApp, 2022).

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1.0 Introduction

In recent years, post-secondary students have reported significantly poorer mental health, especially since the onset of the COVID-19 pandemic, highlighting the growing need for related support (Government of Canada, 2020; Mental Health Commission of Canada, 2022). Many students find traditional mental health treatments such as therapy, counseling, or medication uncomfortable due to stigma, misconceptions, inaccessibility, lack of anonymity, and fear (Clement et al., 2015; Eisenberg et al., 2007; Pearson et al., 2022). In Canada, young adults aged 20-30 reported the highest prevalence of mood and anxiety disorders, necessitating innovative supports (Mental Health Commission of Canada, 2021). Recreational physical activity (PA) is a less formal yet accessible and less stigmatizing alternative that offers numerous mental health benefits, including positive effects on stress, anxiety, and depression symptoms (Mason & Holt, 2012; White, 2017; Wilson, 2021).

Despite the positive impact of regular PA on facets of wellness, there is limited research on campus-based PA programs for post-secondary students aimed to enhance/maintain mental health indices (DeJonge, 2021). One challenge related to supervised PA programs is adherence (Delrieu et al., 2020): drop-out rates of 50% are common, especially amongst new exercisers (Dishman, 1986; van der Molen et al., 2010). In the context of behaviour change, it is well known that tailoring programming to the unique needs of participants is vital for promoting success (Rhodes et al., 2019). Further, guided but unsupervised programs can enhance autonomy, which can also lead to improved adherence (Teixeira et al., 2012). While many studies have examined how individualized PA programs can impact facets of mental health, the populations have largely included those with chronic disease (e.g., Tang et al., 2017), children

and adolescents (e.g., Biddle et al., 2019), or older adults (e.g., Rosenbaum et al., 2014). A focus on less active post-secondary students is needed.

Group support is another strategy known to promote PA engagement and improve adherence to programming (Burke et al., 2006; Estabrooks & Carron, 1999). However, group classes may not fit with all schedules (Golaszewski et al., 2022), and policies and procedures may preclude in-person gatherings such as during a pandemic (Government of Canada, 2020). Online PA support groups could potentially boost program PA behaviour through offering asynchronous, non-in-person options (Vandelanotte et al., 2014; Wheatley et al., 2021). Currently, limited research has examined the impact of online PA group support on post-secondary student mental health as part of an individualized aerobic-based PA program (DeJonge et al., 2021, Delrieu et al., 2020; McKeon et al., 2021; Muir et al., 2020). Thus, this study aimed to investigate the effects of a 6-week individualized PA program with and without app-based group chat support on PA behaviour and mental health indices in the general university student population. Specifically, the study utilized a private WhatsApp group as the online social platform, enabling participants assigned to the chat support group to share their experiences and encouragement to motivate one another on their own time. A secondary purpose involved exploring program experiences of participants qualitatively.

2.0 Review of Literature

To position an examination of individualized PA programs and an app-based group chat in relation to PA behaviour and mental health indices, it is essential to analyze current research to identify trends, methodologies, and limitations. This literature review examined PA engagement, mental health, individualized PA programs, group-based PA, online PA support groups, and other interventions for mental health support in a post-secondary student context.

Upon completing this review, several gaps in the literature were identified. Namely, there is limited research exploring the impact of online PA group programs on mental health and well-being among post-secondary students (McKeon, 2021).

2.1 Physical Activity

2.1.1 Determinants of Physical Activity

Numerous personal, social, and behavioural factors determine PA behaviour in the general population. Personal characteristics, including gender, age, ethnicity, education, income, and biomedical status, all influence engagement positively or negatively (Karmeniemi et al., 2018; King et al., 1992). For example, PA typically declines after late adolescence and more so among females; differences in ethnicity and PA can be attributed to varying socioeconomic statuses; and higher education levels are positively associated with leisure time and PA frequency (Karmeniemi et al., 2018; King et al., 1992). Income and PA behaviour also share a positive relationship and healthy individuals tend to be more active than those with medical problems or conditions. Moreover, behavioural determinants such as knowledge, attitudes, and beliefs about PA also affect involvement. Specifically, greater belief in the health benefits of PA has been correlated with increased exercise engagement (Karmeniemi et al., 2018; King et al., 1992).

Another aspect of PA determinants involves individuals' attributes and skills; stable individual differences that across time and situations, can influence PA behaviour (Karmeniemi et al., 2018; King et al., 1992). Attributes like self-motivation or the presence of anxiety play a role, while skills such as goal setting, self-monitoring, and self-reinforcement positively correlate with PA involvement. In summary, a wide range of personal and social determinants can predict PA behaviour and should be taken into consideration when designing related programming given

the known benefits of PA in a mental health context (DeJonge et al., 2021; Karmeniemi et al., 2018; King et al., 1992).

2.1.2 Benefits of Physical Activity

Physical activity has been extensively studied and proven to provide a multitude of physiological benefits, contributing to overall health and well-being (Canadian Society for Exercise Physiology [CSEP], 2021; Colberg et al., 2010; Warburton et al., 2006). According to the CSEP (2021), regular exercise plays a significant role in aerobic health by reducing the risk of heart disease, hypertension, and stroke. Additionally, a meta-analysis by Warburton et al. (2006) emphasized the importance of PA in enhancing lung function and preventing the onset of chronic respiratory diseases. Physical activity has also been shown to aid in the management of Type 2 diabetes by improving insulin sensitivity and glucose metabolism (Colberg et al., 2010). In summary, the physiological benefits of PA are vast, encompassing improved aerobic, respiratory, neurological, and metabolic health, thereby underscoring the importance of incorporating regular exercise into one's lifestyle.

In a similar vein, PA has long been recognized for its numerous psychological benefits, contributing positively to mental health and overall well-being in both those who are seeking mental health support, and those who are not. (DeJonge et al., 2021, Delrieu et al., 2020; Muir et al., 2020). One of the most well-documented psychological advantages of engaging in regular PA is the reduction of symptoms associated with depression and anxiety (Biddle, 1999; Stathopoulou et al., 2006). A comprehensive review by Faulkner and Biddle (1999) shed light on the therapeutic role of exercise as an adjunct treatment for depression, with both acute and chronic PA demonstrating mood-enhancing effects. A study conducted by Stathopoulou et al. (2006) supported these findings, revealing that exercise can serve as an effective intervention in

alleviating symptoms of anxiety disorders by regulating the release of stress hormones and promoting relaxation. Furthermore, PA has been linked to positive age-related cognitive changes, with a Canadian study by Liu-Ambrose et al. (2010) reporting that resistance training can improve cognitive function and reduce the risk of dementia in older adults.

In addition, PA has been shown to promote self-esteem and overall psychological well-being. A meta-analysis by Rebar et al. (2015) revealed that engaging in regular exercise is positively correlated with improved self-esteem, mood regulation, and life satisfaction. The researchers suggested that these benefits may be mediated by increased social interaction and support, as well as a sense of mastery and accomplishment that comes with regular PA. This relationship not only enhances adherence to PA programs through increased motivation and social support but also contributes to the overall quality of life (Bize et al., 2007; Teixeira et al., 2012).

When examining PA, sedentary behaviour is a critical variable to review simultaneously, as it is an important indicator of health. Increased sedentary behaviour can lead to heightened risk for chronic diseases such as obesity, diabetes, cardiovascular disease, and increased risk of early mortality (Biswas et al., 2015). A systematic review of 66 studies worldwide analyzing changes in PA and sedentary behaviour from November 2019 to October 2020 found that the majority reported decreases in PA and increases in sedentary behaviour simultaneously in populations such as children, adults, and individuals with medical conditions (Stockwell et al., 2021). Collectively, these studies paint a complex picture of the impact of the COVID-19 pandemic on PA. As recovery continues, more studies are warranted to better understand the impact of these behavioural changes on affected populations and regions while uncovering ways to promote regular PA engagement.

In sum, PA can be seen as a multifaceted tool that promotes both physical health and mental wellness, and it can even play a supportive role in mental health treatment (Mikkelsen et al., 2017; Rebar et al., 2015). These benefits emphasize the importance of incorporating regular exercise into one's lifestyle. In an effort to encourage uptake, organizations and governments have established PA guidelines for the general public, with the goal of optimizing health and well-being.

2.1.3 Physical Activity Guidelines and Prevalence Trends

Exercise guidelines inform the general population about the appropriate amount and intensity of PA needed to experience health benefits safely. For adults aged 18-64, the CSEP (2021) recommends at least 150 minutes of moderate-to-vigorous-intensity aerobic PA (MVPA) per week, in bouts of 10 minutes or more, along with muscle and bone strengthening activities using major muscle groups at least 2 days per week. According to the CSEP (2021), MVPA activities cause slight sweating and a moderate increase in heart rate, such as brisk walking or bike riding. Vigorous-intensity physical activities, like jogging or uphill biking, lead to more sweating and substantial increases in heart rate and breathing. These guidelines (CSEP, 2021) can be applied to post-secondary students, as they fall within the specified age and health range. A report from Statistics Canada revealed that, on average, Canadian adults were engaging in approximately 24 minutes of MVPA per day (Statistics Canada, 2015). This level of activity translates to roughly 168 minutes per week and suggests Canadians were exceeding national guidelines, a value that has declined in recent years.

2.2 The COVID-19 Pandemic: Impact on Physical Activity

2.2.1 General Trends

One factor that has impacted PA behaviour negatively is the COVID-19 pandemic (Pearson et al., 2022; Stockwell et al., 2021). In March 2020, the Government of Ontario declared a province-wide lockdown to reduce the spread of the COVID-19 virus. This mandate caused recreational facility closures for months, resulting in many individuals changing their mode of PA or not engaging in PA at all (Pearson et al., 2022; Stockwell et al., 2021). Despite lifted restrictions, some individuals remained hesitant to return to pre-pandemic PA levels due to fear of virus exposure, in addition to protections related to masks, vaccines, and capacity restrictions (O'Loughlin et al., 2022).

During the COVID-19 pandemic, several studies examined the related impact on PA levels, revealing a multifaceted picture. For example, one Canadian study using a self-report longitudinal design, found a significant decrease in PA due to fear of the virus and physical distancing recommendations in the general population (Calatayud et al., 2020). Alternatively, a study in Scotland examining the general adult population and utilizing longitudinal data, reported that PA levels decreased during the first national lockdown but returned to pre-pandemic levels as restrictions began to ease (Janssen et al., 2020). Most studies found an overall significant decrease in total PA, including light, moderate, and vigorous types (Stockwell et al., 2021).

2.2.2 Post-secondary Students

Prior to the pandemic, it was well established that post-secondary students face several unique barriers to PA involvement, including academic demands and increased stress levels (Thomas et al., 2019). For example, a study involving over 300 Canadian university students examined PA behaviour and related facilitators/barriers to engagement and found that overall,

PA levels decreased amongst participants over the course of the school year. Barriers included stress and low perceived self-skill, lack of friends and peer influence, homework, class schedules, and overcrowded university facilities. Alternatively, facilitators included programs that allowed students to participate in PA on their own time and the enjoyment of participating in more non-competitive sport and recreation activities, thereby highlighting the importance of tailoring interventions to promote involvement (Thomas et al., 2019).

Since the emergence of COVID-19, barriers to engagement in PA have been amplified and impacted subsequent engagement negatively (Wilson et al., 2021). Wilson and colleagues (2021) examined the impact of the pandemic on PA among 1019 American college students and found a significant decline under COVID-19 circumstances and concluded that proactive programs to promote student health and well-being are needed imminently (Wilson et al., 2021). A systematic review of studies analyzing the impact of the pandemic on post-secondary students' PA levels similarly found that out of eleven studies, nine showed a significant reduction compared to pre-pandemic values in walking, moderate, vigorous, and total PA levels (López-Valenciano et al., 2021). However, participants who met the guidelines prior to the pandemic generally met the guidelines during its tenure, suggesting that established behaviour may help to overcome increased barriers related to the pandemic such as facility closures, fear of contracting the virus, and mental exhaustion/loss of motivation (Janssen et al., 2020; López-Valenciano et al., 2021; Stockwell et al., 2021). Another study of 213 post-secondary students revealed similar results when examining sedentary behaviour (Romero-Blanco, 2020). Sedentary time increased among participants who met and did not meet guidelines, but students who met the guidelines prior to the pandemic mostly met guidelines during (Romero-Blanco, 2020). Taken together,

these studies suggest that post-secondary students who struggle to meet national PA recommendations are particularly worthy of further investigation.

2.3 The COVID-19 Pandemic: Impact on Mental Health

2.3.1 General Trends

Mental health refers to a person's emotional, psychological, and social well-being, affecting how individuals think, feel, and act. It also helps determine how they handle stress, relate to others, and make choices (American Psychiatric Association, 2013). Mental health is on a continuum, reflecting the dynamic and fluid nature of an individual's mental state. This acknowledges that mental health is not a fixed attribute but can fluctuate along a spectrum, ranging from optimal functioning and wellness to severe symptoms and conditions (Keyes, 2002). Interestingly, there exists a complex relationship between PA and mental health (Pearson et al., 2022). While PA has been found to improve mental health and reduce the risk of developing mental health problems, individuals with low mental health are often less likely to exercise (DeJonge et al., 2021; Pearson et al., 2022). This could be due to the fact that individuals with poor mental health may not have the motivation, ability, resources, or support to engage in PA. Thus, the full range of benefits PA can have on mental health may not be realized (Pearson et al., 2022). In order to develop effective interventions, it is critical to understand the interplay between PA and mental health, particularly during times of increased stress and anxiety such as during a worldwide pandemic (DeJonge et al., 2021; Pearson et al., 2022).

Globally, the COVID-19 pandemic has been incredibly challenging for many individuals, especially in relation to mental health (Salari et al., 2020; Twenge & Joiner, 2020; Xiong et al., 2020). A growing body of research has documented the negative effects of the pandemic, with studies showing increased prevalence rates of psychological distress, depression, anxiety, and

post-traumatic stress symptoms among the general population compared to pre-pandemic levels (Salari et al., 2020; Twenge & Joiner, 2020; Xiong et al., 2020). There is a wealth of global research on the effects of the pandemic on mental health, but it is crucial to examine specific populations of interest and understand the gaps in knowledge on issues such as who are most affected by mental health problems, how the pandemic is exacerbating mental health inequities, and what coping strategies people are using (Jenkins et al., 2021; Salari et al., 2020; Twenge & Joiner, 2020; Xiong et al., 2020). A cross-sectional study of 3000 Canadian adults aged 18 or older aimed to address these gaps and found that Canadians are experiencing a decline in mental health and coping mechanisms due to the pandemic (Jenkins et al., 2021). These data emphasize the need for mental health support programs for vulnerable Canadians, such as those with pre-existing conditions, low-income individuals, people of different ethnicities, and those who identify as LGBTQ+ (Jenkins et al., 2021).

Quarantine measures were put in place during the pandemic and required individuals who came into contact with COVID-19 to completely isolate themselves as a preventive measure to limit spread of the virus; an action that can have a detrimental impact on mental health (Daly et al., 2021; Government of Canada, 2020). Protective measures in Canada have evolved throughout the course of the pandemic and included actions such as self-isolation requirements, social distancing guidelines, limitations on gatherings, and stay-at-home orders. These measures have been implemented at both the federal and provincial/territorial levels and have varied over time and region, reflecting the changing nature of the pandemic (Government of Canada, 2021). To examine the relationship between mental health and quarantine measures, 3000 Canadian adults completed a nationwide survey evaluating mental health and isolation during the first pandemic wave in mid 2020 (Daly et al., 2021). The study found that individuals who had to

quarantine were significantly more likely to experience suicidal thoughts and deliberate self-harm than those who did not, even when controlling for variables such as age, pre-existing mental health conditions, living alone, unemployment, and household income. This study by Daly et al. (2021) emphasize the urgent need for targeted interventions and support systems, such as mental health screenings, accessible counseling, and community outreach, to mitigate the risks of suicidal thoughts and self-harm associated with quarantine measures. The study also highlights the potential to improve mental well-being during public health crises like the COVID-19 pandemic (Daly et al., 2021).

Several factors related to quarantine have been identified as contributors to the negative observed impact on mental health including: job and income loss; separation from social supports; food insecurity; fear of spreading illness; or fear of negative symptoms from the virus (Daly et al., 2021). Although quarantine is a crucial public health measure that can prevent 44-81% of cases (Daly et al., 2021), it is clear that such measures can simultaneously have serious mental health implications for Canadians. The peak of COVID-19 restrictions, although now in the past, has left a lasting impact on rates of mental health problems as a whole, casting a prolonged shadow on the well-being of many individuals (Mental Health Commission of Canada, 2021). The stringent measures implemented during the height of the pandemic led to widespread feelings of isolation, anxiety, and depression, highlighting the need for sustained mental health support and community engagement to address the lingering effects of this unprecedented global crisis (Mental Health Commission of Canada, 2021). This widespread impact on mental health was felt across various demographics, including post-secondary students, who faced unique challenges during the pandemic. The following section will explore

in further detail the specific effects of these factors on the mental well-being of students within post-secondary institutions.

2.3.2 Postsecondary Students

Post-secondary students face a considerable number of stressors (Hamza et al., 2021; Mental Health Commission of Canada, 2021). Academic pressures, financial stress, irregular sleep patterns, and living away from home all contribute to a higher risk of mental health problems (Mental Health Commission of Canada, 2021). Over 20% of post-secondary students suffer from anxiety, mood, behavioural, and substance use disorders (Mental Health Commission of Canada, 2021). Furthermore, these mental health problems correlate with increased levels of burnout and negative academic outcomes. Post-secondary students are vulnerable to mental illness due to these stressors, and the impacts of the pandemic have further increased the risk of students experiencing negative mental health symptoms (Government of Canada, Statistics Canada, 2020). The pandemic has significantly impacted Canadians' quality of life, dropping by 15% since its onset based on a self-report question from the Canadian Community Health Survey from 68 to 53 (Government of Canada, Statistics Canada, 2020). Specifically, young Canadians aged 15-24 years experienced the most significant decline in perceived mental health, decreasing by 20% compared to pre-COVID-19 levels from 58 to 38 (Government of Canada, Statistics Canada, 2020).

Limited published research has examined the psychological impact of the pandemic on post-secondary students and identified those at highest risk within the population (Hamza et al., 2021). A group of researchers seeking to address these gaps analyzed a sample of 773 Canadian post-secondary students (74% female, M-age = 18.52) who completed a mental health survey in May 2019 and again in May 2020. The study found that students with pre-existing mental health

concerns experienced stable or improved mental health during the pandemic, a unique finding inconsistent with other research on post-secondary students and the pandemic's effects (Hamza et al., 2021; Mental Health Commission of Canada, 2021; Prowse et al., 2021). This was attributed to participants who had past experience with mental health concerns having developed coping mechanisms, whereas those with new mental health concerns did not have these mechanisms. Conversely, students without pre-existing mental health issues experienced declining mental health (Hamza et al., 2021). These findings emphasize the importance of not only supporting students with pre-existing conditions but also having the necessary support and capacity to help students mitigate the pandemic's negative impact on those with increasing psychological distress (Hamza et al., 2021).

Examining the coping strategies of post-secondary students during the pandemic highlights varied responses to mental health challenges, reflecting differences in individual circumstances, support systems, and resilience. For example, an online survey was completed by Canadian undergraduate students (n=366) to examine the pandemic's impact on mental health, academics, and coping strategies between May and August 2020 (Prowse et al., 2021). Results revealed that women experienced more negative outcomes on mental health and academics compared to their men counterparts. Specifically, for females, frequent use of online social media as a coping mechanism was associated with negative impacts on academics and facets of mental health (Prowse et al., 2021), suggesting that alternative platforms may be worthy of investigation. These findings underscored the necessity for interventions that are not only adequate to support the challenges posed by the pandemic but are also tailored to consider personal differences, ensuring that the unique needs of the university student population are addressed.

Similarly, a study examining various factors impacting the mental health of Canadian post-secondary students during the pandemic used an online survey administered between March and August 2020 to analyze 638 students' symptoms of depression and anxiety, online/physical contact, online learning, COVID-19 knowledge and firsthand experience, and other demographic factors (Boutros, 2021). The study found that anxiety and depression symptoms were not significantly correlated with demographic factors or the amount of contact with others. Students who preferred taking online courses experienced fewer symptoms of anxiety and depression, felt they could achieve their goals, and were satisfied with their performance. On the other hand, students who perceived the pandemic as causing significant changes in their lives exhibited greater anxiety and depression symptoms (Boutros, 2021). This study highlights that individuals who feel that they have experienced unwanted change have a higher risk of anxiety and depression than those who are less resistant to change. Like other studies, these findings highlight the need for student support services and interventions to combat the pandemic's ongoing impact.

2.4 The COVID-19 Pandemic, Physical Activity, and Mental Health

2.4.1 General Trends

One determinant of PA that has been significantly impacted by the COVID-19 pandemic is mental health. The COVID-19 pandemic disrupted individuals' daily routines, including PA involvement. Fortunately, PA has been linked to improving mental health in various situations. Physical activity is associated with better mental health and a reduced risk of mental ill-health (White, 2017). Physical activity helps decrease symptoms of depression and anxiety, two of the most common forms of mental health illnesses for both those with a mental illness, and those without (DeJonge et al., 2021, Delrieu et al., 2020; Muir et al., 2020). According to a recent

cross-sectional study with 165 adolescent participants in the UK, the aforementioned benefits of PA on mental health appeared to hold true during the pandemic (Wright et al., 2021). Specifically, the results revealed that while fear of the virus was a negative predictor of mental ill health, PA participation was a positive and stronger predictor of enhanced mental health and well-being outcomes. Additionally, a study of 352 adults from the United States found that individuals who reported higher levels of PA during the pandemic also reported lower levels of loneliness (Russell et al., 2021). This suggests that PA may be a beneficial strategy for improving social and emotional well-being during the pandemic.

Recent literature continues to highlight the negative impact of the COVID-19 pandemic on mental health, and how this in turn can affect PA levels. According to Puccinelli et al. (2021), individuals who have experienced reduced PA levels due to the pandemic have reported higher levels of anxiety and depression. Similarly, a study of 1038 Canadian adults found that anxiety and depressive symptoms were positively associated with sedentary behaviour and negatively associated with MVPA during the pandemic (Choi et al., 2021). This suggests that individuals with higher levels of anxiety and depression are less likely to engage in PA, potentially exacerbating the negative effects on mental health. Another study of 1446 adults from five European countries found that higher levels of COVID-19-related stress were associated with decreased PA, particularly in individuals who were already physically inactive (Brand et al., 2021). The study highlights the need for targeted interventions to increase PA levels in individuals experiencing COVID-19-related stress, as well as the importance of promoting PA as a coping strategy for stress management (Brand et al., 2021).

Overall, recent literature continues to highlight the important relationship between mental health and PA, and the need for tailored interventions to promote participation in service of enhancing mental health as pandemic recovery continues.

2.4.2 Post-Secondary Students

To grasp the potential influence of PA on anxiety and depression, the two prevalent mental health challenges among post-secondary students, the existing literature can be examined. A study involving 1512 Ukrainian university students examined the relationship between PA, depression, and anxiety during the pandemic (Rogowska et al., 2020). The study utilized a cross-sectional online survey, which included the International Physical Activity Questionnaire (IPAQ), Generalized Anxiety Disorder-7 (GAD-7), and Patient Health Questionnaire-9 (PHQ-9) to assess mental health and PA indices. The study categorized participants by active or inactive, as indicated by meeting the criteria for at least 150 minutes of PA weekly. The study found that 43% of participants were active, 24% met the criteria for generalized anxiety disorder, and 32% met the criteria for depression. Students who met the criteria for anxiety and depression were twice as likely to avoid participating in PA compared to students without mental illness. It was also noteworthy that the inactive group reported higher levels of anxiety and depression than the active group (Rogowska et al., 2020). The authors concluded that PA may be an inexpensive and effective means to cope with the adverse effects of the pandemic from a mental health standpoint.

Another cross-sectional study involving 697 U.S. university students examined the relationships between PA, sedentary behaviour, anxiety, and depression (Coakley et al., 2021). The study similarly employed the GAD-7, PHQ-9, and questions about PA guidelines. Consistent with the Ukrainian study (Rogowska et al., 2020), these researchers found that 49%

of students did not meet the guidelines, and sedentary behaviour was significantly associated with depression and anxiety (Coakley et al., 2021). Taken together, these studies highlight the significant connection between PA and mental well-being in post-secondary students, particularly as it relates to depression and anxiety. Findings emphasize the urgent need to promote engagement in PA, as a decrease in PA levels is correlated with a decline in mental health.

To this end, it is vital to explore various strategies that can effectively encourage PA engagement. The following section will delve into these strategies, considering the unique challenges and opportunities present in the university setting, and the needs and preferences of this demographic. By identifying and implementing tailored approaches to promote PA, a more supportive and student-centred focus may be fostered.

2.5 Strategies to Promote Physical Activity Engagement

2.5.1 Group Support in Physical Activity Programs

Compared to completing a PA program individually, group-based programs have demonstrated higher PA behaviour due to the provision of social support (Burke et al., 2006; Christensen et al., 2006). A group-based PA program refers to a structured PA plan that is conducted in a group setting (Burke et al., 2006). These programs are often led by a trained instructor, may include various forms of PA, are utilized in different contexts including community centers, fitness facilities, rehabilitation centers, and educational institutions, and may be designed to target specific populations or health outcomes (Fraser & Spink, 2002; Golaszewski et al., 2022). Physical activity groups consistently offer social support, community, and feelings of cohesion, resulting in greater program PA engagement (Fraser & Spink, 2002; Golaszewski et al., 2022).

Group support provided through PA programs fosters social connections, enhances motivation, creates a sense of belonging, allows for varied and engaging activities, and provides emotional support compared to programs where individuals are active independently (Crozier & Spink, 2014). These advantages can contribute to increased perceived identity and satisfaction, reinforcing commitment to the activity, and enhancing participants' overall experience (Crozier & Spink, 2014). Moreover, individuals engaging in group-based programs are more likely to seek out information, companionship, or validation from others in their group compared to those in programs where individuals are active independently (Golaszewski et al., 2022). From a mental health perspective, PA-based groups have been observed to protect individuals against depression, likely due to the dual pathways of increased PA and reduced loneliness (Stevens et al., 2021). In addition, the majority of research on group-based PA programs focuses on populations such as older adults, children, or populations with a disease, but they appear to be equally effective in the general population (Golaszewski et al., 2022). Hence, it is likely that applying a group-based strategy in a PA context will be useful in a post-secondary population.

Although in-person PA groups are widely accepted to increase PA behaviour and satisfaction, limited research has examined if online PA groups yield similar results (Smith et al., 2018). In one study, a team of researchers utilized an online platform called Walk Georgia as a support intervention to increase PA using groups (n = 13,902; Smith et al., 2018). Walk Georgia is a group-based app where participants can set goals, chat in groups, and view others' PA history. The researchers compared self-reported PA levels between a control group of individual members and group members using the Walk Georgia platform (Smith et al., 2018). Of the total 13,902 participants, 41% were group users, with groups formed in various contexts such as workplaces, schools, and faith-based organizations. Groups were formed by self-allocation

depending on user preference. Participants were asked to log their minutes of PA, and if they were in a group, to engage in that group on a weekly basis by sharing updates and words of encouragement. Users in the group programs reported statistically significant increases in minutes of PA and a larger number of participants reached 150 minutes or more of PA per week (Smith et al., 2018). The average group size that experienced these improvements was 7.6 (Smith et al., 2018).

These findings align with other literature whereby it has been posited that in smaller groups (5-7 individuals), participants are more aware of one another. As groups grow larger, the number of links between members increases at an exponential rate, which can be challenging to manage (Hackman & Vidmar, 1970). Larger groups also tend to experience relational loss, where support becomes less available, especially as size increases (Mueller, 2012). Based on these factors, it is presumed that smaller groups are more optimal for promoting PA behaviour (Hackman & Vidmar, 1970; Mueller, 2012; Smith et al., 2018). While the effectiveness of group-based PA programs, especially in smaller group sizes, has been clearly demonstrated, there is a growing interest in understanding the nuances of individualized approaches and how they might compare to or complement group interventions as they are tailored to meet personal needs and preferences (McKeon et al., 2021; Mueller, 2012; Smith et al., 2018).

2.5.2 Individualized Physical Activity Programs

Individualization is a training principle that emphasizes the effectiveness of considering individual needs, wants, and abilities, as no two individuals will respond the same way to a given training program (Kent, 2006). Consequently, individuals are more likely to have lower PA behaviour and benefit less from programs that lack individualization compared to those that take individuality into account. Although the principle of individuality is well-established, many

group-based exercise programs do not consider it (Maseli et al., 2018). To date, limited research has examined the effects of an individualized PA program on the Canadian post-secondary student population: especially transitioning out of a pandemic when personal needs and circumstances may be unique (DeJonge et al., 2021).

According to a systematic review of 27 studies examining interventions promoting PA among university students, interventions should address a range of behavioural determinants and have a personalized approach (Maseli et al., 2018). The review found that most studies that used a personalized approach had an increase in PA levels. However, many studies had a high risk of bias due to attrition and poor reporting, which limits the conclusions and highlights the need for high-quality studies that use an individualized approach to PA interventions. Although PA is known to offer several mental health benefits, limited research has explored effective strategies for campus-based PA programs to support mental health and well-being in post-secondary students (DeJonge et al., 2021). A team of researchers at a Canadian university implemented a 6-week individualized PA program for students seeking mental health support (DeJonge et al., 2021). Using a pre-test post-test mixed-methods design for the 68 participants, the study found statistically significant reductions in psychological distress, anxiety, and depression indices over time. The observed qualitative themes, such as a structured program design and a holistic approach, suggest that the methodology used in the study is an acceptable and effective avenue for improving mental health in students. Overall, this study demonstrates that individualized PA programs can serve as an effective alternative therapy for students seeking mental health support, even during the pandemic, when the need for mental health resources has increased. However, while this study demonstrated that the intervention design was well-received and effective, it cannot establish a true cause and effect relationship, as it was not an experimental study (Taris &

Kompier, 2014). Moreover, the methodologies used focused on participants seeking mental health support, leaving the effects of an individualized PA program on the general post-secondary student population during the pandemic unknown.

Similarly, another Canadian study involving 49 post-secondary students seeking mental health support used a quasi-experimental pre-test post-test single group-design to determine if a 6-week PA program would improve psychological distress (Muir et al., 2020). Students completed four sessions of PA per week, including three supervised sessions and one unsupervised. Each session consisted of aerobic, strength, and flexibility training. The mode of training depended on participant preference. Participants completed the Mental Health Inventory-38 (MHI-38) to measure changes in three subscales of psychological distress: 1) anxiety; 2) depression; and 3) loss of emotional control. The findings revealed significant changes in anxiety and depression after participants completed the program (Muir et al., 2020), providing evidence for the positive effect of exercise in reducing university students' psychological distress through a tailored program.

While the positive impact of individualized PA programs have been demonstrated in a mental health context, adherence rates are modest and experiences of adverse mental health continue to increase (DeJonge et al., 2021; Maseli et al., 2018; Muir et al., 2020). Exploring complementary supportive mechanisms to promote engagement is warranted. The use of modern technology shows promise in this regard. In particular, the emerging field of online asynchronous PA support, and how digital platforms and virtual communities are being utilized to foster engagement, motivation, and well-being amongst individuals in various contexts (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021).

2.5.3 Online Asynchronous Physical Activity Support

Several behaviour change techniques have proven effective in evoking behaviour change and have largely been applied via in-person interventions (e.g., Dombrowski et al., 2012; Greaves et al., 2011; Michie et al., 2009). An analysis of reviews revealed several effective behaviour change techniques related to PA: information on the behaviour-health link, specific goal setting, clear structure, self-monitoring, and social comparison were used successfully (Michie et al., 2009). It has been shown that PA is likely to increase if online PA interventions apply evidence-based components such as self-monitoring and incorporate online social networking. For example, Vandelanotte and colleagues (2014) evaluated whether websites delivering PA interventions used evidence-based behaviour change techniques in a social networking context. They examined 46 available websites, considering a wide range of variables such as self-monitoring and goal setting, and evaluated intervention quality by behavioural components, interactivity, and user-generated content. Although the use of self-monitoring, goal setting, and feedback are known to support PA, only half of the interventions examined used those features. Despite advancements in technology, online-based interventions were generally low quality, with only half of them using evidence-based components (Vandelanotte et al., 2014). These findings underscore the urgent need for the development of high-quality online interventions that fully utilize evidence-based BCT components, such as self-monitoring, goal setting, and feedback, to effectively promote and sustain PA. By leveraging these proven strategies, online PA interventions can potentially achieve greater success in supporting individuals in their pursuit of healthier lifestyles.

To understand participant experiences with an online asynchronous PA support, the Run Every Day (RED) January initiative can be considered (Wheatley et al., 2021). This program

challenges individuals to be physically active during January and highlights the potential for improvement in mental health and well-being (Wheatley et al., 2021). Researchers explored the elements of this intervention that motivate PA participation for mental health using a qualitative methodology among the worldwide adult registrants (n = 55,772). Transcripts from 31 interviews with participants were thematically analyzed, and two main themes relating to motivation were identified: pleasure and purpose. These themes suggested that successful PA interventions may need to consider both the intrinsic joy or pleasure that physical activities can provide, as well as aligning them with larger, meaningful goals or purposes that resonate with the participants (Wheatley et al., 2021). Notably, some negative aspects were also highlighted, such as feelings of failure when not achieving goals. The study demonstrated the elements to include in app-based support interventions to achieve positive outcomes. While several studies have used Facebook as the mode of online PA support, similar methodologies may be followed using other online sites (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021). These studies have used private or open groups to allow for participant communication, or for providing participants with information (e.g., McKeon et al., 2021; Vandelanotte et al., 2014). WhatsApp is an understudied alternative that allows users to be anonymous and does not require individuals to set up profiles with personal information, which potential participants may be more comfortable with.

A group of researchers in Australia conducted a mixed-methods pilot study examining the feasibility and acceptability of delivering a mental health-informed PA program for first responders (McKeon et al., 2021). This study used an app-based support group to deliver mental health-informed PA interventions. A co-designed 10-week web-based PA program was delivered through a private Facebook group, offering weekly education and motivation on topics

like goal setting, overcoming exercise barriers, and reducing sedentary behaviour; participants were provided with a Fitbit to track activity. Employing a multiple time series design where participants acted as their own controls, the study recruited 24 participants who completed assessment questionnaires. Significant reductions in psychological distress and improvements in quality of life, depression, anxiety, stress scores, and walking minutes were observed. High acceptability of the intervention was noted through qualitative interviews. However, the researchers noted that the study was limited by the first responder sample population and its lack of a true experimental design. To improve external validity, it was suggested that future research should examine various populations and use a study design that will allow for cause and effect to be determined (McKeon et al., 2021).

Based on the studies reviewed, it would appear that online asynchronous PA support is a viable avenue to improve mental health indices and participation, especially when integrated validated behaviour change techniques (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021).

2.6 Recent Online Interventions to Support Mental Health

The COVID-19 pandemic has led to a surge in mental health issues, prompting researchers to implement interventions to address the growing need for mental health support (Mental Health Commission of Canada, 2021). The Canadian Policy Briefing report focuses on how the pandemic has increased mental health needs and provides recommendations to improve the well-being of Canadians (Asmundson et al., 2021). The mental health care system in Canada is insufficient, with 55% of Canadians dissatisfied with wait times for publicly funded mental health resources, which can last from six months to a year (Asmundson et al., 2021). This

research highlights the need for timely interventions to support Canadians' mental health, especially for at-risk populations such as post-secondary students (Asmundson et al., 2021).

A group of researchers identified digital interventions to support the mental health of the Canadian population during the pandemic, aiming to reduce the need for in-person mental health support (Strudwick et al., 2021). They examined the target populations, the resources' effect, and any barriers or facilitators to the resource experienced by participants. The researchers reviewed 31 mobile apps and 114 web-based resources, including telemedicine, virtual peer support groups, and discussion forums that could support mental health during the pandemic (Strudwick et al., 2021). The study found that the interventions catered to various populations and were effective in their context, reducing symptoms of Post-Traumatic Stress Disorder, anxiety, depression, and loneliness (Strudwick et al., 2021). Barriers to use included technology issues, lack of data sharing, difficulty establishing a therapeutic alliance with a healthcare worker, and poor web connectivity (Strudwick et al., 2021). Facilitators included organizational support, access to technology and training, access to a specific type of mental health care, low or no cost, and anonymity (Strudwick et al., 2021). The researchers noted that future interventions should consider these barriers and facilitators to create more effective interventions.

Asynchronous virtual mental health supports can be accessed at any time and do not require a specific time and place (Richardson et al., 2020). Asynchronous supports, such as websites, videos, or applications that provide mental health strategies or explanations, have significant potential for support since they are not constrained by schedules (Richardson et al., 2020). However, literature examining the use of such mental health supports before the pandemic found them to be minimally effective (Richardson et al., 2020). Canadian researchers explored the use of asynchronous supports during the pandemic among the general population

and those seeking mental health support (Richardson et al., 2020). In a sample of 3,000 Canadian adults, only 2% reported using asynchronous support to cope with stress. Participants who reported self-harm (10%) and poor coping with stress (5%) showed the highest usage rates. Despite the government's promotion of asynchronous supports in response to the increased need for mental health resources due to the pandemic, the uptake of these programs remains low. Further research is needed to understand the facilitators and barriers to asynchronous supports and why so few Canadians are using them when the demand for support is at an all-time high (Richardson et al., 2020).

2.7 Limitations in the Literature and Study Purpose

Overall, current literature highlights a critical need for mental health support for post-secondary students, especially since the onset of the COVID-19 pandemic (DeJonge et al., 2021; Delrieu et al., 2020; Hamza et al., 2021; Mental Health Commission of Canada, 2021). Although several studies have demonstrated improvements in mental health indices using app-based PA support, there is limited research on its use among post-secondary students (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021). The majority of recent literature in the area of PA as mental health support for post-secondary students has focused on symtpmatic students seeking mental health support; however, the general student population may still experience a similar benefit (DeJonge et al., 2021; Delrieu et al., 2020; Hamza et al., 2021). Thus, it would seem that implementation of an individualized PA program with and without online group support could provide unique insights into improving mental health indices and student well-being, and has yet to be explored in this context. Thus, the primary purpose of this experimental pre-post parallel group design study, incorporating both qualitative and quantitative methods, was to examine the impact of a personalized 6-week aerobic PA program with and without an

app-based group chat platform on PA behaviour, aerobic fitness, and mental health indices in post-secondary students. A secondary purpose was to explore participants' experiences upon completing the program. It was hypothesized that while an exercise program alone would yield positive improvements to all mental health indices, the benefits would be enhanced further for those participating in an app-based support group (DeJonge et al., 2021; McKeon et al., 2021). Specifically, participants in the online group were expected to have higher PA engagement (measured by total minutes of PA) to the exercise program, given the known benefits of social support (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021). It was hoped that the qualitative findings would provide insight into participant study-related experiences and add further context to the quantitative data.

3.0 Methods

3.1 Study Design

This pilot study utilized a randomized experimental pre-post parallel group design with repeated measures, integrating both qualitative and quantitative methods to allow for cause-and-effect relationships to be uncovered and to understand participant experiences (DeJonge et al., 2021; McKeon et al., 2021). Pilot research is a small-scale preliminary study conducted to evaluate viability in order to make recommendations for future larger-scale projects, to identify and address potential issues or challenges early in the development process (Thabane, 2010). Participants completed an individualized 6-week aerobic PA program beginning in January and February 2023 with or without an app-based group chat. Participants were assessed within one week prior to and following their programs, and again 4-weeks after completing the intervention to determine if observed changes were maintained after program completion. Ethical approval was received from the host institution’s Research Ethics Board prior to initiating recruitment.

3.2 Participants

Participant eligibility criteria included: clearance to participate in PA safely according to the Get Active Questionnaire (GAQ; CSEP, 2021); falling below CSEP guidelines for PA prior to beginning their program (i.e., less than 150 minutes per week); and being enrolled full-time at Lakehead University (Appendix A; CSEP, 2021). The participants also needed to be fluent in English to complete the survey and engage in the group chat. Participant eligibility further required access to a device with Wi-Fi capacity to complete the assessments and participate in the app-based support group if individuals were randomized to that condition. All students who met these criteria were considered eligible, regardless of their academic program, level of study, or mental health status. These criteria have been used when recruiting a diverse sample of university students previously (Busse et al., 2021; Pearson et al., 2022).

3.3 Sample Size

A power analysis was calculated using G*Power based on anticipated means from previous research analyzing PA (DeJonge et al., 2021; Vandelanotte et al., 2014). It was determined that eight participants (16 total) were required for each group to have sufficient power ($\alpha = 0.05$, $\beta = 0.2$, power = 0.8; Rosner, 2011). Four participants were added to the total sample size to account for attrition, as dropout rates for a 6-week PA program can range from 0-20% (e.g., DeJonge et al., 2021; Delrieu et al., 2020). Thus, to have an optimal group size while accounting for potential dropouts, 10 participants were deemed sufficient for each group (20 total).

Previous research integrating online PA support groups had an average size of 5 members per group and observed a statistically significant increase in PA compared to those in an exercise-only condition ($p < .001$; Smith et al., 2018). With smaller groups, participants were

more aware of one another. As groups get larger, the number of connections that are present between members increase at an exponential rate, which can be difficult to manage (Hackman & Vidmar, 1970). Larger groups also tend to experience relational loss, where support is less available in conjunction with group expansion (Mueller, 2012). Based on these factors, it was presumed that smaller groups would be optimal for promoting PA behaviour (Hackman & Vidmar, 1970; Mueller, 2012; Smith et al., 2018).

Allocation occurred on a rolling basis to allow for groups to begin in a timely manner and create a group size ideal for eliciting social support and group cohesion (Mueller, 2012; Smith et al., 2018). Participants in the 6-week individualized program began exercising as soon as they were recruited. Participants in the 6-week individualized program with an app-based support group began their programs once a minimum of two participants were recruited so participants would always have at least one other member in their group chat. In line with the anticipated sample size and previous research (Hackman & Vidmar, 1970; Mueller, 2012; Smith et al., 2018), it was expected that two groups would be formed over time with approximately 5 in each.

3.4 Recruitment

Internal communications within Lakehead University and social media were the primary modes of recruitment (e.g., Student Health and Wellness social media accounts; recruitment posters sent to clerical staff within academic departments; Appendix B) and took place in January 2023. More specifically, the student researcher contacted administrative assistants from each university faculty and asked them to share the research poster with their students. In addition to these internal communications, snowball sampling was encouraged once participants were enrolled. All recruitment materials contained a link to the information letter/consent form online via SurveyMonkey (Appendix C). Students were directed to this page and underwent the

consent and eligibility process (Appendix C). Participants could consent to participate by selecting “next,” where they were prompted to enter their email address for the student researcher to contact them. Contact information for the student researcher was included in the information letter/consent form to enable students to ask questions and/or speak with someone regarding involvement details prior to and following enrolment.

3.5 Procedures

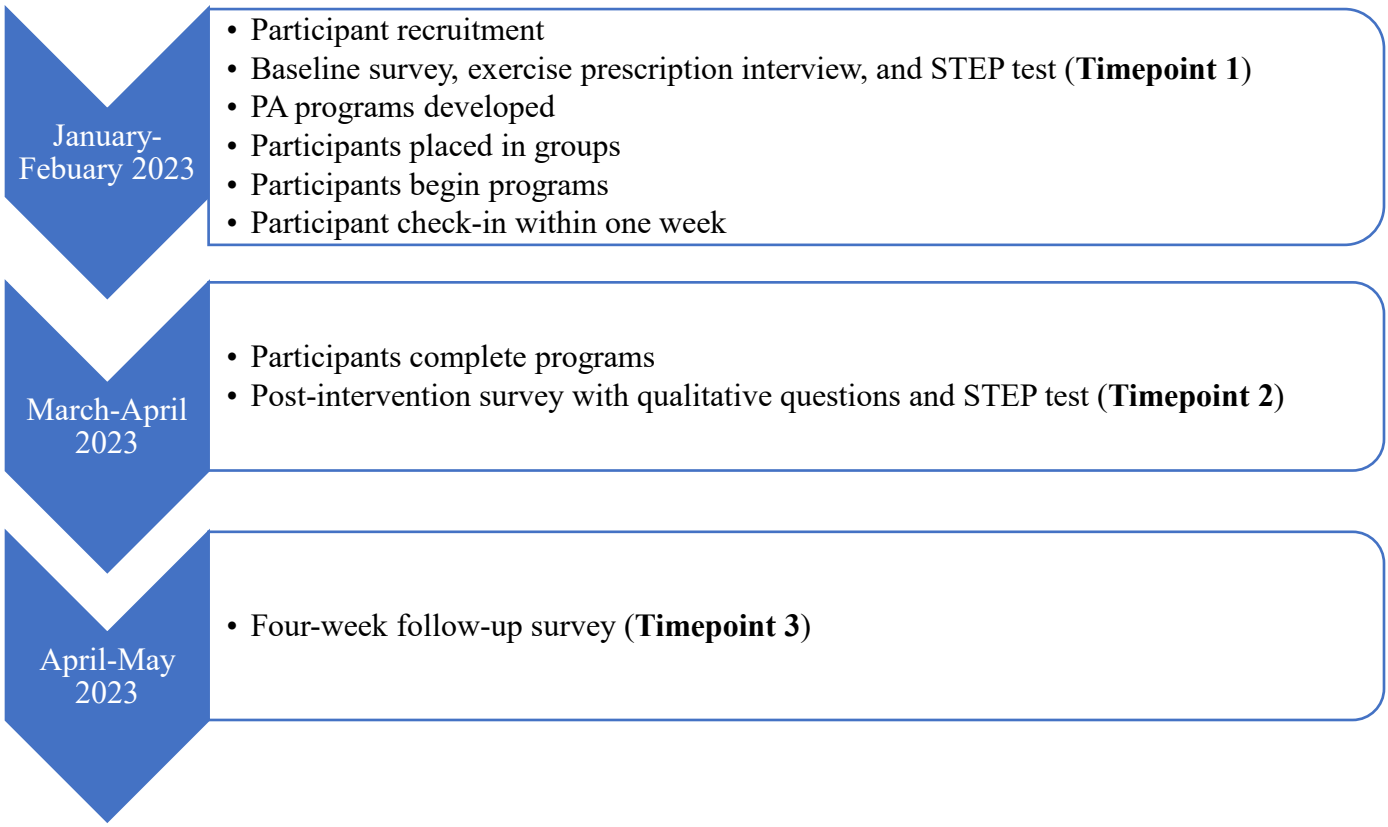
Once deemed eligible and prior to beginning their program, the student researcher scheduled an individual in-person meeting with each participant to create their PA program. During this meeting, each participant completed the baseline survey electronically which included a series of questionnaires inquiring about demographics, PA behaviour, symptoms of psychological distress (i.e., anxiety, depression, and stress), and mental health (Appendix D). After this, they completed an exercise prescription interview to inquire about information related to developing their program. This was followed by the Step Test Exercise Prescription (STEP) test under the supervision of the student researcher (Appendix E; Petrella & Wright, 2000) to determine aerobic capacity. An assessment form was used to facilitate consistency between meetings (Appendix F).

On average, each assessment meeting took 35 minutes: 15 minutes to complete the baseline survey, 15 minutes for the exercise prescription interview, and 5 minutes for the STEP test (Petrella & Wright, 2000). The meeting took place in the Lakehead University Sanders Fieldhouse. Participants were randomly placed into one of two groups: 6-week individualized PA program or 6-week individualized PA program with app-based support (1:1). To reduce bias, participants were assigned after their PA programs were developed and they had completed their baseline assessment. Participants were not blind to their study condition. To randomize the

participants, a stratified research randomizer was used: https://www.randomizer.org/. Once the student researcher randomized participants using the aforementioned process, the participants were informed of what group they were placed in. The student researcher contacted the participants one week after their program had started via email to check in and make any necessary changes to the program: for example, modifying intensity or duration of an activity (Appendix G). Six weeks after participants began their programs, the student researcher contacted them via email to schedule their post-intervention assessment and STEP test; this also included the addition of open-ended questions inquiring about personal experiences with their program. A follow-up survey was administered on-line 4-weeks after the post assessment to determine the degree to which participants continued engaging in PA and changes to the dependent variables were maintained.

Figure 1

Chronological Timeline for Intervention and Measures



3.5.1 Individualized Physical Activity Program Procedures

As noted above, participants received an individualized exercise prescription prior to randomization into groups. The student researcher, an Honours Bachelor of Kinesiology graduate, had extensive training and experience in PA prescription including an undergraduate exercise prescription course and one year of personal training experience with youth and young adults. Physical activity programs were based on the CSEP Physical Activity Training for Health (CSEP-PATH) recommendations for adults aged 18-64 (CSEP, 2021; Appendix H). Key factors considered as part of development included the participants' expectations, current and past PA and lifestyle behaviour patterns, medical concerns identified by the participant, current fitness level, areas of strengths and weaknesses as informed by the participant, STEP test results, as well

as current demands that could present barriers to PA (e.g., family and work responsibilities, hectic schedule, extensive travel, access to facilities or equipment; CSEP, 2021). The initial meeting with the student researcher also included discussion of several effective behaviour change techniques known to promote PA behaviour (Michie et al., 2011). For example, during the meeting, the student researcher worked with the participants to set specific, measurable, attainable, realistic, and timely (SMART) goals, create a clear program structure, and encourage the participants to self-monitor their PA throughout their program (discussed below; CSEP, 2021; Michie et al., 2011). Previous literature has found that programs incorporating these techniques are more effective for promoting participant PA behaviour change compared to those without (CSEP, 2021; McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021).

The resultant PA prescription focused on making incremental changes to time spent engaging in MVPA. At a minimum, participants were encouraged to engage in PA three times a week within their target intensity (a rating of 5-8 on the 10-point modified Borg Rating of Perceived Exertion scale during activity) up to the recommended minimum of 150 minutes of MVPA (Wilson & Jones, 1989). The student researcher collaborated with the participant to set a weekly target that included frequency, duration (in minutes), and type of aerobic exercise to facilitate an increase in their time spent being active. These methods were based on a previous study using an individualized PA program which showed a statistically significant increase in minutes of PA per week which were attributed to enjoyment among participants regarding program design (DeJonge et al., 2021; Gill et al., 2017). As per CSEP-PATH recommendations for adults, aerobic exercise was the focus, with some flexibility training. Five to ten minutes of flexibility training was also included after each bout of aerobic activity and based on participant preferences (CSEP, 2021). The specific exercise mode and location depended on the equipment,

gym membership status, likes, and dislikes of each participant. Participants were encouraged to use the on-campus student athletic facility if they felt comfortable doing so. All participants were informed briefly on the benefits of PA, and the risks of sedentary behaviour during the initial meeting based on CSEP-PATH documentation (CSEP, 2021). These methods were consistent with other PA programs developed to improve mental health (e.g., Fibbins et al., 2020; Lederman et al., 2017).

Based on their fitness score from the STEP test (predicted VO_2 max), participants received an exercise prescription with a personalized target heart rate (65–85% of estimated maximum heart rate) for PA. For more insight into the individualized prescription, please see Appendix I. Any contact time with participants, regardless of group allocation, was tracked for comparative purposes post-intervention with the goal of providing equal amounts. All participants were provided with and instructed to complete a weekly logbook via SurveyMonkey to monitor each exercise bout and any deviations from their program (Appendix J).

3.5.2 Individualized Physical Activity Program with App-based support Procedures

Similar to the exercise-only group, participants placed in the 6-week individualized PA program with app-based support worked with the student researcher to complete their baseline survey, complete their initial STEP test, and develop their aerobic exercise program. Participants were then instructed to join a private WhatsApp group created and overseen by the student researcher, with the only members being study participants. Participants were instructed to share updates at least once a week based on their program experiences, as well as tips and words of encouragement to motivate participation and facilitate social support with others in the group (Golaszewski et al., 2022). A digital handout was provided to participants with guidelines, expectations, and suggestions for content (Appendix K). If participants did not engage during

one of the weeks, the student researcher sent a one-time reminder email. This methodology for an online PA support group has been used previously in several like studies and has shown to be effective in improving mental health indices and PA levels (e.g., McKeon et al., 2021; Wheatley et al., 2021). Consistent with the exercise-only group, participants were provided with and instructed to complete a logbook via SurveyMonkey to track each exercise and any deviations from their program (Appendix J). After 6-weeks had elapsed from their start date, participants were removed from the WhatsApp group by the student researcher.

3.6 Measures/Instrumentations

Participants completed an online survey at the three timepoints via Survey Monkey containing five sections: Demographics; PA behaviour; Psychological Distress, and Mental Health (Appendix D). The IPAQ (Lee et al., 2011) examined intensity and duration of PA and sedentary behaviour retrospectively within one week; PA behaviour was tracked through a self-monitoring-based online platform. The Mental Health Continuum-Short Form (MHC-SF; Lamers et al., 2011) measured participants' mental health using three subscales of well-being: social, emotional, and psychological. Psychological distress symptoms were assessed using the Depression Anxiety and Stress Scale-21 (DASS-21; Antony et al., 1998). Predicted VO_2 max was measured using the STEP test at pre- and post-intervention (Petrella & Wright, 2000). Each measure is described in detail below.

3.6.1 Demographics

Demographics including age, height, weight, location, ethnicity, gender, employment status, relationship status, and university program were assessed to contextualize the population (Appendix D).

3.6.2 Physical Activity & Sedentary Behaviour

The IPAQ (Lee et al., 2011) was included to assess the types of intensity of PA, total PA, and sedentary time over the past week (Appendix D). The IPAQ uses seven self-report questions to measure the five main outcome variables: time spent in low, moderate, and vigorous-intensity activity, total PA minutes, and total time spent sitting over the past week. The IPAQ has good stability, is highly predictive, and has been shown to have acceptable convergent, concurrent, criterion, and discriminant validity, as well as high reliability ($r > .80$; Lee et al., 2011). The IPAQ's target population is anyone over the age of 15 and it has been used previously in studies examining university students' PA levels (e.g., DeJonge et al., 2021; Rogowska et al., 2020).

3.6.3 Physical Activity Behaviour

To examine PA behaviour, an online logbook was used via SurveyMonkey (Appendix J). Physical activity behaviour was calculated as a percentage based on the activity prescribed versus the activity completed (minutes) by participants on a weekly basis. Participants entered the duration, type, and perceived intensity of the activity for each day they engaged in PA. This was included to describe and contextualize the sample, as well as examine any change to PA behaviour over time by group.

3.6.4 Predicted VO_2 max

One method of demonstrating the physiological benefits of PA is by measuring maximal oxygen consumption, or VO_2 max. This widely accepted measure of aerobic health and fitness (Bassett & Howley, 2000) represents the maximum volume of oxygen an individual can utilize during intense or maximal exercise, and is expressed in milliliters of oxygen consumed per kilogram of body weight per minute (ml/kg/min; Bassett & Howley, 2000). This measurement reflects the body's ability to take in, transport, and utilize oxygen to produce energy during PA.

In essence, VO_2 max is an indicator of the efficiency of the aerobic, respiratory, and muscular systems working together (Jones & Carter, 2000). A higher VO_2 max value signifies better aerobic endurance and overall aerobic health. Several factors can influence an individual's VO_2 max such as age, gender, genetics, and training status (Levine, 2008). Typically, VO_2 max declines with age and tends to be higher in men compared to women. However, regular aerobic exercise, such as running, cycling, or swimming, can significantly improve VO_2 max, leading to enhanced aerobic health and fitness (Swain & Franklin, 2006). For the purposes of this study, the STEP test was chosen as it is an ecologically valid predictive VO_2 max test requiring little equipment (Knight et al., 2014; Petrella & Wright, 2000). The STEP test has also been described as a safe, quick to administer, and inexpensive method that can effectively assess predicted VO_2 max (Knight et al., 2014). As a physiological measure, predicted VO_2 max adds some validation to participants' self-reported PA data. If a participant significantly increases their aerobic MVPA, their predicted VO_2 max will also increase (Ekblom-Bak, 2018).

When conducting the STEP test, heart rate was collected pre- and post by the student researcher using a wireless Polar heart rate monitor. The participants were asked to perform 20 steps up and down a two-step staircase at a self-selected, comfortable pace. The student researcher showed an example of the stepping pattern for each participant. The student researcher then counted the number of steps and the time elapsed for each participant. For more detail on the STEP protocol, see Appendix E. The STEP test demonstrates sufficient and absolute test-retest reliability ($r = .78$, $p < 0.001$; Knight et al., 2014). This test has been used to assess fitness levels among individuals similar in age to the current participants (Knight et al., 2014). Predicted VO_2 max was calculated by the student researcher using the STEP test calculator resource which uses sex, age, height, weight, seconds to complete test, and heart rate

after the test to compute a VO_2 max estimate measured in ml/kg/min. The student researcher compared the results to normative data based on sex and age, allowing participants to be placed in a rating from poor to excellent (Petrella & Wright, 2000).

3.6.5 Psychological Distress

Psychological distress was assessed using the reliable ($r > .94$) DASS-21: a 21-item self-report measure evaluating symptoms associated with the three main outcome subscales of depression, anxiety, and stress, where each ranges from normal to extremely severe (Antony et al., 1998; Appendix D). The DASS-21 is effective for both clinical and healthy populations; however, it was not developed to make discrete diagnoses of psychological disorders in clinical settings (Johansson et al., 2021). The DASS-21 has effectively measured depression-, anxiety-, and stress-related symptoms in university students and was therefore deemed appropriate for this group (Johansson et al., 2021). Depression, anxiety, and stress were scored based on survey responses, with lower scores indicating "normal" levels and higher scores indicating "mild," "moderate," "severe," and "extremely severe" levels (Johansson et al., 2021). Summative scores were calculated for each subscale using the scoring resource provided with the questionnaire (Antony et al., 1998).

3.6.6 Mental Health

The MHC-SF (Lamers et al., 2011; Appendix D) evaluates participants on three outcome measures of well-being: social, emotional, and psychological. The MHC-SF consists of 14-items that are answered based on the frequency of symptoms which respondents experienced during the past month (Lamers et al., 2011). This allows for a clear standard and categorization of levels of mental health. The short form of the MHC showed strong internal consistency ($r > .80$) and discriminant validity among adults in North America (Lamers et al., 2011). The three-factor

structure of the MHC—emotional, psychological, and social well-being—was confirmed in nationally representative samples of university students (Robitschek & Keyes, 2009). Higher scores for each subscale of well-being indicate higher levels of well-being, whereas lower scores indicate lower levels of well-being (Lamers et al., 2011; Robitschek & Keyes, 2009). Summative scores were calculated for each subscale using the scoring resource provided with the questionnaire (Kelley, 2008).

3.7.7 Participant Experiences

To contextualize the quantitative data and gain insight into participant experiences with their program, eight open-ended questions were added to the post-intervention survey (Timepoint 2):

1. What did you like about your individualized exercise program? What didn't you like?
2. How did your involvement in the study make you feel?
3. What changes have you noticed if any, over the past 6 weeks that you would attribute to your involvement in the program (e.g., mood, physical state, mental health, other)?
4. What facilitators have you experienced to getting or staying involved in the program, if any?
5. What barriers have you experienced to getting or staying involved in the program, if any?
6. What did you like about this study?
7. What did you dislike about this study?
8. Is there anything else that you would like to add about your study involvement that hasn't already been shared?

For the app-based support group, participants were asked these additional questions:

1. How have your PA habits changed since using the WhatsApp group? Please expand.

2. What did you like about this app-based support group?
3. What did you dislike about this app-based support group?
4. What suggestions do you have for future research involving an online physical activity support group such as this?

3.7 Quantitative Data Analysis

All statistical analyses were calculated using IBM SPSS v.28. To account for missing data, the multiple imputation method was used at baseline (Xu et al., 2020). This approach generates multiple plausible values calculated via SPSS for each missing data point based on the observed data and their relationships. These multiple imputed datasets are then analyzed independently, and the results are combined to yield a final estimate. For subsequent surveys (timepoints two and three), the Last Observation Carried Forward method was implemented (Streiner, 2010). This approach replaces missing values with the most recently recorded value for that specific participant and timepoint.

Demographic data were analyzed using descriptive statistics (e.g., means, standard deviations, frequencies). To determine if changes took place over time by group, data for PA and sedentary behaviour (IPAQ; MVPA and sedentary minutes per week), VO_2 max (STEP test), psychological distress (DASS-21), and mental health (MHC-SF) were examined separately using a series of one-way repeated measures ANOVAs within groups, and a series of two-way repeated measures ANOVAs between groups. Following this process, a post-hoc analysis was conducted for each variable via individual related samples t-tests to examine differences further by time-point (i.e., baseline to post-intervention, post-intervention to the 6-week follow-up, and baseline to the 6-week follow-up). Physical activity adherence was measured as a percentage by

comparing participants completed PA to their prescribed PA as recorded in their activity logs, and means were examined between and within groups.

Effect sizes are essential in behaviour change research to differentiate between statistical and practical significance, enable comparisons across studies, and gauge real-world impact. To provide more in-depth context and as a measure of external validity, effect sizes were calculated based on the t-test result using Cohen's d (Goulet-Pelletier, 2018). Cohen's d has been deemed suitable to include with t-test and Analysis of Variance (ANOVA) results and is commonly used in the field of psychology (Goulet-Pelletier, 2018). The following values were used to define each effect size: small (d = 0.2), medium (d = 0.5), and large (d = 0.8; Goulet-Pelletier, 2018).

3.8 Qualitative Data Analysis

The open question responses were reviewed by the student researcher who then used a general thematic analysis where common group sentiments are examined (Stephens et al., 2019). First, the student researcher reviewed the responses to identify codes which were then combined with other similar codes to form sub-concepts in a qualitative analysis program (NVivo). These sub-concepts were further analyzed by combining similar sub-concepts into broader categories (i.e., themes; Stephens et al., 2019). Throughout this process, a number of strategies were employed to enhance the trustworthiness of the data. Detailed descriptions of participant characteristics were provided by the student researcher, promoting transferability, and offering insights into the applicability of the findings (Malterud, 2001). The student researcher enhanced dependability by maintaining an audit trail that documented each step of the research process, thereby providing a blueprint for potential replication of the study (Malterud, 2001). Confirmability was addressed through the student researcher's consistent practice of reflexivity, critically assessing their own biases and their impact on the findings throughout the research by

regular consultations with the research team (Malterud, 2001). Reflexivity was applied by regular journaling which entailed writing down thoughts, feelings, biases, and assumptions before and during coding/analysis. This process allowed for the student researcher to highlight the common themes of the responses and increase understanding of the data.

4.0 Results

4.1 Sample Characteristics

Forty-eight potential participants completed the screening survey. Eighteen of these did not meet the criteria based on MVPA per week or student status (part-time enrolment). Thirty participants were contacted to have an initial meeting with the student researcher. Nine of these participants did not sign up for posted meeting times. Thus, the study included a total of 21 participants who were provided individualized exercise prescriptions; 10 were subsequently randomly allocated to the exercise-only condition while 11 were allocated to the condition with support. Two of these participants dropped out due to busy schedules within the first two weeks of their program, one in each condition, and were therefore not included in the analysis.

Participant ages spanned from 18 to 50 years old, with a mean of 24.7 years (Standard Deviation (*SD*) = 7.1). The with support condition had a mean age of 22.72 years (*SD* = 3.64) compared to the those in the exercise-only condition, which had a mean age of 27 years (*SD* = 9.32). In terms of gender distribution, the with support condition primarily consisted of women (*n* = 7), while the those in the exercise-only condition featured an equal number of men and women (*n* = 5 each). Participants' academic program enrolments varied, with engineering being the most common (*n* = 5). Figure 2 provides a detailed breakdown of participant enrolment by academic program and group. Table 1 provides a full account of participant demographics.

Figure 2

Participant Enrolment by Academic Program and Group (n = 19)

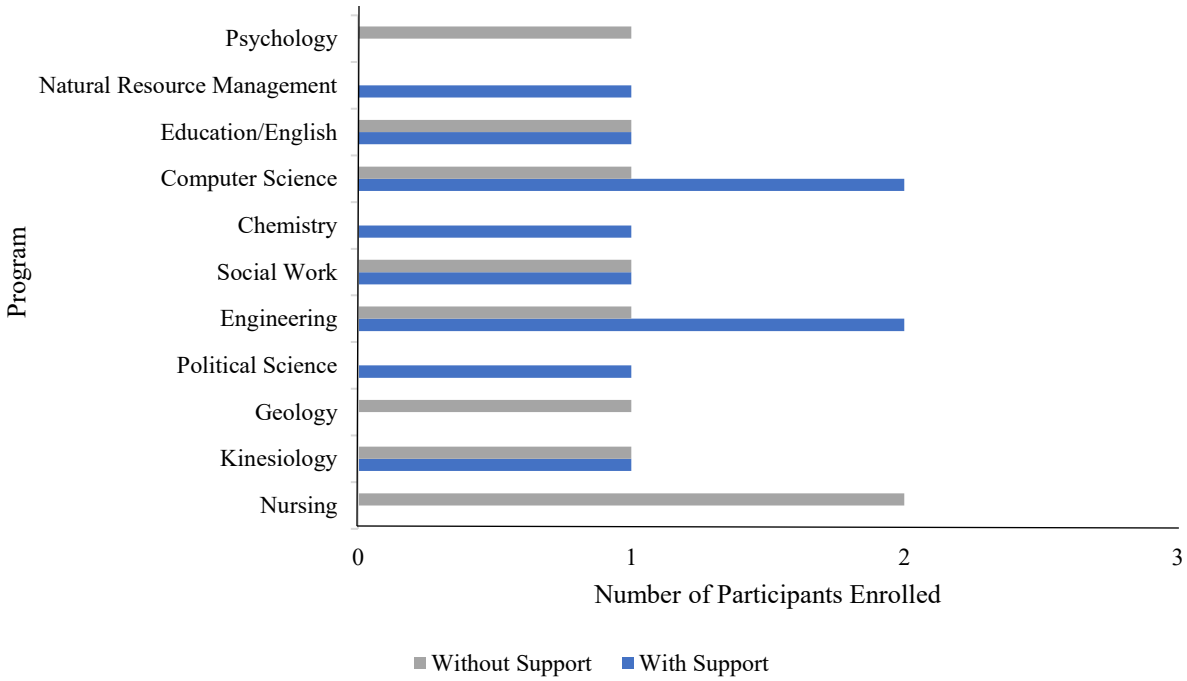


Table 1

Participant Demographics at Baseline (n = 19)

Demographics	Frequency (%)	Mean
Age	Range: 18 – 50	24.76 (*SD* = 7.1)
Gender		
Women	12 (63%)	
Men	7 (36%)	
Ethnicity		
Caucasian	11 (57%)	
Indian	4 (19%)	
Asian	2 (10%)	
African	1 (5%)	
First Nation	1 (5%)	
Years of Completed University		3.81 (*SD* = 1.91)
0	2 (10%)	
1	3 (16%)	
2	2 (10%)	
3	4 (21%)	
4	5 (26%)	
Equal to or Greater Than 6	3 (16%)	
Level of Study		
Undergraduate	11 (57%)	
Graduate	8 (42%)	
Employment Status*		
Not Employed	3 (16%)	
Full-time Employed	2 (10%)	
Part-Time Employed	10 (53%)	
Casual Employed	4 (21%)	
Relationship Status		
Single	10 (53%)	
Significant Other	5 (26%)	
Married	2 (10%)	
Common Law	2 (10%)	
Living Status*		
Live Alone	1 (5%)	
Live with Roommate(s)	7 (37%)	
Live with Friends	1 (5%)	
Live with Family	10 (52%)	

**Note: Percentage adds up to more than 100 as multiple responses were allowed*

4.2 Quantitative Results

To determine whether significant differences existed between groups at baseline, an equivalency test was run for each of the dependent variables using independent sample t-tests. A significant difference was found for MVPA ($t(19) = 2.54$, $p = .02$) whereby the with support group was higher, suggesting that detecting differences between groups is more difficult and caution should be used when interpreting these data. No other measures had significant differences between groups at baseline.

4.2.1 Physical Activity Behaviour

A one-way repeated measures ANOVA revealed no statistically significant change when analyzing MVPA minutes by group over time: $F(2,34) = .103$, $p = .752$, $\eta_p^2 = .02$ (Figure 3). Due to the significant differences at baseline, a covariate adjustment (ANCOVA) was run to statistically control for the baseline differences, and similarly found no significance (Field, 2013). Conversely, a one-way repeated measures ANOVA did reveal a significant change when analysing sedentary minutes by group over time: $F(2,34) = 5.75$, $p < .001$, $\eta_p^2 = .23$. Individual related samples t-tests revealed that this significant change took place in the exercise only group from baseline to post, $t(9) = 1.56$, $p = .02$. d = .95, and then again from baseline to follow up, $t(9) = 1.88$, $p = .01$, d = .87. These results suggest that the exercise-only group's sedentary minutes significantly decreased during the intervention (Figure 4). When looking within groups, no statistical significance was observed across all PA level measures ($p > 0.05$) as determined by a one-way repeated measures ANOVA. Logbooks indicated that all participants adhered to their prescribed programs (150 mins/week of MVPA) with less than 20% deviation from their prescribed PA program (CSEP, 2013). Descriptive statistics by group across time for PA behaviour, along with the other dependent variables can be found in Table 2.

Table 2

Descriptive Statistics for Physical Activity Behaviour, Psychological Distress, and Mental Health Measures by Group Over Time

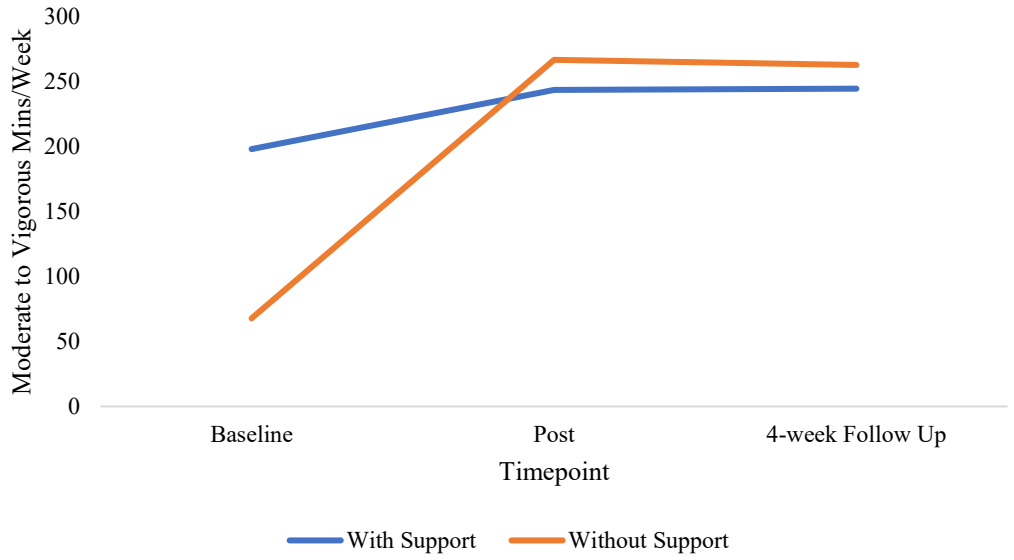
	Exercise-only condition (*n = 9*)			With Support Condition (*n* = 10)			Within Groups (*n = 19*)		
Variable	Baseline	6-Week	4-Week Fup	Baseline	6-Week	4-Week Fup	Baseline	6-Week	4-Week Fup
MVPA mins/week	67.78* (64.23)	266.67 (357.46)	262.78 (290.04)	198.00* (152.37)	243.50 (306.52)	244.50 (290.17)	136.32 (133.81)	254.47 (332.34)	253.16 (288.50)
Sedentary mins/week	3383.33 (1523.20)	2310.00 (921.37)	1913.33 (1004.08)	2961.00 (1284.84)	3150.00 (1740.17)	3066.00 (1815.15)	3161.05 (1379.68)	2752.11 (1441.20)	2520 (1563.68)
Depression Symptom Score	18 (7.13)	10.44 (6.62)	18.89 (9.60)	16.50 (10.88)	11.60 (9.32)	15.20 (11.08)	17.26 (8.95)	11.05 (7.96)	16.95 (10.29)
Anxiety Symptom Score	14 (7)	12.89 (6.00)	13.56 (6.31)	14.40 (14.35)	11.20 (10.59)	11.00 (13.28)	14.21 (10.97)	12.00 (8.54)	12.21 (10.37)
Stress Symptom Score	15.11 (4.66)	15.56 (8.76)	12.22 (7.97)	15.40 (9.98)	13.60 (8.42)	8.40 (7.71)	15.26 (7.52)	14.53 (8.40)	10.21 (7.86)
Psychological Well-being	22.7 (6.27)	17.78 (5.38)	19.44 (5.98)	23.50 (7.66)	23.10 (4.38)	20.00 (8.46)	22.95 (6.98)	20.58 (5.47)	19.74 (7.19)
Emotional Well-being	11.67 (2.18)	9.56 (2.30)	9.22 (2.73)	10.50 (4.48)	10.10 (3.45)	10.20 (3.58)	11.05 (3.54)	9.84 (2.9)	10.21 (3.16)
Social Well-being	16.56 (3.94)	13.33 (5.75)	14.11 (4.83)	17.60 (6.10)	15.10 (6.06)	13.60 (7.86)	17.11 (5.08)	14.26 (5.82)	13.84 (6.43)

Predicted VO_2 max	44.27 (6.24)	46.99 (6.58)	48.02 (6.44)	49.97 (5.42)	46.24 (6.47)	48.56 (6.03)

*Note: * Indicates a significant difference between groups at baseline, results should be interpreted with caution; Number in parentheses indicates standard deviation; Fup connotes follow-up.*

Figure 3

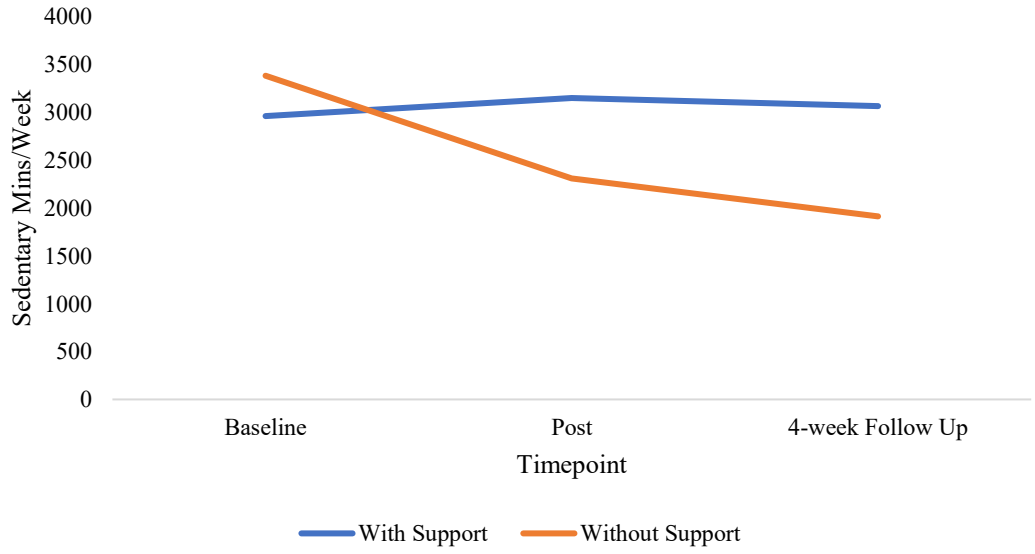
Mean Moderate to Vigorous Minutes of PA per week Between Groups by Timepoint (n = 19)



Note: Results should be interpreted with caution given the significant difference between groups at baseline

Figure 4

Mean Sedentary Minutes per week Between Groups by Timepoint (n = 19)

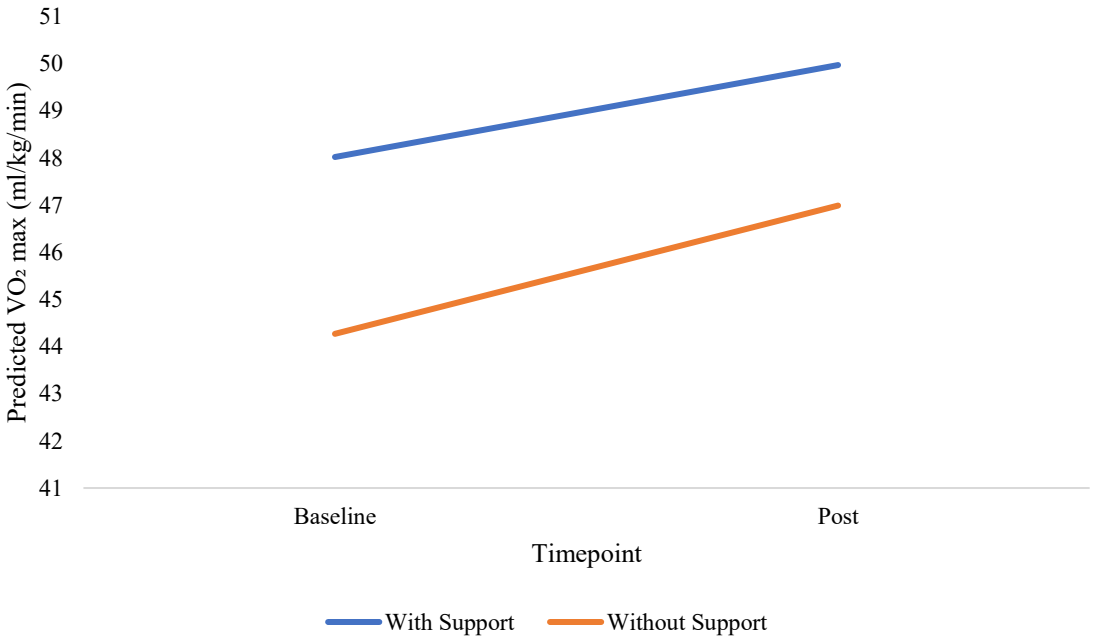


4.2.2 Predicted VO_2 max

A one-way repeated measures ANOVA was run for VO_2 max scores at two timepoints for both groups. No significant changes were found. However, scores for both groups appear to increase positively between baseline and two. Analyzing within groups, scores increased significantly from baseline to post ($t[19] = 5.01$, $p < .001$, d = 1.11).

Figure 7

Mean Predicted VO_2 max Between Groups at Both Timepoints (n = 19)



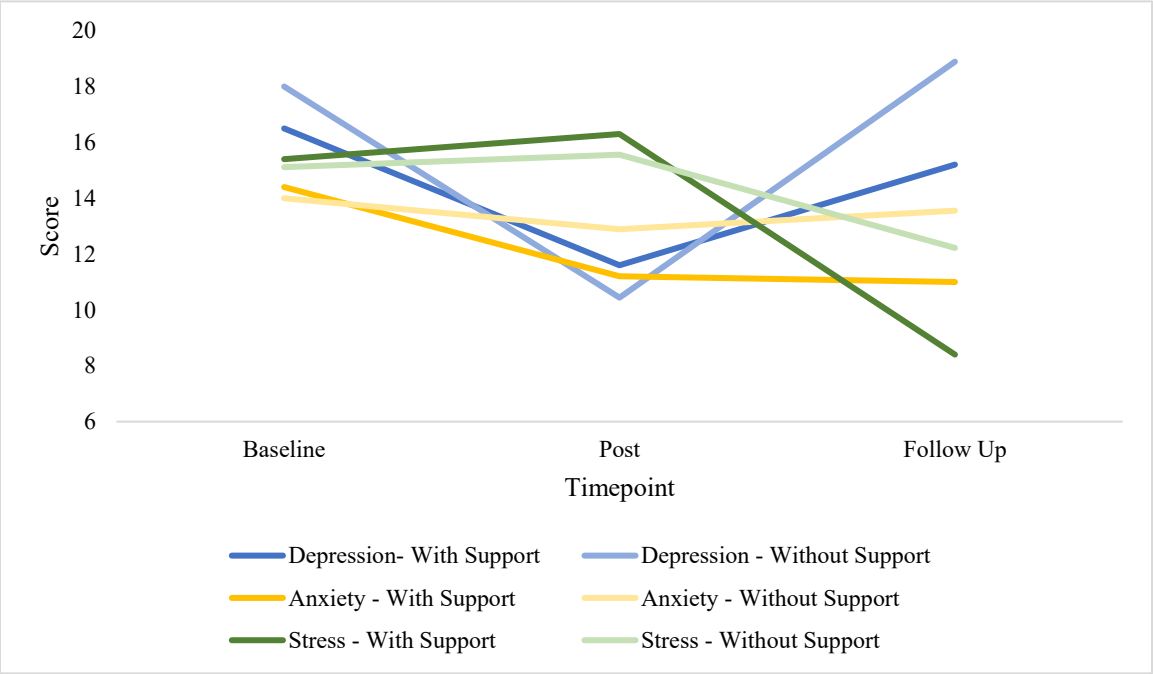
4.2.3 Psychological Distress

A one-way repeated measures ANOVA revealed no statistically significant changes when analyzing depression, anxiety, and stress subscale scores by group over time. Looking within groups, individual related samples t-tests revealed a significant decrease in depression scores between baseline and post ($t[19] = 2.45$, $p = .02$, d = .54). Conversely, a significant increase in depression scores was observed between post and follow up ($t[19] = -2.72$, $p = .01$, d = .59).

While no significant change was observed from baseline to post for stress scores, a significant decrease was observed from post to follow up ($t[19] = 2.4$, $p = .03$, d = .53).

Figure 5

Mean Psychological Distress Scores Between Groups at Each Timepoint (n = 19)

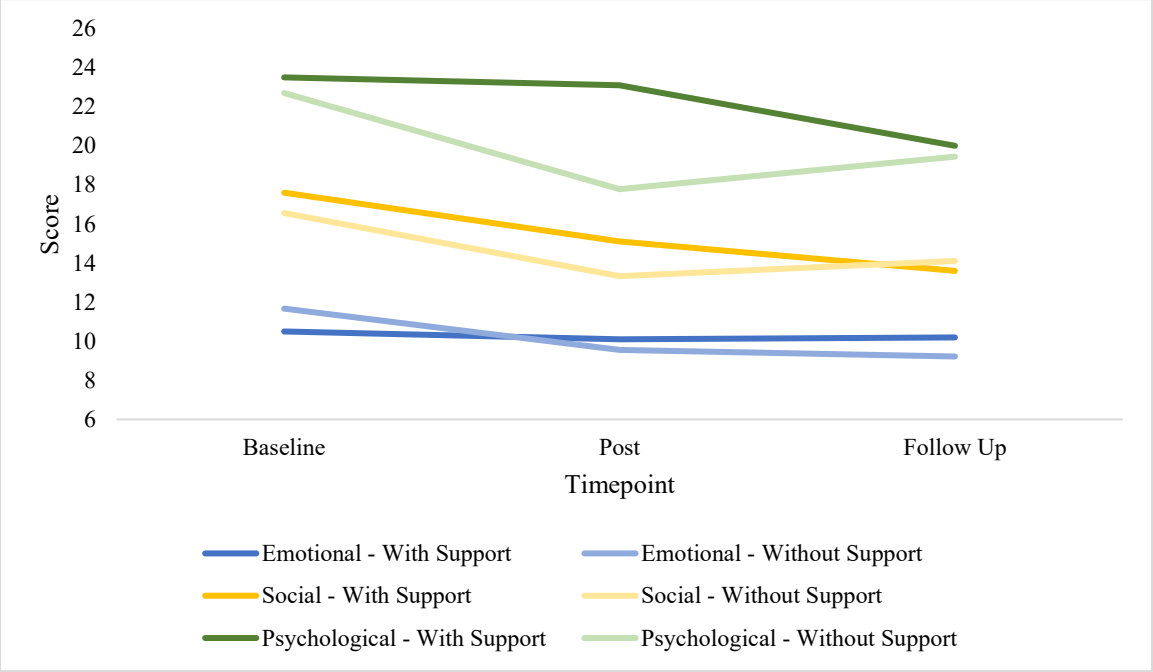


4.2.4 Mental Health

A one-way repeated measures ANOVA revealed no statistically significant changes for emotional, social, and psychological well-being scores at three timepoints between both groups. When looking within groups, emotional well-being scores decreased significantly from baseline to post ($t[19] = 2.58$, $p = .02$, d = .56), and baseline to follow up ($t(19) = 2.29$, $p = .03$, d = .50). Social well-being scores followed a similar pattern, with a significant decrease from baseline to post ($t[19] = 3$, $p = .01$, d = .65), and baseline to follow up ($t[19] = 2.60$, $p = .02$, d = .57). Psychological well-being scores did not mirror these trends and instead, revealed a significant decrease between baseline and follow up ($t[19] = 2.53$, $p = .02$, d = .55).

Figure 6

Mean Mental Health Scores Between Groups at Each Timepoint (n = 19)



4.3 Qualitative Findings

Eighteen participants responded to the open-ended questions through the post-intervention survey to share their experiences with their programs (65% female; 82% undergraduate students; 50% with support condition, mean age = 24.8). Five main themes with 14 related subthemes emerged from the dataset and are detailed in Table 12. In this section, EO will classify participant quotes as the *exercise only* group, and WS will classify quotes as the *with support* group.

Table 12

An Overview of Overarching Themes and Corresponding Sub-Themes (n = 18)

Overarching Themes	Sub-Themes			
Program Design	Individualized and Structured Program (25)			
Impact of PA Program Involvement	Enhanced Motivation to Engage in PA (11)	Enhanced Motivation Outside of PA (8)	Enhanced Dimensions of Health (15)	Increased PA Awareness (9)
Facilitators to PA	Active with Friends (6)	Accountability to Study (4)		
Barriers to PA	School/Work (11)	Health and Amotivation (7)		
Impact of Involvement in Support Group	Facilitator to PA (11)	Suggestions for Future Support Group (9)	Lack of Participation/ Benefit (12)	

Note: Number indicates the frequency which a sub-theme was referred to across all participant responses

4.3.1 Program Design: Individualized and Structured Program

This theme is characterized by a harmonious blend of personalization and organization, as highlighted by participants' responses. Most participants noted they found value in the program's individualized approach, appreciating the flexibility and adaptability it provided. They praised the program for allowing them to select, modify, and focus on exercises based on their unique preferences and circumstances, which helped them integrate the program into their daily routines and facilitated the achievement of personal fitness goals. Simultaneously, many participants expressed high satisfaction with the program's structured and manageable design. Participants appreciated the balance of activity and rest, the short and flexible exercise durations, and the gradual increase in challenges. Most responses noted the program's focus on realistic and attainable weekly goals as a standout feature. According to participants, this fusion of

individualization and structure in the PA program fostered greater engagement, satisfaction, and integration of fitness activities into daily life. For example, one participant stated that "I liked that I had a personalized workout plan, and I could ask to have things modified" (P1: EO). Another stated similarly that "I really liked the fact that I was able to fit it into my life and do what I needed to do around it. I was able to do what worked for me during that day" (P3: EO). With regards to goal setting, another participant expressed: "I like how it is more structured and focused towards weekly goals which are realistic and achievable" (P13: WS)

4.3.2 Impact of Physical Activity Program Involvement

4.3.2.1 Enhanced Motivation to Engage in Physical Activity. The PA program appeared to boost many participants' exercise motivation, regardless of group allocation. Key factors highlighted included: seeing visible progress; enjoying included exercises; and adhering to a schedule. For example, one participant stated that "Seeing muscle growth and fat loss kept me motivated" (P7: EO). The program's design also promoted consistency, fostering sustained PA. Regarding this, one participant expressed: "I liked that it kept me on a schedule, and kind of forced me to keep up with exercise" (P15: WS)

4.3.2.2 Enhanced Motivation Outside of Physical Activity. Several participants noted that the PA program not only boosted exercise motivation but also positively impacted motivation in other life areas. Participants reported increased drive to pursue regular goals, maintain a balanced diet, and achieve a healthy work-life balance. For example, one participant expressed that they had "more motivation for goals I regularly have i.e., eating a balanced diet, balance between school and life" (P6, EO). According to many participants, the program fostered a sense of broader engagement, improving productivity, and enthusiasm for activities like academic work and networking. With regards to this, another participant stated, "I am feeling

confident as well as positive and ready to face the problem and difficulties of life" (P9, WS). Several participants also experienced enhanced mental well-being, marked by increased confidence, positivity, and readiness to face challenges. For example, one participant expressed that "Having a constant aspect of my life [the exercise program] gave me guidance when I felt out of control and some days it pushed me to get out of bed when I was struggling" (P4, EO).

4.3.2.3 Enhanced Dimensions of Health. According to participants, the program enhanced aspects of participants' mental and physical health. For example, participants expressed that it improved mood, happiness, calmness, and emotional regulation while providing stability, guidance, and emotional resilience. Regarding this, one participant expressed that they "found my mood was much higher over the past 6 weeks: not just feeling happier, but also much calmer and I felt like I had better emotional regulation. My mental health also was positively impacted" (P10, WS). Similarly, another participant stated: "The study helped me to find a bit of a balance between life and prioritizing my health. I was able to figure out how to make time to include exercise into my life, even when it appears I have no time" (P7, EO). Participants also expressed that the exercise helped channel anxious energy, promoting inner peace and alleviating anxiety. From a physical standpoint, some participants stated that they had increased energy levels, enhanced sleep quality, and better breathing. For example, one participant shared: "I feel energized and ready to seize the day. My sleep is better, and it takes less time to wind down at the end of the night. My breathing has been better. I do not catch my breath as much as I used to, especially doing lighter physical activities" (P5, EO). Some participants stated that they experienced increased stamina, reduced soreness, and developed healthier habits. A few also noted a holistic view on life with regards to health, acknowledging the interplay between physical and mental well-being.

4.3.2.4 Increased Physical Activity Awareness. Based on the views shared, the PA program fostered participants' self-awareness, deepening their understanding of fitness levels, in addition to body strengths, limitations, and potential. According to participants, the PA program encouraged a broader perspective on exercise, extending beyond traditional gym activities. Several developed a healthier outlook on exertion, prioritizing consistent, moderate exercise over extreme efforts. For example, one participant stated: “I think I have felt more comfortable with not working out to the hardest I can. I feel like it is better to get up and move and get my heart rate up a bit everyday rather than fully exert myself” (P13, WS). Survey responses indicated that participants' commitment to the program stemmed from a clear understanding of the benefits of PA. Participants also acknowledged the long-term advantages of exercise for enduring mental well-being. Regarding this, one participant stated: “I also wanted to be more mentally stable. I knew working out helped me in the long run with my mental health” (P15,WS). By combining increased self-awareness with a comprehensive understanding of the benefits, participants shared they were motivated to sustain their engagement in the program. They embraced a diverse range of exercises and adopted a balanced approach, fostering a long-term commitment to their physical well-being. According to participants, this integrated perspective on self-awareness and motivation nurtured an appreciation for the sustainable benefits of regular PA.

4.3.3 Facilitators to Physical Activity

4.3.3.1 Active with Friends. Several participant responses indicated that friends enhanced their participation in the PA program and added a social aspect, making the program more enjoyable and encouraging consistency. For example, one participant stated: “I had a friend I did the program with so we would talk about it and go to the gym together” (P7, EO). Several participants shared that their friends from both inside and outside the program provided

motivation, support, and companionship, establishing themselves as facilitators of PA within the program. Regarding this theme, one participant stated: “Having friends outside of the group motivating me” (P2, EO). Similarly, another participant stated “Other people going through it [was helpful]. Motivation from my roommate (P14, WS).”

4.3.3.2 Accountability to Study. The sense of accountability to the study appeared to facilitate engagement in the PA program for several participants. Some expressed how they were motivated by the program's research nature and their responsibility towards the study. For example, one participant expressed that “I recognized that this was a research project and wanted to participate fully, as if I were to complete research, I would want a participant to do” (P4. EO). Regular follow-ups from the researcher and the need to complete a weekly logbook provided additional accountability and motivation, thereby enhancing participant engagement. For example, one participant stated, “I think having the external motivation of needing to complete a survey (logbook) at the end of the week helped” (P15, WS).

4.3.4 Barriers to Physical Activity

4.3.4.1 School/Work. Many survey responses identified school and work-related commitments as significant barriers to the PA program. Specifically, academic workloads, extracurricular activities, family life, and erratic work schedules hindered consistent exercise engagement. Some participants found it challenging to plan exercise regimens, particularly when gym availability and free time did not align. Stress from work and academic responsibilities also strained some participants' time and mental energy for regular PA.

4.3.4.2 Health and Amotivation. Several participants noted personal health issues posed significant barriers to PA program engagement. Illnesses and ongoing health concerns disrupted participants' regular exercise routines which proved demotivating, according to some. Regarding

this, one participant stated: “Barriers definitely included my personal health issues. Having a procedure done and having difficulties with my health definitely made me less motivated to exercise” (P7, EO). Some participants also struggled with feelings of laziness and a lack of motivation, especially during disruptions to their usual routines. For example, one participant expressed that “[A barrier] was motivation during reading week when I wasn't in my usual routine” (P9, EO). Similarly, another participant stated the “biggest barrier was motivation, but eventually I found it” (P13, WS). Overcoming these hurdles remained a consistent challenge throughout the program according to some participants.

4.3.5 Impact of Involvement in Support Group

4.3.5.1 Facilitator to Physical Activity. Many participants noted that the WhatsApp support group facilitated engagement in the PA program by fostering camaraderie, enhancing motivation, and promoting accountability. One participant stated: “Seeing others improving their mood and mental health is encouraging” (P12, WS). Several participants noted it served as a platform for mutual encouragement and shared experiences, helped maintain consistency through regular reminders from other participants, and provided an honest space for dialogue about fitness journeys. For example, one participant stated: “The group chat with other participants helped me stay involved as when I would receive messages, it would remind me to do my program and it was a motivator to share my experiences with other people as well. It felt as though I had more reason to do it since there was other people following along with me” (P13, WS).

4.3.5.2 Suggestions for Future Support Group. Many **s**urvey responses suggested improvements for the support group in future PA programs including clearer communication guidelines, addressing privacy concerns, fostering deeper conversations, and organizing group

workouts. For example, one participant stated: “I felt if we were continuously talking more in depth about our experiences it may have been better” (P12, WS). Similarly, another participant stated: “I found there was a lot of variability. Some people using words of encouragement, some just stating what their workouts were” (P14, WS). Some participants also recommended larger group sizes for more varied experiences and perspectives.

4.3.5.3 Lack of Participation/Benefit. Some participants felt a perceived lack of participation in the support group impacted its effectiveness in the PA program. Some shared that they desired a more active chat, seeing it more as a weekly report forum than a motivational platform due to lack of responses and interaction. For example, one participant expressed that “I disliked that the group chat didn't pan out to what it could have been. Not too much for motivational messages between people. However, I don't think that was the fault of the study: only the fault of the participants” (P16, WS). Similarly, another participant stated: “I wish that the group chat that was made to motivate people was more active. That was the only downside” (P18, WS). Lastly, another participant expressed: “I felt not many people were engaging in it. Maybe the requirement of once a week was not enough to make an impact” (P14, WS). Some participants reported no substantial changes in their PA or motivation due to the group, attributing this to a lack of genuine communication among members. Despite overall positive feedback, a subset found the support group had minimal or no impact on their PA experiences and outcomes.

5.0 Discussion

The purpose of this study was to understand how an individualized 6-week PA program with and without an app-based group chat component impacted PA behaviour and mental health indices in university students. A secondary purpose was to explore participant experiences

qualitatively upon program completion. Given the heightened need for mental health support in this population since the onset of the COVID-19 pandemic (Delrieu et al., 2020; Hamza et al., 2021; Mental Health Commission of Canada, 2021) and known benefits of PA (CSEP, 2021; Faulkner & Biddle, 1999; Kandola et al., 2018; Warburton et al., 2006) and group-based support in a behaviour change context (McKeon et al., 2021; Vandelanotte et al., 2014), this research is both timely and warranted.

While previous studies have investigated individualized PA programs to improve mental health indices (e.g., DeJonge et al., 2021, Delrieu et al., 2020; Muir et al., 2020), to the student researcher's knowledge, this was the first of its kind to use app-based group chat in an effort to enhance engagement in an unsupervised 6-week individualized PA program for university students. Unique study findings included an adherence rate of 80% or higher to the prescribed programs compared to other studies which report much lower rates (e.g., DeJonge et al., 2021, Jeftic et al., 2023). Participants as a whole also experienced reductions in stress over time which is critical as university students experience significantly more stress than the general population (Hamza et al., 2021; Mental Health Commission of Canada, 2021). Similarly, VO_2 max improved for both groups which comes with a host of health benefits which are vital for this population as they transition to adulthood and start to develop important lifelong health behaviours (Levine, 2008; Swain & Franklin, 2006). Another valuable study feature was the use of a mixed methods approach which allowed for multiple ways to evaluate the impact of the study. Regarding the qualitative data, there were more areas of commonality discussed between the two groups than differences which provide insights into this type of program that can now be leveraged in the future by key stakeholders who work with university students (e.g., Student Health and Wellness Centres; Athletics Departments, Campus Health Promotion Planners, etc.).

While the app-based group chat did not result in the outcomes hypothesized, it is noteworthy that the individualized, unsupervised nature of the current program led to significant mental and physical health-oriented changes for both groups. This is valuable information for stakeholders as unsupervised, tailored programming represents a cost-effective and practical means to deliver a PA prescription. To this end, the quantitative results and experiential accounts are discussed below.

5.0.1 Physical Activity Behaviour

5.0.1.1 Moderate to Vigorous Physical Activity Levels. Contrary to the hypothesis, the study found that there was no significant increase in moderate to vigorous minutes of PA per week for the group chat condition when compared to those in the exercise-only condition. Past studies analyzing app-based group support as an intervention to increase PA found significant changes in PA between groups, which creates an apparent discrepancy based on results of the current study (e.g., Naimark et al., 2015; Vandelanotte et al., 2014; Wheatley et al., 2021). This may be because these earlier studies did not compare results to another control group being prescribed an individualized PA program; that is, the control groups did not engage in PA. Likely, the effects of the app-based support would be more pronounced had the non-intervention group been a true control (i.e., had no intervention). Thus, it would seem that the differentiating factor, as evidenced by the current study, appears to be the individualization that was present for both treatment groups. This was provided in the form of a 20-minute interview where the likes, dislikes, routines, and resources of the individual were taken into account to arrive at a tailored PA program. Based on the adherence rates noted, it appears that such personalization is relevant in this context and should be considered for future interventions involving university students: a group with many competing priorities which could impact PA engagement negatively (Nesbitt,

2021; Rogowska et al., 2020). A potential confounding factor in drawing conclusions from the MVPA data is that the groups were significantly different at baseline, with the support condition group having significantly higher levels of MVPA at that timepoint. This may have imposed a ceiling effect (Patel et al., 2023) to changes in MVPA over time for the app-based chat group.

5.0.1.2 Sedentary Behaviour. Unexpectedly, statistical significance was observed for sedentary minutes decreasing across time between groups. More specifically, this change took place in the exercise only group from baseline to post, and then again from post to follow up. In comparison, the app-based support group minutes appeared to stay consistent. Relatedly, VO_2 max improved significantly for all participants across time, which indicates that participants were engaged in more PA. Thus, it makes sense that sedentary behaviour decreased and this is supported by current literature (Stockwell et al., 2021). One possible explanation for the lack of improvement in the app-based condition is that these individuals were encouraged to engage in the online group chat. This behaviour may have inadvertently led to increased sedentary (i.e., screen) time compared to those in the exercise-only condition. One meta-analysis of randomized controlled trial studies examining technology use to influence PA and sedentary behaviour noted the indirect ways in which using apps can contribute to less movement (Direito et al., 2017). For example, if a person spends a lot of time using non-exercise related apps, such as those for social media or streaming video content, this could increase sedentary behaviour (Direito et al., 2017). But in these cases, it's not the app-based interventions themselves increasing sedentary behaviour, but the overall amount of screen time (Direito et al., 2017). The bottom line in this context appears to be that it is possible to have increased sedentary time (which may consist of screen time on one’s phone) but still participate in an exercise program that improves aerobic capacity.

5.0.1.3 Program Adherence. An encouraging finding in the current study was that participants adhered to at least 80% of their prescribed activity, irrespective of group allocation. This finding was reinforced by the qualitative responses whereby most participants noted that they had a positive experience with their programs, and that they appreciated the balance of individualization and structured design. Moreover, they valued the option to customize workouts based on their preferences, goals, and circumstances, which made integration into daily life easier. It may be the case that these short, flexible exercise durations and a balanced progression of challenges enhanced the program's manageability: a principle supported by the literature (e.g., DeJonge et al., 2021; Maseli et al., 2018; Muir et al., 2020).

5.0.1.4 Program Individualization. The value placed on the tailored program structure as highlighted through the qualitative data was expected, as individualization is a well-established training principle (Kent, 2006). The COVID-19 pandemic, with its varied impacts on young adults, has necessitated individualized health and wellness interventions that consider unique challenges, mental health conditions, and fluctuating pandemic-related restrictions (Czeisler et al., 2020). Technology is well positioned to play a crucial role in this individualization, facilitating personalized guidance that promotes engagement and adaptability in PA programs during unpredictable times (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021). The finding regarding appreciation of program design is consistent with other literature examining 6-week individualized PA programs with various participant samples (DeJonge et al., 2021; Delreui et al., 2020; Farran et al., 2016). More specifically, DeJonge et al. (2021) used a 6-week supervised individualized PA program with the intention of supporting university student mental health. Their study used a mixed methods approach, and found a major theme was acceptability of the structured program design with an emphasis on behaviour change;

a theme congruent with the current study. The DeJonge et al. (2021) study also found that participants appreciated a flexible approach that was tailored towards students' needs, interests, and ability levels which was similarly noted by participants in the current study and important in a university context (Nesbitt, 2021).

5.0.1.5 Enhanced Motivation. Another qualitative theme relating to adherence that was shared by many participants was that they experienced enhanced motivation to engage in PA through their programs. Indeed, one critical component of creating and sustaining behaviour change is motivation (Ryan & Deci, 2000). According to participants in the present study, this construct was impacted positively as a result of program flexibility, enjoying the exercises included, and having a structured schedule to follow (Michie et al., 2011). Many participants from both groups also noted several facilitators to PA including being active with friends, accountability to the study, and knowing the benefits of PA. This heightened awareness regarding understanding the benefits of PA has been shown to boost intrinsic motivation, making people more likely to stick with exercise even when it's challenging (Teixeira et al., 2012). Similarly, recognizing how PA impacts personal health can increase its perceived relevance and foster persistence (Rhodes & Nigg, 2011). Several participants noted that the PA program positively impacted motivation in areas outside of PA, such as drive to pursue regular goals, maintain a balanced diet, and achieve a healthy work-life balance. This is a common trend in the literature, where participants' motivation is enhanced outside of the intended behaviour change as they can apply the techniques to other areas of life (Michie et al., 2009; Teixeira et al., 2012).

5.0.1.6 Enhanced Engagement with Friends and Accountability. Several participant responses across both groups indicated that the inclusion of friends in bouts of PA enhanced engagement in the program further, adding that a social aspect made the program more

enjoyable, encouraged consistency, and provided support. This notion of being active with friends is well supported in the literature and often leads to more PA engagement (e.g., Fitzgeral et al., 2012; Maher et al., 2014). Studies consistently find that friends can enhance program adherence through providing social support, fostering a sense of accountability, and promoting healthy competition (Fitzgeral et al., 2012; Maher et al., 2014). Additionally, they can share interests and help navigate barriers to PA, thereby increasing consistency in program adherence (Fitzgeral et al., 2012; Maher et al., 2014). The sense of accountability to the study facilitated engagement in PA, with participants sharing that they were motivated by the program's requirement to complete a weekly logbook. Logbooks have demonstrated utility in the literature as a tool for facilitating health behaviour change, through mechanisms such as enhancement of self-monitoring, awareness, and accountability (Locke & Latham, 2006; Michie et al., 2009): key determinants of PA participation (Karmeniemi et al., 2018; King et al., 1992).

5.0.1.7 App-based Support as a Facilitator to Physical Activity. Several participants in the group that was randomly allocated to participate in the app-based condition noted that the group chat itself was a facilitator to PA through fostering camaraderie and serving as a communal space for encouragement, reminders, and open dialogue about their fitness journeys. This qualitative theme might suggest that these participants would have a greater increase in MVPA given the known relationship between support and PA engagement (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021); however, this was not the case. One potential explanation for this could be that, while identified as a facilitator, the experience was not universal for all group members; thus, a significant change in mean MVPA per week was not feasible. As noted previously, the individualization that was inherent in the design of the PA programs for both groups may have masked any additional benefit afforded by being part of a

group chat support. Several group chat participants also noted that the intensity of the intervention could have been stronger with more explicit instructions so as to enhance the impact further. Future researchers should consider these delivery attributes in related study design.

5.0.2 Predicted VO_2 max

Similar to the other outcome measures, no statistically significant changes were found between groups when examining predicted VO_2 max. When looking within groups, predicted VO_2 max significantly increased from baseline to post. This finding supports the 6-week individualized PA program to improve physiological health and validates participants' self-reporting of PA levels. These observed VO_2 max improvements are consistent with the literature (Helgerud et al., 2007). Helgerud et al. (2007) used an 8-week aerobic PA program, and found significant improvements among participants with a mean change of 4 ml/kg/min. The current study found a significant increase with a mean change of 2 ml/kg/min, even though it was shorter in duration compared to the Helgerud et al. study. While predicted VO_2 max was not explicitly noted in the qualitative responses, the theme of Improved Dimensions of Health supports these quantitative findings. For example, several participants indicated increased stamina and cardiovascular endurance which directly relate to aerobic fitness. Improved VO_2 max from PA programs can offer significant benefits for university students who are developing lifelong health habits in their transition to adulthood (Levine, 2008). Moreover, regular PA and related improvements to aerobic fitness during these formative years can establish a foundation for better cardiovascular health, mental well-being, and reduced chronic disease risk (Swain & Franklin, 2006).

5.0.3 Psychological Distress

Contrary to the hypothesis, the study found that there were no significant changes in psychological distress for the group chat condition when compared to the those in the exercise-only condition. According to the DASS-21 scoring, participants on average scored as having moderate symptoms of stress, anxiety, and depression at baseline. Several studies have shown that mental health apps can have significant effects for those experiencing symptoms of anxiety and depression (Firth et al., 2017; Linardon et al., 2019). Such apps often incorporate elements of cognitive-behavioural therapy, mindfulness, stress management techniques, and other therapeutic approaches that have been shown to be effective in traditional therapy settings. For instance, apps like Headspace and Calm provide mindfulness training via fostering awareness, acceptance, and non-judgment of present-moment experiences, and have been found to reduce stress and anxiety in some users (Flett et al., 2019). In these studies, the authors integrated several validated psychological techniques that extended beyond the scope of the instructions offered in the current study which may explain the lack of a significant improvement in psychological distress. Therefore, future researchers striving to improve dimensions of psychological distress may wish to consider integrating components similar to those noted above.

When looking within groups, depression scores significantly decreased from baseline to post, but then significantly increased from post to follow up. The significant decrease in depression scores is supported by the literature regarding the beneficial effects of PA programs on reducing symptoms of psychological distress in university students as determined by the DASS (e.g., Bailey et al., 2018; DeJonge et al., 2021; Pascoe et al., 2020). For example, DeJonge et al. (2021) similarly reported decreased depression scores using a supervised individualized 6-week PA program in university students. The observed increase in depression scores may have

related to the timing of assessments. These took place during the last four weeks of the participants' semester, which is a demanding time for university students (Pearson et al., 2022). It was interesting to note that stress scores decreased from post to three for all participants which might also be attributed to the therapeutic effects of exercise (Biddle, 1999; Stathopoulou et al., 2006). While no significant changes were observed for anxiety, qualitatively, some participants noted that they channeled anxious energy into exercise, leading to a sense of peace. This finding is promising, as it implies that some participants experienced relieved anxiety as a result of the program; a major concern in university students (Mental Health Commission of Canada, 2021). Programs that have found significant changes in anxiety scores have implemented a direct support, such as informative content (McKeon et al., 2021), a resource that was lacking in the current study. Some participants also shared that they experienced enhanced confidence, positivity, readiness to face life's challenges, and an overall improvement in mental health post-exercise. These findings demonstrate that while there were no quantitative improvements in psychological distress, there is merit to employing individualized exercise programs to alleviate symptoms of psychological distress in university students: a tool that may help see students through stressful periods of the school year.

5.0.4 Mental Health

Similar to the other outcome measures, no statistically significant changes were found between groups when examining emotional, social, and psychological well-being scores. In fact, contrary to the hypothesis, a statistically significant decline was observed within groups for each subscale across time. These findings create a discrepancy in the literature, as there is extensive research on PA improving levels of well-being (e.g., DeJonge et al., 2021; Rebar et al., 2015; Wheatly et al., 2021). It is understood that there is often a decline in mental health indices among

university students during semesters due to a variety of factors including academic stress, social pressure, lifestyle changes, and financial strain (Auerback et al., 2018). Thus, it is important to contextualize these results in line what typically happens for students over the course of the academic year. Other studies using the MHC-SF and related mental health and well-being surveys in university students have found significant improvements over time (DeJonge et al., 2021; Bray & Kwan, 2006). One potential explanation for this discrepancy is that some studies showing a significant positive change in well-being scores were conducted prior to March, 2020. During the pandemic, university students have experienced significantly poorer mental health (Mental Health Commission of Canada, 2021). Interventions known to elicit improvements to mental health constructs prior to the pandemic may not be sufficient to evoke improvements currently in their pre-pandemic formats. To further understand this discrepancy, future research should include a control group with no intervention, to examine if the gradual decline would be more pronounced in a similar study, and intensity of the PA program should be considered.

Despite the absence of significant improvements to dimensions of mental health, participants still noted qualitatively positive changes that they linked to study involvement. For example, several participants reported improved mood, increased happiness, calmness, and better emotional regulation. These outcomes are not surprising given the demonstrated links between more movement and improvements to mental health indices (Mikkelsen et al., 2017; Rebar et al., 2015). Similar to the explanation mentioned above, one potential reason for this discrepancy is the time of the semester that students were surveyed. A larger sample size may also be needed to illustrate statistical significance.

5.05 Room for Improvement

Three of the themes revealed through qualitative analysis related to the support group and improving future interventions. Firstly, some participants noted that they experienced no benefit from the support group, which contradicts the literature in this area (McKeon et al., 2021; Vandelanotte et al., 2014; Wheatley et al., 2021). More specifically, two studies using similar methodologies of social networking to elicit group support to enhance PA programs found modest but significant effects (Cavallo et al., 2012; Maher et al., 2015). The study by Cavallo et al. (2012) examined the effectiveness of an intervention using social networking and self-monitoring to enhance social support for PA among 134 undergraduate students. Participants were randomized into two groups: education-only control and an intervention group that had access to PA self-monitoring and a Facebook group. The main goal was to test whether the combination of social networking and self-monitoring could increase perceived social support and PA compared to education alone. Results revealed that participants saw growth in social support and physical activity as time progressed (Cavallo et al., 2012). The study suggested that further research is needed to understand how online social networks can be leveraged for health promotion. The study by Maher et al. (2015) examined 110 adults that were randomly assigned to either the app-based intervention or a wait-listed control condition. Results at the 8-week follow-up showed significant increases in the intervention group's total weekly MVPA and walking time, compared to the control group. The authors found high engagement with the intervention, especially with self-monitoring features. The study concluded that such interventions can lead to significant changes in MVPA. One potential explanation for why some participants in the current study noted no benefit is that there was a lack of engagement in the chat, even when participants were prompted. Most participants who indicated that they did not

experience a benefit also indicated that there was a lack of participation in the chat, some indicating that "the requirement of once a week was not enough to make an impact." According to a search of literature as of August 2023, no definitive guideline specifies the optimal number of prompts needed in a support group for optimal engagement in a PA program. However, there are some studies suggesting that a higher frequency (e.g., daily or several times per week) might be more effective in the short-term for habit formation (Fjeldsoe et al., 2009). For instance, Fjeldsoe et al. (2009) found that a PA intervention involving five text messages per week over a 12-week period was effective in increasing the PA levels of the adult women participating in the study. These authors suggest that SMS-delivered interventions have positive short-term behavioural outcomes, and that further research is required to evaluate interventions for preventive health behaviors that incorporate this feature to affect outcomes positively (Fjeldsoe et al., 2009).

The quality of studies in this emerging field of research may need time to allow this medium to be explored more fully. According to Fjeldsoe et al. (2009), it is essential to strike a balance: too few messages and the participant may forget or lose motivation; too many, and they might feel overwhelmed or annoyed, leading to disengagement. Many participants who participated in the group chats gave suggestions for future app-based support groups to have improved outcomes. Participants recommended clear communication guidelines, addressing privacy concerns, fostering deeper conversations, and organizing group workouts. These data suggest that the app-based support was suboptimal, which could explain why no quantitative significance was found between groups.

5.1 Study Strengths and Limitations

This study provides evidence on the effectiveness of an online PA support program to enhance PA behaviour and mental health indices for university students through a combination of quantitative and qualitative data. Pioneering the use of app-based group chat support and an unsupervised 6-week individualized PA program among university students resulted in 80% adherence among participants: a value considerably higher than similar previous research (DeJonge et al., 2021; Jeftic et al., 2023). It also revealed noteworthy stress reductions in participants, highlighting its importance for students who generally face higher stress levels than the average population (Hamza et al., 2021; Mental Health Commission of Canada, 2021). Improvements in VO_2 max were also revealed, thereby conferring benefits for young adults who are poised to develop lifelong health behaviours (Levine, 2008; Swain & Franklin, 2006). The use of mixed methods provided insights into the program's impact, informing future health-promotion planning that can be leveraged by university intuition student health and wellness centers. Despite the app-based support not meeting the hypothesized outcomes, the individualized, unsupervised nature of both treatment groups fostered significant mental and physical health improvements. Unsupervised programs are inherently practical and efficient, while emphasizing the key ingredient of individualization which has demonstrated value from a sustainability standpoint (DeJonge et al., 2021; Kent, 2006).

On the contrary, there were several limitations to this study. The small sample limited the statistical relationships that could be made. Gender differences may also have played a role given the documented ways in which males and females respond to stress and cope with related situations (King et al., 1992; Nienhuis & Lesser, 2020): a finding prevalent in past studies examining PA and mental health. The data collected was self-reported, which might have been

skewed based on participants' beliefs and social desirability (Prince et al., 2008; Schwarz, 1999). Another limitation was that the with support group had a significantly higher MVPA at baseline which would have imposed a ceiling effect to any improvements. Due to participant scheduling, the timeframe between the screening survey and the baseline survey varied between one and three weeks. In this period, participants PA could have increased to greater than 150 minutes per week, which could explain the significant difference between groups at baseline. Another potential explanation is the Hawthorne Effect. This is where individuals modify their behavior in response to their awareness of being observed (McCarney et al., 2007). Utilizing snowball sampling as a recruitment method could also have influenced the efficacy of the intervention, as friends who are both participating might act as an engagement facilitator or influence dynamics in the group chat. Increased sense of social support was an identified study mediator, however, it was not measured quantitatively. Including a measure of social support would allow for clear findings to show if the app-based support effects social support. Another limitation is that the participants were not required to be seeking mental health supports, which could explain the lack of mental health benefit however, this was a unique study feature. Lastly, the absence of a control group without any PA might have influenced the study's conclusions. However, one could argue that it is unethical to enroll individuals eager to improve their health or engage in exercise into a study, only to provide them with no intervention.

5.2 Recommendations for Future Research

The study findings provide an overview of how an individualized 6-week PA program with and without app-based support can benefit and be experienced by university students. Further investigation using an experimental quantitative methodology with a larger sample size must be considered to examine if an app-based support can significantly improve unsupervised,

individualized PA programs in this context. To begin, future studies should verify that both groups have similar baseline levels of quantitative measures (i.e., MVPA) to ensure equality between groups. To have a more optimal group chat, the participant suggestions of clearer communication guidelines, and fostering deeper conversations should be implemented in future programs using app-based supports. More specifically, having a more active group chat would likely improve results as mentioned by participants and supported by the literature (Fjeldsoe et al., 2009). Another suggestion, fostering deeper conversations in online support groups, may be achieved through open-ended prompts from the program organizer in real time that encourage self-reflection and thoughtful expression (Rovai, 2007). Establishing norms for respectful and considerate interaction (Rovai, 2007), and building trust among participants through personal sharing (Hess & Smythe, 2001; Rheingold, 2000) should also be considered. Researchers can model desired communication by sharing their reflective thoughts (McInnerney & Roberts, 2004). These strategies have been shown to leverage group dynamics and? foster meaningful engagement in previous research (Hess & Smythe, 2001; McInnerney & Roberts, 2004; Rheingold, 2000). Lastly, the study should be conducted at university institutions in different geographical locations to enhance external validity by incorporating diverse populations and environmental factors, reducing biases, and allowing for comparative analysis. This broader approach adds complexity and depth, making the findings more generalizable and applicable across various contexts.

6.0 Conclusion

To the student researcher's knowledge, this was the first study to examine an individualized 6-week PA program with and without app-based support to enhance mental health in university students. The use of both quantitative and qualitative methodologies rendered a

large body of data to better understand the effects of the program. Quantitative findings did not support the hypotheses. However, participants in both experimental groups experienced statistically significant improvements in aerobic fitness (VO_2 max), as well as subscales representing psychological distress. Qualitative inquiry reinforced these findings, and added further clarity regarding the positive impacts of the program. Despite the app support not evoking changes as anticipated, the unsupervised, individualized nature of the PA program led to meaningful mental and physical health changes for both groups, demonstrating the value of this type of intervention, especially during recovery from a worldwide pandemic. Increasing the sample size, modifying the app-based delivery structure, and considering the timing of the intervention should be considered in the future. As a whole, study results may be valuable to key stakeholders who work with university students and can be integrated into future health promotion strategies.

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8.0 Appendices

8.1 Appendix A

Screening and Get Active Questionnaire (GAQ)

Do you engage in less than 150 minutes of aerobic physical activity per week? Aerobic physical activity is defined as any type as aerobic physical activity, and can include activities such as brisk walking, swimming, running, or cycling.

Are you enrolled full-time at Lakehead University?

Do you have access to a device with internet access?

Are you fluent in English?

Are you 17 years of age or older?

CSEP | SCPE
THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

Get Active Questionnaire

CANADIAN SOCIETY FOR EXERCISE PHYSIOLOGY –
PHYSICAL ACTIVITY TRAINING FOR HEALTH (CSEP-PATH®)

Physical activity improves your physical and mental health. Even small amounts of physical activity are good, and more is better.

For almost everyone, the benefits of physical activity far outweigh any risks. For some individuals, specific advice from a Qualified Exercise Professional (QEP – has post-secondary education in exercise sciences and an advanced certification in the area – see csep.ca/certifications) or health care provider is advisable. **This questionnaire is intended for all ages – to help move you along the path to becoming more physically active.**

☐ I am completing this questionnaire for myself.
☐ I am completing this questionnaire for my child/dependent as parent/guardian.

PREPARE TO BECOME MORE ACTIVE

The following questions will help to ensure that you have a safe physical activity experience. Please answer **YES** or **NO** to each question before you become more physically active. If you are unsure about any question, answer **YES**.

YES	NO	
		1 Have you experienced **ANY** of the following (A to F) **within the past six months**?
☐	☐	**A** A diagnosis of/treatment for heart disease or stroke, or pain/discomfort/pressure in your chest during activities of daily living or during physical activity?
☐	☐	**B** A diagnosis of/treatment for high blood pressure (BP), or a resting BP of 160/90 mmHg or higher?
☐	☐	**C** Dizziness or lightheadedness during physical activity?
☐	☐	**D** Shortness of breath at rest?
☐	☐	**E** Loss of consciousness/fainting for any reason?
☐	☐	**F** Concussion?
☐	☐	**2** Do you currently have pain or swelling in any part of your body (such as from an injury, acute flare-up of arthritis, or back pain) that affects your ability to be physically active?
☐	☐	**3** Has a health care provider told you that you should avoid or modify certain types of physical activity?
☐	☐	**4** Do you have any other medical or physical condition (such as diabetes, cancer, osteoporosis, asthma, spinal cord injury) that may affect your ability to be physically active?

NO to all questions: go to Page 2 – ASSESS YOUR CURRENT PHYSICAL ACTIVITY

YES to any question: go to Reference Document – ADVICE ON WHAT TO DO IF YOU HAVE A YES RESPONSE

CSEP | SCPE
THE GOLD STANDARD IN EXERCISE SCIENCE AND PERSONAL TRAINING

Get Active Questionnaire

ASSESS YOUR CURRENT PHYSICAL ACTIVITY

Answer the following questions to assess how active you are now.

1 During a typical week, on how many days do you do moderate- to vigorous-intensity aerobic physical activity (such as brisk walking, cycling or jogging)? ☐ DAYS/WEEK

2 On days that you do at least moderate-intensity aerobic physical activity (e.g., brisk walking), for how many minutes do you do this activity? ☐ MINUTES/DAY

For adults, please multiply your average number of days/week by the average number of minutes/day: ☐ MINUTES/WEEK

Canadian Physical Activity Guidelines recommend that adults accumulate at least 150 minutes of moderate- to vigorous-intensity physical activity per week. For children and youth, at least 60 minutes daily is recommended. Strengthening muscles and bones at least two times per week for adults, and three times per week for children and youth, is also recommended (see csep.ca/guidelines).

GENERAL ADVICE FOR BECOMING MORE ACTIVE

Increase your physical activity gradually so that you have a positive experience. Build physical activities that you enjoy into your day (e.g., take a walk with a friend, ride your bike to school or work) and reduce your sedentary behaviour (e.g., prolonged sitting).

If you want to do **vigorous-intensity physical activity** (i.e., physical activity at an intensity that makes it hard to carry on a conversation), and you do not meet minimum physical activity recommendations noted above, consult a Qualified Exercise Professional (QEP) beforehand. This can help ensure that your physical activity is safe and suitable for your circumstances.

Physical activity is also an important part of a healthy pregnancy.

Delay becoming more active if you are not feeling well because of a temporary illness.

DECLARATION

To the best of my knowledge, all of the information I have supplied on this questionnaire is correct.
If my health changes, I will complete this questionnaire again.

I answered NO to all questions on Page 1

Sign and date the Declaration below

I answered YES to any question on Page 1

Check the box below that applies to you:

☐ I have consulted a health care provider or Qualified Exercise Professional (QEP) who has recommended that I become more physically active.

☐ I am comfortable with becoming more physically active on my own without consulting a health care provider or QEP.

Name (+ Name of Parent/Guardian if applicable) [Please print] | Signature (or Signature of Parent/Guardian if applicable) | Age

Date | Email (optional) | Telephone (optional)

With planning and support you can enjoy the benefits of becoming more physically active. A QEP can help.

☐ Check this box if you would like to consult a QEP about becoming more physically active.
(This completed questionnaire will help the QEP get to know you and understand your needs.)

8.2 Appendix B

Research Poster

8.3 Appendix C
Letter to Participants/Consent Form

Lakehead UNIVERSITY

School of Kinesiology
t: (807)343-8074 f: (807) 343-8944
e: inewhous@lakeheadu.ca

Letter of Information

Dear Potential Participant:
You are invited to participate in a research study entitled, '**Understanding how online-based support impacts PA behaviour and mental health indices in a 6-week physical activity program for University students**.'
Taking part in this study is voluntary. Before you decide whether or not you would like to take part in this study, please read this letter carefully to understand what is involved. After you have read the letter, please ask any questions you may have by email or phone number provided in the contact information section.

PURPOSE
The research team, comprised of the lead researcher Brenden Degiacomo, a master's student researcher in Kinesiology, Dr. Ian Newhouse, principal investigator and supervisor, Dr. Erin Pearson, co- principal investigator, and committee members, Samantha Morris and Leanne Smith are interested in understanding how online -based support may impact PA behaviour and mental health indices in a 6-week physical activity program for university students.

WHAT IS REQUESTED OF ME AS A PARTICIPANT?
You will be asked to meet with the student researcher to engage in a questionnaire inquiring about physical activity behaviour, mental health, and well-being. During this meeting, you will also complete a 5-minute physical assessment and develop a 6-week physical activity program based on your likes, dislikes, and availability. You will then be randomly placed in one of two groups: 1) 6-week individualized physical activity program or 2) 6-week individualized physical activity program with app-based support. If you are placed in the intervention with the support group, you will be asked to engage in a private WhatsApp group to increase motivation and encourage others. After completing your aerobic exercise program, you will once again meet with the student researcher to complete the survey identical to the pre-survey, with the addition of open-ended questions to collect your experiences with the program and another 5-minute physical assessment. Four weeks after the post-survey, you will once-again complete the survey. The estimated time to complete the initial meeting is 35 minutes, 20 minutes for the post-intervention meeting and 15 minutes for the follow-up surveys.

WHAT ARE MY RIGHTS AS A PARTICIPANT?

You, as the participant:

- are under no obligation to participate, are free to withdraw at any time
- your decision to participate will not affect your academic status
- will be given, in a timely manner throughout the course of the research project, information that is relevant to your decision to continue or withdraw from participation
- will be reminded at the beginning of each survey that you can omit any questions and withdraw from the study at any time without penalty
- will be given information on your right to request the withdrawal of data

WHAT ARE THE RISKS AND BENEFITS?

Due to the exploratory nature of mental health related constructs, involvement could serve as a trigger, or make those uncomfortable who already experience related conditions or symptoms. A list of mental health resources will also be provided for you to access at the end of the letter of information should you so wish. Due to the nature of unsupervised individualized physical activity programs, you may wish to participate in modes of physical activity that have varying risk. General PA has shown to have less than a 1% risk of injury. To address this, handouts and verbal instruction will be provided with protocol on proper warm-up, cool-down, and exercises. The risks are not greater than if you were to engage in PA outside of this study. Due to the nature of an app-based support group, users can post what they please. If you are placed in this group, you will be provided with guidelines which state that if they post inappropriate content, it will be deleted, and they will be removed from the group. There are no other foreseeable risks associated with involvement in this study (e.g., reputation or privacy).

Potential benefits for participating in this study include the opportunity to reflect on and have heightened awareness of physical activity behaviours and aspects of mental health. You will also have the individualized 6-week physical activity programs developed and may enjoy participating in the physical activity program. While the individualized 6-week PA program alone may have some positive effects on mental health indices, there may be enhanced benefits for those participating in the PA program with an online exercise group. The participants who partake in the online group may better adhere (total minutes of PA) to the exercise program as group support will be a motivating factor. Increased minutes of PA may be associated with improved mental health indices, specifically, stress, depression, and well-being.

HOW WILL MY CONFIDENTIALITY BE MAINTAINED?

Your participation in this study is completely confidential. The survey will not be labelled to identify who completed it and you will create a unique identification number. However, it is important to note that due to the type of survey software being used, we cannot absolutely guarantee the full confidentiality of your data. Survey Monkey is hosted by a server located in the USA, and the US Patriot Act permits US law enforcement officials, for the purpose of anti-terrorism investigation, to seek a court order that allows access to the personal records of any person without the person's knowledge.

Due to the interactive nature of the app-based support groups, anonymity cannot be guaranteed if you are randomly placed into this group. However, individuals who consent to involvement will be explained that the content of the group should remain within the group, and that everyone should strive to maintain confidentiality and anonymity by the student researcher when they are invited to the group. Sharing personal information such as contact information is not permitted.

WHAT WILL MY DATA BE USED FOR:
Research findings may be presented in a poster presentation to both academic peers and the public in a classroom setting, poster fair, conference, or through publication.

WHERE WILL MY DATA BE STORED?
Data collected will be stored on the Survey Monkey cloud server on a password protected account belonging to a member of the research team (BD); any resultant analyses will similarly be stored on a password protected computer belonging to a member of the research team (BD). The research team will have access to a master key with the participants identifiable information and their participants IDs within a password protected document stored separately from the research data and a password protected computer belonging to a member of the research team. After the research is completed, the information will be removed from the Survey Monkey cloud. In line with Lakehead University protocol, the data will be accessed for the duration of the study for a minimum of five years post completion on a password protected computer belonging to a member of the research team at Lakehead University, School of Kinesiology.

HOW CAN I RECEIVE A COPY OF THE RESEARCH RESULTS?
Should you wish to know the results of the study, a copy of the results will be made available to you upon request to the research team.

WHAT IF I WANT TO WITHDRAW FROM THE STUDY?
Should you wish to withdraw from the study, you are free to do so at any time. The student researcher can be contacted by if you wish to withdraw your participation or previously collected data (please see Researcher Contact Information). Any completed questionnaire(s) or other participant data in the study can be withdrawn. Should you wish to withdraw from the study, please let me know by March 2023 at the latest.

If you have questions prior to proceeding, please contact the research team to discuss. Otherwise, please review the following.
Clicking next below means that I have read and understood this letter. I am aware of the study purpose, its benefits, and potential risks. I understand that I am a volunteer and free to not answer any of the questions included. I agree to have my anonymous information used by the researchers as part of their project. I am aware that the survey results will be securely stored for a minimum of 5 years after the project is finished. I understand that I can request a copy of the general findings by contacting the research email below.
`

RESEARCHER CONTACT INFORMATION:

If you have any questions or concerns, please contact the research team email address: onlinepasupportresearch@lakeheadu.ca

Research Team Members

Brenden Degiacomo - Student Researcher, School of Kinesiology, Lakehead University

Dr. Ian Newhouse – Principal Investigator, School of Kinesiology, Lakehead University

Dr. Erin Pearson – Co- Principal Investigator, School of Kinesiology, Lakehead University

Samantha Morris - Committee Member, School of Kinesiology, Lakehead University

Leanne Smith - Committee Member, School of Kinesiology, Lakehead University

RESEARCH ETHICS BOARD REVIEW AND APPROVAL:

This research study has been reviewed and approved by the Lakehead University Research Ethics Board. If you have any questions related to the ethics of the research and would like to speak to someone outside of the research team, please contact Sue Wright at the Research Ethics Board at 807-343-8283 or research@lakeheadu.ca

Lakehead UNIVERSITY

School of Kinesiology
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Consent Form for Potential Participants

MY CONSENT:

I agree to the following:

- ✓ I have read and understand the information contained in the Letter of Information
- ✓ I agree to participate
- ✓ I understand the risks and benefits to the study
- ✓ That I am a volunteer and can withdraw from the study at any time and may choose not to answer any question
- ✓ That the data will be securely stored in Dr. Ian Newhouse's office for a minimum period of 5 years following completion of the research project
- ✓ That my answers during the potential focus group/interview can be recorded
- ✓ I understand that the research findings will be made available to me upon request
- ✓ My identity will remain confidential
- ✓ All of my questions have been answered

By consenting to participate, I have not waived any rights to legal recourse in the event of research-related harm.

I have read and agree to the above information and by completing and submitting this survey, agree to participate in Understanding How Online Social Support Impacts PA behaviour and Mental Health Indices in an Individualized 6-week Physical Activity Program for University Students. _____

I allow the research team of the present study to audio record my voice YES NO

This research study has been reviewed and approved by the Lakehead University Research Ethics Board and the School of Kinesiology Undergraduate Research Ethics Committee at Lakehead University

8.4 Appendix D

Online Survey

Before you begin, please read your rights as a participant below. You can withdraw your data up to the point of submission.

You, as the participant:

- are under no obligation to participate, are free to withdraw at any time
- your decision to participate will not affect your academic status
- will be given, in a timely manner throughout the course of the research project, information that is relevant to your decision to continue or withdraw from participation
- will be reminded at the beginning of each survey that you can omit any questions and withdraw from the study at any time without penalty
- will be given information on your right to request the withdrawal of data

Demographics Survey

Before continuing, please create your unique ID to remain anonymous and connect your responses from survey 1 and 2 by using the instructions below:

To create your unique ID, please use the first letter of your first name, date of birth [1-31], first initial of the town /city of your birth, and the last two digits of your phone number. For example, Taylor was born on December 31st in Kitchener and her phone number ends in 00. ID = T31K00

_____

Please tell us a little bit about yourself.

Demographics

Age:_____ Height:_____ Weight:_____
City/Town:_____

Ethnicity:_____

Gender: _____

Education

What is the location of your campus?
- ☐ Thunder Bay
- ☐ Orillia

How many years of University have you completed to date?
- ☐ Zero, this is my first year
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5
- ☐ Equal or greater than 6

What kind of program are you currently enrolled in?
- ☐ Undergraduate
- ☐ Graduate
- ☐ Graduate Diploma
- ☐ PhD

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e: movingthroughcovid@gmail.com

What Department at Lakehead University are you enrolled in?

- ☐ Aboriginal Education
- ☐ Anthropology
- ☐ Bioinformatics
- ☐ Biology
- ☐ Bora Laskin Faculty of Law
- ☐ Business
- ☐ Chemistry
- ☐ Computer Science
- ☐ Engineering
- ☐ Economics
- ☐ Education
- ☐ English
- ☐ Gender and Women's Studies
- ☐ Geography and the Environment
- ☐ Geology
- ☐ Gerontology
- ☐ Health Sciences
- ☐ History
- ☐ Indigenous Learning
- ☐ Kinesiology
- ☐ Languages
- ☐ Mathematics
- ☐ Music
- ☐ Nursing
- ☐ Natural Resources Management
- ☐ Northern Ontario School of Medicine
- ☐ Northern Studies
- ☐ Outdoor Recreation, Parks, & Tourism
- ☐ Philosophy
- ☐ Physics
- ☐ Political Science
- ☐ Other
- ☐ Psychology
- ☐ Social Justice Studies
- ☐ Social Work
- ☐ Sociology
- ☐ Sustainability Sciences
- ☐ Visual Arts
- ☐ Water Resource Science

Employment Status

Outside of being a full-time student, what is your employment status?

- ☐ Not Employed
- ☐ Full-time Employed
- ☐ Part-time Employed
- ☐ Casual Employed
- ☐ Volunteer
- ☐ Other

Home Life

What is your relationship status?

- ☐ Single
- ☐ Significant Other
- ☐ Married
- ☐ Common Law
- ☐ Other

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What is your living status?

- ☐ Live Alone
- ☐ Live with Roommate/Roommates
- ☐ Live with Friends
- ☐ Live with Family
- ☐ Other

If answered above to living with other(s), how many others do you live with excluding yourself?

- ☐ Live with 1 other
- ☐ Live with 2 others
- ☐ Live with 3+ others
- ☐ Other

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think *only* about those physical activities that you did for at least 10 minutes at a time.

1. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling?

   _____ **days per week**

   ☐ No vigorous physical activities → ***Skip to question 3***

2. How much time did you usually spend doing **vigorous** physical activities on one of those days?

   _____ **hours per day**

   _____ **minutes per day**

   ☐ Don't know/Not sure

Think about all the **moderate** activities that you did in the **last 7 days**. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

   _____ **days per week**

   ☐ No moderate physical activities → ***Skip to question 5***

4. How much time did you usually spend doing **moderate** physical activities on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

Think about the time you spent **walking** in the **last 7 days**. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time?

_____ **days per week**

☐ No walking → ***Skip to question 7***

6. How much time did you usually spend **walking** on one of those days?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

The last question is about the time you spent **sitting** on weekdays during the **last 7 days**. Include time spent at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the **last 7 days**, how much time did you spend **sitting** on a **week day**?

_____ **hours per day**

_____ **minutes per day**

☐ Don't know/Not sure

This is the end of the questionnaire, thank you for participating.

Adult MHC-SF (ages 18 or older)

Please answer the following questions are about how you have been feeling during the past month. Place a check mark in the box that best represents how often you have experienced or felt the following:

During the past month, how often did you feel …	NEVER	ONCE OR TWICE	ABOUT ONCE A WEEK	ABOUT 2 OR 3 TIMES A WEEK	ALMOST EVERY DAY	EVERY DAY
1. happy						
2. interested in life						
3. satisfied with life						
4. that you had something important to contribute to society						
5. that you belonged to a community (like a social group, or your neighborhood)						
6. That our society is a good place, or is becoming a better place, for all people						
7. that people are basically good						
8. that the way our society works makes sense to you						
9. that you liked most parts of your personality						
10. good at managing the responsibilities of your daily life						
11. that you had warm and trusting relationships with others						
12. that you had experiences that challenged you to grow and become a better person						
13. confident to think or express your own ideas and opinions						
14. that your life has a sense of direction or meaning to it						

DASS21

Name: Date:

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you **over the past week**. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

0 Did not apply to me at all
1 Applied to me to some degree, or some of the time
2 Applied to me to a considerable degree or a good part of time
3 Applied to me very much or most of the time

1 (s)	I found it hard to wind down	0	1	2	3
2 (a)	I was aware of dryness of my mouth	0	1	2	3
3 (d)	I couldn't seem to experience any positive feeling at all	0	1	2	3
4 (a)	I experienced breathing difficulty (e.g. excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5 (d)	I found it difficult to work up the initiative to do things	0	1	2	3
6 (s)	I tended to over-react to situations	0	1	2	3
7 (a)	I experienced trembling (e.g. in the hands)	0	1	2	3
8 (s)	I felt that I was using a lot of nervous energy	0	1	2	3
9 (a)	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
10 (d)	I felt that I had nothing to look forward to	0	1	2	3
11 (s)	I found myself getting agitated	0	1	2	3
12 (s)	I found it difficult to relax	0	1	2	3
13 (d)	I felt down-hearted and blue	0	1	2	3
14 (s)	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
15 (a)	I felt I was close to panic	0	1	2	3
16 (d)	I was unable to become enthusiastic about anything	0	1	2	3
17 (d)	I felt I wasn't worth much as a person	0	1	2	3
18 (s)	I felt that I was rather touchy	0	1	2	3
19 (a)	I was aware of the action of my heart in the absence of physical exertion (e.g. sense of heart rate increase, heart missing a beat)	0	1	2	3
20 (a)	I felt scared without any good reason	0	1	2	3
21 (d)	I felt that life was meaningless	0	1	2	3

The following questions will only be included on Survey Two:

Open-Ended Survey Questions

Five open ended questions will be added to the post survey to gain insight into participant experiences with their physical activity program:

1. Please describe your feelings and thoughts with your physical activity program.
2. What changes have you noticed in your mood/feelings/mental health/other if any, over the past 6 weeks?
3. To what degree do you attribute these changes to your involvement in this program, if at all?
4. What facilitators have you experienced to getting or staying involved in the program, if any?
5. What barriers have you experienced to getting or staying involved in the program, if any?
6. What did you like about this program?
7. What did you dislike about this program?
8. Is there anything else that you would like to add about the program?

For the individualized PA program with app-based support group, participants will be asked additional questions on social support/group cohesion:

5. Have your PA habits (frequency, duration) changed since using the WhatsApp group? Why or why not?
6. What did you like and dislike about an app-based support group?
7. What suggestions do you have for future research involving an app-based support group such as this?

Mental Health Resource Page

Lakehead University Student Health and Wellness
Student Health and Wellness provides a range of counselling options, health services, and wellness programs. There are many different types of support available. The stepped care model will help determine the type of support that is right for you. You can also refer to WellU and Staying Healthy for more information on health and wellness topics.

Phone Number: (807) 343-8361
Email: health@lakeheadu.ca

Thunder Bay Counselling "Talk-In"
The Talk-in Counselling clinic provides immediate and free counselling and therapy services to individuals, couples and families on a first come, first served basis.

Website: https://www.tbaycounselling.com/walk-in-counselling/
Phone Number: (807)700-0090

BounceBack
A free cognitive behavioural therapy (CBT) program that offers guided mental health self-help support for adults and youth 15 and older.

Toll-free phone number: 1(866)345-0224

211 Ontario
Information and referral for community, government, social and health services, including mental health resources across Ontario.

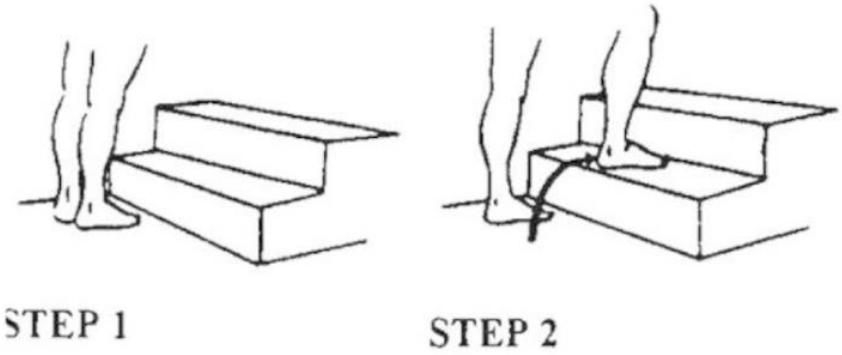
Phone Number: 211

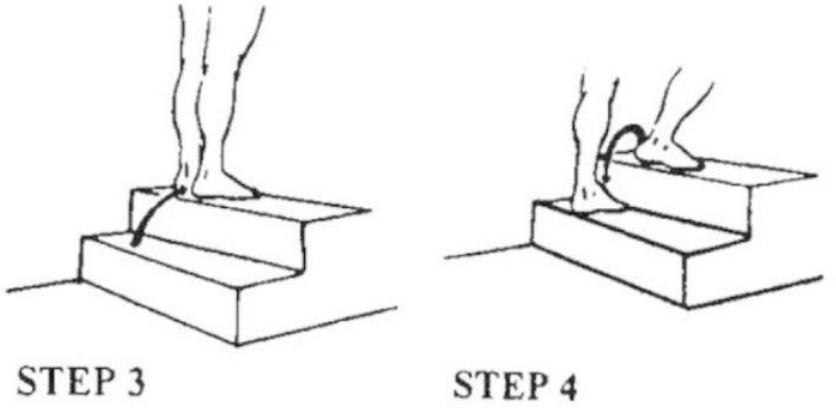
Good2Talk
General mental health support, email and phone counselling for individuals aged 17 to 25.

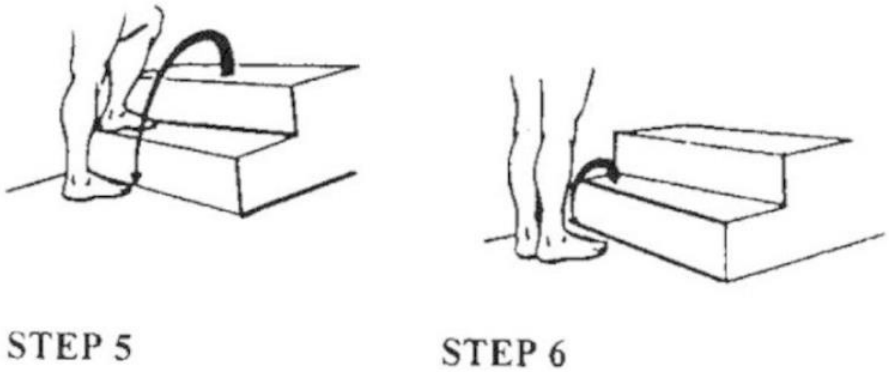
Toll-free phone number: 1(866)925-5454
Email: https://good2talk.ca/contact/

8.5 Appendix E

STEP Protocol







Participants will participants walk up and down a set of 2 standardized steps 20 times (most tests take around 1.5-2 minutes). Participants will complete the test at a self-selected pace and predicted maximum oxygen consumption will be collected based on age, sex, body weight, stepping time, and heart rate after exercise.

8.6 Appendix F

Assessment Form

Current minutes of PA/week:

Current modes of PA:

Past levels of activity/modes of activity:

Goals for program (SMART):

Current lifestyle demands (School, work, family; barriers to PA):

Likes/dislikes regarding PA:

Access to equipment/facilities:

Comfort of using facilities:

Current/past facilitators to PA:

8.7 Appendix G

Check-in Email

Hi (insert participant name),

I hope that you are doing well and enjoying the physical activity program. I have a couple of questions regarding your experience with the program to determine whether some changes need to be made:

- How has the program been going?
- Are there any areas that you are struggling in?
- Do you feel that the program is progressing at an adequate level?
- Do you think that any changes need to be made to your program?

Feel free to pass on any questions if you like. Please reach out anytime over of the remainder of your program by replying to this email if you have any questions.

Thank you for your time,
Brenden

8.8 Appendix H

CSEP Recommendations for Adults Aged 18-64

CSEP-PATH: MOVEMENT COUNSELLING TOOL

FOR ADULTS AGED 18-64 YEARS

The Canadian 24-Hour Movement Guidelines for adults integrate three core movement behaviour recommendations for optimal health benefits:

MOVE MORE	REDUCE SEDENTARY TIME	SLEEP WELL

Use this tool to guide your conversation with clients that express an interest in changing a movement behaviour.

STEP 1: ASK client for permission to discuss their movement behaviours (i.e., physical activity, sedentary time, sleep).

- *"May I discuss Canada's daily movement recommendations with you?"*
- Discuss the Canadian 24-Hour Movement Guidelines with your client.

STEP 2: ASSESS client's physical activity, sedentary time, and sleep.

- Ask open-ended questions such as *"Tell me about your current physical activity levels?"* or *"How would you describe your sleep schedule?"*
- Use the information gathered and the movement recommendations below to help guide goal setting and action planning (STEP 4).

A HEALTHY 24 HOURS INCLUDES:

PHYSICAL ACTIVITY

- 150 minutes per week of moderate to vigorous aerobic physical activities
- Muscle strengthening activities at least twice a week
- Several hours of light physical activities including standing

SEDENTARY TIME

- Limit sedentary time to 8 hours or less
- No more than 3 hours of recreational screen time
- Break up long periods of sitting as often as possible

SLEEP

- Get 7 to 9 hours of good-quality sleep on a regular basis
- Consistent bed and wake-up times

Replacing sedentary behaviour with additional physical activity and trading light physical activity for more moderate to vigorous physical activity, while preserving sufficient sleep, can provide greater health benefits.

STEP 3: ADVISE client on their current movement behaviours.

- Discuss the health benefits and/or risks of their current status if necessary.

STEP 4: AGREE on a realistic goal with your client.

- Ask client which movement behaviour(s) they would like to focus on. Create a SMART goal with your client that helps them move towards the guideline recommendations (see **Goal Setting Worksheet**). Offer practical strategies when needed. (examples of strategies for each target are below)
- **Remind** client that progressing towards **any** of the movement behaviour targets will result in some health benefits.

PHYSICAL ACTIVITY

Discuss ways to increase the types and intensities of aerobic activity they perform each day.

Develop an appropriate resistance training program for your client.

Discuss how they could replace sedentary periods of their day with light activities such as standing.

SEDENTARY TIME

Identify periods of the day where they are sedentary and discuss how to replace them with other movement behaviours (e.g., standing).

Encourage them to keep screens away from bedrooms and eating areas.

Encourage them to get up and get a glass water during the day, or use technology to remind them to take breaks.

SLEEP

Have them develop relaxing bedtime routine, avoid caffeine consumption in afternoon, no screens 30-60 mins before bedtime.

Encourage them to go bed at the same time every day.

SMART Goal:

_____

_____

STEP 5: ASSIST client to increase self-confidence and overcome barriers.

- Consider using tools such as the **Decision Balance Worksheet** or the **Barriers to Physical Activity Tool**, to help facilitate the discussion.

STEP 6: ARRANGE a follow-up with your client (e.g., 2 weeks).

Follow-up date and time: _____

8.9 Appendix I

Physical Activity Individualization Example

Preliminary Information: John Doe is 24-year-old business major who reports that he'd like to get into shape and has heard that engaging in PA may benefit his mood/mental health. In the meeting, he expressed that he enjoys biking and used to play recreational soccer. John has access to a bicycle and Lakehead University's fieldhouse exercise facility. John has briefly used exercise equipment in the past and is open to being in a gym setting. John's main method of transportation is an automobile to get to class Monday to Friday. Two SMART goals were developed with John based on his wants: improve predicted VO_2 max from baseline to post-program test and engage in at least 150 minutes of moderate to vigorous activity each week . After discussion he identifies riding a bike to school would be a time efficient means to increase his MVPA levels. At the beginning of his program, John will bike to and from school twice a week, which involves 60 minutes of PA. John is also going to begin playing recreational soccer once a week for 45 minutes. The remaining 45 minutes will consist of two strength-training sessions which will take place at the LU fieldhouse.

8.10 Appendix J

SurveyMonkey Logbook Template

Note. Please fill out this tracking log to the best of your ability. If you are completing more than one activity in a day, please track type, duration, and intensity for EACH activity that you complete and separate them by a semi colon.

For example, John walked and did a core workout on Monday. He would fill out his tracking sheet as follows:
Date: September 30th, 2022
Type of Activity: Walking; Jogging
Duration of Exercise: 30 min; 10 min
Perceived Intensity: 4; 6

To create your unique ID number, please use the first letter of your first name, day of birth [1-31], and the last two digits of your phone number.

For example, Taylor was born on December 31st and her phone number ends in 00. ID = T-31-00

What's your ID number?

Monday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

Tuesday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

Wednesday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

Thursday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

Friday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

Saturday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

Sunday

Date:

Type of Activity:

Duration of Exercise (min):

Perceived Intensity (see below for scale):

Comments:

8.11 Appendix K

WhatsApp Expectations and Suggestions

Thank you again for your willingness to participate in this study.

What is required of me as a participant in the group?

You are asked to **share updates at least once a week** with **your experiences** with the program, tips, and **words of encouragement to motivate** others. You are welcome to post appropriate responses to other posts or post more than one update per week. Due to the nature of mental health, physical activity, and group support, some participants may post about mental health. If this is uncomfortable for you, you are not required to respond to any post. **If you wish to leave the group, you are welcome to do so at anytime.**

What shouldn't I post in the group?

To ensure anonymity, please **do not share any personal information** (full name, location) with others in the group. To ensure confidentiality, **do not share posts in the group with anyone outside of the group**. **Do not post any inappropriate verbal or visual media** to the group. If a participant does post something inappropriate, they will be removed.

Who can see what I am posting?

Four other participants and the research team will be able to access and respond to your posts. The student researcher will monitor the group to ensure the group guidelines are being met.