Effects of A Remote, YouTube-Delivered Exercise Intervention on Young Adults' Physical Activity, Sedentary Behavior, Sleep Quality, and Psychosocial Outcomes during the COVID-19 Pandemic: Randomized Controlled Trial

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Dedication

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Abstract

Introduction: Recent population-level surveillance data indicate that over 80% of U.S. adults fail to meet the minimum physical activity recommendations for aerobic and muscle-strengthening physical activities. This has become a major public health challenge given the numerous physiological and economic consequences associated with physical inactivity. Additionally, high levels of physical inactivity have been observed to adversely affect individuals' sleep quality which further contributes to the incidence of hypokinetic diseases and all-cause mortality and further burdens the economy indirectly by decreasing daytime productivity. With the outbreak of the Coronavirus disease 2019 (COVID-19) and the enacted regulations to reduce its transmission, there is currently an infectious disease pandemic that has compounded the preexisting physical inactivity pandemic. While all demographics have been affected by these regulations, U.S. young adults in particular have been forced to make extraordinary changes to their lifestyle and behavioral patterns which has created exceptional barriers to their physical activity participation and has further exacerbated the issue of poor sleep quality in this population. Recent public health guidelines, therefore, have called for innovative and flexible physical activity intervention strategies to promote physical activity and health amid the COVID-19 pandemic. Given present-day young adults are technology-savvy and are the primary consumers of social media, delivering a physical activity promotion intervention via social media may be an effective strategy for remotely disseminating such an intervention. However, meta-analyses have observed social media-based interventions to be ineffective at improving young adults' physical activity levels and only one randomized controlled trial to date has examined the effectiveness of *video*-based social media platforms on this populations’ physical activity, showing no positive effects. Therefore, this study’s purpose was to examine the effects of a remote, home-based, YouTube video-delivered aerobic and muscle-strengthening physical activity intervention on young adults’ free-living aerobic and muscle-strengthening physical activity, sedentary behavior, sleep quality, and psychosocial health outcomes over 12 weeks compared to control (ClinicalTrials.gov identifier: NCT04499547).

Methods: Sixty-four young adults (48 females; $\bar{X}_{age} = 22.8 \pm 3.4$ years; $\bar{X}_{BMI} = 23.1 \pm 2.6$ kg/m^2) from a large metropolitan research University in the Midwest participated in this prospective, 12-week, parallel randomized controlled trial during Fall 2020/Winter 2021. In detail, participants were randomized (1:1) into the intervention group (received weekly aerobic and muscle-strengthening physical activity videos grounded in Self-determination theory) or control group (received weekly general health education videos) for 12 weeks. Briefly, the intervention videos were grounded in Self-determination Theory because recent research observed that young adults demonstrated lower autonomous motivation to engage in home-based physical activities during the COVID-19 pandemic due to limited or no access to familiar exercise equipment, among other reasons. Briefly, Self-determination theory postulates that by fulfilling three basic human psychological needs (i.e., competency, autonomy, and relatedness), one’s motivation for physical activity will progress to more internally regulated forms, ranging from amotivation to intrinsic motivation, thereby improving the likelihood of longer-term adherence to physical activity. The primary outcome was free-living moderate-to-vigorous-intensity physical activity, and the secondary outcomes were sedentary behavior, light physical activity, and sleep quality (measured using wrist-worn ActiGraph GT9X accelerometers) and muscle-strengthening physical activity frequency, Self-determination theory-related autonomous motivation for physical activity (i.e., non-regulation, external regulation, introjected regulation, identified regulation, integrated regulation, and intrinsic regulation), perceived physical activity barriers, physical activity-related enjoyment, physical activity-related self-efficacy, and Self-determination Theory-related social support (assessed using validated questionnaires). Process evaluation outcomes (intervention fidelity, use, and adherence) were also evaluated. Repeated measures ANCOVAs examined between-group differences for all study outcomes at a Bonferroni-adjusted significance level of 0.003 (0.05/16 outcomes) to account for potential bias from multiple comparisons and effect sizes were calculated as partial eta-squared (η_p^2) for outcomes which were observed as statistically significant.

Results: Three experimental group participants discontinued participation for reasons unrelated to the study (retention rate = 95.3%). Because these participants' baseline data were not significantly different from completers' data, an intent-to-treat analysis was employed which was determined a priori. Because between-group demographic differences in randomized, parallel trials are, by definition, due to chance, baseline group differences were not statistically examined. Overall, however, it was determined that baseline comparisons between groups were not materially different and thus, concluded that the randomization procedures were robust. Statistically significant between-group differences were observed for moderate-to-vigorous-intensity physical activity, sleep efficiency, muscle-strengthening physical activity frequency, non-regulation, integrated regulation, and intrinsic regulation, perceived physical activity barriers, and physical activity-related self-efficacy ($F(1, 62) = 10.64$-228.87, $p < 0.001$-0.002, $\eta_p^2 = 0.15$-0.79) with all outcomes favoring the intervention group after 12 weeks. However, no statistically significant between-group differences were observed for sedentary behavior, light physical activity, sleep duration, external, introjected, and identified regulations, and physical activity-related enjoyment after 12 weeks ($F(1, 62) = 0.69$-4.60, $p = 0.04$-0.61).

Conclusion: With some national COVID-19 restrictions still in place and uncertainty regarding post-pandemic physical activity/exercise environments and behaviors, a remote, YouTube-delivered physical activity and exercise intervention may help foster clinically meaningful improvements in young adults' free-living moderate-to-vigorous-intensity physical activity, muscle-strengthening physical activity frequency, sleep efficiency, physical activity-related intrinsic motivation, perceived physical activity barriers, and physical activity-related self-efficacy after 12 weeks. Indeed, this intervention yielded high interest, adherence, and use/acceptability among the sample of young adults.

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Chapter One: Introduction

Physical Inactivity and Obesity Prevalence in the U.S.

Currently, approximately 75% of the U.S. population is overweight (body mass index ≥ 25 kg/m^2) or obese (body mass index ≥ 30 kg/m^2) (Ogden, Carroll, Fryar, & Flegal, 2015). Adult obesity is a complex, multi-faceted health issue as it is the result of many contributing factors (e.g., behavioral, genetic, medications) (Centers for Disease Control, 2017a). While genetics, prescribed medications, and other exposures may not be controlled by the individual, behavioral factors (e.g., dietary behaviors, regular physical activity participation) are lifestyle choices which the individual can control. As such, a major contributing factor to the high prevalence of obesity are high physical inactivity rates. In fact, the World Health Organization now recognizes physical inactivity as the fourth leading risk-factor of global mortality (World Health Organization, 2010).

Based on this knowledge, the World Health Organization developed the *2020 Physical Activity Guidelines* which were similar to the American College of Sports Medicine's *2018 Physical Activity Guidelines for Americans*, which, based on decades of compiled epidemiological and experimental research, recommended adults engage in at least: (1) 30 minutes of moderate-intensity physical activity on five or more days per week; (2) 75 minutes of vigorous-intensity physical activity three or more days per week; or (3) an equivalent combination of the two (Bull, et al., 2020; Physical Activity Guidelines Advisory Committee, 2018). Additionally, the guidelines recommend adults engage in muscle-strengthening physical activities using a variety of resistance-types (e.g., body weight, free weights, elastic bands, cables, etc.) on at least two days per week targeting all seven major muscle groups (i.e., shoulders, arms, back, chest, abdomen, legs, and hips).

Yet, large-scale, accelerometer-determined physical activity epidemiology studies (Haskell et al., 2007; Physical Activity Guidelines Advisory Committee, 2018; U.S. Department of Health and Human Services, 2008) have indicated that only about 5-20% of U.S. adults adhere the recommended minimum of 30 minutes of moderate-to-vigorous-intensity aerobic physical activity per day on at least five days per week (Troiano et al., 2008). Moreover, data from the 2015 Behavioral Risk Factor Surveillance System (Bennie et al., 2018; Centers for Disease Control, 2015) indicated that only 30% of U.S. adults met the muscle-strengthening physical activity guidelines and approximately 60% of U.S. adults engage in no muscle-strengthening exercise whatsoever. Likewise, recent population-level surveillance data suggests that 80% of U.S. adults fail to meet both the aerobic and muscle-strengthening guidelines, concurrently (Bennie et al., 2019). Distinctly, physical inactivity rates in the U.S. are alarmingly high. Of concern is the fact that physical inactivity is a major contributor to obesity and obesity is strongly associated with the prevalence of chronic diseases (e.g., heart disease, stroke, type 2 diabetes, and certain types of cancer) which are responsible for approximately 70% of deaths and 85% of health care costs in the U.S., annually (Centers for Disease Control, 2017b; Tremmel, Gerdtham, Nilsson, & Saha, 2017; Ding et al., 2016). Given the many physiological and economic consequences associated with obesity, the World Health Organization has declared obesity as “one of the greatest public health challenges of the 21st century” (World Health Organization, 2017).

Therefore, it is imperative to identify innovative and enjoyable intervention strategies to promote physical activity and associated health outcomes, especially in populations which are at high-risk of overweight and obesity due to high levels of physical inactivity. One such population are U.S. young adults.

Obesity and Physical Inactivity Prevalence in Young Adults

A population which demonstrates high levels of physical inactivity and overweight/obesity in the U.S. are young adults, or those aged 18-35 years (Nelson, Gortmaker, Subramanian, Cheung, & Wechsler, 2007; Peterson, Sirard, Kulbok, DeBoer, & Erickson, 2018). Indeed, young adults often make lifestyle choices like physical activity behaviors autonomously for the first time and given the demand to balance school and/or work, a social life, and other lifestyle behaviors, physical activity participation often gets neglected (Deliens, Deforche, De Bourdeaudhuij, & Clarys, 2015; Desai, Miller, Staples, & Bravender, 2008). Indeed, according to the National College Health Assessment, only approximately 23% and 19% of male and female young adults, respectively, met the minimum moderate-to-vigorous-intensity physical activity guidelines of 30 minutes at least five days per week in 2018 (National College Health Assessment, 2018). Consequently, > 40% of U.S. young adults were overweight or obese in 2018 (National College Health Assessment, 2018). This is concerning given that overweight and obesity in early adulthood has been observed to track throughout the remainder of life (Laska, Pasch, Lust, Story, & Ehlinger, 2011; Haberman & Luffey, 1998). Common barriers to physical activity participation in young adults include lack of time, lack of motivation, lack of social support, and lack of understanding of the health benefits and physical literacy (i.e., knowing how to properly perform various exercises) (Bopp, Vadeboncoeur, Stellefson, & Weinsz, 2019; Edwards, Bryant, Keegan, Morgan, & Jones, 2017; Stutts, 2002; Lacaille, Dauner, Krambeer, & Pedersen, 2011; Nelson, Kocos, Lytle, & Perry, 2009; Harada, Shibata, Lee, Oka, & Nakamura, 2014). Additionally, high levels of physical inactivity have been observed to negatively affect individuals' sleep quality (i.e., sleep duration and efficiency [Falck, Stamatakis, & Liu-Ambrose, 2021]) (Kredlow, Capozzoli, Hearon, Calkins, & Otto, 2015) which further contributes to the incidence of hypokinetic diseases (Grandner, Chakravorty, Perlis, Oliver, & Gurubhagavatula, 2014) and all-cause mortality (Gallicchio & Kalesan, 2009) and further burdens the economy indirectly by decreasing daytime productivity (Daley, Morin, LeBlanc, Grégoire, & Savard, 2009). Accordingly, novel and innovative physical activity intervention strategies are needed among young adults, to promote health and prevent weight-related morbidities in later adulthood.

Effect of the COVID-19 Pandemic on Physical Activity and Sleep in Young Adults

With the outbreak of the Coronavirus disease 2019 (COVID-19) and the enacted regulations to reduce its transmission (e.g., physical distancing, gym and recreation center closures, home quarantine [Jurak, Morrison, Leskošek, et al., 2020; Amekran & El Hangouche, 2020; Zhu, 2020]), the U.S. is currently facing an infectious disease pandemic that has compounded the preexisting physical inactivity pandemic (Kohl III, Craig, Lambert, et al., 2012; Hall, Laddu, Phillips, Lavie, & Arena, 2021). While all demographics have been affected by these regulations, U.S. young adults in particular have been forced to make extraordinary changes to their lifestyle and behavioral patterns

(Huckins, DaSilva, Wang, et al., 2020) which has created exceptional barriers to their physical activity participation and has further exacerbated the issue of poor sleep quality in this population (Huckins, DaSilva, Wang, et al., 2020; Marelli, Castelnuovo, Somma, et al., 2021). Further, with the home environment emerging as the only viable indoor opportunity for physical activity, the inaccessibility of commercial exercise equipment has decreased young adults' autonomous motivation to engage in home-based aerobic and muscle-strengthening physical activities (Kaushal, Keith, Aguiñaga, & Hagger, 2020). Accordingly, the American College of Sports Medicine has released a call to action for health professionals to develop novel and flexible approaches to physical activity which account for these unprecedented circumstances (Denay, Breslow, Turner, Nieman, Roberts, & Best, 2020). Thus, there is an urgent need to develop innovative and enjoyable, home-based physical activity promotion interventions which minimize human contact, are cost-effective, and have mass-reach to help mitigate the compounding effects of the COVID-19 pandemic on physical inactivity and poor sleep quality among U.S. young adults. One physical activity promotion intervention strategy that fulfills the preceding criteria is delivery by social media.

Social Media Use in the United States

In the modern world, technology use is ubiquitous, especially in developed countries like the U.S. In fact, recent Pew Research (2019a) indicates that 90% of U.S. adults use the Internet and > 70% use online social media regularly (Pew Research, 2019c). Obar and Wildman define social media as "interactive computer-mediated technologies that facilitate the creation or sharing of information, ideas, career interests and other forms of expression via virtual communities and networks" (2015). Simply put, users create and share content via websites and applications and/or connect with others by participating in social networking. Social media sites allow users to create online profiles to connect with friends/family, express opinions on current events, and access information on a myriad of topics presented in various media formats (e.g., text-based, audio-based, or multimedia content) within a given network (Green et al., 2013). Indeed, online social media use is becoming increasingly popular in the U.S. as evidenced by the fact that in 2007, large-scale survey data indicated that 69% of U.S. adults accessed the Internet and 23% used a social media platform (Chou, Hunt, Beckjord, Moser, & Hesse, 2009). Further, by 2023, the number of social network users in the United States is forecast to increase to approximately 257 million—a 5.3% increase from 2019 (Statista, 2019).

To date, among the most commonly used social media platforms in the U.S. are Facebook, Twitter, Instagram, and Snapchat. Until recently, Facebook was the most widely used social media platform. In fact, in 2014, Facebook had over 1.3 billion active users (Maher et al., 2014), the majority of which were teens and young adults. In detail, in 2014 and 2015, 71% of teens reported using Facebook (Pew Research, 2015) followed by Instagram (52%), Snapchat, (41%), and Twitter (33%). However, the social media landscape has shifted in recent years, especially among American teens, as today, >85% report using YouTube, followed by Instagram (71%) and Snapchat (69%), whereas only 51% of teens now report using Facebook (Pew Research, 2018). This trend is similar in U.S. adults as well (Pew Research, 2019b), as YouTube now leads the way with 73% of the adult population reporting using YouTube, followed by Facebook (69%) and Instagram (37%). Given the vast reach online social media has, especially in the U.S., recent public health efforts have utilized social media as a delivery vehicle by which to promote physical activity and associated health outcomes.

YouTube: The New Leader in Social Media

YouTube is now the most widely used social media platform worldwide and in the U.S. (Pew Research, 2018). Specifically, the number of U.S. adults using YouTube online or on their phones has reached 73% (94% of 18- to 24-year-olds) compared to 68% of U.S. adults who use Facebook (Pew Research, 2018). In detail, YouTube currently has over 2 billion logged-in monthly users who spend over an hour a day watching YouTube videos generating > 1 billion daily hours of watched videos and > 500 million hours of video per minute are uploaded to this platform (Shinal, 2018). What distinguishes YouTube from all other social media platforms is that it is first and foremost a search engine (Cannell, 2018). Indeed, YouTube—owned by Google—is the second largest search engine in the world (second to Google) so search functionality is at its heart (Smith, 2019). Moreover, YouTube is a video-based social media platform. Though other social media platforms have followed suit and integrated video into their respective platforms, YouTube is premised on video-based content (Cannell, 2018).

Indeed, the consumption of online content has shifted from mediums, such as written or audio content to video, such that in 2018, 55% of people watched videos online every (50Wheel, 2018) and by the end of 2019, global consumer internet video traffic will account for 80% of all consumer internet traffic (Vernon, 2018). One reason video content is popular is that videos allow for the sharing of complex ideas in a simple format (Azer, AlGrain, AlKhelaif, & AlEshaiwi, 2013). Indeed, the ability to look someone (i.e., the teacher in front of the camera) in the eye and gauge their facial expressions while consuming video content is what separates this delivery method from teaching via written or audio content (Cannell, 2018). Thus, it makes sense that 86% of YouTube users visit the platform for learning purposes (Google Statistics, 2018). However, research investigating physical activity interventions on YouTube is sparse and the information currently available on the platform is unreliable and/or taught by unqualified individuals (Madathil, Rivera-Rodriguez, Greenstein, Gramopadhye, 2015). Additionally, to the author's knowledge, YouTube-delivered physical activity interventions are nonexistent. In fact, a recent review of literature on this topic stated the need for future research to fill this gap (Knight, Intzandt, MacDougall, & Saunders, 2015). Given that 86% of YouTube users visit the platform for learning purposes (Google Statistics, 2018), YouTube represents an ideal platform for qualified health professionals and practitioners to disseminate physical activity promotion and health literacy information.

Social Media Use in Physical Activity Promotion

As previously mentioned, technology is ubiquitous in the U.S. and as such, there has growing population-level interest to obtain free, readily-accessible, Internet-based technologies to fulfill individuals' health and wellness needs (Fisher, & Clayton, 2012; Gold et al., 2012; Thackeray, Crookston, & West, 2013; Fallows, 2005). Accordingly, Maher and colleagues (2015) suggested that online social media is ideal for the delivery of physical activity interventions because of its: (1) vast reach to large and diverse populations; (2) ability to disseminate physical activity and health information using multimedia content (i.e., video content integrated with text and sound) as opposed to solely using traditional text-based content; and (3) ability to establish and maintain high levels of user engagement due to the popularity of these platforms. Indeed, the application of online social media in the health domain has shown promise. In detail, at the population level, these platforms have been used for public health surveillance (Eysenbach, 2011) and treatment in communicable (Eysenbach, 2011; Salathé, Freifeld, Mekaru, Tomasulo, & Brownstein, 2013) and chronic diseases (Mandl et al., 2013; Weitzman, Kelemen, Quinn, Eggleston, & Mandl, 2013). Moreover, at the individual level, online social media platforms have been observed to facilitate access health-based information (Hawn, 2009; Greene, Choudhry, Kilabuk, & Shrank, 2011; Greaves, Ramirez-Cano, Millett, Darzi, & Donaldson, 2013) and social support (Cobb, Graham, & Abrams, 2010) and even prompt better-informed treatment decisions (Wicks et al., 2010; Wicks, Vaughan, Massagli, & Heywood, 2011). However, due to a lack of high-quality studies (e.g., those which used randomized controlled trial designs), there is insufficient evidence that health behavior change interventions using social media as the delivery vehicle are effective for improving health and especially physical activity behaviors (Maher et al., 2014; Johns, Langley, & Lewis, 2017; Williams, Hamm, Shulhan, Vandermeer, B., & Hartling, 014). Specifically, while one study (Cavallo, Tate, Ries, Brown, DeVellis, & Ammerman, 2012) reported a large effect size suggesting there is indeed potential for social media-based health behavior change interventions to increase physical activity engagement, the majority of studies investigating physical activity behavior change using social media-based interventions have reported negligible (Turner-McGrievy & Tate, 2011) or medium (Foster, Linehan, Kirman, Lawson, & James, 2010; Valle, Tate, Mayer, Allicock, & Cai, 2013) effect sizes. However, these studies had some methodological flaws which may have influenced their results.

To begin, these studies failed to identify and focus on the causal mechanism(s) of social media-based interventions to prompt health-related behavior change. Granted, these studies were all conducted before Zhang, Brackbill, Yang, and Centola's (2015) work which was the first study to identify potential mechanisms behind the effectiveness of social media-based interventions. Indeed, the *social* component of social media-based interventions (i.e., peer networks) has been observed to be the causal mechanism of such interventions for increasing physical activity in young adults compared to promotional messages (e.g., broadcasts, infographics) which aim to motivate and teach (Zhang, Brackbill, Yang, & Centola, 2015). In contrast, previous studies have identified promotional health messages to be the causal mechanism, but these effects were observed to attenuate with time (Hornik, 2002; Randolph & Viswanath, 2004). As such, it has been recommended that future studies use a hybrid approach which utilizes promotional messages in the beginning and focuses on the social aspect as the study progresses (Maher et al., 2014). Further, the majority of social media-based interventions lack the use of behavioral change theories embedded in their interventions (Maher et al., 2014). In detail, only three social media-based health behavior change interventions aiming to promote physical activity participation used behavior change theories (e.g., Social Cognitive Theory, Social Learning Theory) for intervention development (Valle, Tate, Mayer, Allicock, & Cai, 2013; Turner-McGrievy & Tate, 2011; Freyne, Berkovsky, Kimani, Baghaei, & Brindal, 2010). Indeed, interventions driven by theory are fundamental for facilitating researchers' ability to more effectively identify and target health behavior determinants (Brug, Oenema, & Ferreira, 2005; Glanz & Rimer, 2005) and interpret the results of an intervention (Patten, 2014). Third, attrition was high and intervention fidelity in these studies was low (Maher et al., 2014). Specifically, study attrition to range from 4% in smaller interventions (Napolitano et al., 2010; Valle et al., 2013) to upwards of 41-84% in larger scale interventions (Ma, Chen, & Xiao, 2010; Brindal, Freyne, Saunders, Berkovsky, Smith, & Noakes, 2012) and intervention fidelity to range from 5-15% (i.e., low use) (Freyne, Berkovsky, Kimani, Baghaei, & Brindal, 2010; Valle, Tate, Mayer, Allicock, & Cai, 2013; Turner-McGrievy & Tate, 2011). Lastly, the majority of social media-based health behavior change interventions have used Facebook or Twitter (Johns, Langley, & Lewis, 2017; Maher et al., 2014)—formerly the most used social media platforms globally and in the U.S. Not only are these platforms outdated (Pew research, 2019) and replaced by YouTube as the leader in global and U.S. social media, but these platforms are primarily text-based platforms whereas YouTube is a multimedia (i.e., video [visual *and* audio components])-based platform. Indeed, multimedia-based health education facilitates higher arousal and increases responsiveness compared to text-based health education content (Houts, Doak, Doak, & Loscalzo, 2006; Kang, Cappella, & Fishbein, 2006).

YouTube for Improving Physical Activity and Physical Literacy

As can be seen, myriads of web-based physical activity promotion interventions have been conducted. These interventions have largely demonstrated short-term effectiveness for increasing participants' physical activity (Davies, Spence, Vandelanotte, Caperchione, & Mummery, 2012; Vandelanotte, Spathonis, Eakin, & Owen, 2007). However, many studies have observed rapid declines in website/media usage as the interventions progress, thereby limiting their effectiveness for promoting long-term physical activity behaviors (Eysenbach, 2005; Leslie, Marshall, Owen, & Bauman, 2005). Indeed, Internet-/web-based intervention content is commonly disseminated as text-based information (e.g., Facebook, Twitter—text-based social media platforms which have been the primary delivery vehicles of such interventions). This is problematic given that text-based information is not effectively transmitted/retained over the Internet given that humans tend to 'skim' or 'scan' text-based information over the Internet and do not fully read the disseminated information (Liu, 2005). In detail, Internet-based reading behavior lacks time spent on in-depth/concentrated reading as people spend more time on non-linear, selective reading (e.g., browsing/scanning and keyword spotting) (Liu, 2005; Sutherland-Smith, 2002). In fact, Nielsen and Pernice (2010) conducted an eye-tracking study and found that participants did not read content on websites as they would read traditional text-based content like a book or newspaper such that the participants quickly scanned websites in an 'F-shaped' pattern focusing on the top-left quadrant of the page, independent of website content. Video-based content has been observed more acceptable compared to text-based content and has been observed to increase time spent on intervention websites (Soetens, Vandelanotte, de Vries, & Mummery, 2014; Alley, Jennings, Persaud, Horsley, Plotnikoff, & Vandelanotte, 2014)—findings echoed by Lee

(2011) in their video-delivered health education intervention who observed better intervention attention, interactivity, and overall website evaluation and preference among college-aged participants compared to a text-based web-intervention group. Given the preceding statistics regarding the increased consumption of video-based content in the modern world and the shift to YouTube (a video-based social media platform) as the new leading social media platform (see **YouTube: The New Leader in Social Media,** above**)** and the superiority of video-based content to increase participant attention and retention in health interventions, the efficacy of using YouTube as a platform to disseminate physical activity information in the promotion of physical activity warrants investigation.

Despite YouTube's positioning as the new global and U.S. leading social media platform, and given the fact that 86% of users visit YouTube for learning purposes (Google Statistics, 2018)—demonstrating this platform's potential to disseminate a physical activity intervention—there is a paucity of research examining the effect of YouTube as a physical activity intervention dissemination tool for promoting physical activity (Madathil, Rivera-Rodriguez, Greenstein, Gramopadhye, 2015; Knight, Intzandt, MacDougall, & Saunders, 2015). Despite the stated need in recently published research to disseminate health and physical activity-related information on YouTube (Knight, Intzandt, MacDougall, & Saunders, 2015; Madathil, Rivera-Rodriguez, Greenstein, Gramopadhye, 2015), to the author's knowledge, only two systematic reviews have been published on this topic and these reviews have been *content*-based rather than reviews of conducted studies using YouTube as a dissemination vehicle to promote behavior change (Knight, Intzandt, MacDougall, & Saunders, 2015; Bopp, Vadeboncoeur, Stellefson, &

Weinsz, 2019). Other similar reviews have been conducted on content-analyses in in the dissemination of medical information (Madathil, Rivera-Rodriguez, Greenstein, Gramopadhye, 2015; Murugiah, Vallakati, Rajput, Sood, & Challa, 2011; Sood, Sarangi, Pandey, & Murugiah, 2011; Stellefson et al., 2014; Oremule, Patel, Orekoya, Advani, & Bondin, 2019; Ward, Ward, Nicheporuck, Alaeddin, & Paskhover, 2019)—the majority of which have acknowledged the lack of regulation of content uploaded to YouTube and the fact that information on such topics may be misleading and potentially dangerous. Accordingly, possible reasons for the lack of content in this field of inquiry may be due to the fact that those qualified to disseminate such information are unfamiliar with how to use platform and/or are uncomfortable speaking in front of a camera. Thus, this section will focus on the available and relevant physical activity-based YouTube-delivered physical activity *content* which will serve as a guideline for the content to be disseminated in this study.

To begin, Knight et al. (2015) reviewed YouTube for sedentary behavior-based content. In detail, the authors identified 106 videos uploaded from 13 different countries which were based on physical activity promotion- and/or sedentary behavior-based content. Their analysis identified numerous components of the content of these YouTube videos. For example, the authors (Knight et al. 2015) observed that the length of the videos had no relationship with the amount of views received, suggesting that videos should be detailed and as succinct as possible (i.e., “get to the point”). Additionally, Knight et al. observed that videos on this subject matter are primarily uploaded from health organizations and individual users with the primary aim of educating other users and that videos which emphasized the promotion of physical activity were most popular rather than reducing sedentary behavior (identified by the number of views and "Likes" a video received and the total engagement which was measured by the number of viewers' comments) (2015). These findings are in line with more recent work (2019) which was a content analysis on YouTube examining physical literacy-based videos in the promotion of physical activity (Bopp, Vadeboncoeur, Stellefson, & Weinsz). In detail, 300 YouTube videos with this content catalogue were identified and the authors observed that videos which focused on delivering physical activity-based content and related behaviors were ranked as having the highest quality among viewers (Bopp, Vadeboncoeur, Stellefson, & Weinsz, 2019). Unique to this content analysis was that the authors observed that videos which covered the affective domains of physical activity (e.g., motivation and acknowledging perceived barriers and social support) were ranked nearly as high as those videos which solely focused on physical literacy and the promotion of physical activity. Moreover, the authors from the Knight et al, review acknowledge a need for qualified health professional or practitioners to produce health-/physical activity-based content on YouTube from accredited academic institutions and/or medical institutions due to an overflow of misinformation uploaded by individual users—users who tend not to be qualified on physical activity promotion- or sedentary behavior-based content (2015). Similar observations were made in Bopp et al.'s (2019) works such that those videos which adhered to the 8 principles of the Health on the net Code of Conduct (i.e., HONcode)—a measure of video quality for health-related topics—were regarded as the highest quality and most reliable by viewers. Briefly the 8 primary principles of the

HONcode (HONcode, 2019) are: (1) authority (i.e., give qualifications of authors); (2) complementarity (i.e., information to support, not replace); (3) confidentiality (i.e., respect the privacy of site users); (4) attribution (i.e., cite the sources and dates of medical information); (5) justifiability; (i.e., justification of claims/balanced and objective claims); (6) transparency (i.e., accessibility/provide valid contact details); (7) financial disclosure (i.e., provide details of funding); and (8) advertising (i.e., clearly distinguish advertising from editorial content). Accordingly, the authors (Knight et al., 2015) call for the research community to "leverage the popularity of YouTube as a knowledge translation vehicle to promote evidence-based information" especially pertaining to reducing sedentary behavior and promoting physical activity. Moreover, also unique to Bopp et al.'s work was that they observed discussions mixed with demonstrations and tutorial-style content to be rated the highest quality and preferred by viewers compared to discussions alone or other similar-style content (2019). Overall, the authors suggest that those seeking physical literacy- and physical activity-based content have a desire for quality videos to be uploaded to the platform and acknowledge YouTube as a powerful dissemination tool of such information (Bopp et al., 2019).

Taken together, social media interventions, especially those which utilize novel and enjoyable, multimedia-based content like YouTube as a delivery vehicle to disseminate a physical activity intervention, should implement the preceding guidelines and content to maximize potential intervention effectiveness. YouTube is free to use for the consumer and free to upload content for researchers/practitioners (i.e., cost-effective for the dissemination of physical activity interventions) and given the preceding statistics regarding its global use, represents a promising tool to disseminate a physical activity intervention which achieves mass-reach—important given that physical inactivity and related health issues in the globally and in the U.S. have reached epidemic proportions.

Use of Theory in Physical Activity Interventions

Changing one's behavior, especially physical activity behavior, is a complicated task given that during the behavior change process, individuals often encounter personal and environmental barriers and challenges (Sallis, Cervero, Ascher, Henderson, Kraft, & Kerr, 2006). Therefore, researchers began to apply psychological, social, behavioral and environmental theories to get a better understanding of the correlates and determinants of physical activity behavior (Sutton, 2008). Indeed, the use of theory in the pursuit of behavior change has been observed important because (Sutton, 2008; Brug, Oenema, & Ferreira, 2005; Patten, 2014): (1) as aforementioned, use of theory allows researchers to gain a better understanding of the physical activity determinants and correlates which facilitates researchers in predicting how certain behaviors may change once these determinants and correlates have been manipulated; (2) physical activity determinants and correlates may be systematically grounded in a physical activity intervention making them more effective and capable of addressing individual's perceived barriers and challenges; and (3) once the intervention has been completed, analysis and interpretation of the study results may be facilitated such that the researchers have a more clear understanding of the relationships of the observed variables.

Three classifications of behavior change theories have been postulated (King, Stokols, Talen, Brassington, & Killingsworth, 2002): (1) personal-level theories; (2)

micro-environmental theories; and (3) macro-environmental theories. As such, behavior change theories not only differ in the physical activity determinants and correlates targeted but also the level of manipulation of these physical activity determinants and correlates (i.e., individual-level, environmental level, or a combination of the two). Indeed, physical activity interventions have increasingly used the environmental-based theoretical approaches (e.g., Social Ecological Model) given that physical activity behavior is premised on the interaction of physical activity determinants and correlates at the individual *and* environmental levels (U.S. Department of Health and Human Services, 2014). However, in doing so, creating interventions with such theoretical underpinnings has been observed difficult as they do not naturally account for environmental-individual interactions in human behavior (Stokols, 1996). Physical activity interventions which naturally target personal-level factors may therefore be more effective. One well-established personal-level factor/physical activity determinant is motivation.

According to Ryan and Patrick (2009), a lack of motivation to engage in physical activity can be explained broadly by two orders of factors: (1) individuals may lack interest in physical activity and/or may not value its outcomes enough to make it a priority in their lives. Indeed, as previously mentioned, adults (especially young adults) often experience competing demands (e.g., work, school, social lives) which often get prioritized over allotting time for physical activity or exercise; and (2) individuals may not feel physically fit or skilled enough (i.e., lack competence) to safely and effectively engage in physical activity and or may have health limitations (e.g., obesity) which present a barrier to physical activity participation (Korkiakangas, Alahuhta, & Laitinen, 2009). Despite the factor—low interest in physical activity or low perceived physical activity competence—the physical activity participation data, especially in the U.S. (Troiano et al., 2008), indicate that many people are either unmotivated (i.e., amotivated) with no intention to be more physically active or are insufficiently motivated relative to other interests or time demands.

In addition to amotivation, another source of abbreviated persistence in physical activity participation comes from those who *do* express personal motivation to engage in physical activity, yet start these behaviors with little maintenance. In detail, individuals may engage in physical activity due to controlled motivations (i.e., extrinsic motivation), where participation in activities like going to the gym or taking a brisk walk regularly are completed based on feelings of *having* to rather than truly *wanting* to (Ryan & Patrick, (2009). More external forms of motivation are not autonomous (i.e., lack volition) and are often predominant when physical activities are perceived mostly as a means to an end and are often associated with motives or goals like improving one's appearance or receiving tangible rewards or awards (Markland, 2009). Thus, Deci & Ryan (2000) hypothesize that one's motivational stability is, to some extent, partially dependent on some of its qualitative features, especially the degree of one's perceived autonomy or internally-perceived locus of causality. Thus, there remains a need to investigate more closely the goals and self-regulatory features associated with regular physical activity participation in the modern world. Deci & Ryan's Self-determination Theory (1985, 2000) is a popular and well-studied personal-level theory fundamentally centered on human motivation and aims to examine the differential effects of different types of motivation which underlie behaviors. Specifically, the Self-Determination Theory originates from a humanistic perspective (Deci & Ryan, 1985, 2000) and is therefore built around the fulfillment of needs, self-actualization, and the realization of human potential. The following section will detail the structure and concepts of Self-Determination Theory.

Self-determination Theory

Deci & Ryan's Self-determination Theory (1985, 2000) has been observed effective for explaining individuals' situational and proximal motivation in regard to physical activity and health behaviors. This theory assumes that individuals possess three distinct psychological needs: (1) *self-determination* (i.e., the need for autonomy or self-dependent behavior); (2) *competence* (i.e., the need for experience task mastery); and (3) *relatedness* (i.e., the need for social interactions) (Deci & Ryan, 1985; Deci & Ryan 2000), and that individuals seek challenges to fulfill these needs. Further, Self-determination Theory posits that there are three types of motivation which drive behaviors of achievement and follow a continuum from non-motivated to highly motivated: (1) amotivation (i.e., relative absence of motivation/no intention to engage in a physical activity behavior); (2) external motivation (i.e., motivation induce by a force outside of an individual); and (3) intrinsic motivation (i.e., engaging in a physical activity behavior for inherent pleasure or personal challenge) (Deci & Ryan, 1985; Deci & Ryan 2000). Moreover, there are four types of extrinsic motivation which lie between amotivation and intrinsic motivation on the continuum (from least self-determined to most self-determined): (1) external regulation (i.e., engaging in a behavior to receive an award or to avoid punishment); (2)

introjected regulation (i.e., behavior is driven by a self-perceived source of pressure or obligation); (3) identified regulation (i.e., a behavior is motivated by the achievement of personal goals); and (4) integrated regulation (i.e., engaging in a behavior to confirm a sense of self) (Deci & Ryan, 1985). Along this continuum, self-determination decreases from intrinsic motivation to amotivation and therefore, order of these motivation types is relevant such that those closest to one another (e.g., intrinsic motivation, integrated regulation) share similar motivational qualities that those more distant from one another (e.g., intrinsic motivation, introjected regulation). This has significance because motivation that is higher in self-determination (autonomy) are related to positive achievement outcomes, especially those related to physical activity.

Past research has provided empirical support for Self-determination Theory to increase physical activity behavior (King et al., 2002; Mullan, Markland, & Ingledew, 1997; Chatzisarantis & Biddle, 1998). Indeed, interventions promoting more internally-motivated forms of regulation (i.e., identified-, integrated-, and intrinsic-regulation) by increasing PA-related competence have been observed to facilitate greater amounts of physical activity and weight loss in adults (Silva et al., 2010) and be more predictive of young adults' exercise behaviors—the population to be used in this study (Farmanbar, Niknami, Lubans, & Hidarnia, 2013). Further evidence indicates that those with higher levels of amotivation tend to get bored easily and avoid physical activity (Gao, Hannon, Newton, & Huang, 2011; Gao, 2012; Gao, Podlog, & Harrison, 2012). These findings are in line with findings from Thøgersen-Ntoumani & Ntoumanis (2006) which observed exercisers who reported greater self-determination (i.e., higher levels of intrinsic motivation and introjected regulation) also reported greater levels of self-efficacy to overcome perceived exercise barriers, lower social physique anxiety, increased physical self-worth, and greater intentions to exercise than those with lower levels of self-determined motivation (i.e., increased amotivation and external regulation.

Taken together, a YouTube-delivered physical activity intervention which utilizes Self-determination Theory may be an effective approach for increasing participants' aerobic and muscle-strengthening physical activity behaviors.

Purpose of Study

Therefore, the purpose of this proposed randomized controlled trial was to determine the effectiveness of a remote, home-based, YouTube-delivered physical activity intervention grounded in Self-determination Theory in the promotion of healthy physical activity and sleep behaviors and associated health outcomes over 12 weeks in young adults compared to a general health education control group. In detail, the following specific aims and associated hypotheses were proposed:

Study Aim 1 (Primary Outcome). Determine the effectiveness of a weekly remote, YouTube-delivered physical activity intervention grounded in Self-determination Theory on young adults' objectively measured free-living (i.e., habitual) moderate-to-vigorous-intensity physical activity levels over 12 weeks versus control participants who received weekly general health education videos.

Hypothesis 1. Participants in the intervention group receiving the weekly remote, YouTube-delivered physical activity intervention will have significantly greater improvements in their objectively measured, free-living moderate-to-vigorous-intensity physical activity levels than the general health education control group after 12 weeks.

Study Aim 2 (Secondary Outcomes). Determine the effectiveness of a weekly remote, YouTube-delivered physical activity intervention grounded in Self-determination Theory on young adults' objectively measured sedentary behavior, light-intensity physical activity, and sleep quality, weekly muscle-strengthening physical activity frequency, Self-determination theory-related autonomous motivation for physical activity, perceived physical activity barriers, physical activity-related enjoyment, physical activity-related self-efficacy, and Self-determination Theory-related social support over 12 weeks versus control participants who received weekly general health education videos.

Hypothesis 2. Participants in the intervention group receiving the remote, YouTube-delivered physical activity intervention will have greater improvements in sedentary behavior, light-intensity physical activity, and sleep quality, weekly muscle-strengthening physical activity frequency, Self-determination theory-related autonomous motivation for physical activity, perceived physical activity barriers, physical activity-related enjoyment, physical activity-related self-efficacy, and Self-determination Theory-related social support over 12 weeks than the control group.

Study Aim 3. Determine intervention interests, use/acceptability, adherence, and retention.

Summary

As can be seen in the preceding literature review, it is well-established that online media consumption in the U.S. has shifted from traditional text-based formats to video-based formats which have shown to be more enjoyable and to prompt more long-term engagement—a major issue and limiting factor with past social media-based physical activity interventions disseminated via text-based platforms like Facebook or Twitter. Despite this knowledge, social media-based physical activity promotion interventions still rely on text-based formats to disseminate information and have neglected the use of video to educate and inform individuals of the benefits and "how-to" regarding physical activity. Therefore, results from this research may help fill this research gap and validate YouTube (again, the most-used social media platform globally and in the U.S.) as an effective social media platform to disseminate cost-effective, mass-reach physical activity promotion interventions to national and global audiences in enjoyable, video-based formats. Additionally, findings from this research may encourage qualified health professionals and practitioners to create physical activity- and physical literacy-based content with the aim of increasing physical activity and ultimately, improving health and decreasing the risk of chronic disease onset among U.S. young adults.

Applying this YouTube-delivered physical activity intervention in a real-world setting is feasible and quite simple. Indeed, as with any social media platform, all one must do is register for a free account, create content suitable for the platform, and upload or post this content directly to the platform. In this case, qualified health professionals/scholars (preferably) can create video-based content using their preexisting knowledge regarding the benefits of physical activity and employ theory-based intervention strategies to educate the masses with the aim of prompting long-term physical activity behavior change. Health and medical information can be found in abundance on YouTube. For instance, YouTube users can find videos and educate themselves on a variety of topics including, but not limited to immunization (Keelan, Pavri-Garcia, Tomlinson, & Wilson, 2007), cardiopulmonary resuscitation (Murugiah et al., 2011), rheumatoid arthritis (Singh, Singh, & Singh, 2012), reminiscence therapy in dementia patients (O'Rourke, Tobin, O'Callaghan, Sowman, & Collins, 2011), surgical preparations (Rapp, Healy, Charlton, Keith, Rosenbaum, & Kapadia, 2016), and even nursing curriculum (Sharoff, 2011; Skiba, 2007). However, as previously mentioned, YouTube contains misleading, primarily anecdotal information, which contradicts reference standards and there is a relatively high probability of the lay user finding such content in their search for information (Madathil et al., 2015). Accordingly, Madathil and colleagues (2015) state that "the need to design interventions to enable consumers to critically assimilate the information posted on YouTube with more authoritative information sources to make effective healthcare decisions." This is in agreeance with Hayanga and Kaiser (2008) who purport that YouTube is a major mechanism for communicating health information and that health professionals who ignore it will simply facilitate its domination by viewpoints discordant with evidence-based medical opinion. Thus, there is a dire need for more authoritative sources to create health-related content on YouTube and given that physical inactivity and associated health disorders are at epidemic levels, qualified professionals in the field of physical activity epidemiology should consider disseminating evidence-based information to promote physical activity behavior change at scale. This is especially crucial during and after the COVID-19 pandemic given the uncertainty in young adults' physical activity and exercise behaviors and environments.

Chapter Two: Methodology

The Consolidated Standards of Reporting Trials (CONSORT; Moher et al., 2010) guidelines were referred to while drafting this manuscript (Appendix A). Further, this study was approved by the University of Minnesota Institutional Review Board (STUDY00010444; Appendix B) and received University Sunrise approval for conducting human-based research during the COVID-19 pandemic (Appendix C) in November 2020 and the trial was registered the with ClinicalTrials.gov (NCT04499547). All study questionnaires were distributed to participants using Qualtrics (Qualtrics; Provo, UT)—an online survey software. Notably, for all survey questions within this software, the "force response" function was applied to ensure a 100% survey response and completion rate.

Study Design and Participants

A prospective, 12-week, parallel randomized controlled trial was employed wherein participants were randomized (1:1) into either: (a) the experimental group (received weekly YouTube video-delivered aerobic and muscle-strengthening physical activity and exercise videos grounded in Self-determination Theory); or (b) the control group (received weekly YouTube video-delivered general health education videos with no physical activity- or exercise-related content). In detail, 64 participants from the University of Minnesota participated in Fall 2020/Winter 2021 and all 64 participants started the study concurrently given the study University's winter break was approaching and the impending graduation of the principal investigator (D.J.M.). Given national COVID-19-related campus closures, participants were only recruited via email communication using various University email servers to sample from a variety of disciplines. Study inclusion criteria were determined a priori and included: (1) participants who were between the ages of 18 and 35 years; (2) were enrolled or employed at/by the study University; (3) had a body mass index ≥ 18.5 kg/m^2; (4) had physical activity levels below national recommendations over the last month (verified by questionnaire; Appendix E); (5) possessed no self-reported diagnosed physical and/or mental disability and had no contraindications to physical activity participation (assessed by the physical activity Readiness Questionnaire; Appendix D); (6) had Internet access and a device capable of accessing YouTube; and (7) were willing to be randomized into either the intervention or control group. Conversely, participants were excluded from participation in the study if: (1) they were younger than 18 years or older than 35 years; (2) had a body mass index < 18.5 kg/m^2; (3) met or were above the physical activity recommendations over the last month; (4) answered ‘yes’ to at least one question on the Physical Activity Readiness Questionnaire; (5) did not have access to the Internet and/or YouTube; or (6) were not willing to be randomized into either the intervention or control group. University of Minnesota Institutional Review Board approval and written informed consent (digitally signed; Appendix D) were obtained from participants prior to recruitment and data collection. Further, all participant-involved procedures were performed in accordance with the ethical standards of the Institution and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards (World Medical Association, 2009). Participants were paid $30 for successful study completion (i.e., all data collection sessions were completed and all study materials were returned in normal condition to the study laboratory).

Procedures

Interested participants were instructed to respond directly to the recruitment email, after which the project manager (M.A.H.) responded with an email link containing the online consent form and questionnaires to determine if they met the preceding inclusion criteria. Participants who qualified were emailed another link which contained a battery of online baseline surveys to obtain demographic information (Appendix D) and assess psychosocial and other self-reported study outcomes. The same psychosocial and self-report questionnaires were re-distributed at 12 weeks for post-intervention assessments. Additionally, at baseline and 12 weeks, participants who qualified for the study were mailed an ActiGraph GT9X accelerometer with an adjustable wrist strap, the associated wear instructions (Appendix K), and a sleep log (Appendix L) and were also provided a self-addressed stamped envelope to return the accelerometer and sleep log after the seven-day day wear periods. Notably, the wear log was only utilized as a wear-compliance strategy given the analysis of raw accelerometer data did not require sleep log input. All accelerometers were disinfected based on World Health Organization guidelines (World Health Organization, 2020) as well as study University policies before being distributed to participants. Accelerometers were mailed back by participants in the supplied envelope with pre-paid postage and the returned accelerometers were left untouched (i.e., quarantined) for ≥ 14 days to rid them of any potential COVID-19 contamination (World Health Organization, 2020).

Following the seven-day baseline testing period, the project manager informed participants of their group allocation. To preserve participants' privacy per the University's Institutional Review Board policy and to also blind the study investigators of participants' group allocation, participants were instructed by the project manager to create a new YouTube account that was linked to their University email under a pseudo username (i.e., a creative username other than their given name so they could not be identified [e.g., "YouTube Intervention Participant 2021"]). Participants were then instructed to subscribe to the YouTube channel for their respective study group and turn on upload notifications by clicking the "bell" icon. Turning on upload notifications was used as an intervention adherence strategy as it ensured that participants would be immediately notified via email when each video was uploaded to the study channel. Lastly, as part of the intervention fidelity protocol, participants were encouraged to contact the project manager with questions and were also contacted every three weeks during the study with standardized emails encouraging continued intervention adherence (Appendices G and H). Lastly, to prevent intervention contamination, participants were asked to refrain from sharing their group allocation and/or content from their group videos with friends/peers who were enrolled in the study.

Interventions

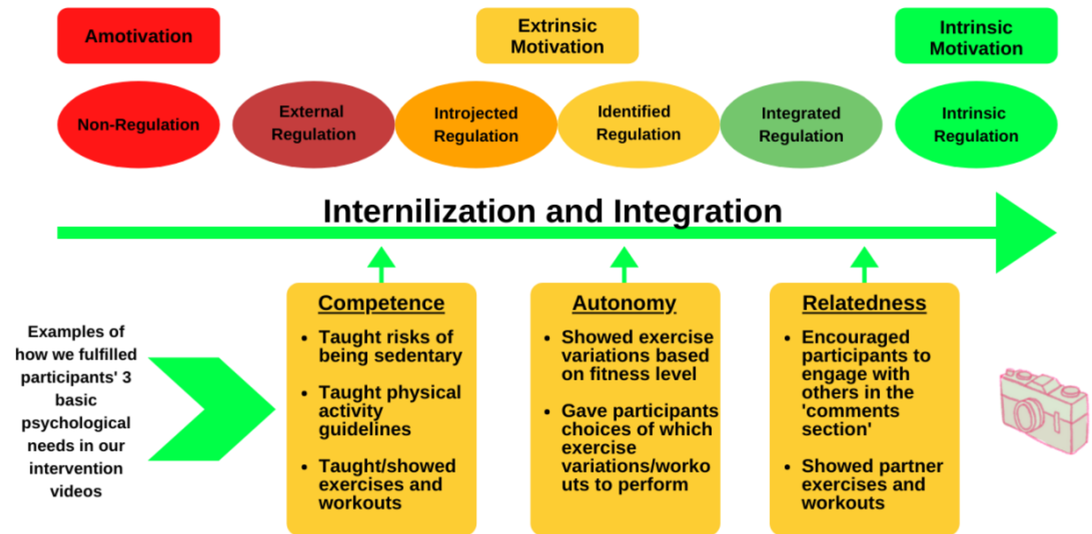
YouTube as used as the delivery vehicle for the intervention videos to maximize ecological validity as the formative testing among young adults at the study University revealed this platform to be the primary place of consumption for Internet-based video—consistent with statistics demonstrating YouTube to be the top social media platform both globally and in the U.S. and particularly among young adults (used by 94%) (Smith & Anderson, 2018; Smith, 2019). Additionally, social media platforms like YouTube are cost-effective methods of increasing user interaction and providing peer-to-peer support (Mack et al., 2021; Moorhead, Hazlett, Harrison, Carroll, Irwin, & Hoving, 2013) through interactions in the "comments section" of the videos which the formative testing revealed to be an enjoyable intervention component.

Formative testing was conducted in the Spring and Fall of 2020 among young adults around the study University by distributing surveys and conducting small focus groups to help identify preferred physical activity-based video content (e.g., preferred video lengths and upload frequencies, preferred physical activity- and sedentary behavior-related content, workout interests, etc.). Based on the findings, to achieve high intervention adherence make the study videos enjoyable in both groups, the American Medical Association's (American Medical Association, 2021) video quality guidelines for video and sound recording and best practices for video editing (e.g., utilizing "jump-cuts" for conciseness) were adhered to. Also based on feedback from the formative testing, "A-roll" (i.e., primary footage of the main subject [M.A.H.] wherein the main content is taught interview-style) was utilized and "B-roll" (i.e., supplemental video footage) overlaid the A-roll footage during post-production editing to visually demonstrate what was being talked about and show how to properly execute the information to facilitate participants' physical literacy (Bopp, Vadeboncoeur, Stellefson, & Weinsz, 2019). To further increase video quality and participants' comprehension of the intervention content, during post-production editing the video footage was overlaid with text using dynamic motion graphics titles, relevant stock images and video footage (Shutterstock.com; Shutterstock; Ney York, NY, USA), copyright-free music to the workouts, and multiple camera angles to demonstrate proper biomechanics of the demonstrated exercises. To track intervention adherence (i.e., watching all study videos in their entirety), both groups were instructed to respond to "in-video response questions" (embedded randomly within each study video) within the comments section of each video. Intervention adherence was also tracked using watch-time metrics provided by YouTube's Creator Analytics and informed participants that if their video adherence was deemed too low, they may be removed from the study. Lastly, to improve ecological validity and facilitate Self-determination Theory-related social support, participants were encouraged to interact with other participants and provide feedback on their responses to the response questions within the comments section of each video.

Experimental group intervention

In addition to the formative testing, the intervention videos were informed by an empirically based content analysis (Bopp, Vadeboncoeur, Stellefson, & Weinsz, 2019) which examined the best practices for disseminating physical activity, sedentary behavior, and exercise information via video (e.g., emphasis should be placed more on increasing physical activity rather than reducing sedentary behavior). Moreover, given research demonstrating young adults' decreased autonomous motivation for engaging in home-based physical activities and exercise (Kaushal, Keith, Aguiñaga, & Hagger, 2020), the intervention group videos were grounded in Self-determination Theory (Deci & Ryan, 1997; Deci & Ryan, 2000; Ryan, & Patrick, 2009)—a well-documented health behavioral change theory which has demonstrated effectiveness for improving young adults' intrinsic motivation for physical activity and exercise. Intervention group instructions are available in Appendix I and sample video content and script are available in Appendix M, O, and P, respectively. Self-determination Theory and how the intervention group videos were grounded in Self-determination Theory is demonstrated in Figure 1.

Figure 1. Self-Determination Theory-Grounded Intervention Videos



The intervention group received one YouTube video per week ($\bar{X}_{duartion}$ = 6.3 ± 3.9 minutes) and were asked not to consume other physical activity- and/or exercise-related YouTube videos during the duration of the 12-week intervention. In detail, the videos contained sedentary behavior-related content (e.g., discussed the negative effects of prolonged sedentary behavior and different strategies regarding how to break up daily sedentary behavior), physical activity-related content (e.g., taught participants the aerobic and muscle-strengthening physical activity guidelines (Bull et al., 2020) and various strategies to increase their daily moderate-to-vigorous-intensity physical activity and muscle-strengthening physical activities), and/or home-based aerobic and muscle-strengthening workouts that participants could follow along to on-screen. Regarding the home-based workout videos, in the absence of commercial gym equipment, high-intensity interval training has been observed as a feasible and effective option for home-based aerobic physical activity/exercise—especially that of moderate-to-vigorous intensities—with limited space (Schwendinger & Pocecco, 2020). Briefly, pre-recorded video was leveraged and on-screen countdown timers were edited in (green countdown timers indicated work intervals, red countdown timers indicated rest intervals) so participants could follow along and up-tempo music was added in during the workout intervals to increase enjoyment and workout intensity. Likewise, muscle-strengthening exercise (e.g., resistance-training) could effectively be achieved in the home setting using one's own bodyweight and by manipulating various resistance-training variables (e.g., focusing on eccentric muscle actions, shortening between-set rest intervals, using general home items to add external resistance, etc.) (Schwendinger & Pocecco, 2020; Campos et al., 20002; Schoenfeld, Grgic, Ogborn, & Krieger, 2017; Schoenfeld, Peterson, Ogborn, Contreras, & Sonmez, 2015). Additionally, high-quality PDF files were created (e.g., Appendix P) which contained written versions of the workouts and linked them directly under the YouTube videos so participants could download them and readily access them any time they wanted to re-visit the workouts to help meet the weekly muscle-strengthening physical activity guideline (Bull et al., 2020). Lastly, given only one video per week was uploaded, participants were encouraged to re-visit the previous study videos and PDF workout files and perform the provided workouts multiple times per week to further increase moderate-to-vigorous-intensity physical activity and muscle-strengthening physical activity levels. Full access to the control group's videos was provided after successful completion of the 12-week intervention as an additional intervention adherence strategy.

Control Group Intervention

The control group also received one video per week during the 12-week intervention and were asked not to consume other health-related YouTube videos during the 12-week intervention. In detail, these videos were delivered on the same days/times as the intervention group videos but contained no physical activity- and/or exercise-related content. Rather, the video content within the control group covered a variety of general health education topics relevant to young adults (e.g., nutrition, anxiety, mental health). As an additional incentive for intervention fidelity in the control group, full access to the intervention group's videos was provided after successful completion of the 12-week intervention. Control group instructions are available in Appendix J and sample video content for the control group is available in Appendix N and P.

Study Outcomes

The following tests were conducted to measure free-living moderate-to-vigorous-intensity physical activity (primary outcome) and sleep quality, adherence to the muscle-strengthening physical activity guidelines, Self-determination Theory-related autonomous physical activity/exercise motivation, perceived physical activity/exercise barriers, physical activity-related self-efficacy, and physical activity-related enjoyment (secondary outcomes). All study outcomes were determined a priori.

Baseline demographics and anthropometric measures

The online survey software was used to collect participants' self-reported demographic information (e.g., age, sex, previous YouTube use/experience, COVID-19-related effects on their physical activity/exercise levels, etc.) using a variety of response-types (e.g., multiple-choice, short answer; Appendix D). Full demographic information for the study's sample by study group is provided in Table 1. Given the fully remote nature of the study, baseline anthropometric measures (e.g., height [cm], weight [kg]) were also self-reported and body mass index was calculated as weight (kg)/height (m^2)

after converting centimeters to meters. These data were collected at baseline and analyzed descriptively to characterize the study sample.

Free-living physical activity, sedentary behavior, and sleep quality

Daily minutes in moderate-to-vigorous-intensity physical activity, light-intensity physical activity, and sedentary behavior and sleep quality were measured using the wrist-worn ActiGraph GT9X accelerometer (ActiGraph; Pensacola, FL, USA)—a small (3.5 x 3.5 x 100 mm), lightweight (14g) device that captures one's movement along the three orthogonal axes. Notably, wrist-worn over hip-worn accelerometers were used because they are perceived as less burdensome among adults in free-living conditions (Pavey, Gomersall, Clark, & Brown, 2016), thereby resulting in higher levels of compliance and also to allowed for accelerometer-measured sleep monitoring which has been validated against full-night polysomnography (Meltzer, Walsh, Traylor, & Westin, 2012; Sadeh, Sharkey, & Carskadon, 1994; Cole, Kripke, Gruen, Mullaney, & Gillin, 1992)—the gold standard for objective sleep analysis. Participants were instructed to snugly and comfortably fit the accelerometers using the provided wrist strap on the wrist of the non-dominant arm and to remove any other health wearable device(s) for the duration of the wear periods (McDonough, Su, & Gao, 2021). To allow for the collection of physical activity and sleep data, participants were asked to wear the accelerometer all day and night for a period of seven days with the only exception being during activities of prolonged deep-water submersion (e.g., swimming). Data were sampled at a frequency of 30 Hz and the screens were intentionally turned the off to disable physical activity-related feedback to prevent performance bias. sleep quality was defined as sleep duration (i.e., total true sleep time) and sleep efficiency (i.e., the ratio of time sleeping divided by total time in bed) (Falck, Stamatakis, & Liu-Ambrose, 2021). Accelerometer data were considered valid if worn for at least four days, including at least one weekend day, and for at least 16 hours each day (van Hees et al., 2018; Dillon, Fitzgerald, Kearney, et al., 2016).

The raw accelerometer data were processed into five-second epochs using the R Studio-package ‘GGIR’ (version 1.2.1335) (Migueles, Rowlands, Huber, Sabia, & van Hees, 2019) in R (version 4.0.4). Briefly, GGIR calculates physical activity intensities and detects non-wear time by converting all raw acceleration values into a single omnidirectional acceleration value (Migueles et al., 2019). Specifically, the raw accelerometer data were auto-calibrated and converted into gravity-corrected vector magnitude units called Euclidian norm minus one with negative values set to zero (ENMONZ). For valid wear days, physical activity intensities (i.e., moderate-to-vigorous-intensity physical activity, light-intensity physical activity, sedentary behavior) were calculated based on previously established cut-points in milligravity (mg) for ENMONZ values: sedentary behavior (0-56.2 mg), light-intensity physical activity (56.3-191.6 mg), and moderate-to-vigorous-intensity physical activity (> 191.6 mg) (Hildebrand, van Hees, Hansen, & Ekelund, 2014; Hildebrand, Hansen, van Hees, & Ekelund, 2014). For detection of participants’ sleep quality, GGIR was used to estimate change(s) in arm angle while sleeping relative to the horizontal plane, with a change in arm angle of < 5º over a five-minute period considered as a possible sleep period (Van Hees, Sabia, Anderson, et al., 2015). The following sleep variables were calculated: sleep duration (hours/night) and sleep efficiency (total sleep time (hours)/time in bed (hours)*100). Mean values for all intensity categories of physical activity, sedentary behavior, and both sleep quality outcome categories were calculated at both baseline and 12 weeks.

Muscle-strengthening Physical Activity Frequency

Muscle-strengthening physical activity frequency was assessed using an item from the Behavioral Risk Factor Surveillance System survey—a valid (Dankel, Loenneke, & Loprinzi, 2016) and reliable (Yore, Ham, Ainsworth, et al., 2007) self-report assessment of adults' habitual participation in muscle-strengthening physical activities (Appendix F). The full script for this item has been published elsewhere (Bennie, De Cocker, Teychenne, et al., 2017). Notably, participants reported their muscle-strengthening physical activity frequency as times per week or per month. For those who reported times per month, this number was divided by four to provide estimates of weekly muscle-strengthening physical activity frequency (Dankel et al., 2016). Further, it was a priori decided to truncate weekly frequency of muscle-strengthening physical activity at 14 times/week to limit the possibility of unrealistic responses (Bennie et al., 2019). Based on previous research, participation in muscle-strengthening physical activities (times/week) was categorized into five groups: zero, one, two, three to four, and ≥ five (Bennie et al., 2019). Mean changes in participants' days per week of muscle-strengthening physical activity were used as the primary study outcome and were measured at baseline and 12 weeks.

Self-determination Theory-Related Self-Determined Motivation

Participants' Self-determination Theory-related self-determined motivation for physical activity/exercise was evaluated using the 24-item Behavioral Regulation in Exercise Questionnaire-3 survey (Wilson, Rodgers, Loitz, & Scime, 2006)—an amended version of the Behavioral Regulation in Exercise Questionnaire-2 survey to include an assessment for integrated regulation which has demonstrated good validity and reliability for measuring self-determined motivation for physical activity in U.S. young adults (D'Abundo, Sidman, Milroy, Orsini, & Fiala, 2014) (Appendix F). Briefly, the Behavioral Regulation in Exercise Questionnaire-3 survey is used to quantify the continuum of behavioral regulation types in physical activity and exercise applications by evaluating three levels of motivation, progressing from amotivation to extrinsic motivation and then to intrinsic motivation with six subscales progressing along this continuum: (1) non-regulation; (2) external regulation; (3) introjected regulation; (4) identified regulation; (5) integrated regulation; and (6) intrinsic regulation (Mullan, Markland, & Ingledew, 1997). In detail, using a five-point Likert-type scale (0 = "not true for me"; 2 = "sometimes true for me"; 4 = "very true for me"), the Behavioral Regulation in Exercise Questionnaire-3 survey required participants to determine how true different statements were, such as "I don't see why I should have to exercise," (for amotivation) and "I exercise because it's fun" (for intrinsic regulation). The mean score for each of the six subscales was used as the outcome with higher scores indicating a greater regulation-type. Participants' Self-determination Theory-related self-determined motivation was assessed at baseline and 12 weeks. Internal consistency (Cronbach's alpha) for this measure was good among the study sample (α = 0.84) (Tavakol & Dennick, 2011).

Perceived Physical Activity/Exercise Barriers

Participants' perceived physical activity/exercise barriers were evaluated using the 14-item Perceived Barriers Scale which has demonstrated good reliability and validity among adults (Sechrist, Walker, & Pender, 1987) (Appendix F). In detail, this scale required participants to rate the agreement between their own perceived physical activity/exercise barriers and hypothetical physical activity/exercise barriers using a four-point Likert-type scale (1 = strongly disagree; 2 = disagree; 3 = agree; and 4 = strongly agree) for statements, such as "Physical activity takes too much of my time" and "There are too few places to be physically active." Mean scores were used as the study outcome with higher scores indicating greater perceived barriers to physical activity/exercise. Participants' perceived physical activity/exercise barriers were assessed at baseline and 12 weeks. Internal consistency for this measure was good among the sample ($\alpha = 0.81$) (Tavakol & Dennick, 2011).

Physical Activity-Related Social Support

Participants' perceived social support for physical activity was determined using the five-item Perceived Social Support questionnaire which has been previously validated (Carlson et al., 2012) (Appendix F). In detail, using a five-point Likert-type scale (1 = *almost never*; 2 = *once in a while*; 3 = *sometimes*; 4 = *often*; and 5 = *very often*), participants answered the question, "How often in the last 30 days has your family or friends done the following?" with five different responses, such as "encouraged you to do physical activity" and "done physical activity with you." This Perceived Social Support questionnaire has demonstrated good internal consistency ($\alpha = 0.85$-0.89 for women and men, respectively) (Carlson et al., 2012). Corresponding with scoring protocol, the items in this scale were summed and averaged (range = 5-25) with higher scores indicating higher perceived social support. Participants' perceived social support was evaluated at baseline and 12 weeks.

Physical Activity-Related Self-Efficacy

The Self-Efficacy for Exercise scale was revised from McAuley's (1990) self-efficacy barriers to exercise measure. This nine-item self-report instrument asks individuals to rate their self-efficacy expectations for continuing PA despite certain barriers in situations such as, "If the weather was bothering you" or "If you were tired" (see Appendix F). Individuals rate their self-efficacy on a scale from 0 (not confident) to 10 (very confident) on how confident they are that they could be active three times a week for 20 minutes each time in nine situations. The Self-Efficacy for Exercise scale has demonstrated both validity (Resnick, Luisi, Vogel, & Junaleepa, 2004) and high internal consistency ($\alpha = 0.92$; Resnick & Jenkins, 2000).

Physical Activity-Related Enjoyment

The Physical Activity Enjoyment Scale included 18-items and was designed to assess physical activity-related enjoyment in adults across different modalities (Kendzierski & DeCarlo, 1991). Items included paired statements, such as, "I enjoy it" against "I hate it" or "It's not at all stimulating" against "It's very stimulating" (see Appendix F). These statements were at opposite ends of a seven-point Likert scale and participants were asked to respond based on which statement best represented their feelings. The Physical Activity Enjoyment Scale varies the positive and negative items on either side of the Likert scale, thereby resulting in reverse scoring for positive items. All items were summed together for the total enjoyment score. This measure has demonstrated good validity and reliability (Kendzierski & DeCarlo, 1991; Lewis, Williams, Frayeh, & Marcus, 2016).

Process Evaluation Outcomes

Interest in the YouTube-Delivered Exercise Intervention

Interest remote, YouTube-delivered physical activity intervention was operationalized as the number of individuals who contacted the principal investigator with study interest over the cumulative recruitment duration of one week.

Adherence to the YouTube-Delivered Exercise Intervention

Adherence to the remote, YouTube-delivered physical activity intervention was tracked among both study groups. In detail, participants' pseudo-usernames were cross-referenced with their given names to determine whether participants watched the videos and watched them in their entirety. Specifically, participants were instructed to comment below each video in the "Add a public comment" and provide a detailed response to the "in-video response question(s)" which were embedded randomly throughout each video. Participants were assigned one point for each video that they fully adhered to (i.e., responded to the in-video question(s)). Accordingly, there were 12 possible points (12 weeks of once-weekly video uploads) and 12-week adherence was the outcome (i.e., the number of points earned at 12 weeks divided by 12 [total possible points] * 100).

Intervention Use/Helpfulness

At the end of 12 weeks, during post-intervention testing, participants in the YouTube video-delivered physical activity experimental group were administered a simple, two-item survey used in previous research (Pope et al., 2019) to assess the helpfulness and use of the YouTube-delivered physical activity tips and aerobic and muscle-strengthening exercise regimens. Given that the original survey was intended for Facebook use, this survey was modified and adapted for the use of a YouTube video-delivered intervention. In detail, using a seven-point Likert-type scale (1 = *Very Unhelpful*; 7 = *Very Helpful*), participants responded to the question "How helpful would you consider the physical activity/exercise tips delivered to you via the YouTube channel?" and using a 6-point Likert-type scale (1 = *Never*; 6 = *Daily*), answered the question "How many days a week/month did you implement at least one of the physical activity/exercise tips delivered to you via the YouTube channel in daily life?".

Sample Size Calculation, Randomization, and Blinding

G*Power (G*Power; Brunsbüttel, Germany) was used to determine the necessary sample size for this study based on changes in free-living moderate-to-vigorous-intensity physical activity—the primary study outcome. Based on average (small) effect sizes for changes in young adults' moderate-to-vigorous-intensity physical activity (d = 0.30) from previous social media-delivered physical activity promotion interventions of the same duration (Pope, Barr-Anderson, Lewis, Pereira, & Gao, 2019; Williams, Hamm, Shulhan, Vandermeer, & Hartling, 2014), it was estimated that 60 participants (30 per group) were necessary to detect a significant between-group difference to give 80% power with a two-sided significance level of 0.05. Assuming 15% attrition, the goal was to enroll 69 participants. No interim analysis was planned.

Randomization, participant enrollment, and group allocation was completed by the project manager who was blinded to the study questions and outcomes. Specifically, the random allocation sequence was completed using the 'ranomizeR' package in R Studio with no block restrictions applied. Given the use of pseudo usernames within the intervention YouTube channels to preserve participants' privacy, all other investigators were blinded to participants' group allocation which was not broken until the primary and secondary analyses were completed.

Statistical Analysis

All data were collected and organized using an online Microsoft Excel spreadsheet (Microsoft Corp., Redmond, WA, USA). Prior to the main analysis, the raw accelerometer physical activity and sleep data were extracted from the associated ActiLife accelerometer software (version 6.13.3; Pensacola, FL, USA) and these data were analyzed using the GGIR package in R Studio. Missing data were handled and analyzed under the intent-to-treat principle (i.e., based on original random allocation) using multiple imputation on a missing at random assumption and Multiple Imputation was completed with Chained Equations (MICE) using the 'MICE' package in R Studio. Following, the main analysis was conducted using SPSS Statistics Version 27.0 (IBM Corp., Armonk, NY, USA). First, histograms and Shapiro-Wilks' statistics were used to examine the assumptions of normality and outliers for the repeated measures ANOVAs. Following, two-way (time x group) repeated measures ANCOVAs were conducted for all outcomes, with time as the within-subject factor, group as the between-subject factor, and mean baseline measures for each individual outcome as the covariate. The significance level was set to $p = 0.05$ and to account for potential bias from multiple comparisons, the Bonferroni correction was applied for the 16 dependent variables. Thus, the adjusted familywise error rate was 0.004 ($\alpha = 0.05/16 = 0.003$) at the individual outcome level. Lastly, for statistically significant outcomes, effect sizes were reported as partial eta-squared (η_p^2) with small, medium, and large effect sizes classified as 0.01, 0.06, and 0.14, respectively (Richardson, 2011; Cohen, 1988). Means and associated standard deviations (SDs) were reported for all outcomes.

Notably, because the distribution of between-group baseline covariates in parallel-group randomized controlled trials, by definition, are due to chance (American Medical

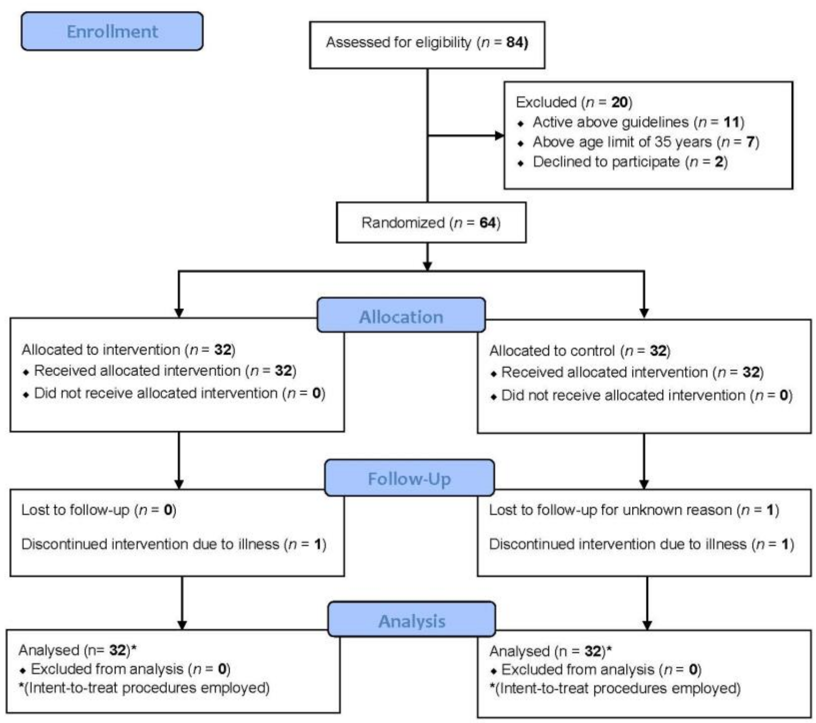
Association, 2020), hypothesis tests regarding the distribution of between-group baseline covariates were not conducted. Accordingly, statements of statistical comparisons among the randomized groups were not included, nor were p values reported in the baseline participant characteristics table. Nevertheless, to control for any potential effect of baseline performance, baseline measures for each individual outcome were used as the covariate.

Chapter Three: Results

Participant Flow Through the Trial

Participant flow of through the trial is shown in Figure 2. Briefly, 64 participants were deemed eligible, completed baseline testing, and were randomized (reasons for ineligibility at each stage of recruitment are shown in Figure 2).

Figure 2. CONSORT Flow Diagram



Baseline Participant Characteristics

Descriptive statistics for participants' baseline characteristics by group are shown in Table 1. No clinically meaningful baseline differences between groups were observed for participant demographics and it was therefore determined that the randomization procedures were robust. Therefore, no covariate analyses were performed. Additionally, it was determined that dropouts' baseline data were not materially different from completers' baseline data and thus, the planned imputation procedures were employed. Overall, the sample was healthy ($\bar{X}_{BMI}$ = 23.1 kg/m^2), 100% used YouTube prior to the study, and the primary device for consuming YouTube was by smart phone (78%). Notably, 53.1% of participants reported using YouTube 'very often' (i.e., daily), 34.4% reported 'often' (i.e., a few times per week), 7.8% reported 'sometimes' (i.e., a few times per month), and 1.6% reported 'rarely' (i.e., a few times per year). The primary recruitment strategy was email (90.6%) followed by word of mouth (9.4%). Lastly, 62.5% and 68.8% of intervention and control group participants, respectively, reported COVID-19 made them "less active", 9.4% and 12.5% reported "more active", and 28.1% and 18.7% reported "no difference".

Table 1. Baseline Group Comparisons (Self-Reported).

	Experimental (*n* = 32)	**Control (*n* = 32)**
Sex		
Male	9	7
Female	23	25

Race/Ethnicity		
Non-Hispanic White	26	24
Black	3	2
Asian	3	3
Hispanic	0	3
Age (years)	22.69 (3.06)	22.91 (3.68)
Physical Activity Levels		
MVPA/Day (minutes)	8.28 (6.47)	9.16 (7.01)
LPA/Day (minutes)	183.11 (42.19)	192.17 (48.79)
SB/Day (minutes)	688.02 (88.58)	675.86 (65.38)
Sleep Quality		
Sleep Duration (hours/night)	7.99 (0.82)	8.07 (0.74)
Sleep Efficiency (%)	84.62 (7.12)	86.69 (5.99)
Muscle-Strengthening PA		
Days per week	0.81 (0.86)	0.94 (1.06)
Met guideline	7	7
Did not meet guideline	25	25
Psychosocial Variables		
SDT-Related Intrinsic Motivation		
Non-regulation	0.42 (0.43)	0.51 (0.53)
External regulation	1.30 (0.95)	1.18 (0.98)
Introjected regulation	2.68 (0.94)	2.50 (0.97)

Identified regulation	2.96 (0.63)	2.98 (0.61)
Integrated regulation	2.21 (0.92)	2.32 (0.60)
Intrinsic regulation	2.48 (0.96)	2.38 (0.83)
Perceived Physical Activity Barriers	2.33 (0.39)	2.25 (0.40)
PA-Related Enjoyment	5.49 (0.62)	5.81 (0.83)
PA-Related Self-Efficacy	5.75 (1.56)	5.87 (1.62)
PA-Related Social Support	2.36 (0.88)	2.44 (0.92)
Internet/YouTube Use		
Previous experience using YouTube	32	32
Device most used to consume YouTube		
Phone	26	24
Laptop	4	5
Tablet	2	3
Anthropometric Variables*		
Height (cm)	171.29 (8.56)	168.94 (10.04)
Weight (kg)	67.29 (10.24)	66.12 (10.07)
BMI (kg/m^2)	22.90 (2.74)	23.34 (2.45)

Note. All categorical variable values are frequency (*n*), all continuous variable values are mean (standard deviation). Abbreviations: PA, physical activity; MVPA, moderate-to-vigorous physical activity; LPA, light physical activity; SB, sedentary behavior; BMI, body mass index; SDT, Self-determination Theory.

Primary Outcome

All assumptions for ANOVA were met for the primary outcome and therefore, the planned analysis was employed. Table 2 shows the descriptive statistics for the primary outcome at baseline and 12 weeks follow-up. Notably, all outcomes were analyzed at the adjusted $p < 0.003$ level. Briefly, the primary analysis showed significant between-group diffferences for moderate-to-vigorous-intensity physical activity ($F(1, 62) = 20.95$, $p < 0.001$, $\eta_p^2 = 0.26$) such that the intervention group's moderate-to-vigorous-intensity physical activity significantly increased after 12 weeks compared to the control group.

Secondary Outcomes

All assumptions for ANOVA were met for the secondary outcomes and therefore, the planned analyses were employed. Table 2 shows the descriptive statistics for the secondary outcomes at baseline and 12 weeks follow-up. A significant between-group difference was observed for sleep efficiency ($F(1, 62) = 19.83$, $p < 0.001$, $\eta_p^2 = 0.25$) which indicated that intervention group participants significantly increased their sleep efficiency after 12 weeks compared to the control group. Further, a significant between-group difference was observed for muscle-strengthening physical activity frequency ($F(1, 62) = 92.60$, $p < 0.001$, $\eta_p^2 = 0.61$) which indicated intervention group participants to significantly increase their frequency at the 12 week follow-up compared to the control group. No statistically significant between-group differences were observed after 12 weeks for sedentary behavior, light-intensity physical activity, or sleep duration ($F(1, 62) = 0.69$-2.04, $p = 0.16$-0.41). Regarding the six subgroups of Self-determination Theory-related autonomous motivation for physical activity, statistically significant between-group differences were observed for non-regulation ($F(1, 62) = 14.57$, $p < 0.001$, $\eta_p^2 =$

0.19), integrated regulation ($F(1, 62) = 10.64$, $p = 0.002$, $\eta_p^2 = 0.15$), and intrinsic regulation ($F(1, 62) = 34.37$, $p < 0.001$, $\eta_p^2 = 0.36$), such that intervention group participants' motivational states significantly decreased in amotivation and increased in integrated and intrinsic regulation states after 12 weeks compared to the control group. Lastly, statistically significant between-group differences were observed for perceived physical activity barriers ($F(1, 62) = 228.87$, $p < 0.001$, $\eta_p^2 = 0.79$) and physical activity related self-efficacy ($F(1, 62) = 25.20$, $p < 0.001$, $\eta_p^2 = 0.29$), such that only participants in the intervention group significantly decreased their perceived physical activity barriers and improved self-efficacy after 12 weeks. No statistically significant between-group differences were observed after 12 weeks for Self-determination Theory-related external, introjected, and identified regulations or physical activity-related enjoyment and social support ($F(1, 62) = 2.48\text{-}4.60$, $p = 0.04\text{-}0.61$).

Table 2. Primary and Secondary Outcomes by Group at Baseline and 12 Weeks.

	Group	**Baseline**	**12 Weeks**	***p***	**η_p^2**
Primary Outcome					
MVPA (min/day)*	Experimental	8.28 (6.47)	22.75 (9.32)	< 0.001	0.26
	Control	9.16 (7.01)	7.75 (6.83)		
Secondary Outcomes					
LPA (min/day)	Experimental	183.11	203.28	0.41	
	Control	(42.19)	(43.33)		

		192.17 (48.79)	193.47 (39.11)		
SB (min/day)	Experimental Control	688.02 (88.58) 675.86 (65.38)	658.92 (71.82) 696.16 (114.55)	0.16	
Sleep Duration (hours/night)	Experimental Control	7.99 (0.82) 8.07 (0.74)	8.07 (0.75) 7.84 (1.41)	0.34	
Sleep Efficiency (%)*	Experimental Control	84.62 (7.12) 86.69 (5.99)	88.44 (4.83) 85.88 (6.68)	< 0.001	0.25
Muscle-Strengthening PA (days/week)*	Experimental Control	0.81 (0.86) 0.94 (1.06)	3.28 (1.33) 0.81 (0.86)	< 0.001	0.61
SDT-Related Intrinsic Motivation					
Non-regulation*	Experimental Control	0.42 (0.43) 0.51 (0.53)	0.18 (0.40) 0.63 (0.55)	< 0.001	0.19
External regulation	Experimental Control	1.30 (0.95) 1.18 (0.98)	1.18 (0.82) 1.35 (0.93)	0.07	
Introjected regulation	Experimental Control	2.68 (0.94) 2.50 (0.97)	2.46 (1.00) 2.58 (0.86)	0.12	

Identified regulation	Experimental Control	2.96 (0.63) 2.98 (0.61)	3.18 (0.49) 3.00 (0.61)	0.04	
Integrated regulation*	Experimental Control	2.21 (0.92) 2.32 (0.60)	2.55 (0.96) 2.19 (0.54)	0.002	0.15
Intrinsic regulation*	Experimental Control	2.48 (0.96) 2.38 (0.83)	3.05 (0.88) 2.09 (0.73)	< 0.001	0.36
Perceived PA Barriers*	Experimental Control	2.33 (0.39) 2.25 (0.40)	1.58 (0.31) 2.40 (0.29)	< 0.001	0.79
PA-Related Enjoyment	Experimental Control	5.49 (0.62) 5.81 (0.83)	5.71 (0.69) 5.68 (0.77)	0.11	
PA-Related Self-Efficacy*	Experimental Control	5.75 (1.56) 5.87 (1.62)	7.90 (2.34) 5.23 (1.58)	< 0.001	0.29
PA-Related Social Support	Experimental Control	2.36 (0.88) 2.44 (0.92)	2.28 (0.86) 2.49 (0.93)	0.04	

Note. The Bonferroni correction was applied to account for possible bias from multiple comparisons. Significance level was set to $p < 0.05$ and the adjusted familywise error rate at the individual outcome level for 16 comparisons was $p < 0.003$. * = statistically significantly different between groups after 12 weeks ($p < 0.003$) in favor of the intervention group. Abbreviations: MVPA, moderate-to-vigorous physical activity; LPA, light physical activity; sedentary behavior, sedentary behavior; BMI, body mass index; min, minutes; PA, physical activity; SDT, Self-determination Theory.

Intervention Interest and Retention

Regarding intervention interest, in only one week of recruiting strictly via email due to COVID-19 restrictions and the impending graduation of the principal investigator, 84 individuals expressed interest in participating in the present study and were screened for study participation. Regarding participants retention, 96.9% of the experimental group and 93.8% in the comparison group completed the study, respectively. Briefly, one experimental group participant dropped out for reasons unrelated to the study (illness) and two dropouts from the control group were for loss of contact and illness.

Intervention Adherence

Based on the aforementioned metric for intervention adherence, adherence to the YouTube video-delivered intervention was very high in both groups. In detail, average adherence in the intervention group was 97.23 ± 8.56% and 95.71 ± 7.69%.

Intervention Use/Helpfulness

Regarding intervention use, participants in the intervention group reported implementing the intervention between one and three times per week. Regarding intervention helpfulness, four (12%) reported that the intervention was "somewhat helpful, 13 (41%) of the intervention group participants rated the intervention as "helpful", and 15 (47%) reported that the intervention was "very helpful". Further, 29/32 (91%) of the intervention group reported that they would recommend this intervention to family or friends. Examples of the intervention group's comments regarding the YouTube video-delivered physical activity intervention are available in Table 3.

Table 3. Experimental Group's Comments Regarding the YouTube Exercise Intervention.

	Comments
Positive Features	• "I really liked when the workouts were made into a PDF. This made it easier to do my workouts away from a laptop screen. I think I have gained some muscular endurance from the HIIT workouts so that's good. I will try to keep doing HIIT workouts each week to continue reaping the benefits." • "I enjoyed the creativity of workouts that can be implemented at home, especially during the COVID pandemic. The use of backpacks and random equipment around my home is just something I have never thought of using before. I am usually handicapped by my limited amount of time to exercise, but after doing this study I can do a workout between my schedule to reach my 300 minutes of weekly activity. I also like when DJ was on screen doing the workout at the same time because it felt as though someone else was doing it with me." • "I liked how we changed tension and time (of exercise) over the duration of the study. It felt nice to learn physical activity terminology as well. Also, it was helpful to do short videos that we could replicate as many times as we want throughout the week. I also liked learning different exercises for each muscle group." • "I really liked how the intervention was a YouTube study and could be done at our own pace. Oftentimes, when doing HIIT workouts it is to fall behind or not complete the adequate amount of reps. By having a YouTube intervention, you can pause the video and catch your breath. This intervention really taught me that a gym isn't necessary for getting in shape." • "I had neglected muscle strengthening exercise because I prefer cardio, but I liked the tips about how to get the most from a shorter strengthening session (maxing each time, supersets, etc.). I also remembered that I like HIIT and Tabata style workouts." • "I was glad that this was an at-home workout intervention. With COVID, but also just for regular life, I am glad that I have tips for getting an intense workout from home without needing expensive gym equipment. In addition, having it on YouTube made

	it easily accessible so I can always go back to the workouts. This intervention made it more likely that I will work out regularly whether I am home, have access to a gym, on vacation, etc.”
Negative Features	• “Better music would have been nice but good overall” • “I would recommend not requiring the workout to be done on a Friday, especially for college students. I also thought some of the workouts were very advanced. However, I did like how they didn't take much time and including cardio like jumping jacks was my favorite.” • “My one note about the videos themselves is that I wish the music weren't repeated so much -- by the end of the study, I set my own interval timer instead of following the videos, so that I could listen to my own music.”

Adverse Events

No adverse events related to the intervention were reported in either study group. Notably, however, one participant dropped out mid-intervention due to contracting COVID-19.

Chapter Four: Discussion

The present study examined the effectiveness of a remote, home-based, YouTube video-delivered aerobic and muscle-strengthening physical activity promotion intervention grounded in Self-determination Theory for improving young adults' free-living aerobic and muscle-strengthening physical activity, sedentary behavior, sleep quality, Self-determination Theory-related autonomous physical activity motivation, perceived physical activity barriers, and physical activity-related enjoyment, self-efficacy, and social support. Statistically significant improvements were observed for free-living moderate-to-vigorous-intensity physical activity, weekly muscle-strengthening physical activity frequency, sleep efficiency, Self-determination Theory-related autonomous physical activity motivation, perceived physical activity barriers, and physical activity-related self-efficacy after 12 weeks in the intervention group. Conversely, no statistically significant between-group differences were observed for light-intensity physical activity, sedentary behavior, sleep duration, or physical activity-related enjoyment and social support after 12 weeks, and no statistically significant main effects for time were observed for any outcome in the control group.

Congruent with the first hypothesis, participants in the intervention group significantly improved their free-living moderate-to-vigorous-intensity physical activity after 12 weeks. The intervention group's post-intervention increases in moderate-to-vigorous-intensity physical activity were likely a result of their more internally regulated motivational states (e.g., significantly decreased non-regulation and increased integrated and intrinsic regulation) as well as their significantly decreased perceived physical activity barriers. Regarding Self-determination Theory-related physical activity motivation, as postulated by Self-determination Theory (Ryan & Deci, 2000; Deci, Eghrari, Patrick, & Leone, 1994), methodically embedded video components that aimed to progress participants' motivational states from less to more internally-regulated forms were added to the intervention videos by targeting this group's three basic psychological needs: (1) competence (e.g., taught participants the risks of high sedentary behavior and low physical activity levels and benefits of achieving the physical activity guidelines with B-roll visually demonstrating how to achieve these guidelines); (2) autonomy (e.g., used B-roll to visually demonstrate more and less intense exercise varieties to allow participants to choose which version to perform based on their level of physical fitness); and (3) relatedness (e.g., used B-roll to visually demonstrate partner exercises which overlaid the A-roll encouraging participants to perform these exercises/workouts with a friend or family member who they felt safe to exercise around during the pandemic). Given young adults have been observed to be less intrinsically motivated to perform physical activities and exercises in the home setting without commercial exercise equipment (Schwendinger & Pocecco, 2020), it is purported that Self-determination Theory's well-documented ability to improve habitual physical activity behaviors (Cohen, 1988) facilitated the observed changes in moderate-to-vigorous-intensity physical activity among the intervention group. Notably, although not statistically significant, sedentary behavior decreased by an average of 30 minutes in the intervention group after 12 weeks which may be practically and clinically significant. Indeed, because significant changes in moderate-to-vigorous-intensity physical activity were observed but no significant changes in light-intensity physical activity, it is feasible that intervention group participants replaced some of their sedentary behavior time with moderate-to-vigorous-intensity physical activity which both have clinically meaningful implications independent of one another (Bull et al., 2020). Additionally, the intervention videos were leveraged to create pre-recorded high-intensity interval training workouts which focused on full-body exercises that participants could seamlessly follow along to on-screen and perform with the study's primary investigator. Indeed, high-intensity interval training requires maximal or near-maximal effort and has demonstrated effectiveness in a recent randomized controlled trial (Menz, Marterer, Amin, Faulhaber, Hansen, & Lawley, 2019) to improve adults' cardiorespiratory fitness in only four weeks and therefore, performing these workouts weekly likely greatly contributed to the increased moderate-to-vigorous-intensity physical activity levels among the intervention group.

Likewise, participants in the intervention group were observed to significantly improve their self-reported muscle-strengthening physical activity frequency after 12 weeks whereas those in the control group demonstrated no meaningful changes in this outcome. Notably, participants in the intervention group increased their average weekly muscle-strengthening physical activity frequency from less than one day per week (i.e., below the recommended guideline of at least two days per week [Bull et al., 2020]) to over three days per week (i.e., exceeding the recommended guideline) after 12 weeks. Again, it is likely the use of video, and particularly B-roll within the intervention videos, helped improve participants' physical literacy—a major barrier to muscle-strengthening physical activity in this population (Wilson, Papalia, Duffey, & Bopp, 2019; Fairchild Saidi, & Branscum, 2020; Rhodes, Lubans, Karunamuni, Kennedy, & Plotnikoff, 2017)—and allowed them to see how to properly perform these exercises with the use of various angles as well as exercise variations based on one's muscular fitness level. Being confined to the home during the COVID-19 pandemic and thus without familiar commercial exercise equipment not only affects autonomous motivation to engage in muscle-strengthening activities like resistance-training (Schwendinger & Pocecco, 2020), but was likely also a perceived muscle-strengthening physical activity barrier. However, assuming exercise intensity is near-maximal, one’s own bodyweight is sufficient to induce favorable musculoskeletal adaptations (e.g., muscular strength and hypertrophy) (Schwendinger & Pocecco, 2020; Campos, Luecke, Wendeln, et al., 2002; Schoenfeld, Grgic, Ogborn, & Krieger, 2017; Schoenfeld, Peterson, Ogborn, Contreras, & Sonmez, 2015). Therefore, the muscle-strengthening-oriented videos in this study promoted various methods of enhancing resistance-training workout intensity like adding general household items to exercises to increase the working load (e.g., wearing a loaded backpack during squats to train the legs, holding filled laundry soap containers to perform lateral raises for the shoulders) and by introducing various resistance-training techniques like eccentric-focused training wherein an emphasis was placed on muscle lengthening (or eccentric muscle actions) for longer periods of time. Moreover, not only were the intervention participants taught the muscle-strengthening recommendations and provided on-screen demonstrations of full-body resistance-training workouts which employed various training techniques to increase workout intensity, but participants were also encouraged to perform these workouts multiple times per week and werr provided with high-quality PDF files with the written workouts so they could download them and readily access them when they planned to perform the resistance-training workout(s) later in the week. Specifically, for the convenience of participants, these PDF files were linked directly below their respective videos on YouTube. Thus, in the absence of commercial gym equipment in the home setting, pre-recorded YouTube videos which teach the muscle-strengthening physical activity guidelines and demonstrate exercises and workouts using the above strategies could effectively improve muscle-strengthening physical activity participation which has a myriad of physical and mental health benefits independent of aerobic physical activity participation (Maestroni, Read, Bishop, et al., 2020; El-Kotob, Ponzano, Chaput et al., 2020; Westcott, 2012) including improved depressive symptoms (Gordon, McDowell, Hallgren, Meyer, Lyons, & Herring, 2018) which may be especially important among young adults during and after the COVID-19 pandemic (Huckins, DaSilva, Wang, et al., 2020).

Also in line with the secondary hypotheses, only participants in the intervention group significantly improved their sleep efficiency despite no changes in either group for total sleep duration. The observed increases in sleep efficiency were likely attributed to the observed decreases in this group's sedentary behavior and increased aerobic and muscle-strengthening physical activity levels. These findings are consistent with recent findings among young adults demonstrating that there is an inverse relationship between sedentary behavior and sleep efficiency (Liu, Yuan, Zeng, et al., 2021). Likewise, compiling research has demonstrated increased physical activity levels to improve adults' sleep quality and thus, the concurrent decreases in sedentary behavior and increases in physical activity among the intervention group—especially that of moderate- and vigorous-intensities—lead to significantly improved sleep efficiency. Interestingly, despite the preceding improvements in sleep efficiency among the intervention group, no differences in sleep duration were observed in either group. Further, also surprising was that average sleep duration in both groups was high (about eight hours per night) despite research demonstrating poor sleep behaviors among this population during the pandemic (Huckins, daSilva, Wang, et al., 2020; Marelli, Castelnuovo, Somma, et al., 2021). This was likely attributed to the sample being young adults enrolled at or employed by the study University during their winter break and therefore, lacking school-related responsibilities and thus, being able to sleep longer each night regardless of group allocation. Nevertheless, the ability for participants in the intervention group to fall asleep faster and thus, get more quality sleep, may have great public health implications (Falck, Stamatakis, & Liu-Ambrose, 2021) regarding their physical health (Grandner, Chakravorty, Perlis, Oliver, & Gurubhagavatula, 2014; Gallicchio & Kalesan, 2009) as well as daytime productivity and being able to contribute to society (Daley, Morin, LeBlanc, Grégoire, & Savard, 2009). Therefore, the use of video to deliver remote, home-based, physical activity, sedentary behavior, and aerobic and muscle-strengthening information/workouts not only directly improves participants' physical activity behaviors but also indirectly affects individuals' sleep quality—both of which have major public health implications during the COVID-19 pandemic and beyond.

The hypotheses for the secondary psychosocial outcomes were mixed. To begin, no statistically significant between-group differences were observed for physical activity-related enjoyment. This is not surprising given physical activity-related enjoyment was fairly high at baseline in both study groups. This suggests that the sample as whole enjoyed participating in physical activities despite being highly physically inactive (as identified by the baseline questionnaire). Thus, other COVID-19-related factors, such as perceived physical activity barriers (which were observed to be high in both groups at baseline) were more likely to affect physical activity participation. Because perceived physical activity barriers were high in both groups at baseline, it makes sense that physical activity-related self-efficacy would be low as well. That is, because young adults may perceive performing aerobic and muscle-strengthening activities in the home setting without familiar, commercially available exercise equipment as a barrier (Schwendinger & Pocecco, 2020), their perceived ability (i.e., self-efficacy) to properly and effectively perform these activities while confined to the home setting without such equipment was likely compromised as well. Thus, it stands to reason that a video-delivered intervention that could be completed in the home setting where participants can see what aerobic and muscle-strengthening exercises to perform, why to perform them, and more importantly, *how* to perform them, that their perception of both physical activity-related barriers and self-efficacy would improve over a 12-week period. Indeed, given the high intervention adherence and fidelity statistics, it is not surprising that participants in the exercise intervention group improved in these outcomes from pre- to post-intervention. Lastly, regarding physical activity-related social support, the hypothesis was not supported in that there were no statistically significant differences in this outcome for either group. Both groups reported low social support for physical activity at baseline. While the intervention videos attempted to facilitate physical activity-related social support as one of the Self-determination theory-grounded components (e.g., promoting family- and friend-oriented exercises and activities), it is likely that the COVID-19 pandemic may have been a factor in the null findings for this outcome. For instance, due to the home quarantine orders during the time of the intervention and call for social distancing, participants in the intervention group may have avoided performing these activities with others and thus, did not experience increased support from their significant others.

Strengths and Limitations

The present study had several strengths. First, this sufficiently powered randomized controlled trial allowed for the examination of causal relationships between the independent and dependent outcome variables between homogonous groups of young adults. Second, device-based measurements were used for the primary physical activity and sleep quality outcomes as well as valid and reliable questionnaires for the muscle-strengthening physical activity and psychosocial outcomes. Lastly, the intervention videos were based on formative assessments among young adults, a recent empirically based content analysis and principles of health videos (Bopp, Vadeboncoeur, Stellefson, & Weinsz, 2019), and were grounded in and a single behavior change theory (Self-determination Theory) which has been observed to be more effective for physical activity behavior change than multi-theory interventions (Gourlan, Bernard, Bortolon, et al., 2016; Prestwich, Sniehotta, Whittington, Dombrowski, Rogers, & Michie, 2014). However, despite the preceding strengths, this study had some limitations which must be addressed.

First, as one of the primary outcomes, a self-reported muscle-strengthening physical activity assessment was employed which may have been prone to response bias. Nevertheless, this item has demonstrated good validity and reliability among adults and is currently the only viable option for this assessment given objective, device-based assessments for muscle-strengthening physical activity are not available. Second, given the impending graduation of the principal investigator, long-term follow-up assessments could not be employed and thus, the long-term effectiveness of this intervention could not be examined. Third, in an effort to maximize ecological validity (i.e., have participants consume the intervention YouTube videos as they would be in the real world), internal validity may have been compromised in that intervention adherence was not directly assessed. That is, participant responses and YouTube-provided metrics were relied on to determine if participants watched the videos in their entirety and adhered to the intervention rather than directly observing them watch the videos and actioning the information. Fourth, a recent moderator analysis (To, Duncan, Short, et al., 2021) of a large-scale randomized controlled trial (Vandelanotte, Short, Plotnikoff, et al., 2021) of a video-delivered physical activity promotion intervention found that the video intervention was more effective among female participants. Given this study's sample was primarily female, this may have influenced the results to some degree and therefore, future studies should aim to recruit an equal distribution of male and female participants. Lastly, this study was conducted in the middle of the COVID-19 pandemic wherein participants were facing enacted regulations to reduce the transmission of COVID-19 (e.g., home quarantine) and thus, it remains unknown if this intervention will effectively improve physical activity behaviors during the post-pandemic era with lifted restrictions (e.g., no home confinement, access to commercial fitness centers). Likewise, this intervention was conducted in the state of Minnesota during the winter season wherein temperatures are consistently freezing and therefore, participants in both groups may have been more motivated to engage in outdoor physical activities/exercise during the warmer spring/summer months. Thus, future research should employ similar interventions in warmer climate regions and/or during warmer seasons, post-pandemic, and with longer follow-up periods and more representative samples.

Chapter Five: Conclusion

Findings of the current study indicated that a remote, home-based, YouTube video-delivered physical activity intervention grounded in Self-determination Theory significantly improved young adults' free-living moderate-to-vigorous-intensity physical activity, muscle-strengthening physical activity, sleep efficiency, and physical activity-related self-efficacy which was likely a result of the intervention's positive effects on participants' self-determined motivation for physical activity and decreased perceived barriers to physical activity. Thus, with COVID-19 still prevalent in the U.S. and with uncertainty regarding young adults' preferred physical activity and exercise environments in the post-pandemic era, remote, home-based interventions utilizing Self-determination Theory-grounded, pre-recorded videos demonstrating physical activity promotion, sedentary behavior reduction, and aerobic and muscle-strengthening exercise routines has emerged as an effective intervention strategy for reducing physical activity barriers and facilitating more autonomous forms of physical activity motivation and self-efficacy to help combat the compounding effects of the COVID-19 pandemic on the preexisting pandemic of physical activity and poor sleep quality in the U.S.

Also noteworthy is that these interventions are cost-effective for both researchers (e.g., content can be filmed using a smart phone and uploaded for free to YouTube) and participants (e.g., YouTube content is free to consume) and have mass-reach capabilities. Indeed, video-based physical activity/exercise platforms like YouTube are rapidly emerging, such as Apple's "Apple Fitness +" and video-delivered exercise routines through commercial gyms. Therefore, it is encouraged that qualified health professionals to utilize these findings and remotely disseminate video-based physical activity/exercise interventions using high-traffic video platforms like YouTube.

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Chapter Seven: Appendices

Appendix A. CONSORT Checklist from Publication in the *Journal of Sport and Health Science* (2021, In Press)

CONSORT 2010 checklist of information to include when reporting a randomised trial*

Section/Topic	Item No	Checklist item	Reported on page No
Title and abstract			
	1a	Identification as a randomised trial in the title	1
	1b	Structured summary of trial design, methods, results, and conclusions (for specific guidance see CONSORT for abstracts)	1
Introduction			
Background and objectives	2a	Scientific background and explanation of rationale	4-7
	2b	Specific objectives or hypotheses	7
Methods			
Trial design	3a	Description of trial design (such as parallel, factorial) including allocation ratio	8
	3b	Important changes to methods after trial commencement (such as eligibility criteria), with reasons	N/A
Participants	4a	Eligibility criteria for participants	8-9
	4b	Settings and locations where the data were collected	8
Interventions	5	The interventions for each group with sufficient details to allow replication, including how and when they were actually administered	12-14
Outcomes	6a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	14
	6b	Any changes to trial outcomes after the trial commenced, with reasons	N/A

Sample size	7a	How sample size was determined	18-19
	7b	When applicable, explanation of any interim analyses and stopping guidelines	N/A
Randomisation:			
Sequence generation	8a	Method used to generate the random allocation sequence	18-19
	8b	Type of randomisation; details of any restriction (such as blocking and block size)	18-19
Allocation concealment mechanism	9	Mechanism used to implement the random allocation sequence (such as sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	18-19
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	18-19
Blinding	11a	If done, who was blinded after assignment to interventions (for example, participants, care providers, those assessing outcomes) and how	18-19
	11b	If relevant, description of the similarity of interventions	14
Statistical methods	12a	Statistical methods used to compare groups for primary and secondary outcomes	19-20
	12b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	20
Results			
Participant flow (a diagram is strongly recommended)	13a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analysed for the primary outcome	20-21
	13b	For each group, losses and exclusions after randomisation, together with reasons	20-21
Recruitment	14a	Dates defining the periods of recruitment and follow-up	8
	14b	Why the trial ended or was stopped	27
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	Table 1
Numbers analysed	16	For each group, number of participants (denominator) included in each analysis and	20-21

		whether the analysis was by original assigned groups	
Outcomes and estimation	17a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (such as 95% confidence interval)	21-22
	17b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	N/A
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	N/A
Harms	19	All important harms or unintended effects in each group (for specific guidance see CONSORT for harms)	22
Discussion			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	26-28
Generalisability	21	Generalisability (external validity, applicability) of the trial findings	26-28
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	22-28
Other information			
Registration	23	Registration number and name of trial registry	2, 8
Protocol	24	Where the full trial protocol can be accessed, if available	N/A
Funding	25	Sources of funding and other support (such as supply of drugs), role of funders	

*We strongly recommend reading this statement in conjunction with the CONSORT 2010 Explanation and Elaboration for important clarifications on all the items. If relevant, we also recommend reading CONSORT extensions for cluster randomised trials, non-inferiority and equivalence trials, non-pharmacological treatments, herbal interventions, and pragmatic trials. Additional extensions are forthcoming: for those and for up to date references relevant to this checklist, see www.consort-statement.org.

Appendix B. IRB Approval Form

UNIVERSITY OF MINNESOTA

Twin Cities Campus

Human Research Protection Program
Office of the Vice President for Research

Room 350-2
McNamara Alumni Center
200 Oak Street S.E.
Minneapolis, MN 55455

612-626-5654
irb@umn.edu
https://research.umn.edu/units/irb

APPROVAL OF NEW STUDY

612-626-4639
gaoz@umn.edu

Dear Zan Gao:

On 10/8/2020, the IRB reviewed the following submission:

The IRB determined that the criteria for approval have been met and that this studyinvolves no greater than minimal risk.

The IRB approved the study from 9/4/2020 to 9/3/2021 inclusive. You will be sent a reminder from ETHOS to submit a Continuing Review submission for this study. You must submit your Continuing Review no later than 30 days prior to the last day of approval in order for your study to be reviewed and approved for another Continuing Review period. If Continuing Review approval is not granted before 9/3/2021, approvalof this protocol expires immediately after that date.

You must also submit a Modification in ETHOS for review and approval prior to makingany changes to this study.

If consent forms or recruitment materials were approved, those are located under theFinal column in the Documents tab in the ETHOS study workspace.

In conducting this study, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the HRPP ToolkitLibrary on the IRB website.

For grant certification purposes, you will need the approval and last day of approval dateslisted above and the Assurance of Compliance number which is FWA00000312 (Fairview Health Systems Research FWA00000325, Gillette Children's Specialty Healthcare FWA00004003).

IMPORTANT: All human research conducted at the University of Minnesota mustadhere to the IRB guidance and requirements, Office of the Vice President for Research guidance, and the Medical School/Office of Academic Clinical Affairs Sunrise Implementation Plan in response to the COVID-19 pandemic. Non-medicalschool investigators should contact their Associate Dean for Research for information on the "sunrise" process.

Even with IRB approval, in-person research visits may not take place without documented approval by either the Medical School/OACA sunrise process or the

Associate Dean for Research sunrise process. These reviews are intended to protectthe health of all research participants and the broader University/Fairview communities during the COVID-19 pandemic. Researchers must inform the IRB oftheir approved sunrise plans. The IRB will document the approval status on ETHOS via a comment in the study history section. Please note that IRB approved COVID-19 related research is exempt from the sunrise requirements.

All researchers should review the guidance for the IRB, the medical school and theirown departments as guidance is updated frequently.

We strive to provide clear, consistent and timely service to maintain a culture ofrespect, beneficence and justice in research. Complete a brief survey about yourexperience.

Type of Review:	Initial Study
Title of Study:	Effect of a YouTube-Delivered Physical ActivityIntervention on Young adults' Aerobic and Muscle-Strengthening Physical Activity: A Randomized Controlled Trial
Investigator:	Zan Gao
IRB ID:	STUDY00010444
Sponsored Funding:	None
Grant ID/Con Number:	None

Internal UMN Funding:	None
Fund Management Outside University:	None
IND, IDE, or HDE:	None
Documents Reviewedwith this Submission:	• Recruitment Email-McDonough_Dissertation.pdf,Category: Recruitment Materials; • Physical activity readiness questionnaire, Category:Other; • Intrinsic motivation survey, Category: Other; • Physical activity screening questionnaire, Category:Other; • Recruitment Flyer 2.0, Category: RecruitmentMaterials;

Sincerely,

Bri Warner
IRB Analyst

Appendix C. Sunrise Plan Approval Document (COVID-19 Research Procedures)

This form is to be used for all research involving face-to-face (F2F) interaction with/on human beings. This means all research that focuses on human beings, measures or observes human beings, or work where human interaction is involved. Included are randomized experiments, observational studies, community-engaged research, surveys, and clinical research which entail F2F activity.

If you have any questions about the applicability of this form or the OVRP F2F sunrise process, please contact your school/program's Associate Dean for Research or Associate Vice President Michael Oakes (oakes007@umn.edu).

Section A: General Information about study and Principal Investigator(s)

1. College/Campus/School: University of Minnesota/Twin Cities/School of Kinesiology
2. Department/Program/Center: Physical Activity Epidemiology
3. Study name: Effect of a YouTube-Delivered Physical Activity Intervention on Young adults' Aerobic and Muscle-Strengthening Physical Activity: A Randomized Controlled Trial
4. Contact PI name: Daniel McDonough
5. Contact PI Email: mcdo0785@umn.edu
6. Other PI names ("NA" if not applicable): Dr. Zan Gao (advisor)
7. Funding source ("unfunded" if so): unfunded
8. Study IRB number ("NA" if not applicable): STUDY00010444

Section B: Study Description

9. Describe your study in simple terms. What is the goal? Who are the research participants/subjects? What is the intervention, if applicable? When was this study's start date? When is the expected end date for research with human participants? What measurements

Note: This section must conform to the study's approved IRB application, if applicable. No modifications are permissible without prior IRB approval.

This study will be a 4-week randomized controlled trial with the goal of examining the effect of a YouTube-delivered physical activity intervention (remote intervention) on young adults' physical activity, sleep, and psychosocial health outcomes. Specifically, this will be a physical activity intervention delivered via YouTube over a 4-week period. The intervention group will receive aerobic and muscle-strengthening videos twice a week and the control group will receive general health information videos without any physical activity education or instruction. The participants will report to the study laboratory on the East Bank campus (Physical Activity Epidemiology Laboratory) and complete 2 data collection sessions (baseline [0 weeks], post-post-intervention [4 weeks). The intervention will be delivered via YouTube and participants may apply the information in a home- or fitness center-setting, depending on their access/desire. Outcome measures will be objectively-measured physical activity, muscular endurance, sleep quality, and psychosocial measures. Participants will be randomized in a 1:1 fashion to either group. The study was scheduled to start on September 8, 2020 but will now be scheduled to start October 12, 2020 given the delayed IRB/F2F approval from COVID-19. The intervention is delivered via social media (YouTube videos) and thus, there will be no F2F contact during the intervention period. There will be only 2 F2F contact periods with all participants which are for data collection (pre-/post-measurements). Measurement intervals will be 0 weeks and 4 weeks (post-intervention) and will take place on the East Bank campus (Physical Activity Epidemiology Laboratory). Physical activity levels will be measured using ActiGraph accelerometers and muscle-strengthening activity levels will be measured using the abbreviated Physical Activity Recall interview. Sleep quality will be assessed using the same accelerometers used for the physical activity levels. Cardiovascular fitness will be measured via the YMCA 3-minute step test. Muscle endurance will be assessed using the FITNESSGRAM pushup and sit-up tests. Psychosocial outcomes will be assessed via questionnaires. A scale will be used to assess bodyweight and %body fat and a stadiometer will be used to measure height.

10. are taken, when, and what are the measurement intervals if applicable?

11. Who are the researchers involved? Has each researcher considered the risks of this research to themselves and their social contacts, especially in light of each

researcher's own COVID risk profile? What is the background/training of each researcher with respect to infection control and COVID prevention? What training has each research had in terms of proper use of PPE (e.g., mask donning and doffing, hand washing, hand sanitizer), if any?

The only researcher involved is me (Daniel McDonough). Yes, I have fully considered the risks of this research to myself and my social contacts, especially in light of each researcher's own COVID risk profile. With respect to infection control and COVID prevention, I have taken graduate-level infectious disease epidemiology classes and I am up to date on the CDC's and WHO's COVID updates and recommendations regarding infection control and COVID prevention. I have had no formal training on the proper use of PPE (e.g., mask donning and doffing, hand washing, hand sanitizer) but as previously mentioned, I am up to date on the CDC's and WHO's COVID updates and recommendations regarding infection control and COVID prevention.

12. Explain why face-to-face (F2F) interaction is necessary for this research. Why can't the study be done <u>without</u> F2F interaction? Be specific.

This physical activity intervention was designed to take place in the home-setting (or in a fitness center if participants wish/feel safe doing so) which is advantageous given the current pandemic situation. F2F interaction has been minimized in this study to 2 time-points (pre-/post- data collection) which is necessary to assess the changes (physical activity and fitness levels, etc.) in the dependent variables and to see if this type of intervention is effective/feasible. Indeed, tracking objective physical activity levels and fitness levels as well as sleep and psychosocial outcomes cannot be rigorously done without in-person contact/instruction/supervision of at least 1 trained researcher (myself). Thus, F2F is not necessary for the intervention but rather, is only necessary to take brief measurements to assess the study's effectiveness/efficacy.

13. Describe the participants of this study. What is the age distribution? Do any participants or their social contacts have an elevated risk for COVID due to diabetes, high blood pressure, asthma, COPD, smoking, etc? Are their other vulnerabilities (e.g., diminished capacity, educational attainment, low income) that merit consideration? Are there participants who were enrolled prior to the COVID-19 pause and who will be invited to resume participation? Be specific and use data if possible.

The participants of this study are healthy young adults (18-35 years of age) with healthy weight status and no chronic conditions (i.e., able to safely participate in physical activity/exercise). Thus, participants or their social contacts DO NOT have an elevated risk for COVID due to diabetes, high blood pressure, asthma, COPD, smoking, etc. Likewise, there are NO other vulnerabilities (e.g., diminished capacity, educational attainment, low income) that merit consideration. Lastly, there are NO participants who were enrolled prior to the COVID-19 pause and who will be invited to resume participation. Thus, participants in this study are healthy and young adults.

14. <u>Where</u> exactly will face-to-face research interactions take place? Classroom, computer lab, community center, home, outdoors? Describe all such settings/environments. Be precise and specific. (Note: If clinics are involved, go to question 15)

The 2 F2F data collection sessions will take place on the East Bank campus (Physical Activity Epidemiology Laboratory). This is a clean laboratory and no individuals have been in there since the start of COVID. All equipment necessary for the 2 F2F data collection sessions have been in this lab since quarantine started and thus, there has been no human contact with any of the assessment tools since COVID. Further, we have access to many cleaning supplies/disinfectants and we are located near the Kinesiology building (Cooks Hall) where we have easy access to more cleaning/preventative supplies provided by the School. Lastly, I will be the only researcher allowed in the lab with Sunrise/F2F approval.

15. Answer this question if the research will take place at a location owned/managed by someone other than UMN (e.g., community group, YMCA, business). Who owns/manages the location, especially with respect to COVID protections? What is the owner/manager's contact information? Has the owner/manager had training in infection control and/or COVID prevention? If so, describe. Is the location "open for business" for other activities or just this study? Are location owners/managers prepared for and willing to support this research study and take steps to prevent transmission of the new coronavirus? Explain.

16. Answer this question if the research will take place in a clinical setting or involve any health system/M Health Fairview resources or services (e.g. investigational drug pharmacy, imaging, lab, interventional radiology, etc.). Provide a description of any health system/M Health Fairview resources or services needed (e.g. investigational drug pharmacy, imaging, lab, interventional radiology, etc). Will study team members need to be physically present within an M Health Fairview facility? If yes, what facility(ies)?

Section C: Mitigating Participant Risk

17. Describe any situations where researchers will not be able to maintain at least 6 ft between participants in the research setting. Describe any situations in which anyone in the research setting will not be able to maintain at least 6 ft distance.

During the 2 F2F data collection sessions, I will maintain 6 ft distance from the participants (while wearing a University-distributed mask) at all times. The psychosocial surveys will be on the table beforehand and will be disinfected prior to participant arrival. I will administer fitness-related tests at a 6 ft distance. The PAR interview is abbreviated (shortened) and I will be over 6 ft away with a University-distributed mask on at all times. Anthropometric measurements will take place with participants setting up and stepping on the weight scale by themselves. The same will go for height measurements. Thus, I will be the only researcher in the lab and all necessary F2F testing will take place at a safe, > 6 ft, distance from the participants, and I will wear a University-distributed mask at all times and disinfect all study materials/lab spaces before and after all data collection sessions.

18. List the steps for research staff to self-assess their health status (e.g., body temperature, other symptoms) before F2F interactions with participants or other researchers.

I will be the only research staff in the lab for my 2 F2F data collection sessions. To monitor my body temperature, I have purchased a personal thermometer, and I will take the CDC's Coronavirus Self-Checker (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/coronavirus-self-checker.html) which can be taken online and will take me less than 1 minute to complete. This checker tells you if the CDC recommends I get tested (based on the answers) or if the CDC deems that no testing is needed due to no reported COVID symptoms. I will be sure to monitor my body temperature and symptoms before every participant enters the lab for the F2F data collection sessions. I will inform all participants of my COVID symptom status and body temperature as well as inform them that I will be the only person in the lab during testing before they enter the lab for the 2 F2F data collection sessions so they feel safe and comfortable.

19. Describe procedures for study participants to self-assess their health status (e.g., body temperature, other symptoms) before F2F interactions with researchers or other study participants. Describe how the research team will screen participants/subjects upon arriving for F2F research interaction.

Before any F2F contact for the 2 necessary F2F data collection sessions, I will send all participants the CDC's Coronavirus Self-Checker (https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/coronavirus-self-checker.html) which can be taken online and will take participants less than 1 minute to complete. This checker tells you if the CDC recommends participants get tested (based on the answers) or if the CDC deems that no testing is needed due to no COVID symptoms. I will ask all participants to send a picture or screenshot of their results vis email to me before being allowed to enter the study laboratory. I will also ask them to self-assess their body temperature to monitor for a fever and report to me their temperature via email (along with their results from the preceding CDC survey) to ensure all participants do not have COVID symptoms before entering the lab for F2F contact for the 2 necessary F2F data collection sessions.

20. Describe any electronic scheduling/calendaring/consent mechanisms used that will minimize face-to-face contact among people within the research setting. Note, F2F interactions should be minimized.

As discussed, I have intentionally minimized F2F interactions for my study as the intervention is purposefully designed to be delivered remotely, with no contact. There will only be 2 necessary F2F data collection sessions. For electronic scheduling/calendaring, I will use Google Calendars and share privately with my participants to schedule the 2 necessary F2F data collection sessions. Additionally, I will email them the IRB-approved study consent document which they will be able to fill out electronically and email to me before starting the study/entering the study lab.

21. Describe use of PPE (e.g., masks, respirators, sanitizer) to mitigate risk. What will be used? How much is needed? What must be procured and by when? How will procurement and distribution for and within the study be conducted?

For use of PPE (e.g., masks, respirators, sanitizer) for my study and to mitigate risk, I will follow the CDC's PPE recommendations/guidelines (https://www.cdc.gov/coronavirus/2019-ncov/hcp/using-ppe.html). Procurement and distribution for and within the study will be conducted by the School of Kinesiology to obtain all necessary the University-approved PPE (e.g., masks, respirators, sanitizer). I will use all of these PPE materials before, during, and after all participants' F2F data collection sessions within our lab.

22. Describe procedures to disinfect surfaces (e.g., tables, door handles, computers) before, between, and after interactions in the F2F research space. What cleaners/sanitizers will be used, by whom, and where will such items be procured?

For disinfecting all lab and study equipment surfaces (e.g., tables, door handles, computers, testing equipment), I will strictly follow the CDC's COVID-specific disinfecting recommendations/guidelines (https://www.cdc.gov/coronavirus/2019-ncov/community/disinfecting-building-facility.html). Procurement and distribution for and within the study will be conducted by the School of Kinesiology to obtain all necessary the University-approved disinfecting supplies. I will use all of these disinfecting materials before, during, and after all participants' F2F data collection sessions within our lab. Disinfectants (https://www.epa.gov/pesticide-registration/list-n-disinfectants-coronavirus-covid-19) will be University-approved and -provided and will be on the preceding CDC-approved list.

Section D: Mitigating Research Staff Risk

23. Describe procedures for research staff to self-assess their health status (e.g., body temperature, other symptoms) after F2F interactions with participants.

Akin to question 17, above, to self-assess my health status to monitor my body temperature after F2F interactions with participants, to monitor my body temperature I have purchased a personal thermometer, and I will take the CDC's Coronavirus Self-Checker

(https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/coronavirus-self-checker.html) which can be taken online and will take me less than 1 minute to complete. This checker tells you if the CDC recommends I get tested (based on the answers) or if the CDC deems that no testing is needed due to no reported COVID symptoms. I will be sure to monitor my body temperature and symptoms after every participant leaves the lab from the F2F data collection sessions.

24. If applicable, describe how research staff will interact with each other or other employees? How will risk of COVID be mitigated in such settings?

N/A. I will be the only research staff in my laboratory for data collection sessions.

Section D: PI Attestation of OVRP Research Sunrise

I confirm that I understand and will comply with any and all COVID mitigation requirements set forth by the University and the Office of the Vice President for Research.

I confirm that I understand and will comply with any and all COVID mitigation requirements set forth by my school's Dean and/or Associate Dean for Research.

I confirm that I will quickly alert my Associate Dean for Research if there are any changes or Adverse events to my study procedures or COVID mitigation plans.

I confirm that neither participants nor researchers will be pressured to engage in F2F research activities.

I confirm that information shared in this document conforms to the study's IRB approval and no changes or modifications to the protocol/procedures will be made without prior IRB approval.

I understand that as conditions change I may be required to alter or pause all face-to-face research interaction in this study.

Daniel McDonough 9/27/2020

Contact PI Signature **Date**

Other PI Signature **Date**

Other PI Signature **Date**

Other PI Signature **Date**

Associate Dean for Research Signature **Date**

Note: Typed signatures from UMN email account is acceptable

Appendix D. Consent Form, PAR-Q, and Participant Demographics Survey

(1) Study Consent Form; (2) Physical Activity Readiness Questionnaire; and (3) Demographics Survey

---

Start of Block: Consent Form. Please select 'consent' or 'not consent'

Q1
Title of Research Study: ***Effect of a Remote, YouTube-Delivered Physical Activity Intervention: A Randomized Controlled Trial***

Investigator Team Contact Information:
For questions about research appointments, the research study, research results, or other concerns, call the study team at:
Investigator Name: DJ McDonough
Investigator Departmental Affiliation: School of Kinesiology
Phone Number: 650-580-6253
Email Address: mcdo0785@umn.edu

Supported By: This research is supported by the **Physical Activity Epidemiology Laboratory**.

Key Information About This Research Study
The purpose of the study is to investigate the effects of a remote, YouTube-delivered physical activity (PA) intervention on young adults' PA levels, sleep quality, and psychosocial outcomes (perceived barriers and social support) as compared to YouTube-delivered general health education.
We are asking you to take part in this research study because you met the inclusion criteria for participation: 1) 18-35 years-old; 2) Have a body mass index (BMI) greater than or equal to 18.5 and less than 35; and 3) Possess no diagnosed severe physical or mental disorder (e.g., cystic fibrosis, multiple sclerosis, schizophrenia, bipolar disorder and major depressive disorder).

What should I know about a research study?
- Our research staff will explain this research study to you.
- Whether or not you take part is up to you.
- You can choose not to take part.

- You can agree to take part and later change your mind.
- Your decision will not be held against you.
- You can ask all the questions you want before you decide.

Why is this research being done?
The fact that more than 80% of adults fail to meet the guidelines for both aerobic and muscle-strengthening activities, while YouTube is a social media platform that is most interesting and appealing to young adults. Regrettably, present evidence regarding the use of YouTube in the promotion of individuals' physiological and psychological health outcomes is lacking. To this end, we will conduct a study exploring the effects of YouTube-delivered exercises on health-related outcomes in comparison with traditional health education among healthy young adults.

How long will the research last?
We expect that you will be in this research study for 12 weeks

What will I need to do to participate?
You will engage in twice-weekly YouTube-delivered aerobic and muscle strengthening workouts from a home- or gym-based setting (whichever works best for you and your schedule), or, if randomized to the control group, watch YouTube videos with general health education-based content. More detailed information about the study procedures can be found under "What happens if I say yes, I want to be in this research?"

Is there any way that being in this study could be bad for me?
More detailed information about the risks of this study can be found under "What are the risks of this study? Is there any way being in this study could be bad for me? (Detailed Risks)"

Will being in this study help me in any way?
More detailed information about the benefits of this study can be found under "Will being in this study help me in any way? (Detailed Benefits)"

What happens if I do not want to be in this research?
There are no known alternatives, other than deciding not to participate in this research study.

Detailed Information About This Research Study
The following is more detailed information about this study in addition to the information listed above.

How many people will be studied?
We expect about 60 people here will be in this research study out of 50,000 people in the entire University of Minnesota.

What happens if I say "Yes, I want to be in this research"?
If you agree to participate in this study, we would ask you to engage in 1 aerobic and 1 muscle strengthening physical activity workout (delivered via video by way of YouTube) each week (intervention group) or watch 2 general health education videos (control group) for a total of 12 weeks:

Before starting the study, participants will be randomly assigned to the intervention group or control group using a random numbers table in Microsoft Excel. The study will take place during over a 12-week period wherein the participants in the intervention group will engage in the previously outlined twice-weekly exercise sessions or general health education sessions with each session separated by 2 days whereas participants in the control group will receive general health education videos with no workouts to complete. Participants will be asked to do the following in addition to engaging in exercise at two separate time points (0 weeks [baseline]; and 12-weeks [post-test]):
• Anthropometric measurements: Participant's self-reported height and weight measurements will be taken at home using a personal scale/tape measure.
• Physical activity levels/sleep quality: Each participant will be assigned an accelerometer (worn on the wrist as a watch) to wear for 7 consecutive days at the 2 different time points described above). The participants will be asked to wear the accelerometers 24 hours per day over the 7-day periods to allow for physical activity and sleep quality measurements.
• Muscle strengthening PA participation: Will be measured using a brief, 5-minute physical activity recall interview (via phone call) at the 2 different time points described above. This brief, informal interview will be conducted by the principle investigator of the study to assess weekly adherence to the muscle strengthening guidelines.
• Questionnaires regarding psychosocial constructs: Questionnaires will be delivered in an online format assessing the following physical activity-related psychosocial constructs will be administered at the 3 different time points described above: perceived barriers and social support.

What happens if I say "Yes", but I change my mind later?
You can leave the research study at any time and no one will be upset by your decision. Choosing not to be in this study or to stop being in this study will not result in any penalty to you or loss of benefit to which you are entitled. This means that your choice not to be in this study will not negatively affect your right to any present or future medical care, your academic standing as a student, or your present or future employment.

What are the risks of being in this study? Is there any way being in this study could be bad for me? (Detailed Risks)
The study has the following risks:
(1) Delayed onset muscle soreness occurring several hours to a couple of days after physical activity engagement.
(2) Given the study's potential to increase your physical activity participation a possibility

exists for the development of symptoms such as muscular strains/sprains, shortness of breath, joint pain, cramping, fatigue, fainting, and dizziness.
(3) Although very unlikely, mental distress caused by the administration of assessments of physical activity-related psychosocial constructs is possible.
(4) A risk in the study is potential identification through comments on the YouTube videos. To help protect against this risk, we will have participants use a pseudonym email account that can be used for logging into YouTube and posting comments.

Will it cost me anything to participate in this research study?
There will be no costs to you as a result of taking part in this study other than the time spent participating. Taking part in this study is voluntary.

Will being in this study help me in any way? (Detailed Benefits)
The benefits to study participation are: 1) the participants may receive acute improvements in psychosocial variables related to physical activity participation such as situational motivation, situational interest, mood, self-efficacy and enjoyment; and 2) the participants may also receive acute health-related benefits related to improved blood pressure resulting from increased participation in physical activity during the exercise sessions.

What happens to the information collected for the research?
The records of this study will be kept private. Your record for the study may, however, be reviewed by designated departments at the University with appropriate regulatory oversight. We will not include any information in publications or presentations that will make it possible to identify you. To these extents, confidentiality is not absolute. Study data will be encrypted according to current University policy for protection of confidentiality. No data will be shared with the ActiGraph accelerometer company.

Will I receive research test results?
The investigator(s) will not contact you or share your individual test results. However, the summary of the research findings may be available upon request.

Will anyone besides the study team be at my consent meeting?
No.

Whom do I contact if I have questions, concerns or feedback about my experience?
This research has been reviewed and approved by an IRB within the Human Research Protections Program (HRPP). To share feedback privately with the HRPP about your research experience, call the Research Participants' Advocate Line at 612-625-1650 or go to https://research.umn.edu/units/hrpp/research-participants/questions-concerns. You are encouraged to contact the HRPP if:

- Your questions, concerns, or complaints are not being answered by the research team.

- You cannot reach the research team.
- You want to talk to someone besides the research team.
- You have questions about your rights as a research participant.
- You want to get information or provide input about this research.

Will I have a chance to provide feedback after the study is over?
The HRPP may ask you to complete a survey that asks about your experience as a research participant. You do not have to complete the survey if you do not want to. If you do choose to complete the survey, your responses will be anonymous.

What happens if I am injured while participating in this research?
In the event that this research activity results in an injury, treatment will be available, including first aid, emergency treatment and follow-up care as needed. Care for such injuries will be billed in the ordinary manner to you or your insurance company. If you think that you have suffered a research related injury, let the researchers know right away.

Will I be compensated for my participation?
If you agree to take part in this research study, we will pay you $30.00 for your time and effort.

STATEMENT BY PERSON AGREEING TO PARTICIPATE IN THIS STUDY
I have read the informed consent document and I understand the material contained in it. I understand each part of the document, all of my questions have been answered, and I freely and voluntarily choose to participate in this study (please select an option below):

○ Yes I Consent (1)

○ No I Do Not Consent (2)

End of Block: Consent Form. Please select 'consent' or 'not consent'

Start of Block: Physical Activity Readiness Questionnaire

Q29 **Has your doctor ever said that you have a heart condition and that you should only perform physical activity recommended by a doctor?**

○ Yes (1)

○ No (2)

Q30 **Do you feel pain in your chest when you perform physical activity?**

- Yes (1)
- No (2)

Q31 **In the past month, have you had chest pain when you were not performing any physical activity?**

- Yes (1)
- No (2)

Q32 **Do you lose your balance because of dizziness or do you ever lose consciousness?**

- Yes (1)
- No (2)

Q33 **Do you have a bone or joint problem that could be made worse by a change in your physical activity?**

- Yes (1)
- No (2)

Q34 **Is your doctor currently prescribing any medication for your blood pressure or for a heart condition?**

○ Yes (1)

○ No (2)

Q35 **Do you know of any other reason why you should not engage in physical activity?**

○ Yes (1)

○ No (2)

End of Block: Physical Activity Readiness Questionnaire

Start of Block: Demographics Survey. Please answer questions honestly. No data will be shared.

Q4 **What is your name (Last, First)?**

____

Q22 **What is your email? (For study contact purposes only)**

____

Q23 **What is your cell phone number? (For study contact purposes only)**

____

Q25 **What is your current mailing address? (For study contact purposes only. You will be mailed study materials at the end of the study)**

____

____

____

____

____

Q26 **Will your mailing address change in February of 2021? (Due to moving, graduating, etc.)**

○ Yes (1)

○ No (2)

Q6 **What is your age (in years)?**

____

Q18 **What is your sex?**

○ Male (1)

○ Female (2)

Q7 **Are you Hispanic?**

○ Yes (1)

○ No (2)

Q8 **Please indicate your race. *Check as many as you feel apply to you*.**

- ☐ Caucasian or White (49)
- ☐ African American or Black (50)
- ☐ American Indian or Alaskan Native (51)
- ☐ Asian (52)
- ☐ Pacific Islander or Native Hawaiian (53)
- ☐ Prefer not to state (54)

Q20 **How did you hear about this study?**

- ○ Email (4)
- ○ Word of mouth (5)
- ○ Other (6)

Q36 During the course of this study, will you be concurrently enrolled in another University study which involves physical activity/exercise?

- ○ Yes (1)
- ○ No (2)

Q21 **What is your preferred learning style?**

- ○ Text only (e.g., reading) (1)
- ○ Audio only (e.g., podcast) (2)
- ○ Visual only (e.g., pictures) (3)
- ○ Combination text+audio+visual (e.g., video) (4)

Q9 **Have you used YouTube before?**

- ○ Yes (1)
- ○ No (2)

Q10 **If you answered *yes* to the previous question, how often do you use YouTube?**

- ○ Rarely (about a few times a year) (9)
- ○ Sometimes (about a few times a month) (10)
- ○ Often (about a few times a week) (11)
- ○ Very Often (about daily or almost daily) (12)

Q11 **Do you consume health- and/or fitness-related content online?**

- ○ Yes (1)
- ○ No (2)

Q12 **If you answered *no* to the previous question, please list some reasons as to why you do not consume this type of content online below:**

____

____

____

____

____

Q14 **On which platform do you consume social media the most (e.g., phone, laptop tablet, etc.)?**

- ○ Phone (1)
- ○ Tablet (2)
- ○ Laptop (3)
- ○ Other (4)

Q15 **On which platform do you plan to consume the YouTube videos in this intervention most?**

- ○ Phone (1)
- ○ Tablet (2)
- ○ Laptop (3)
- ○ Other (4)

Q13 **How has COVID-19 affected your physical activity/exercise levels?**

◯ Made me less active (1)

◯ No difference (2)

◯ Made me more active (3)

Q16 **Do you currently feel safe exercising in a gym/fitness center given the current COVID-19 pandemic?**

◯ Yes (1)

◯ No (2)

Q17 **What is your previous resistance-training (e.g., weightlifting) experience?**

◯ None (never resistance-trained before) (1)

◯ Some (tried resistance-training before but never stuck with it) (2)

◯ Lots (resistance-train weekly for over 2 years) (3)

Q19 **If you answered *"none"* or *"some"* to the previous question, what are some reasons you do not resistance-train? Please list below.**

____

____

____

____

____

End of Block: Demographics Survey. Please answer questions honestly. No data will be shared.

Appendix E. Physical Activity Screening Questionnaire

Physical Activity Screening Questionnaire

Participant Name:___________________________ **Date:** _____________

Over the past month, did you participate in any moderate-intensity physical activity? What I mean by moderate-intensity activity is any activity that feels as hard or harder than a brisk walk. It gets your heart rate going faster and feels like you are runninglate for an appointment or walking to get out of the rain. For the activity to be counted, it needs to be for at least 10 continuous minutes without stopping. Some examples of activities that are at least of moderate intensity could include brisk walking 3-4 mph, running, aerobic dance, swimming, and bicycling.

YES NO

If no, then continue the survey to ascertain approximately how much physical activity theindividual has engaged in, with the knowledge the individual is eligible for this criteria ofthe study.

If yes, please remember to clarify that it was at least 10 continuous minutes without stopping and was at least of moderate intensity. For example, someone might say they did60 minutes of housework but only 30 of those minutes were at the moderate-intensity level and were at least 10 minutes at a time.

Regardless of whether the individual responded yes OR no, pose the following questions:

a. What activities have you done over the past month?

b. How many times per week (average)?

c. For how many minutes each time (average)?

d. How long have you been doing this activity (average)? (Note: Remind individual to bespecific: weekly, monthly, yearly)

If greater than 90 minutes per week of at least moderate-intensity physical activity, thenthe individual is ineligible for the study.

If there is a question as to whether the activities are at the moderate-intensity level, pleaselet the individual know that you will get back into touch with them. It is at this point you will contact DJ regarding the individual's responses.

Appendix F. Psychosocial Surveys, Physical Activity Recall Questionnaire, Body Measures (Self-Report)

Psychosocial Surveys; Physical Activity; and Body Measures

Start of Block: Name and Email

Q9 **Please provide your name (Last, First)**

____

Q17 **Please provide your Major (area of study)**

____

Q10 **Please provide your new YouTube username that you created (i.e., channel name). This will be used to track intervention adherence.**

____

End of Block: Name and Email

Start of Block: Barriers to physical activity (Circle the response that best describes you)

Q5 **Below are potential barriers to engaging in physical activity/exercise. For each barrier, please respond how each barrier currently pertains to you (ranging from strongly disagree to strongly agree).**

	Strongly Disagree (1)	**Disagree** (2)	**Agree** (3)	**Strongly Agree** (4)
(1) Physical activity takes too much of my time (1)	◯	◯	◯	◯
(2) Physical activity tires me (2)	◯	◯	◯	◯
(3) Places for me to be physically active (e.g., parks, gyms) are too far away (3)	◯	◯	◯	◯
(4) I am too embarrassed to be physically active (4)	◯	◯	◯	◯
(5) It costs too much to be physically active (5)	◯	◯	◯	◯
(6) Exercise facilities do not have convenient schedules for me (6)	◯	◯	◯	◯
(7) I am fatigued by physical activity (7)	◯	◯	◯	◯
(8) My spouse (or significant other) does not encourage physical activity (8)	◯	◯	◯	◯
(9) Physical activity takes too much time from family relationships (9)	◯	◯	◯	◯
(10) I think people in exercise clothes look funny (10)	◯	◯	◯	◯
(11) My family members do not encourage me to exercise (11)	◯	◯	◯	◯
(12) Physical activity takes too much time from my responsibilities (e.g., school, work) (12)	◯	◯	◯	◯
(13) Physical activity is hard work for me (13)	◯	◯	◯	◯
(14) There are too few places to be physically active (14)	◯	◯	◯	◯

End of Block: Barriers to physical activity (Circle the response that best describes you)

Start of Block: Exercise Regulations Questionnaire-3 (BREQ-3)

Q2
WHY DO YOU ENGAGE IN EXERCISE?

We are interested in the reasons underlying peoples' decisions to engage, or not engage, in physical exercise. Using the scale below, please indicate to what extent each of the following items is true for you. Please note that there are no right or wrong answers and no trick questions. We simply want to know how you personally

feel about exercise. Your responses will be held in confidence and only used for our research purposes.

	0 (1)	1 (2)	2 (3)	3 (4)	4 (5)
(1) It's important to me to exercise regularly (1)	○	○	○	○	○
(2) I don't see why I should have to exercise (2)	○	○	○	○	○
(3) I exercise because it's fun (3)	○	○	○	○	○
(4) I feel guilty when I don't exercise (4)	○	○	○	○	○
(5) I exercise because it is consistent with my life goals (5)	○	○	○	○	○
(6) I exercise because other people say I should (6)	○	○	○	○	○
(7) I value the benefits of exercise (7)	○	○	○	○	○
(8) I don't see why I should bother exercising (8)	○	○	○	○	○
(9) I enjoy my exercise sessions (9)	○	○	○	○	○
(10) I feel ashamed when I miss an exercise session (10)	○	○	○	○	○
(11) I consider exercise part of my identity (11)	○	○	○	○	○
(12) I take part in exercise because my friends/partner/family say I should (12)	○	○	○	○	○
(13) I think it is important to make the effort to exercise regularly (13)	○	○	○	○	○

(14) I don't see the point in exercising (14)	○	○	○	○	○
(15) I find exercise a pleasurable activity (15)	○	○	○	○	○
(16) I feel like a failure when I haven't exercised in a while (16)	○	○	○	○	○
(17) I consider exercise a fundamental part of who I am (17)	○	○	○	○	○
(18) I exercise because others will not be please with me if I don't (18)	○	○	○	○	○
(19) I get restless if I don't exercise regularly (19)	○	○	○	○	○
(20) I think exercise is a waste of time (20)	○	○	○	○	○
(21) I get pleasure and satisfaction from participating in exercise (21)	○	○	○	○	○
(22) I would feel bad about myself if I was not making time to exercise (22)	○	○	○	○	○
(23) I consider exercise consistent with my values (23)	○	○	○	○	○
(24) I feel under pressure from my friends/family to exercise (24)	○	○	○	○	○

End of Block: Exercise Regulations Questionnaire-3 (BREQ-3)

Start of Block: Physical Activity Enjoyment Scale (PACES)

Q3 **Please rate <u>how you feel at the moment about physical activity</u>. Below is a list of feelings with respect to physical activity. For each feeling, please mark the number that best describes you (1-7).**

	1	2	3	4	5	6	7	

	1 (1)	2 (2)	3 (3)	4 (4)	5 (5)	6 (6)	7 (7)	
I enjoy it	○	○	○	○	○	○	○	**I hate it**
I feel bored	○	○	○	○	○	○	○	**I feel interested**
I dislike it	○	○	○	○	○	○	○	**I like it**
I find it pleasurable	○	○	○	○	○	○	○	**I find it unpleasurable**
I am very absorbed in physical activity	○	○	○	○	○	○	○	**I am not at all absorbed in physical activity**
It's no fun at all	○	○	○	○	○	○	○	**It's a lot of fun**
I find it energizing	○	○	○	○	○	○	○	**I find it tiring**
It makes me depressed	○	○	○	○	○	○	○	**It makes me happy**
It's very pleasant	○	○	○	○	○	○	○	**It's very unpleasant**
I feel good physically while doing it	○	○	○	○	○	○	○	**I feel bad physically while doing it**
It's very invigorating	○	○	○	○	○	○	○	**It's not at all invigorating**
I am very frustrated by it	○	○	○	○	○	○	○	**I am not at all frustrated by it**
It's very gratifying	○	○	○	○	○	○	○	**It's not at all gratifying**
It's very exhilarating	○	○	○	○	○	○	○	**It's not at all exhilarating**
It’s not at all stimulating	○	○	○	○	○	○	○	**It’s very stimulating**

It gives me a strong sense of accomplishment	◯	◯	◯	◯	◯	◯	◯	**It does not give me any strong sense of accomplishment**
It's very refreshing	◯	◯	◯	◯	◯	◯	◯	**It's not at all refreshing**
I feel as though I would rather be doing something else	◯	◯	◯	◯	◯	◯	◯	**I feel as though there was nothing else I would rather be doing**

End of Block: Physical Activity Enjoyment Scale (PACES)

Start of Block: Self-Efficacy for Exercise Scale (SEE)

Q4 **Now I am going to give nine situations that might affect your participation in exercise. For each one, use this scale where 0 is Not Confident and 10 is Very**

Confident, to tell me how confident you are right now that you could exercise 3 times a week for 20 minutes each time, in each of these situations:

	0 (1)	**1** (2)	**2** (3)	**3** (4)	**4** (5)	**5** (6)	**6** (7)	**7** (8)	**8** (9)	**9** (10)	**10** (11)
(1) If the weather was bothering you (1)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(2) If you were bored by the program or activity (2)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(3) If you felt pain when exercising (3)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(4) If you had to exercise alone (4)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(5) If you did not enjoy it (5)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(6) If you were too busy with other activities (6)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(7) If you felt tired (7)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯
(8) If you felt stressed (8)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

(9) If you felt depressed (9)	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯

End of Block: Self-Efficacy for Exercise Scale (SEE)

Start of Block: Social Support for physical activity (Select the answer that best describes you)

Q8 **How often in the last 30 days has your family or friends done the following?**

	1 (1)	**2** (2)	**3** (7)	**4** (3)	**5** (8)
(1) Encouraged you to do physical activity (1)	◯	◯	◯	◯	◯
(2) Discussed how not doing physical activity is unhealthy (2)	◯	◯	◯	◯	◯
(3) Reminded you to do physical activity (3)	◯	◯	◯	◯	◯
(4) Shared ideas on how to get enough physical activity (4)	◯	◯	◯	◯	◯
(5) Done physical activity with you (5)	◯	◯	◯	◯	◯

End of Block: Social Support for physical activity (Select the answer that best describes you)

Start of Block: Physical Activity Questionnaire (P-PAQ)

Q13

Please use the table below to record your physical activity for the last seven days.

• You will be asked to label your physical activity as moderate, hard, or very hard activity.

- <u>Moderate activity</u> would be like a brisk walk. It should feel like you are trying to get out of the rain, running late for an appointment, or trying to catch a bus.

- <u>Hard activity</u> feels like a jog.

- <u>Very hard physical activity</u> feels like a run.

• Please indicate at what time of day (morning, afternoon, evening) the physical activity occurred. The first section below is for the <u>morning</u> of each day; the second section is for the <u>afternoon</u> of each day; and the third section is for the <u>evening</u> of each day.

• Please indicate within the boxes (if there was any activity at all) the <u>minutes per session</u> and you may also briefly include the type of activity performed (if any).

• If you are recording more than one physical activity session, please separate by time of day. For example, if you did a 30 minute moderate workout in the morning and a 10 minute very hard workout in the afternoon, you would record the 30 minutes in the morning and 10 minutes in the afternoon on the same day.

• In order to count the activity, <u>it has to be of at least 10 continuous minutes</u>.

• The first day you will record is yesterday. Then the day before yesterday and so on until you have recorded the last seven days of physical activity.

MORNING

	Yesterday (9)	**3 Days Ago** (10)	**4 Days Ago** (11)	**5 Days Ago** (12)	**6 Days Ago** (13)	**7 Days Ago** (14)
Moderate (1)						
Hard (2)						
Very Hard (3)						

Q14 **AFTERNOON**

	Yesterday (1)	**3 Days Ago** (2)	**4 Days Ago** (3)	**5 Days Ago** (4)	**6 Days Ago** (5)	**7 Days Ago** (6)
Moderate (1)						
Hard (2)						
Very Hard (3)						

Q15 **EVENING**

	Yesterday (1)	**3 Days Ago** (2)	**4 Days Ago** (3)	**5 Days Ago** (4)	**6 Days Ago** (5)	**7 Days Ago** (6)
Moderate (1)						
Hard (2)						
Very Hard (3)						

End of Block: Physical Activity Questionnaire (P-PAQ)

Start of Block: Behavioral Risk Factor Surveillance System survey (BRFSS)

Q16 **During the past month, how many times per week, *or* per month, did you do physical activities or exercises to strengthen all of your major muscle groups (i.e., shoulders, arms, back, chest, abdomen, legs, and hips)? (Do not count aerobic activities like walking, running, or bicycling). Count activities using your own body weight like sit-ups or push-ups and those using weight machines, free weights, or elastic bands. In your answer, please specify 'per week' or 'per month'.**

____

End of Block: Behavioral Risk Factor Surveillance System survey (BRFSS)

Start of Block: Body Measures (Please respond honestly. No data will be shared).

Q6 **Please list your current height (feet, inches).**

____

Q8 **Please list your current bodyweight (in pounds). Please use a scale, if possible.**

____

End of Block: Body Measures (Please respond honestly. No data will be shared).

Appendix G. Monthly Check-In Survey Example (Intervention Group Fidelity Procedure)

Monthly Check-In (Workout Group)

Start of Block: Default Question Block

Q1 Participant Name

____

Q2 Of the 4 videos uploaded to the Workout Group's YouTube channel so far, how many of them have you watched?

○ 0 (1)

○ 1 (2)

○ 2 (3)

○ 3 (4)

○ 4 (5)

Q3 Have you watched all 4 videos in their entirety?

○ Yes, all (1)

○ Some (2)

○ None (3)

Q4 Have you responded to *all* in-video response questions within the Comments Section of each of the 4 uploaded videos so far? (*Please* remember to do this for <u>all</u> videos)

- ○ Yes, all (1)
- ○ Some (2)
- ○ None (3)

Q5 Have you re-watched any of the videos to refer back to/implement previous tips/workouts?

- ○ Yes (1)
- ○ No (2)

Q6 Has the Workout Group YouTube channel helped you become more physically active?

- ○ Yes (1)
- ○ Somewhat (2)
- ○ No (3)

Q7 On average, how many times per week did you use the tips/workouts provided via the Workout Group's YouTube channel in the last month?

____

Q8 Do you enjoy using the tips provided via the Workout Group YouTube channel?

- ○ Yes (1)
- ○ Somewhat (2)
- ○ No (3)

Q9 How is the quality of the YouTube videos?

- ○ Good (1)
- ○ OK (2)
- ○ Bad (3)

Q10 What (if any) recommendations would you make for the Workout Group YouTube channel moving forward to better fit your needs?

____

____

____

____

____

Q11 Do you have any questions for me?

____

____

____

____

____

End of Block: Default Question Block

Appendix H. Monthly Check-In Survey Example (Health Education Group Fidelity Procedure)

Monthly Check-In (Health Education Group)

Start of Block: Default Question Block

Q1 Participant Name

____

Q2 Of the 4 videos uploaded to the Health Education Group's YouTube channel so far, how many of them have you watched?

- ◯ 0 (1)
- ◯ 1 (2)
- ◯ 2 (3)
- ◯ 3 (4)
- ◯ 4 (5)

Q3 Have you watched all 4 videos in their entirety?

- ◯ Yes, all (1)
- ◯ Some (2)
- ◯ None (3)

Q4 Have you responded to *all* in-video response questions within the Comments Section of each of the 4 uploaded videos so far? (*Please* remember to do this for <u>all</u> videos)

- ◯ Yes, all (1)
- ◯ Some (2)
- ◯ None (3)

Q5 Have you re-watched any of the videos to refer back to/implement previous health tips?

- ◯ Yes (1)
- ◯ No (2)

Q6 Has the Health Education Group YouTube channel helped you become more health-conscious?

- ◯ Yes (1)
- ◯ Somewhat (2)
- ◯ No (3)

Q7 On average, how many times per week did you use the health education tips provided via the Health Education Group's YouTube channel in the last month?

____

Q8 Do you enjoy using the health tips provided via the Health Education Group YouTube channel?

- Yes (1)
- Somewhat (2)
- No (3)

Q9 How is the quality of the YouTube videos?

- Good (1)
- OK (2)
- Bad (3)

Q10 What (if any) recommendations would you make for the Health Education Group YouTube channel moving forward to better fit your needs?

____

____

____

____

____

Q11 Do you have any questions for me?

____

____

____

____

____

Appendix I. Group Instructions for the Intervention Group (After Randomization)

YouTube Workout Group Instructions

You have been randomized into the Workout Intervention Group. Please see the following group instructions and adhere to them throughout the 12-week duration of this study. If you have any questions, please do not hesitate to contact me!

(1) Using your newly created YouTube account/channel, please: (1) "subscribe" to the study YouTube channel (the link to this channel will be sent to you via email) by clicking the red "subscribe" button on the channel's homepage; and (2) after clicking the "subscribe" icon, click the "bell" icon and select "all" to turn video upload notifications on. Additionally, I will email you every week notifying you that the week's videos have been uploaded to the study channel. Please do this by TODAY.

(2) ***Please do the workouts within each video on the day that the videos are uploaded. We encourage you to refer back to each video and perform them multiple times during the week to further increase the health and performance benefits!

(3) ***If you have a friend in the study who was randomized into the General Health Education Information Control Group, please do not discuss any details regarding the intervention group with them during the 12-week study period. This will contaminate the results of the study. The Control Group will have full access to the Intervention Group workout videos after the 12-week study is complete. Likewise, you will have full access to their general health education videos after completion of the 12 weeks.

(4) ***For each video uploaded, there will be interactive questions (within the video) that you need to respond to within the Comments Section, under each video. This is necessary for us to track intervention adherence (i.e., participants are actually watching the videos in their entirety). The videos will be concise and to the point!

(5) We encourage you to interact with other participants in the comments section of each video regarding their responses to the in-video interactive prompts/questions. This will help increase your social support for exercise (i.e., knowing that you're not in this alone) which is important, *especially* during the pandemic period. Please keep all interactions respectful!

(6) There will be 1 (sometimes 2) video uploads per week. Videos will contain physical activity/exercise information as well as demonstrate exercises and workouts that you can follow along to while at home or in the gym! For example, videos may include high-intensity interval training (HIIT) workouts with on-screen timers so you can set your device down and follow the workouts as they go! Further,

resistance-training exercises will be demonstrated and the basic anatomy and biomechanics will be explained for each exercise. <u>We encourage you to find a friend/significant other/roommate/etc. who you can do these workouts with</u>!

Thank you for your adherence to these instructions. I look forward to working with you over the next 12 weeks and helping you become more active!

Appendix J. Group Instructions for the Control Group (After Randomization)

YouTube General Health Education Information Group Instructions

You have been randomized into the YouTube General Health Education Group. Please see the following group instructions and adhere to them throughout the 12-week duration of this study. If you have any questions, please do not hesitate to contact me!

(1) Using your newly created YouTube account/channel, please: (1) "subscribe" to the study's YouTube channel (the link to this channel will be sent to you via email) by clicking the red "subscribe" button on the channel's homepage; and (2) after clicking the "subscribe" icon, click the "bell" icon and select "all" to turn on video upload notifications. Additionally, I will email you every week notifying you that the week's videos have been uploaded to the study channel. Please do this by TODAY.

(2) Please watch each video on the day that the videos are uploaded. Likewise, please complete #3 (below) on the day that the videos are uploaded.

(3) ***For each video uploaded, there will be interactive questions (within the video) that you need to respond to within the Comments Section, under each video. This is necessary for us to track intervention adherence (i.e., participants are actually watching the videos in their entirety). We will track this by cross-referencing your YouTube account/channel name within the comments section of each video. The videos will be concise and to the point!

(4) If you have a friend in the study who was randomized into the Workout Intervention Group, please do not discuss any details regarding the General Health Education group with them during the 12-week study period. This will contaminate the results of the study. The Workout Intervention Group will have full access to the Health Education Group videos after the 12-week study is complete. Likewise, you will have full access to their Intervention Workout videos after completion of the 12 weeks.

(5) There will be 1 (sometimes 2) video uploads per week. Videos will contain general health education and will cover a variety of public health-related topics like COVID-19, nutrition, mental health, etc. that will better inform you and help you maintain good health on your long college/adult journey!

(6) ***Please do not watch any other health or fitness-related YouTube videos during the 12-week intervention period. This, too, will contaminate the results of the study. Again, you will have full access to the other groups' videos after the 12-week intervention period. Thank you!

Thank you for your adherence to these instructions. I look forward to working with you over the next 12 weeks and helping you achieve optimal health!

Appendix K. Accelerometer Wear Instructions for Both Groups

Accelerometer Wear Instructions

1. **Please wear the accelerometer on your <u>non-dominant</u> wrist, <u>24 hours per day</u>, starting from your scheduled pick-up date through your scheduled drop-off date.**
    a. **This will allow us to track/collect sleep-related data as well (please see the Sleep Log on the next page)**

2. **Please do not swim with the accelerometer on. If you do swim, please take the accelerometer off and put it back on your nondominant wrist immediately after.**
    a. **Showering with the accelerometer on is OK. Please keep it on during this time as well.**

3. **Please maintain your normal daily activity as if the accelerometer were non-existent.**
    a. **Please note the screen will be black the entire time. This is OK as it is still working.**

4. **Please be as careful as possible with your accelerometer. These devices are very expensive per unit.**

5. **Please see the Sleep Log on the next page and please fill in your sleep time every night and wake time every morning during the entire 7-day wear period. <u>Please return this Sleep Log to me with the accelerometer during your scheduled drop-off time</u>.**

6. **If you have any questions or concerns, please do not hesitate to contact me via phone (650-580-6253) or email (<u>mcdo0785@umn.edu</u>)**

Thank you very much for your continued cooperation! The first part of your participation incentive $ will be given to you during your scheduled accelerometer drop-off!

Appendix L. Sleep Log Example for Accelerometer-Wear Compliance

7-Day Sleep Log

Participant name ___________________
Accelerometer pick-up date ________
Accelerometer Drop-off date _______

Please wear your accelerometer on your nondominant wrist for 7 consecutive days, 24 hours per day (please see the Accelerometer Wear Instructions sheet for more details). This will allow us to track/collect sleep-related data. *No individual participant data will be shared.

Please add your sleep time and wake every day during your 1-week wear time. We recommend you keep this sheet near your bed as a reminder to fill it our during these times.

*****Please complete this entire Wear Log and bring it with you to the lab when you drop your accelerometer off**

Date	Bedtime	Wake Time	Notes

APPENDIX M. Intervention Group Physical Activity Video Examples

Week/Video	Video Title	Topic/Content	SDT Psychological Components Targeted	How Inclusivity Was Addressed
1	Week 1 - Introduction	- Adverse health effects of sedentary behavior - Introduction to the World Health Organization's aerobic and muscle strengthening physical activity guidelines for adults. - B-roll showing moderate- and vigorous-intensity activities - Showing the seven major muscle groups - Discussed the videos to come in the coming 11 weeks	<u>Competence</u>: Taught the World Health Organization's aerobic and muscle strengthening physical activity guidelines and the adverse health effects of sedentary behavior <u>Autonomy</u>: Encouraged participants to choose and perform activities that fits best into their schedules and lifestyles <u>Relatedness</u>: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing moderate- and vigorous-intensity activities
2	Week 2 - Dynamic Warmup + Leisure Time	- Taught dynamic vs. static warmups - Taught benefits of dynamic	<u>Competence</u>: Taught dynamic vs. static warmups, benefits of	- A-roll was a multi-racial research assistant

	Physical Activity	warmups prior to all workouts - B-roll of principal investigator performing and demonstrating the full dynamic warmup - Taught leisure time physical activity - Encouraged setting a step/day goal	dynamic warmups prior to all workouts, and strategies to increase daily physical activity levels (e.g., take stairs over escalators, park further away at the grocery store) Autonomy: Encouraged participants to choose and perform leisure time activities that fits best into their schedules and lifestyles Relatedness: N/A	- B-roll of multi-racial adults performing various warmups and leisure time physical activities
3	Week 3 - Home HIIT Workout #1 (2:1)	- 10-minute, home-based, high intensity interval training workout at a 2:1 work:rest ratio that participants could follow along to on-screen - Taught high intensity interval training and time saving benefits - Taught how high intensity interval training can contribute to weekly moderate-to-vigorous physical activity	Competence: Taught the World Health Organization's aerobic and muscle strengthening physical activity guidelines and the adverse health effects of sedentary behavior Autonomy: Encouraged participants to pause the video during rest intervals if the workout was too	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses performing exercises

		- Taught 4 ways to increase intensity of these workouts	intense and to fast forward the video if the workout was too easy. Also, showed exercise variations participants could choose to perform based on their fitness level <u>Relatedness</u>: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable	
4	Week 4 - Muscle-Strengthening Workout #1	- Taught the muscle-strengthening physical activity guideline - Taught five strategies for increasing resistance-training workout intensity in the home setting without gym equipment - Went over the exercises for muscle-strengthening workout #1 and showed which of the seven major muscle	<u>Competence</u>: Taught the World Health Organization’s muscle-strengthening physical activity guidelines and five strategies for increasing resistance-training workout intensity in the home setting without gym equipment <u>Autonomy</u>: Showed exercise variations participants	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses performing exercises

		groups each exercise targeted and provided the number of sets and repetitions to complete as well as between-set rest periods	could choose to perform based on their fitness level <u>Relatedness</u>: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable and showed some partner-based exercises to perform	
5	Week 5 - Home HIIT Workout #2 (1:1)	- 14-minute, home-based, high intensity interval training workout at a 1:1 work:rest ratio that participants could follow along to on-screen - Reminded how high intensity interval training can contribute to weekly moderate-to-vigorous physical activity - Implemented 2 ways to increase intensity of the workouts (decrease rest intervals, increase workout duration)	<u>Competence</u>: Taught 2 ways to increase intensity of the workouts (decrease rest intervals, increase workout duration) and showed more advanced exercise options (e.g., using home products to add external resistance to appropriate exercises) <u>Autonomy</u>: Encouraged participants to pause the video during rest intervals if the	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses performing exercises

		- Showed more advanced exercise options (e.g., using home products to add external resistance to appropriate exercises) - Reminded to stay active throughout the remainder of the day (beyond just the workouts)	workout was too intense and to fast forward the video if the workout was too easy. Also, showed less intense and more intense exercise variations participants could choose to perform based on their fitness level <u>Relatedness</u>: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable	
6	Week 6 - Muscle-Strengthening Workout #2	- Reminded participants of the muscle-strengthening physical activity guideline - Recalled five strategies for increasing resistance-training workout intensity in the home setting without gym equipment - Went over the exercises for muscle-strengthening	<u>Competence</u>: Taught the World Health Organization's muscle-strengthening physical activity guidelines and five strategies for increasing resistance-training workout intensity in the home setting without gym equipment	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses

		workout #2 and showed which of the seven major muscle groups each exercise targeted and provided the number of sets and repetitions to complete as well as between-set rest periods - Reminded participants to perform the workout multiple times per week to adhere to the weekly guideline and provided a downloadable PDF file with the full workout in the description section of the video	Autonomy: Showed less intense and more intense exercise variations participants could choose to perform based on their fitness level and participants could choose appropriate household items to add to the exercises to increase external load Relatedness: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable and showed some partner-based exercises to perform	performing exercises
7	Week 7 - Home HIIT Workout #3 (2:1)	- 14-minute, home-based, high intensity interval training workout at a 1:1 work:rest ratio that participants could follow along to on-screen - Reminded how high intensity	Competence: Taught two ways to increase intensity of the workouts (decrease rest intervals, increase workout duration) and showed more advanced	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure

		interval training can contribute to weekly moderate-to-vigorous physical activity - Implemented 2 ways to increase intensity of the workouts (decrease rest intervals, increase workout duration) - Showed more advanced exercise options (e.g., using home products to add external resistance to appropriate exercises) - Reminded to stay active throughout the remainder of the day (beyond just the workouts)	exercise options (e.g., using home products to add external resistance to appropriate exercises) Autonomy: Encouraged participants to pause the video during rest intervals if the workout was too intense and to fast forward the video if the workout was too easy. Also, showed less intense and more intense exercise variations participants could choose to perform based on their fitness level Relatedness: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable	time physical activities - B-roll of individuals of various weight statuses performing exercises
8	Week 8 - Superset Training	- Reminded participants of the muscle-strengthening	Competence: Taught a resistance-training	- A-roll was a multi-racial research assistant

		physical activity guideline - Taught a resistance-training intensity technique known as "supersets" which was the focus of this video and workout - Recalled five strategies for increasing resistance-training workout intensity in the home setting without gym equipment - Went over the exercises for the muscle-strengthening workout and showed which of the seven major muscle groups each exercise targeted and provided the number of sets and repetitions to complete as well as between-set rest periods - Reminded participants to perform the superset workout multiple times per week to adhere to the weekly guideline and	intensity-boosting technique known as "supersets" as part of the five strategies for increasing intensity of home-based workouts without gym equipment <u>Autonomy</u>: Showed less intense and more intense exercise variations participants could choose to perform based on their fitness level and participants could choose appropriate household items to add to the exercises to increase external load <u>Relatedness</u>: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable and showed some partner-based	- B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses performing exercises

		provided a downloadable PDF file with the full superset workout in the description section of the video	exercises to perform	
9	Week 9 - Tabata HIIT	- 12-minute, home-based, high intensity interval training workout at a 2:1 work:rest ratio Tabata style (20 seconds work: 10 seconds rest, repeated for four minutes and 3 rounds) that participants could follow along to on-screen - Reminded how high intensity interval training can contribute to weekly moderate-to-vigorous physical activity - Implemented 2 ways to increase intensity of the workouts (decrease rest intervals, increase workout duration) - Showed more advanced exercise options (e.g., using home products to add external resistance to appropriate exercises)	Competence: Taught new ways to increase intensity of the workouts (decrease rest intervals, increase workout duration) and showed more advanced exercise options (e.g., using home products to add external resistance to appropriate exercises) Autonomy: Encouraged participants to pause the video during rest intervals if the workout was too intense and to fast forward the video if the workout was too easy. Also, showed less intense and more intense exercise variations participants could choose to perform based	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses performing exercises

		- Reminded to stay active throughout the remainder of the day (beyond just the workouts)	on their fitness level Relatedness: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable	
10	Week 10 - Eccentric Training	- Reminded participants of the muscle-strengthening physical activity guideline - Taught a resistance-training intensity technique known as "eccentric training" which was the focus of this video and workout - Recalled five strategies for increasing resistance-training workout intensity in the home setting without gym equipment - Went over the exercises for the muscle-strengthening workout and showed which of the seven	Competence: Taught a resistance-training intensity-boosting technique known as "eccentric training" as part of the five strategies for increasing intensity of home-based workouts without gym equipment Autonomy: Showed less intense and more intense exercise variations participants could choose to perform based on their fitness level and participants could choose appropriate	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various warmups and leisure time physical activities - B-roll of individuals of various weight statuses performing exercises

		major muscle groups each exercise targeted and provided the number of sets and repetitions to complete as well as between-set rest periods - Reminded participants to perform the eccentric training workout multiple times per week to adhere to the weekly guideline and provided a downloadable PDF file with the full superset workout in the description section of the video	household items to add to the exercises to increase external load Relatedness: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable and showed some partner-based exercises to perform	
11	Week 11 - Sleep + 300 Minutes!	- Taught the potential extra health benefits of going above and beyond the minimum weekly aerobic and muscle-strengthening guidelines - Taught the benefits of getting a good night's sleep every night and how daily physical activity participation can help improve sleep quality	Competence: Taught the potential extra health benefits of going above and beyond the minimum weekly aerobic and muscle-strengthening guidelines and taught the benefits of getting a good night's sleep every night and how daily physical activity participation can	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults performing various exercises and leisure time physical activities

			help improve sleep quality Autonomy: Encouraged implementing favorable sleep behaviors (e.g., minimizing screen time before bed) that they preferred and worked best for their lifestyles and encouraged finding new activities that could help them surpass the minimum activity guidelines that they preferred and worked best for their lifestyles Relatedness: Encouraged participants to find a friend, family member, or roommate who they trust to do partner-based workouts during the study and hold each other accountable and showed some partner-based exercises to perform	

12	Week 12 - Thank You + Next Steps	- Thanked participants for their adherence and completing the study - Discussed next steps (i.e., post-testing, incentive payments, etc.) - Provided a final muscle-strengthening workout via PDF in the description box of the video	N/A	- A-roll was a multi-racial research assistant - B-roll of multi-racial adults

APPENDIX N. Example Script for Intervention Video (Video #1/12)

- WELCOME TO THE Healthier U YouTube STUDY! More specifically, welcome to the workout intervention group! Let's get started!

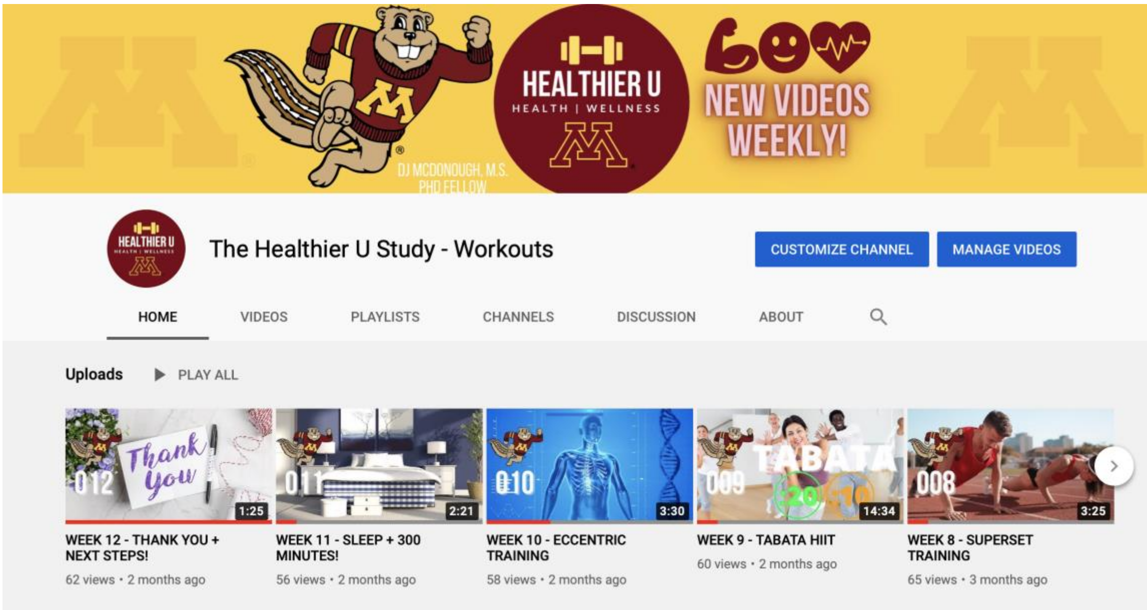
INTRO BUMPER____

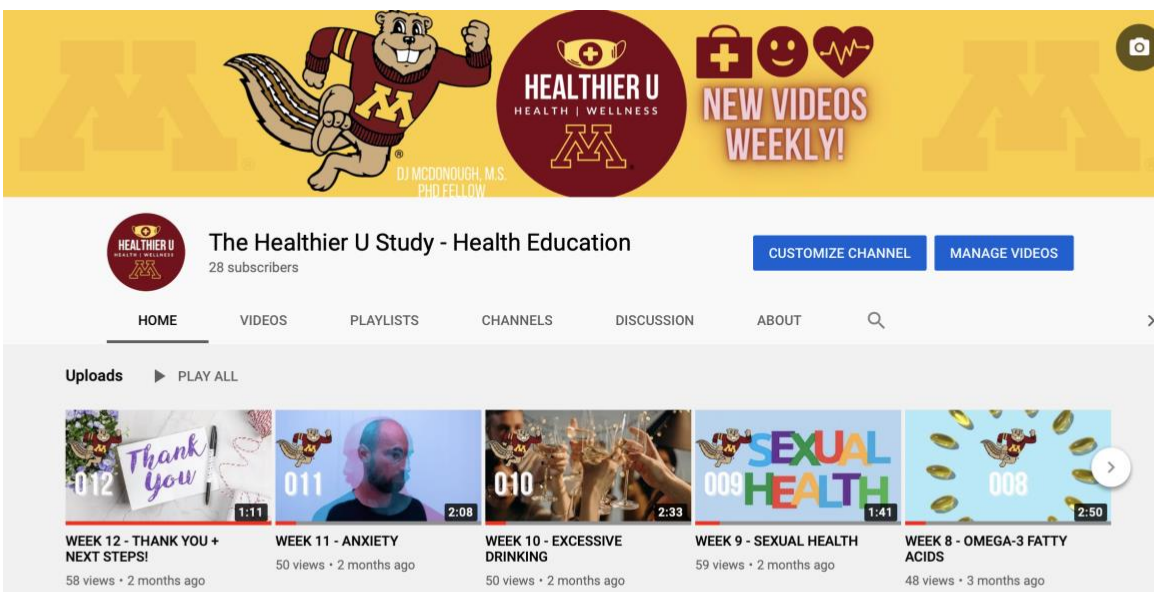
- Hello! Welcome again to the workout intervention group! Over the next 12 weeks we're going to provide you weekly YouTube videos with aerobic and muscle-strengthening information and workouts that you can do in the comfort of your own home, or in the gym!
- Looking at the baseline surveys, 98% of you reported that COVID-19 has made you less active. But don't worry, you're not alone and data indicates that the rest of the world is right there with you!
- However, sedentary behavior is a silent killer and physical inactivity-related deaths, believe it or not, outnumber COVID-related deaths by big margin.
- Therefore, with many of you reporting that you feel unsafe exercising in a gym, and with many gyms closing again, it is crucial to disseminate workouts that can be done <u>at home</u>, and YouTube is a GREAT way to do this given that we can use *video* to not only provide you with important information, but *show* you *how* to perform various exercises and workouts.
- Before we get to those videos in the coming weeks, the purpose of THIS video, is to get you acquainted with the Physical Activity Guidelines for adults so you can get a sense of how active you need to be on a daily basis to achieve optimal health and physical fitness!

- First, to achieve optimal health, public health recommendations state that adults need AT LEAST 150 minutes per week of moderate to vigorous intensity aerobic activity.
- Moderate-intensity exercise would be like a brisk walk. It should feel like you are trying to get out of the rain, running late for an appointment, or trying to catch a bus. Hard activity feels like a jog and very hard feels like a run.
- In addition to exercising at higher intensities, it is crucial that you also stay moving throughout the day given that sedentary behavior is strongly associated with obesity and other chronic diseases.
- Therefore, if you find yourself sitting down for too long studying or watching Netflix, be sure to get up every 30 minutes or so and go on a brisk walk, do some chores around the house, or anything else to get you moving! This will help you achieve and even exceed the 150-minute recommendation!
- Second, public health guidelines state that AT LEAST 2 days per week of muscle-strengthening activity (resistance-training) is needed to optimize your health and that all 7 major muscle groups should be targeted during these sessions. These include the shoulders, arms, back, chest, abdomen, legs, and hips.
- Despite these set guidelines, less than 20% of Americans achieve the minimum recommendations for aerobic and muscle-strengthening activity.
- SO, to reach these daily and weekly guidelines, we'll be doing high intensity interval training (HIIT) workouts that require no gym equipment and can be done in the comfort and safety of your own home! You'll be able to follow along on-screen and do the workouts with DJ!

- Further, over the next 12 weeks we'll show you how to properly resistance-train your major muscle groups at home with little or no equipment and we'll show you various techniques and training variables that can be manipulated to keep your workouts fresh and keep you as active and healthy as possible!
- And that's it for today! Here's the in-video response question for you to respond to and answer in the Comments section BELOW THE VIDEO. Please pause the video if you need to.
- Thank you so much! Stay safe and see you in next week's video!!!!

APPENDIX O. Video Examples for Each Group





APPENDIX P. PDF Muscle-Strengthening Workout Example


ECCENTRIC TRAINING WORKOUT
HEALTHIER U
HEALTH | WELLNESS
EXERCISE*
SETS/REPS**
TARGET MUSCLE(S)
Pushups
3 sets/ Failure
Chest/Triceps/ Shoulders
Split Squats
3 sets (each side)/ Failure
Legs/Hips
Lateral Raises
3 sets/ Failure
Shoulders
Lying Leg Raises
3 sets/ Failure
Abdomen
*PLEASE SEE VIDEOS FOR ALTERNATIVE EXERCISES
**REST 45 SECONDS BETWEEN EACH SET
REPEAT AT LEAST 2X PER WEEK!